Clear perspectives in Educational Progress in Germany

A professional exchange of thoughts with Prof. Dr. Olaf Köller, Director of the Institut zur Qualitätsentwicklung im Bildungswesen, at the Humboldt Universität Berlin

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Challenging and demanding

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SLO • national institute for curriculum development
SLO is the national institute for curriculum development in the Netherlands. SLO was founded thirty years ago by the Dutch government to give independent, professional advice on, and support for, curriculum innovation, development, and implementation. In performing its tasks, SLO takes into account the developments in society in general, both nationally and internationally, and in education in particular. SLO operates in virtually all education sectors, including primary education, secondary education, special education, vocational education and teacher education, and covers all subject areas. The institute’s central task is to advise the government on important education reforms and new curricula. SLO supports and coordinates curriculum development in collaboration with schools and universities, carries out curriculum evaluations, and provides information about teaching materials.
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challenging and demanding
1. Introduction

In the context of our constitutional task, the national Institute for Curriculum Development in the Netherlands (SLO) carries out a comparative research project regarding motives, functions, sources, design and implementation of common aims and contents in Europe in basic education. Basic education can be understood as primary education and the first phase of secondary education. Depending on specific national and system conditions, it concerns the age group between 3/4 and 14/15 years, approximately.

Curriculum and curriculum development are not only issues for schools and teachers; both have broad impact, importance and relevance for the sustained development of communities as well. More than ever, curriculum is, or should be, at the centre of daily life and the responsibility of society in general. The concept curriculum has changed over the years. Traditionally curriculum is connected to a more or less prescriptive book or syllabus, defined on a central level. Today, it is interpreted more and more to include the evocative character of education and process oriented challenges for schools to define their own curriculum policy within the context of a global national framework. The national framework is the point of departure for the research project on ‘core affairs’. As the name suggests, we are mainly looking for what determines the common core of content.

A debate is going on in just about every European and western oriented country, about the core of education, what it should comprise of, and the objectives it should aim for. This debate is not a specific educational debate; it is taking place in several layers of society, and concerns a variety of stakeholders. The debate focuses on the formative and qualifying values of education for individuals as well as for society. It relates to talent development, equal opportunities, preserving and transferring meaningful knowledge and valuable aspects of cultural heritage, social abilities and respect for and fulfilling of common values and societal norms. The debate also concerns the wish of stabilisation and reinforcement of the economic position through effective and useful investments in competence and knowledge development. In this debate, we sometimes see contradictions in the weighing of interests of distinguished stakeholders and the supposed functions of education. In this turbulent environment, governments and other authorities have to make their decisions, which should be relevant to and supporting of the sustainable quality of education.
Some elements of the common content of education are dictated by mutual agreements in the European context, e.g. the European framework for foreign language learning, or affected by results of international comparative research, including PISA, TIMSS, and IGLU. Other aspects can, or will be, nationally or regionally arranged.

In ‘Core Affairs’, research is done by literature and internet search, by case studies and by expert questioning. The research is focused on the influence and role of three issues: policy - research - practice, and three dimensions concerning curriculum and curriculum design and development:

- main and coherent curricular components:
  visions, aims, contents, arrangements for learning, teaching and assessment, and the environment in which learning and teaching takes place.
- relations or gaps between systemic layers:
  international or federal level (supra); national level (macro); institute or school level (meso); group or class level (micro); individual level (nano).
- competences of actors in processes of curriculum development:
  selecting, (re)designing, validation, implementing, valuing.

In this report, we will give an account of an interview and discussion with professor Köller, director of the German Institute for Educational Progress (Institut zur Qualitätsentwicklung im Bildungswesen IQB) at the Humboldt University in Berlin.

Professor Köller is a leading psychologist and has been head of the IQB since 2004. Previously, he occupied positions such as academic staff member at the Leibniz-Institut für die Pädagogik der Naturwissenschaften (IPN) in Kiel, academic staff member and project leader at the Max-Planck-Institut für Bildungsforschung in Berlin, and professor for Psychology (Pädagogische Psychologie) at the Friedrich-Alexander-Universität Erlangen-Nürnberg. The interview with prof. Köller was conducted by Joost Klep, SLO staff member and interim professor at the Justus Liebig University in Gießen, and Jos Letschert, staff executive with SLO and professor by special appointment of Curriculum Studies at the University of Twente. The essence of the interview with prof. Köller, also the essence of the task faced by German as well as Dutch educational policy makers, is how to find a workable balance between what the Germans aptly call ‘Fordern’ and ‘Fördern’, which we will translate by ‘Challenging’ and ‘Demanding’. Education challenges students to develop their talents. All talents are important. While challenging students, the students’ responsibility for their own learning is respected. Emphasising the students’ own responsibility does not, however, imply that no
demands can be made of their learning. On the contrary, education is not without obligations. It is not without obligations for the developing student and it is not without obligations for the sustainable development of society in which the student is growing up, of which the student is a part, and to which the student contributes, now and in the future. The challenging side of education is primarily demonstrated by the pedagogical attitude of teachers and by the didactics. The demanding side of education is demonstrated by the core objectives, the Bildungsstandards, the frames of reference for continuous teaching lines, and the examination requirements.

