

## Introduction

At the annual NVON conference in 2005 in the Netherlands (presented by NVON and Wageningen University Research) a one day conference of participants in the project IMPRESS (Improving Education in Secondary Science), took place. Various speakers presented their views on Science Education in future during this IMPRESS meeting. This article seeks first to summarize major view points that reflect the speakers' views on curriculum and innovation in an effort to identify possible next steps to be taken by the participating teacher associations at the time, i.e. ASE (UK), MNU (Ge), UdPPC (Fr), VeLeWe (Be) and NVON (NL). This 'report' does not at all intend to reflect the respective contributions in a comprehensive manner!

## From the keynotes

*Dr Hans Corstjens* speaking on behalf of the 'Platform for Science and Technology'<sup>1</sup> characterized the current changes with respect to the Dutch secondary school system by means of the following paradigm shift

### 1990

government decides on timetables, teacher qualifications, etc.  
Schools and teachers had clear set of obligations and mandatory elements.

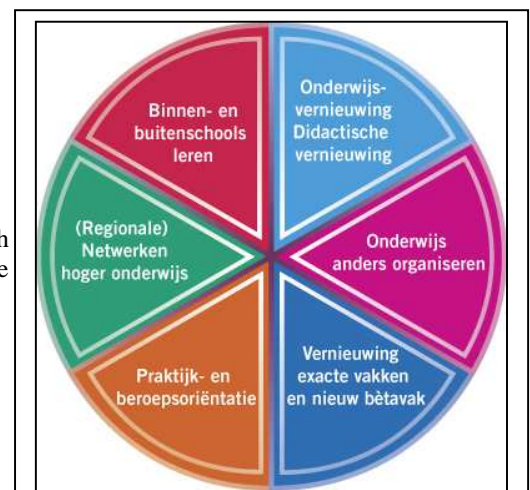
*Result: no innovation minded schools*

### 2005

more responsibility for schools on programma, on organisation, on staff, etc.  
policy is focussing towards urge for quality and results

*Result: more different science programmes in the schools and own policy on science in the school*

<sup>1</sup> The Platform for Science and Technology is a fully sponsored by the Dutch supposed to support a variety of activities that should result into an increase scientists by, i.e. + 15% BA and MA (Lissabon Ambition).



In order to support secondary schools in realizing both the over all school structure and the “teaching culture” in classroom teaching the Agency has installed a particular project –Universum Program- which seeks to stimulate schools to establish goals such as:

- 1) Modernization of (science) subjects, both educational and pedagogical (didactical) changes
  - 2) Inclusion of practical and job orientation
  - 3) establishment of (regional) networks with institutes for higher education
  - 4) improvement of science and education activities
- from projects to structural changes and improvement of science education which attracts more students!

Prof Dr Bernd Ralle from Dortmund University started by sketching outcomes of a couple of recent international surveys – TIMMS 1995 (Grade 4 in Primary), IGLU 2001 (Primary in Germany), and PISA 2003(Secondary), - to illustrate the actual state of science education in Germany:

1. *The increase in scientific literacy competencies stagnates from primary level to lower secondary level till end of compulsory education*
2. *German students loose international competitiveness when passing through lower secondary level science education.*

Prof. Ralle next illustrated his views on particular consequences of these outcomes by means of the following theses and suggested actions:

