# HarmoS – the Development, Implementation and Assessment of Standards in Science Education in Switzerland

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## Abstract

The Swiss project HarmoS (Harmonisierung der obligatorischen Schule = Harmonization of the Compulsory School) intends to harmonize and monitor the educational landscape in Switzerland, which is currently segregated into 26 separate educational systems governed independently by the 26 cantons or "states". It is to be conducted during the time period of 2005 to 2008 and will be followed by the political implementation into the Swiss school system with a continuously ongoing monitoring process afterwards. HarmoS science is one of four sub-projects – the one that is committed to science education. It relies on performance standards that are handled as so-called basic standards, builds encompassing competency models and includes the construction, assessment, and validation of suitable testing instruments. In HarmoS science, an interdisciplinary approach combines physics, biology, earth sciences, and chemistry with STSE issues like sustainable development, technology, environment, science, and society. A broad consensus between Swiss professionals of science education and Swiss science education teachers was established. Moreover, a guiding group was formed and teachers of primary and secondary I level in natural sciences are kept involved in a bottom up research process. The provisional results consist in a three dimensional competency model, a suitable test instrument and a schedule for the assessment process itself. Its results will be of interest not only for the Swiss project itself but also for other similar projects in other countries as well.

## 1) Background, Aims and Framework

The Swiss project HarmoS (Harmonisierung der obligatorischen Schule = Harmonization of the Compulsory School) in Switzerland was initiated by the Swiss Conference of Cantonal Ministers of Education (EDK, Erziehungsdirektorenkonferenz). It profits from a strong political will in this country to harmonize and monitor the educational landscape (EDK, 2004a, 2004b), which is divided into 26 cantons or "states", each with its own educational system so far. This is why the project enjoys high priority in the political agenda of Switzerland. It is strongly influenced by the expertise of Klieme et. al. (2004). Some salient features may be identified as follows (Labudde, in press):

1) HarmoS relies on performance standards that are handled as so-called basic standards (Basisstandards).
2) Including four subjects, namely mathematics, science, first language, and second language (i.e. one of the four official languages in the country or English), standards will be developed for grades 2, 6 and 9.
3) The standards are built on the basis of so-called competencies as they are defined by Weinert (2001). The result is an encompassing model of competence.
4) However, the project HarmoS itself does not end with the development of this model of competence, but includes the construction and assessment of a suitable testing instrument and the subsequent validation of the model.
5) Transparency concerning the construction of the model of competence and the following assessment process must also be guaranteed towards professional and societal stakeholders of science education.

The project HarmoS has strong relations to other international research projects in standards. Some of them will be presented at a symposium of ESERA 2007 (Fischer, Scheckter et. al, in press). Since many National Education Standards (like for example the German ones) do not include neither competence models nor empirical testing methods, various efforts have to be made to complete this task. In the symposium, Neumann, Fischer and Kauertz describe a framework for analyzing competence and the development of competence in physics. They provide also a brief overview on how empirical evidence can be found to determine the consistency and stringency of the model described. Schecker and Einhaus question to what extent science competencies are content-related, if abilities in different processes can be distinguished and if there is a correlation between the expertise of students and the difficulty of specific test items. Liu and Ruiz present a study based on using data mining to develop a competence model in order to predict K-12 students' performances on test items related to energy. A combination of factors related to content type, context, cognitive level of items and students' grade levels is identified to predict student performances. Kauertz, Neumann and Fischer present results of a study to validate a complexity model of competence based on German Standards for Secondary I level physics education.

## 2) Methods

Guided and restricted by the concept described in section one, four consortiums – consisting of educational professionals, i.e. teachers and/or educational researchers – were invited to construct models of competence in a scientific research process. Horizontal coherence between the four different research groups is guaranteed "by regular meetings of the so-called strategy group, which includes members of each of the four consortiums, several experts of international student assessments (members of the Swiss PISA group) and experts of the Swiss Conference of Cantonal Ministers of Education. The strategy group, which meets at least every two months, is standardizing the terminology of their competency models, the frame and quality of the problems for the assessment, as well as the sample of the nationwide assessment" (Labudde, in press, 12).
The HarmoS consortium of natural sciences[1] settled on the following landmarks:

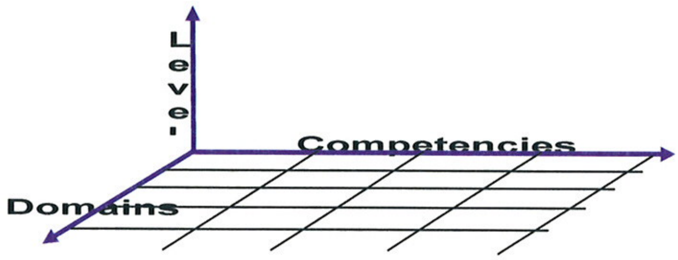
1) An interdisciplinary approach that combines physics, biology, earth sciences, and chemistry with issues such as sustainable development, technology, environment, science, and society.
2) A broad consensus between Swiss science education professionals was established by including members of 9 Swiss academic institutions of teacher education, and a guiding group (Begleitgruppe) consisting of educational professionals and science education teachers of primary and secondary I level.
3) Literature research linked the development process to the experiences of standards' building in other countries (USA, Canada, Germany, and Belgium) and to assessment projects like PISA and TIMMS. A synopsis and analysis of all 26 cantonal science curricula (Szlovák, 2005) provided important information about today's curricular situation in Swiss schools.
4) A core team of scientists propagates the development process, guided by a bottom up approach and profiting from the skills and knowledge of all involved persons.

[1] Adamina, M., Bazzigher, L., Bringold, B., Gigon, P., Gingins, F., Jaun, B., Jetzer, A., Knierim, B., Labudde, P., Metzger, S., Nidegger, Ch., Stebler, R., Theurillat, P-Y., Vetterli, M., Wagner, U., Weber, Ch., Zeyer, A.