The IQB is well aware of the complementarity of ‘Fördern’ and ‘Fordern’ and endeavours to express this in its working method. This is an important task for the Dutch curriculum policy as well. From this point of view, we are not just trying to describe in detail the work and insights of the IQB and its director. We have also endeavoured to link the German information and insights to developments in the Dutch policy context.

The SLO-visit to IQB took place in April 2007 within the context of the SLO-research project ‘Core Affairs’.
challenging and demanding
2. German educational policy context

On the website of the German Ministry of Education the need for educational reform is highlighted. There is a need to reorient education policy. The German school system must enable more children and young people to earn higher education qualifications. This includes a higher performance level as well as more social skills. In schools, the strengths and individual abilities and background of each child must primarily be focussed on. As a policy proposal, the principle of challenging and demanding must be followed consistently. An educational reform, therefore, requires a national effort of all stakeholders and a broad debate in society across ideological barriers.

“We need a change in the orientation of our education policy. Our school system must lead to a higher performance level and must enable more children and young people to earn higher education qualifications. In schools, the strengths and individual abilities and background of each child must be focused upon.

The competition for future opportunities for Germany has essentially become an international competition for the quality of education systems. An educational reform, therefore, requires a national effort of all stakeholders and a broad debate in society across ideological barriers”.

International comparisons
The unsatisfactory performance of German students in international achievement studies, such as TIMSS and PISA, has resulted in a variety of measures to improve educational processes. One of these measures was the development and publication of national educational standards for multiple subjects by the Standing Conference of the Ministers of Education and Cultural Affairs of the federal states in Germany (German: Kultusministerkonferenz, KMK) in 2003. These standards are an important tool allowing for the documentation and evaluation of educational processes. Furthermore, the standards are the basis upon which instructional materials can be developed, which help raise the general achievement profile of students in the German educational system.

On December 4th, 2003, the ‘Kultusministerkonferenz’ decided upon national standards (‘Bildungsstandards’) for mathematics, German language and the first foreign language for the so-called ‘Mittleren Bildungsabschluss’. On October 15th, 2004, it was decided to establish standards for the ‘Hauptschulabschluss’ in
mathematics, German language and the first foreign language, and for primary education for German language and mathematics. On December 16th, 2004, it was decided to establish standards for the ‘Mittleren Abschluss’ in biology, physics and chemistry as well. These standards have been formalised at the beginning of the school year 2004/5 and 2005/6. As a result, the sixteen Bundesländer supported the establishment of an institute for the further development and implementation of so-called ‘Bildungsstandards’. This institute, connected to the Humboldt University in Berlin, is the Institute for Educational Progress, or in German ‘Institut zur Qualitätsentwicklung im Bildungswesen’, IQB.
3. IQB - the German equivalent of SLO

IQB, the German Institut zur Qualitätsentwicklung im Bildungswesen, was established in 2004, as a research-oriented institute within the Humboldt-University in Berlin. In the institute, several interdisciplinary teams work under the direction of Prof. Dr. Olaf Köller, an experienced educational researcher and psychologist with extensive training in empirical research methods. Each team comprises scientists with training in pedagogy, psychology, and measurement, who work alongside teachers with practical experience in instruction, administration, and research.

The Institute for Educational Progress (German: Institut zur Qualitätsentwicklung im Bildungswesen, IQB) is an interdisciplinary institute similar to the national expertise centre for curriculum development SLO. It operates on the interface of research and practice. The IQB supports all sixteen federal states in Germany in their endeavours to ensure that the quality of educational processes are monitored and continually improved upon. The core mandate of the IQB is to establish national performance scales based on the national educational standards and to develop the standards further. Moreover, the IQB supports schools in their implementation of the standards through the creation of large pools of standards-based tasks. To achieve these objectives, the IQB closely collaborates with the individual states as well as with nationally and internationally renowned experts and institutions. The results of the work at the IQB are made accessible to the states, schools, and the general public.

The core objective of the IQB is to establish national performance scales based on the national educational standards, to develop the standards further, and to advance their implementation in schools. To achieve these objectives, large collections of tasks for classroom practice and standardised testing are developed through the institute and empirical research projects that build on these tasks are conducted. The research projects can be divided into the five research areas with the work in each area being explicitly referenced to the standards.
The following research areas exist for the IQB:
1. The specification and empirical evaluation of theoretical models of student competency as specified in the national educational standards.
2. Pedagogical diagnosis of student competencies and the development of intelligent feedback-systems.
3. Empirical research on teaching and learning based on the national educational standards to identify optimal conditions for these processes.
4. Evaluation of innovative school projects in various states.
5. Technology-based testing.

The work at the IQB is, thus, an important building block in the comprehensive process of optimising the German educational system so that all students can benefit from an improved culture of teaching and learning embedded in the national educational standards.
4. Bildungsstandards

4.1 Assignment for national educational standards

The mandate of IQB is to develop standardised national scales based on the national educational standards, to illustrate the standards through tasks for implementation in classrooms, and to develop the standards further. As opposed to a number of other countries, outcomes of school education processes in Germany had not been systematically and continually examined before the nineteen nineties. Instead, the main focus had been on the development and reform of detailed curricula and lesson plans that resulted in numerous guidelines for effective instruction (input orientation). Recently, however, a public interest in whether classroom teaching was actually successful in terms of learner achievements emerged (output orientation). This interest is clearly perceptible in other Western oriented countries.