1. students' motivation and interest in science education decrease in lower secondary more than in other subjects, *leading to*
  - a. *promotion of in stead of selection of lower achievers in order to improve the educational system*
  - b. *flexibilisation of making a transition from general to specific subject based science education*
2. there are lacks in adequate vertical networking of learning contents hindering students' cumulative learning and feeling of becoming competent, *leading to*
  - a. *reduction and reform of the syllabus*
  - b. *elimination of the gap between primary and secondary science education*
3. students learn a lot of facts and data. They are not able however to apply them in various context, nor to communicate and discuss them, *leading to*
  - a. *turning understanding of scientific texts, debating and presentation of scientific themes, problem solving into core objectives of the curriculum*
4. students' lab work does not inherently encourage their understanding of science, *leading to*
  - a. *turning lab work into an important part of science education, since conducting experimental investigation is central of gaining knowledge*
  - b. *turning recent research outcomes on how to integrate lab work in classroom practice into a major topic in teacher education*
5. new media are not inherently conducive for learning, *leading to*
  - a. *drop the idea that the introduction of new media in itself will take away the necessity for students to understand that becoming a successful learner demands from them to make a real effort*
  - b. *the insight that the advantage of self directed learning hyper media has been proven only with learners with high potentials in specific pre-knowledge*
6. enhancement of co-operating learning strategies will improve self-activity, interest and learning outcomes *leading to*
  - a. *the necessity to reform science education accordingly*
  - b. *improve initial and in service teacher training accordingly*
7. context-based curricula seem more efficient due to both cognitive achievement and motivation, *leading to*  
*curricula which include:*
  1. *authentic contexts*
  2. *support of learner's autonomy*
  3. *room for social discourse*

Next Prof. Ralle illustrated in various ways how the participants in the project 'Chemie in Kontext' seek to optimize the use of various strategies to implement this innovative science curriculum.

*Prof Dr Rietje van Dam Mieras from Open University* also speaking as Chairperson of Bèta Federation <sup>2</sup>, presented her ideas in an address entitled “The whole world as your learning environment”, including the following sections:

- Historical background, to analyse the origins of the school of today
- Learning and education, to analyse relations between these two concepts
- Innovation of education, to analyse relations between these two concepts
- A future scenario?, to explain the speaker’s view on the future of education.

Prof. van Dam expects changes in education that reflect changes in the societal environment such as globalisation due to transport, ICT and trade liberalization. It should be noted that:

- Both local and global dimensions are important
- Media are growing in influence
- in communication ratio and emotion are of importance,
- Continuous change is the most constant characteristic

According to this speaker, education in a changing society asks for “world citizens” who are aware of matters such as

- Complexity, which asks for multi- and transdisciplinarity and stakeholder participation which in its turn has particular consequences for learning environments
- Interaction between the global dimension of the ecological- and climate systems of ‘Planet Earth’ and of the economy and the local dimension of the daily life of learners
- Virtual space as a complement to natural space

The educational system therefore faces the following challenges:

- Towards clear learning objectives and a guaranteed good quality combined with flexibility to accommodate different learning styles and preferences

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<sup>2</sup> Bèta Federation is a discussion platform of representatives of a wide variety of interest groups related to both educational and professional institutes

- Design of learning environments that constitute inspiring meeting places for a heterogeneous learning communities
- Facilitating the change on the part of teachers from a teaching to a coaching role
- Design of adequate assessment methods

In summary, the speaker raises the question: Back to basics?, in terms of:

- aim for students to understand both their physical and social environment
- establishing a sound balance between instrumental and substantial rationality
- Use of knowledge in a responsible way
- Towards “Scolè” i.e. creating in school ‘free space’ to think together with others

Mrs Monique Schwob (Union de Professeurs de Physique et Chimie; UdPPC)

This speaker characterized French secondary education by features such as:

- it is strongly state-centralised with a strong role for the ‘Ministère de l’Éducation Nationale’
- schools have little autonomy, e.g. official teaching hours and curricula are decided upon nationally; teachers are also recruited on a national basis
- curricula are set up by national expert groups. No public debate is involved regarding their objectives, pre-testing is hardly exercised nor are didactical aspects taken in account. STA’s are consulted only at the end of the process and not during the development of the national curricula.
- teachers have little autonomy because of character of the national curricula and have to follow detailed instructions on how to implement them. They are also under constrain of the national final exam.
- the final exam (baccalauréat) is also national and consists of both written papers and oral examination. The French public is strongly attached to it.

Starting from 15+, secondary schooling in France includes two streams, general and technical education. The latter however, is chosen by a minority of students. General education in upper secondary consists of three different courses (science, literature, economics). Remarkably, science is the most recognised stream in general education and chosen by the best students, among which a high number of girls.

Up to 16/17 years (bac-2) the curriculum is non-specialised, includes many non-scientific and compulsory subjects plus all the sciences (i.e. maths, physics, chemistry, biology, earth science and technology; the latter is taught in lower secondary only).

To some extent, this multi-science approach, (most subjects being taught) lasts until bac+2. Also, all students in French secondary conduct experiments in science labs, in groups of 24 students in lower secondary and in groups of 18 in upper secondary. This lab work is included up to their final year of science students, and up to bac-1 for the others.

Currently a number of issues is discussed in France, mostly among those working within the education system and hardly among members of the wider public. The issues are

1. Science for all, or science for university mainly?

As was stated earlier the science course is very popular, and is chosen by the best students, basically. Numbers of students are not declining and include lots of girls. The course does contribute to a social awareness in science.

BUT, it does not succeed in meeting the needs of the universities. And, only 30% of the science students do not continue in science after *baccalauréat*.

2. At any rate, our short-term problem is a foreseeable lack of teachers with huge pending retirements.

3. The impact of the final exams on the nature of the school curriculum.

Items of discussion in this context are:

- should all subjects be addressed during the national exam?
- how should the different subjects be balanced to promote science education?
- how can we prevent exam preparation from prevailing over educating students in the broadest sense?

4. What content should be taught to what types of students? Here, a couple of issues is in debate.

- How to balance the curriculum, i.e.

Should we focus on either science for everybody /science for social awareness *or* on science for scientists, as the main facets of the curriculum, or should we include both curriculum facets up to and if yes up to what year should we e.g. deal with science for everybody /science for social awareness mainly and how to link up these two facets in the successive part of the curriculum?

- Concept or context based curricula?

By tradition French science education is strongly concept-based. The issue –concept or context- however starts to come in debate, but not in an explicit way. It is at any rate not yet an issue publicly debated, nor has it been subject of particular educational experiments so far. Didactics is rarely referred to in this context except when related to extremely specific points,

- although today's curricula's 'packaging' is referred to as context based the actual classroom teaching remains concept based and academic. Since the curriculum objectives are not well defined it is questionable if are they supposed to appeal to all students, or to motivate all of them? Should all students be provided with a solid scientific background? How can the intentions of those who devise(d) the national curricula become passed on to the teachers who have to teach them?

- the pressure of the final exam (problem solving in a written paper) results in a concept-based teaching.

#### **- Integrated science vs academic subjects?**

- currently primary teaching is in renovation, including taking on board science teaching of the 'integrated science' type.

- this concept does not appear as such in secondary education. The trend here is rather to promote interdisciplinarity via projects where different teachers share common themes such as energy, health, environment.

- grass-root teachers however, are not ready nor willing to take part in teaching integrated science.

- some academic societies are in favour of it, and it may well be experimented in certain schools.

UDPPC plays its own role in the French debate on education which is constrained however by both the strictly centralised system and the lack of autonomy of schools and teachers. Nonetheless, UDPPC takes the following positions in particular issues:

-as concerns *lower secondary*, UDPPC is in favour of

- 'science for all' in all 4 years of lower secondary

- experimental, research and questioning activities for all, in groups not exceeding

- *lab work*, should be at the core of our teaching, for all, at all levels and until the final exam in the science course and must be assessed before *baccalauréat*. Here, adequate funding is a pre-requisite.
- UdPPC by principle supports the introduction of *new educational methods* (e.g. documentary activities, interdisciplinary activities, project-based teaching)
- *the science course* to UdPPC, has to become a really scientific one again, rather than a general selective path.
- *in service training* of teachers should become extended and compulsory to
  - help the teachers implement changes in curricula decided by the Ministry
  - to contribute to teachers' general scientific culture,
  - to make teachers more receptive and aware of developments in the research field.
- UdPPC favours a national debate on the function of the final exam including: role and status of the different subjects that are assessed according to the differences in courses (literature, economics, science), and their importance for the future studies of the pupils.