In Germany these developments were motivated, in part, by the outcomes of international comparative research, in which Germany scored on a relatively low level compared to other countries involved in the research. Especially the unexpected weak achievement levels of German secondary students in the Third International Math and Science Study (TIMSS) resulted in a broad and heated public debate that still continues. The outcome of TIMSS led to a process of rethinking educational goals and measures to monitor the attainment of these goals, which resulted in a paradigm shift in educational research. Subsequently, a number of different large-scale assessment studies were initiated on a regional, national and international level.

In October 1997, the Kultusministerkonferenz KMK (Standing Conference of the Ministers of Education and Cultural Affairs of the Federal States of Germany) agreed on the German participation in international large-scale studies on student achievement in a resolution called the ‘Konstanzer Beschluss’. The aim of the resolution was to obtain reliable results on learners’ strengths and weaknesses in core competency areas. This led to the participation of Germany in the international PISA (Programme for International Student assessment) and PIRLS (Progress in International Reading Literacy Study) studies. The results of these studies have corroborated that a mere input-oriented approach for school effectiveness does not lead to desired results. In addition, it is necessary to determine which competencies can be expected of students at any particular point.
in time during their educational career and to monitor whether the learners have actually attained these desired competencies.

Based, in part, on an expertise by Prof. Dr. Eckhard Klieme of the DIPF (Deutsches Institut für Internationale Pädagogische Forschung/German Institute for International Educational Research) in 2003, the KMK started to formulate national educational standards. These standards were developed by committees of experts in pedagogy and didactics, educational researchers, and school practitioners from all federal states.

National educational standards are based on a consensus about desired student achievement and all 16 federal states have agreed to comply with these. Rather than simply listing the expected achievement results, these educational standards describe the core competencies learners should have acquired by a certain point in time in their educational careers within unifying conceptual frameworks. These core competencies represent a longterm perspective on learning. They do not replace curricula; instead, they supplement them. While the standards prescribe the targets learners are supposed to achieve, curricula describe different pathways towards reaching these targets.

The national educational standards thus fulfil two key functions. Firstly, they define binding goals for the student population, while allowing individual goals the freedom to determine how to best to attain these goals. Secondly, they describe the competency targets with sufficient precision in order to be assessed through tasks in instructional contexts and items on large-scale tests. This should, in time, positively affect the quality of the curricula and improve of teacher training.

The national educational standards are illustrated with detailed commented example tasks for each respective domain. The demands of these tasks vary, which is expressed by their assignment to a certain level of cognitive complexity. The measurability of competencies through standardised tests is a particularly distinguishing feature of the national educational standards. Now, it can be evaluated whether, and to which extent, the learners are prepared for their further lives and which adjustments in the education system are necessary to make it more effective. Consequently, the national education standards allow states to continually monitor and enhance the processes and the results of schooling.
4.2 Similar problem definition in the Netherlands

These developments in Germany are reflected in the Dutch curriculum policy. The Netherlands boasts a high-quality educational system and scores on a relatively high level in international comparative achievement studies (PISA, TIMSS, PIRLS) for certain learning areas (language, maths, science). At the same time, concern is expressed about:

- the maintenance and enhancement of the quality of Dutch education in the long term;
- the poor matching of certain objectives and forms of educational content pursued to the different educational institutes, from basic education to the entrance levels of higher education;
- the loss of previously gained knowledge, skills and competencies of pupils and students during their educational career.

From a social and political viewpoint, the demand for educational quality and yield is increasingly voiced, simultaneously expressing the need for a frame of reference by which to monitor and measure this quality. Since 1993, the Netherlands operate so-called core objectives for basic education and the first phase of secondary education. Today, the third generation of these objectives, determined upon in 2006, is in force. In a policy environment featuring advanced autonomy and deregulation, these core objectives have been globalised. At the moment, 58 core objectives apply to each sector of basic and secondary education. One of the problems of the Dutch educational system is that the core objectives are too global for the maintenance and enhancement of the quality of Dutch education to be based upon. Another problem, which the Dutch share with the Germans on a similar level, is the poor matching of the different educational types within the system. There is a need for improved matching of programmes, entrance requirements, and completion requirements. Recently, an Expert Group (compare Klieme c.s.) was set up in the Netherlands to prepare a report on the continuous teaching lines for language and maths, from basic education up to the entrance level of higher education, in which clear references are to be formulated and determined upon for preset pivots and transitions within the system. A third problem in the Dutch educational system concerns the pupils’ and students’ loss of previously acquired knowledge, skills and competencies throughout their educational career. The above expert group will also pay attention to this problem, in the context of the problem of poorly matching educational types, mentioned earlier.
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5. Lessons learned from a comparison between a number of German and Dutch steering means concerning contents and level of education and educational yield

5.1 Bildungsstandards: the underlying problem

Next to the many shared features, the Bundesländer of Germany also show many differences in the way education is organised and executed. One example is the duration of the so-called Primarunterricht. In many Bundesländer, this takes 4 years. In other Länder, including Berlin and Brandenburg, six years are reserved for this phase. It may occur, for example, that a German pupil, who went from Primarunterricht onto the Gymnasium, had to return to Primarunterricht after moving to another Bundesland. In addition to this system issue, there are the quality differences in the Länder concerning content. In what ways may the Bundesregierung be able to contribute to a reduction in the relatively large differences in school systems in the various Bundesländer, and to the improvement of scores in the international comparative tests? One of the answers to this question is the idea of the Bildungsstandards of the Konferenz von Kultusminister.