UdPPC envisions actions with respect to

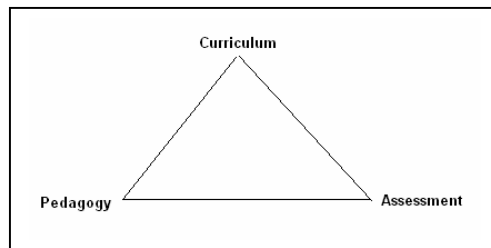
- the Ministry : stances, protest declarations, open letters, meetings with the officials in the Ministry
- other teachers associations and learned societies (collective of 14 associations and learned societies for greater influence) : press releases
- teacher unions (not so easy...)
- teachers : providing them with information is not as vital as it used to be (they can now get it from other channels), we tend more to promote formation and thinking
  - . a journal, formation tool, providing thoughts on our profession and scientific culture
  - . 4-day Annual meeting
  - . regional days
- a very active role in promoting and organising national scientific competitions (Chemistry Olympiads, co-founders of the Physics Olympiads, *Objectif Science*) as well as international ones (International Physics/Chemistry Olympiads, Science on stage)
- a very active support of World Year of Physics 2005

Mrs Lyn Haynes (Association for Science Education, ASE in the UK)

This speaker started by emphasizing the importance of having clarity concerning the aims and objectives of a particular curriculum by quoting from Tyler's Basic Principles of Curriculum and Instruction(1949), i.e.

1. *if an educational program is to be planned and if efforts for continued improvement are to be made, it is very necessary to have a conception of the goals that are being aimed at.*
2. *these educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed and tests and examinations prepared*

She also put forward Prof. Paul Black's concept of 'the Eternal Triangle' consisting of



Obviously, Mrs Haynes aims for

*education that achieves and/or promotes learning rather than a systematized accumulation of knowledge without the ability to apply the knowledge to life*

- On the part of the students this includes in her view education with the following characteristics:

- *broad*
- *problem solving (situation-related solutions)*
- *relevant*
- *stimulating and motivating*
- *exciting or the Wow! Factor in Science*
- *engaging to encourage ownership*
- *thought provoking*

On the part of the teacher the demands are:

*start from the learner's existing understanding*  
*help the learner understand the learning aims*

The speaker also touched the issue: ‘Should all students be taught life-survival skills to enhance survival in the aftermath of conflict, famine, natural disaster?’, while emphasizing the necessity of taking in account also in this respect key questions such as: “Yes/no, which skills and why?”

Finally, concerning the issue of ‘Bringing down the Barriers’ between School and Society, this speaker stated

1. Education is a powerful force in securing equal life chances
2. Curriculum and assessment should encourage innovation
3. Professionalism must be respected
4. “The public have a right to know how effective education is, but accountability can be both rigorous and supportive of schools”

Mrs. Sabine Thomas (MNU, Germany)

This speaker reported that: ‘unsatisfying results with respect to German schools of international studies such as PISA and TIMSS – though not quite unexpected by experts - gave a strong impact for innovation and lead to quite a number of political efforts to improve education’. This aroused several -simultaneously initiated- efforts to further refinement of classroom practice as quickly as possible, however not to re-form the educational system.

To begin with, the “Permanent Conference of Education Ministers ” decided to introduce national educational standards that are compulsory to all 16 German “Bundesländer”. MNU was given important roles such as bringing in fundamental recommendations worked out by experts and making comments on the preliminary draft standards. Currently, the national educational standards are being transferred into new curricula and guidelines for classroom practice. MNU is actively involved in way such as being an acknowledged advisory group, the organiser of expert conferences as platforms for exchange and co-operation.

Mrs Thomas characterized the current change in pedagogy in Germany by means of the paradigm shift: ‘from “input steering” to “output control”’. The following steps to implement this change, are envisioned:

1. the development of a *competence model* consisting of two categories of competencies i.e.:
  - competences related to processes (be able to do something)
  - competences related to concepts (know something)
2. the derivation from the competence model of both *national* educational standards and new subject programs (curricula). Included, both national harmonization and interdisciplinary harmonization are aimed for. The introduction of integrated science in both lower education and primary education. MNU however, does not support integrated science beyond age 11+. Here, it is envisioned to expose the students to the specific methodical and conceptual differences between the classic subjects as well as to well-based interdisciplinary cooperation. The ultimate goals here is to develop with students well-based disciplinary knowledge and abilities that provide a frame or orientation for the learner.

In addition, MNU is also in favour of:

- context-based and cross-disciplinary learning “across the disciplines”. Hence, under development are proposals for a harmonized use of both basic scientific terms –so called “nodal points”- and junctions between the scientific disciplines, such as system concept, balancing concepts e.g. matter and particles, energy, mass, continuum – discontinuity (particle concept)
- changing classroom practice from instruction of students towards construction of knowledge and ability by students themselves
- the use of systematic and regular evaluation on different levels. Hence, valid evaluation instruments have to become developed and field tested. (As a matter of fact, the government supports the development by programmes as e.g. “SINUS Transfer”.)  
reform of teacher training in all three phases i.e. academic training in university, initial and in-service teacher training. As far as MNU is concerned, the current situation in Germany unfortunately tends to become completely unclear since too many universities are actually conceptualising their own study models. MNU is in favour of a particular model for teacher training which
  - acknowledges the professional working field right from the start
  - includes a broad and high quality training in two academic subjects,
  - includes fundamental didactic training as well as attention to practice-oriented pedagogical aspects.

In conclusion, Mrs Thomas compares the strong and simultaneous movements on the German education scene to a heavy earthquake which both makes teachers feel troubled on the one hand and at the same time offers many opportunities to initiate advances in science education. In this turmoil MNU tries to be open-minded, critically driving forward the proceedings on the one hand or pull the brake whenever necessary, on the other hand.

Mrs Jenneke Krüger (NVON Teachers’ Working Party for Upper Secondary Education, Netherlands)

According to this speaker, recent outcomes of research on students’ learning results in Dutch upper secondary schools relate to characteristics of the curriculum such as:

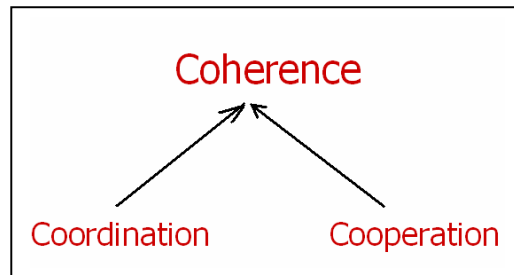
- difficult
- boring
- no connection with real life
- fragmented and isolated pieces of knowledge.

Improvement is felt to be possible by *increasing the coherence* among the respective subject curricula.

The working party Upper Secondary is in the process of developing a curriculum model along these lines. At this stage, a concrete example is in development in which particular

concepts, contexts from daily life, from different vocations and from research and several domains from exam programs are combined. In addition, the working party seeks to define what –minimal- conditions within schools are supposed to be necessary for implementing this particular curriculum model.

The model should contribute in balancing within classroom teaching three kinds of interlinking the science subjects involved:



The underlying pedagogical (didactical) approach of the model includes characteristics such as

- learning activities which support both active and more independent learning
- Groupwork
- Practical work, and hands-on activities
- process evaluation including go/no go type decision making

Mr. Marc Beddegenoots (Vereniging voor Leraars in de Wetenschappen, VeLeWe Belgium)

This speaker presented results from a recent international study -Euroscene 2003- in particular results relevant for science education in Flanders.