The desire to achieve more coherence on Bundesebene has various reasons, including:

• Improved comparability and acceptance of Schulabschlüsse among the Bundesländer will improve the smooth functioning of the study and job markets at Bundesebene.

• It will become easier for parents and children to move from one Bundesland to another, without having to fulfil all sorts of additional requirements and lose precious educational time. Solving this last issue will also benefit society as a whole: not only does an extra teaching year involve extra costs, it will also entail a year’s delay before the student will be able to enter the job market.

• On a European level, it is important to stimulate study and job mobility - for example to reinforce the social, cultural and political stability in Europe. To achieve this, mobility improvement is an important demographic and economic tool.
The Bildungsstandards contribute to the thinking about these three themes in the German educational system in different ways. Two contributions deserve special note:

- The Bildungsstandards are a tool to make the Schulabschlüsse levels comparable and, in time, consistent. These Schulabschlüsse differ per Bundesland because the setup of the Schulsystem is organised independently by each individual Bundesland. In addition, there may be different school types within a certain Bundesland, with corresponding target groups.
- The Bildungsstandards provide schools with a frame of reference within which to think about educational content, regardless of setup, structure and Richtlinien’s terms regarding content of the different Bundesländer and the methods (school books) based on these.

The problem may be formulated as follows: How to add coherence to the educational system at federal level (supra), which, at macro level (by Bundesland) features different structures concerning form, content and level, and which, at meso level (by school), features different structures concerning form, content and level as well?

The IQB proposes to work with a common, global profile of content, starting with Language tuition (i.c. Deutsch) and Maths (i.c. Mathematik) and to illustrate and further specify such a profile by means of example exercises, which may be regarded as paradigms of educational content and (implicitly) as paradigms of the educational programme.

This choice seems appropriate for an educational system which is not controlled at the above-mentioned supra level, but at meso level. The global profile of subjects with their respective paradigms will only affect the autonomy at meso level in a very limited way. These standards are not meant to steer the curricula in an imperative way, but rather to characterise the content and give indications of the levels. Regarding this, the Bundesländer and the schools will be able to position their own thinking and further develop their terminology by means of the common terminology at supra level (all Bundesländer combined).

If this results in sufficient political willingness, this function may be further developed into a more detailed national curriculum and agreements about the professionalisation of teachers.
This choice is vulnerable for different reasons. Political support is required, therefore. A few vulnerable aspects are:

- From time immemorial, the Länder have been autonomous concerning educational policy. Although the interests at mega and supra level tend towards more unity, there are forces at meso level within the Bundesländer that are more than a little reluctant to give up their autonomy and work. These include:
  - the Landesinstituten, which are/were relatively influential at Bundesland level;
  - the Cultusministerien with their fixed opinions about the organisation of education, and
  - the university teacher training institutes, with their influential viewpoints regarding content.

- Teachers are used to think in terms of Richtlinien, assignments and school books and are now invited to think about their daily teaching efforts in relation to the Standards. More intensive guidance is needed for this. Governments now seem to want to solve this problem by stimulating the assessment of education, but fail to stimulate an active policy to promote further professionalisation.

- Choices are only legitimised and validated within the limited circle of - in particular - subject specialists. And it does not seem to be all that important, as yet. The spear point of the Bundesregierung’s policy seems to be the imminent assessment of schools and education, in order to reduce the relatively large differences between the various Bundesländer and to improve the scores in the international comparative tests. Although it is evident that a mere assessment procedure will not solve the problem, it does seem an ideal means to further mature the minds for a more radical intervention in the educational system at administrative level.

5.2 Bildungsstandards Mathematik: form and structure

Germany has a long tradition of thinking in terms of two educational functions: Bildung (education) and Ausbildung (development). It is tricky to formulate a comparable distinction in the Dutch tradition. The three-field function of education, transfer of culture, and personal development is quite another matter. The distinction between Bildung and Ausbildung traverses these three aspects. The Dutch term for development - vorming - is usually explained in terms of personal development. Possibly, the distinction between competency and repertoire (basic professional skills), as formulated by SBL and by SLO, come close. In the German thinking, the term “mathematische Kompetenzen” is used, which,
in the Netherlands, are often indicated as “meta skills”, “learning skills”, or “subject-methodical education”. In the domain of maths didactics, the term “mathematical activity” is sometimes used; a term referring to the whole of problem solution and its formulation in mathematical terms.

In the international field of maths didacticians, the thinking about these mathematische Kompetenzen and mathematical activity are generally accepted. Maths is seen as activity and theory (content) in coherence, whereby activity at personal level is a part of and constitutes maths (content) as it is acquired by someone.