The following conclusions were presented:

1. with respect to the science curriculum

- Pupils think that studies in exact and applied science are too difficult (80% agrees)
  - At secondary level pupils do not obtain a good idea about what science really is (63% not agree)
  - Pupils view exact and applied science as cool and businesslike (55% agrees)
  - Pupils do not have a clear view about what kind of professions are open to them (55% agrees)
  - Other reasons: the curricula are overloaded, which leaves less time for exercises in order to learn to understand
- with respect to (students?) ideas for improving the curriculum:
- education which provides more links between the science subjects(73% agrees)
  - education which provides more links between science and other subjects(70% agrees)
  - less pressure in the curriculum so that more time is available for exploring and reasoning together
  - make sure basic knowledge is acquired first and then links to other subjects can be introduced

**retrospect**

Basically, NVON organised the Impress meetings during the Wageningen conference in 2005 to kick off a co-operation of STA's in Europe. As a result of this particular meeting two aims for the future were identified:

- the representatives of all the STA's represented at the conference agreed to the initial objective of NVON, i.e. to start off a joint effort to identify common European characteristics for future science curricula.
- it was decided to *start* this enterprise by having a couple of meetings in the context of 'getting to know one another'. Therefore, it was decided to exchange information on the state of the art in student lab work, in Rennes at the UdPPC-conference in 2005.

This section of this notice however, mainly functions to propose a couple of suggestions for discussion in Rennes on the topic "identify common European characteristics for future science curricula". These recommendations are based on both the keynote addresses and the presentation by Prof. Dr Brascamp –Wageningen University- who acted as a moderator during the conference.

### **Recommendations for decision makers at the international, national and school level**

- **enable schools and teachers to**
  - **offer more different science programs in the schools**
  - **have their own policy on science in the school**
- **enable schools and teachers to**
  - Modernize the content of the science programs, with respect to both educational and pedagogical (didactical) aspects
  - Include practical and job orientation in student school activities
  - establish (regional) networks with institutes for higher education
  - stimulate the increase in numbers of science students
    - improve the educational system to promote lower achievers
    - make the educational more flexible to enable students to make a transition from general to specific subject based science education
  - **stimulate the implementation of context-based science curricula which include:**
    - authentic contexts
    - room for social discourse among students

### **Recommendations with respect to curriculum, pedagogy and didactics**

- curriculum content. Revise the current subject programs to establish
  - reduction and reform of the syllabi
  - increasingly coherence among the respective subject curricula
  - elimination of the gap between primary and secondary science education
  - turn understanding of scientific texts, debating and presentation of scientific themes, as well as problem solving into core objectives of the curriculum
  - pedagogy and didactics. Change the current classroom practice by
  - turning lab work into an important part of science education

- apply modes of co-operative learning strategies to improve students' self-activity, interest and learning outcomes
- context-based and cross-disciplinary learning “across the disciplines”. Revise the current subject programs to establish a harmonized use of both basic scientific terms –so called “nodal points”- and junctions between the scientific disciplines, such as system concept, balancing concepts e.g. matter and particles, energy, mass, continuum – discontinuity (particle concept)

### **Recommendations with respect to initial and in-service teacher training**

- turn recent outcomes of pedagogical research on how to integrate lab work in classroom practice into a major topic in teacher education
- turn recent outcomes of pedagogical research on how to enhance co-operative learning strategies in classroom practice
- acknowledge the professional working field right from the start
- include a broad and high quality training in two academic subjects
- include fundamental didactic training as well as attention to practice-oriented pedagogical aspects

### **In summary:**

- 1) Do whatever it takes to relate science teaching to student's real (*current and future*) life
- 2) Bear in mind that all –and in particular scientific- concepts function only within particular contexts
3. Do whatever it takes to expand the Wow!Factor in your teaching