This point of view makes that the content of maths education can no longer be expressed in terms of mere mathematical content. Similarly, pupils’ learning paths can no longer be expressed in terms of mere elements of subject matter. Levels of understanding (compare Hiele 1986 a.o.), the denotation of learned concepts (e.g. the curriculum as it is learned by the pupil), the extent of formalisation (mathematisation) and the application (and relation) of the gained insights form a necessary ingredient of the thinking of mathematicians and mathematical philosophers concerning the content of their subject. In addition, this thinking from education-psychological and subject-didactical points of view has gained significance, especially where adaptive (adaptierendes) education is concerned. For Bildungsstandards, therefore, it is important to formulate the Standards in such a way that the educational content can be understood at different levels.

In the Dutch TAL projects, it was endeavoured to describe teaching lines by describing mathematical content and activity with as much coherence as possible. The great advantage of this approach is the clear picture that is obtained of the desired teaching method. A disadvantage of this descriptive method is that it is often too detailed from an administrative point of view. Also, it is rather too obligatory. And this last argument would be unacceptable at Bundesebene. For the Dutch, it would be interesting to find out which solutions the German developers have come up with.
5.2.1 The structure of the German Bildungsstandards for Mathematics (basic education)

As mentioned before, there is a two-dimensional structure in:

1. General mathematical competencies
   - problem solving:
     - application of mathematical knowledge, skills and abilities while carrying out calculations;
     - developing and using solution strategies (e.g. systematical trial-and-error);
     - seeing, using and applying interrelations to similar situations.
   - communication:
     - describing own methods of approach, understanding solutions come up with by others, and thinking about these in collaboration;
     - using mathematical concepts and notations in an appropriate manner;
     - working on exercises together, making agreements, and sticking to these.
   - argumentation (motivation):
     - critically questioning mathematical statements and verifying these;
     - discovering mathematical interrelations and develop educated guesses;
     - coming up with motivations and critical verifications;
     - modellation;
     - extracting relevant information from descriptions of situations and other representations of reality;
     - formulating problems in a situation using mathematical language, solving these within a mathematical context, and interpret these solutions into the original situation;
     - devising contextual exercises for terms, equations and graphical representations;
     - describing in mathematical language;
     - developing, choosing and using appropriate means of describing mathematical problems;
     - translating one type of description into another;
     - comparing descriptive methods with each other and valuating these.
2. Mathematical competencies concerning content
• numbers and operations:
  - number understanding and number relations;
  - understanding and mastering mathematical operations (calculations);
  - doing arithmetic in contexts.
• space and shape:
  - orientation in a space;
  - knowing, naming and representing geometrical figures;
  - knowing, naming and representing simple geometrical images;
  - comparing and measuring surface areas and volumes.
• patterns and structures:
  - knowing, describing and representing patterns;
  - knowing, describing and representing functional relationships;
  - quantities and measurements;
  - understanding - to some extent - quantities;
  - being able to deal with quantities in practical contexts (world orientation).
• data, frequency and probability:
  - gathering and representing data;
  - comparing the probability of events in experiments of chance.

Each of these points have been specified in brief. For example: “understanding and mastering mathematical operations (calculations)” is specified by:
• understanding the four basic calculations and their interrelation;
• knowing by heart the basic exercises of mental arithmetic (addition tables, multiplication tables, division of numbers), being able to apply their inverse functions well, and being able to apply this basic knowledge to analogous exercises using larger numbers;
• understanding mental arithmetic strategies (property calculus) and applying these in an appropriate manner;
• comparing and valuating the different arithmetic strategies; finding, explaining and correcting miscalculations;
• knowing, explaining and using rules of arithmetic;
• understanding the principle of making calculations by addition, subtraction and multiplication, being able to perform these quickly, and apply these to the appropriate exercises;
• checking the solutions by making estimations and using inverse functions.
The coherence between these Standards is described in the first section: “The task of the Grundschule involves the stimulation of elementary development (of the children). It forms the basis for their future learning efforts and their ability to learn about culture independently. To stimulate mathematical competencies is an essential part of this educational task.” The text continues with a description of the preparatory value of maths education for daily life and future schooling. The German text points out that this development becomes more sustainable as central concepts (Leitideen) are more strongly developed. This is also the reason to speak in terms of general competencies and competencies regarding content, which, together, characterise the subject of maths. “These are inseparably interconnected (auf einander bezogen)”. Other descriptions include the importance of insight, problem solving, communication, and a positive outlook on the subject. Important focal points in the envisaged teaching method are: application (“Anwendungsorientierung”) and insight into the structure (“Strukturorientierung”). And a final remark is: “The standards concentrate on central objectives for maths education regarding content.” Aspects of stimulation of social and personal competencies are not explicitly mentioned here (regarding the mathematical Standards); however, they form indispensable parts of the fundamental development in the Grundschule.

5.2.2 The structure of the Dutch core objectives (basic education)

This method of description is similar to the method of description of the Dutch core objectives, in which the different aspects of mathematics are also described in separate group objectives, but where these objectives are inseparably and simultaneously discussed in concrete educational content:

**Mathematical insight and operation**

23 The pupils learn to use mathematical language.
24 The pupils learn to solve practical and formal arithmetical and mathematical problems and clearly represent argumentation.
25 The pupils learn to motivate approaches for solving arithmetical and mathematical problems and learn to assess solutions.
**Numbers and calculations**

26 The pupils learn to understand the general structure and interrelationship of quantities, whole numbers, decimal numbers, percentages, and proportions, and to use these to do arithmetic in practical situations.

27 The pupils learn to quickly carry out the basic calculations in their heads using whole numbers, at least to 100, whereby adding and subtracting up to 20 and the multiplication tables are known by heart.

28 The pupils learn to count and calculate by estimation.

29 The pupils learn clever ways to add, subtract, multiply and divide.

30 The pupils learn to add, subtract, multiply and divide on paper, according to more or less contracted standard procedures.

31 The pupils learn to use the calculator with insight.

**Measuring and geometry**

32 The pupils learn to solve simple geometrical problems.

33 The pupils learn to measure and calculate using units and measurements, such as time, money, length, circumference, surface area, volume, weight, speed, and temperature.

The coherence between these parts are described in the profile of the subject: “In the course of primary education, the children will gradually acquire - in the context of situations that are meaningful to them - familiarity with numbers, measurements, forms, structures, and the relationships and calculations that apply to these. They will learn to use ‘mathematical language’ and gain ‘mathematical literacy’ and skills in calculus. This mathematical language concerns arithmetical, mathematical and geometrical terms, formal and informal notations, schematic representations, tables and graphs, and exercises for the calculator. ‘Mathematical literacy’ and skills in calculus particularly applies to coherent insight in numbers, insight in measurements and three-dimensional insight, a repertoire of ready knowledge, important reference numbers and measurements, characteristic examples and applications, and practice in arithmetic, measurements and geometry. Geometry concerns three-dimensional orientation, the description of phenomena in reality, and the ability to reason on the basis of images in two and three dimensions. The subjects according to which children develop their ‘mathematical literacy’ have different origins: everyday life, other development areas, and mathematics itself. When selecting and offering the subjects, the children’s levels of knowledge and ability are kept in mind, as well as their other areas of development, their interests, and topicalities, so that children will feel challenged to carry out mathematical activity and be able to do maths at their own
level, with satisfaction and pleasure, both independently and as a part of a group. In short, that they are able to ask mathematical questions and formulate and solve mathematical problems.

During the arithmetic or maths lesson, the children learn to solve a problem in a mathematical way and explain to others the solution in mathematical language. They learn to give and receive mathematical criticism with respect for another person’s point of view. Explanations, formulations and notations, as well as the giving and receiving of criticism, are all part of a specifically mathematical method that will teach children to organise and motivate ways of thinking and to avoid mistakes, independently as well as together with others.”

5.2.3 Similarities and differences between the German Bildungsstandards and the Dutch core objectives

The Standards are intended to bring more unity to the different curricula in the Schulabschlüsse. The Dutch core objectives are intended as a tool to maintain unity in Dutch education in general terms, while the autonomy of schools them-selves is increasing.

In Germany, the concept of autonomy for schools is very limited. Schools are given more autonomy concerning funds, appointment policy (which, at the moment, is a state affair) and, in a limited way, when certain subject matter is offered. This is true for all subjects. Concerning the choice of educational content, the schools do not have any freedom.

Concerning content, the Standards and the Core Objectives have a lot in common. At certain points, the German objectives place more emphasis on mathematics itself.

The most important difference is in the further detailing. The Standards are detailed in example exercises, while the Core Objectives are detailed in learning lines, assessment targets, as well as in tests. Both countries are dealing with the problem that the government cannot or will not give direct steering to the intermediate layer in the educational system: in Germany because the Länder are autonomous; in the Netherlands because of the traditional freedom of organisation of education and the schools’ increasing wish for more autonomy. Another important difference is that, in Germany, the Länder lay down their educational content in compulsory Richtliniën and Rahmenlehrpläne, while in the Netherlands, assessment targets and learning lines are only (relatively) new phenomena, which do not, however, play an obligatory part.
5.3 Matching the German and Dutch educational systems

The Standards and Core Objectives are management tools for the educational system, on federal and national level. Such tools are particularly useful in order to match different educational systems: between European countries, between Bundesländer, and between school types and individual schools. The central governments are responsible for the proper functioning of the educational system. At macro level, the differences between pupils are felt only in a very limited way. In Germany, these differences are particularly seen in terms of differences between schools and Schulabschlüsse. Problems occur at the point where the different consecutive parts in the system intersect. Both the Dutch and the German authorities are searching for means to allow children to make the transition as smoothly as possible. It is a tricky problem, because each connection and transition point may involve matching problems as a result of a poor level of the education offered or insufficient progress on the part of the pupil. Similar matching problems may occur when a child is moved up one school year or when he or she changes schools.

The traditional German approach is to provide clear frames of education, to which schools are obliged to stick very closely. This will solve the difference in educational levels. However, it does not solve the problem of differences in children’s performance. In this approach, the problem is most acutely felt at the learning child’s level within the educational system - the child who is facing the problem of missing the connection. In the Dutch educational system, the problem is somewhat different. Because there are no compulsory Richtlinien - although there are more or less compulsory methods - schools are given ample opportunity to differentiate. Hence, problems do not manifest themselves until children change from one school to another.

Both countries have a system for secondary education, which - apart from technical differences - offers students the possibility to make a school career from simple secondary education to education offering access to education at higher vocational or academic levels.

In Germany, the educational system has level indications on different points when a school type is concluded. Such a concluding level determines the type of follow-up education a student has access to. On a number of points within the educational system, a student may make an extra year in the supplying school in order to reach the required level of the receiving school. In the Netherlands, this problem is often solved with a bridging period in the receiving school. In Germany, the student will only receive a Schulabschluss at the level he has actually reached. Should he want more, he may, in some circumstances, remain in the supplying school for one more year.
In Germany, as well as in the Netherlands, we observe a layered educational system with layered responsibilities (macro, meso, micro) in which each layer has certain connection problems as a result of differences in children’s performances and differences in the educational programme. The differences in the programme may be solved by laying down rules. As the programme is laid down in more detail concerning time and content, it becomes more difficult to provide adaptive education - increasing the emphasis on the selective function of education. This pain may be reduced by introducing a prolonged school period in the supplying school/class or a bridging period in the receiving school/class. Both Germany and the Netherlands have a secondary educational system in which students can make a school career.

5.4 Transitions

First of all, a few terms to indicate the types of transitions concerned:
• At macro level (Bundesebene), these concern the transitions of students from one Bundesland to another and from one school to another: horizontal, as children move to another school within the country as a result of a family move, etc., or vertical, when they move up to any type of follow-up education.
• At meso level (school type), as children move to another school horizontally, or change school types within an institute, and as children move horizontally within a school to another class/group, or vertically, when moving up to the next class/group.
• At micro level, as children move horizontally to another group within the same level, or vertically, when for example they move up to a next chapter, and as children move vertically because they have to make a leap in insight or acquire a new skill, or horizontally to develop an analogue insight or skill.

At each level, the transition involves a supplying situation and a receiving one. Between the two, there should be a contract about what is important at that particular transition. A contract describing what the child should know and be able to do. If these contracts are considered too locally, the perspective on a good school career may be lost. Supply problems may occur: the receiving location only “looks” at the things the pupil needs from the receiver’s point of view, while “forgetting” certain subject matter this pupil will need to access a follow-up level. Thinking locally, therefore, may result in gaps in educational programmes, which may stand in the way of a good educational career. Another issue is the fading away of knowledge and skills, such as mathematical skills, for example as a result of its lack
of priority for the receiving school. This lack of maintenance, therefore, may cause gaps in learning results.

Therefore, the solution of connecting problems requires a good system of local contracts among supplying and receiving parties, and agreements to prevent gaps in educational programmes or learning results.

5.5 A content matrix

The German Bildungsstandards offer a matrix for the thinking about educational content and educational yield. In order to enable a discussion about yield, the illustrative exercises have been given an indication of the pupils’ performances when making these exercises. Three Anforderungsbereiche (levels) are distinguished:
1. reproduction;
2. ability to make associations, and
3. generalisations and reflections.

This trichotomy is only provisional, as yet.

It may not even be necessary, considering the fact that the “general mathematical competencies” provide a more refined frame of reference to describe the levels of knowledge and abilities. In Germany, the advantage of these three fields is that - especially in secondary education - people are familiar with this trichotomy.

In general, the multidimensional structure of the Standards and the Core Objectives can be fully utilised by not measuring each individual one, but determine in connection with each other the way in which they are mastered by the pupil. For example, a pupil may have insight in number structures and elementary calculations (Core Objective 26) and be able (or not be able) to use the appropriate mathematical language for these (Core Objective 23), use these to solve practical and formal arithmetical and mathematical problems and motivate this in a clear fashion (Core Objective 24), and be able, or not be able, to motivate approaches for solving arithmetical and mathematical problems and verify solutions (Core Objective 25).

This structure is already present in the Standards and Core Objectives. The German solution illustrates the contents of mathematical education by means of exercises, describing:
• at which level the general mathematical competencies occur, and
• at which level the contents occur in combination.
This way, a content matrix is established, enabling the discussion about levels. An explicit condition would be, however, that the Standards and the Core Objectives are understood and treated in coherence. There should not be a separate level scale of number understanding, for example. The specific details of the other core objectives should be used as well. Incidentally, this coherence is explicitly indicated in the Standards as well as the Core Objectives, as judging from the introduction to the Standards and the Profile in the Core Objectives, quoted above. Another matter is that, in the field, a rather superficial interpretation is used, so that the Core Objectives or a Competency can be viewed apart. Possibly, this misunderstanding has to do with the opinion that mathematics is merely a set of skills, going from simple to complex. In this view, the concept of general mathematical competencies and the thinking in terms of Core Objectives 23-25 do not play a part at all. Yet these general mathematical competencies and the Core Objectives 23-25 play a very important part in mathematics in present and future society and knowledge economy!

5.6 What is missing

The Dutch core objectives and the German Standards remain silent upon the question of why something is important. The advantage of this is that political feasibility is improved and Länder or institutions can decide for themselves why something is considered important.

In educational literature, as well as in the introduction to the Standards, it is stated that education is given for the purpose of:

1. equipping for: participation in society; follow-up education; job performance;
2. personal development;
3. transfer of culture and knowledge.

When organising a matrix, it is important to know whether you are only or especially thinking in terms of equipping for follow-up education or the job market, or whether you are involving other objectives as well. In Dutch basic education, a lot of attention is given to arithmetic, with the emphasis on clever ways to do arithmetic, for example in view of functioning in society and a future job. On the higher levels of Dutch secondary education - havo and vwo - this is not really a theme. Many students are losing their arithmetical skills, which they only understand on a - probably uninteresting - “childish” level. It also seems as though people in the educational system are of the opinion that arithmetical skills, once learned, will never be unlearned. When indeed they can be lost. And there is another important aspect: each mathematical subject can be understood
at an increasingly high level (Core Objectives 23-25) and in an increasingly wide context (Core Objectives 26-33). “Common arithmetic” (refer to Klep, Letschert and Thijs 2004), as taught in primary school, can be learned and mastered at an ever increasingly high level. This is an important fact, for example for teachers-to-be and in another way for people who need to be able to use practical arithmetic. Still, today’s secondary schools barely make time for further enhancement of common arithmetic. This causes gaps in educational programmes as well as development. A suitable answer may be to describe common arithmetic, make sure it is put on the agenda for follow-up education, and that it is taught at an everincreasingly high level. Similarly, professional (preparatory) mathematics and scientific mathematics (central concepts and general mathematical competencies) could be put on the agenda as well. The building blocks for this are ready for the taking in the Standards and the Core Objectives.

5.7 The advantage of these German and Dutch matrices

Above, a matrix is presented that is independent from any school of thought about learning and education and which may be used as a frame of reference in the different teacher training programmes from supra down to nano level. In addition, it can be used as a frame of reference to avoid gaps in educational programmes and development.

The Dutch professor van der Craats (2006) also designed a similar frame of reference, although he limited himself to competencies concerning content, and carries out the thought experiment to describe the contents of different school types as a selection from this content matrix. While doing so, he notes that the content of mathematics is cumulatively structured. However, he overlooks the fact that the development of pupils not only concerns areas of content, but also the core objectives in cohesion - especially the Core Objectives 23-25 - and the general mathematical competencies. Nevertheless, the thought experiment is highly worthwhile, because it demonstrates the possibility to describe and successfully relate the objectives and yield on the one hand to the general and contentrelated mathematical competencies on the other. This way, a system of levels (assessment targets) is built, which can be used to describe the requirements at certain transition levels. Based upon this frame of reference, it can be verified which parts should be taken along in case of a vertical transition in order to be learned at a higher level. It seems
a good idea to put some form of common arithmetic (and skills in calculus) on the agenda in each school type. In short - the main educational challenge is to take up the skills mastered at an earlier stage and teach them at a follow-up level befitting the age and interests of the students.

### 5.8 Structure of continuing lines

At all curricular levels (from macro to micro level within the educational system) lines - both vertical and sometimes horizontal - continue. (Compare Klep 1998, pp 49 et seq.) In each layer of the system, agreements have to be made about transitions. Whatever is done within the sub systems of L, is essentially unimportant at L’s level. What is important is whether the transitions work and whether pupils and society are happy. Each sub system supplies pupils with different levels and receives pupils with different levels. This problem can be solved within the sub system itself, for example by using further sub systems such as modules. (Compare Klep and Westra 2005, Section 6). The more or less heterogeneous group of first-year students in the sub system may develop towards certain transitional values by means of modules (with different levels).

*Figure 1: Figure from Klep and Van Leeuwen (2007)*
This mode of thought (based on learning paths by means of modular arranged basic education) illustrates how pupils are able to develop through a system of modules. A pupil who is willing and able, may develop from weak to strong (from the bottom right-hand corner to the top left-hand corner) by repeatedly joining in modules that form an increasing challenge.

What has been drawn for basic education may also be used at supra level, in which pupils follow different school types. It is a structure that is, in fact, already in existence.

Each system layer of the educational system already has this structure. In fact, this approach means that a clear description of content, clear agreements concerning levels at transitions, and optimum development opportunities for pupils can be combined.

5.9 A final thought

In the above, the German and Dutch thoughts concerning the Standards and the Core Objectives were placed alongside each other. In both countries, the content of mathematical education and the children’s levels are contained in a multidimensional structure, in which the difference between mathematical competencies and content is of the utmost importance. This matrix may be used for horizontal and vertical transitions to describe what pupils should know and be able to do.

In fact, by using this matrix, we are letting go of the thinking along established lines. The matrix allows the description of - for example - the resumption of arithmetic teaching at a higher level, time and again, in the sense of an ever-increasingly high level of mathematical competency and at an ever-increasingly high level of intertwining with the different dimensions within the matrix. Transitions are determined by contracts between supplying and receiving schools, taking into account the following rules:

- retain the learned skills at a higher level, especially common arithmetic;
- find out what is needed for the next receiving schools or jobs;
- ensure a good structure, preventing gaps in the educational programmes.

Within a sub system, a modular system (which already exists in most cases) will ensure that pupils are able to develop in a privileged way: each module has a certain bandwidth for the inflow and the outflow, allowing for the raising of a level.
Using this structure, education is able to react adaptively to children on the one hand, to allow children to make the most of their talents on the other, and finally to provide clarity to society about the requirements.

In this mode of thought, it is essential to validate and legitimate the matrix. In practice, the transitions in each sub system should be monitored. Not just the transitions between sub systems and schools, but also those within sub systems and schools themselves. All sub systems and schools should be able to guarantee the quality of their educational programmes. Possibly, educational standards describing the efforts within a sub system or school are needed.
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