## 3) Results

### 3.1. The model of competence

The resulting model of competence contains three dimensions: competencies, domains and levels:




"The competencies will include skills such as identifying and questioning scientific problems, developing preliminary ideas and plans, carrying out a plan of action, manipulating materials, as well as processing, interpreting and communicating data. The domains of contents are within physical or living systems, e.g. structure and properties of matter, energy and its transformations, the human body/health/well-being, ecosystems, plants and animals. These domains are rather interdisciplinary, more like a STS-approach than driven by the systematics of biology, chemistry, and physics. The domains of contents are strongly influenced by the idea of science for everyday life" (Labudde, in press, 5). The level dimension remains a raw estimation prior to assessment and will be fine-tuned during the statistical processing of the collected data.

#### *3.1.1 Some comments to the dimension of competencies*

The range of competencies includes:

1) To show interests and to be curious
2) To ask questions and to investigate
3) To open fields of interest
4) To organize and structure
5) To estimate and judge
6) To develop and realize
7) To communicate and interchange
8) To work self-reliant, to reflect.

Each of these competencies connects to any domain and in doing that represents a concrete task for students. The construction of these competencies was guided by the examination of important precursors like the US National Science Education Standards (National Science education Standards, 2004) and the study of important theoretical literature like the German Expertise for Bildungsstandards (Klieme, Avenarius et al., 2004). A closer look to the further explanations of each competency, however, reveals some innovations that resulted in fact out of an intense discourse between the members of the consortium. We present here only one paradigmatic example: the competency "to estimate and to judge", which is presented in the following way:

*To collect aspects (facts) and values concerning phenomena, situations, and processes.*
*To judge them, weight them, and value them.*
*To include different perspectives and focuses while judging, weighting, and valuing.*
*To make a personal judgement, to take a personal viewpoint. To critically overview collected information.*
*To critically revise personal positions and judgements.*
*To make clear for oneself the impact and the meaning of nature, science, and technique.*
*To reflect on a caring and respectful commitment to the natural world.*
*To judge the importance and interpretation of facts and situations concerning ecology, society, future.*

This concept is clearly influenced not only by STSE curricula but also by theoretical concepts like cultural border crossing in science education (Aikenhead, 2000). Students should not be enculturated by plain transmission of science contents. They are endorsed to move and/or negotiate back and forth between the culture of western science and their life-world. This concept also smoothly fits into an integrated approach of science education (Zeyer, 2006).

### 3.1.2 Some comments to the dimension of domains

The range of domains includes:

1) the planet earth
2) movement, force, energy
3) communication, to rule and control
4) materials
5) animals and plants
6) natural habitats and societies
7) man and health
8) nature, science, technique, perspectives of the future

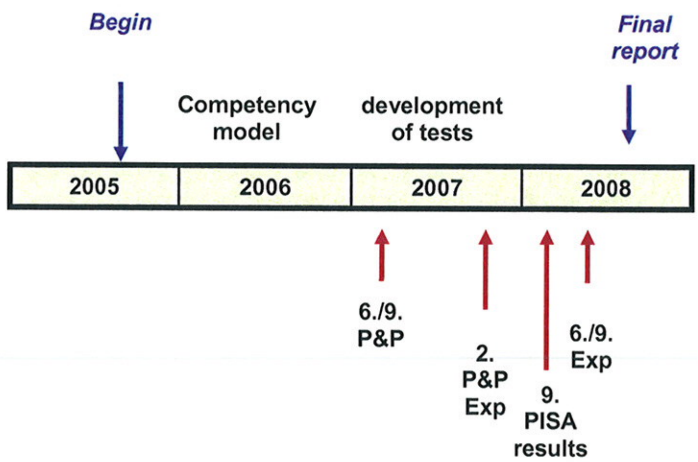
Many of these domains are classical issues of context based curricula. Research provides strong evidence that context-based/STS approaches offer as good a development of understanding as more conventional approaches, foster more positive attitudes toward school science than conventional courses and promote more positive attitudes to science in both girls and boys (Bennett, 2005).
Issue 8, namely *nature, science, technique, perspectives of the future*, represents the core part of a STSE curriculum (science, technique, society, and environment). Furthermore, it also includes topical issues of education in sustainability.
Issue 7, namely man and health, is an innovative domain insofar as it reflects the modern tendency to include health topics into the education of sustainability. It also realizes the concept of health literacy as it is now favoured in health education. This approach – in contrast to the traditional approach of prevention and health promotion – not only focuses on healthy lifestyle but also includes medical management, health knowledge and information, and the issue of social roles in health. This is reflected by the description of the domain, which includes not only topics like healthy nurture, physical exercise (examples of health promotion), drug addiction, and sexually transmitted diseases (examples of prevention), but also topics like "the child in the hospital", "compliance in therapy and medication", or "chronic illness of children and young people in school".

### 3.2. The test instrument

The consortium decided to use a paper and pencil test combined with an experimental test to validate the model of competence. Thereby, the test problems, created by the members of the consortium, are focused on the dimension of competencies, while domains are only used to find a consensus about test topics. The shape of the problems is influenced by the type of questions used in the PISA tests. In each problem, a basic situation is described and several question items concerning the provided information are asked. Each problem will be assessed in a pilot test before it will be incorporated into the body of test problems.

### 3.3. The validation procedure

It was also a task of the consortium to define the details of the assessment procedure. The schedule of the project may be seen in the following figure:




The research process started (as described) in the fall of 2005 and the construction of the model of competence took place in 2006. During spring 2007, the 6th and 9th year level will accomplish a nationwide assessment of the test problems (sample 9'600 students from the German and French speaking part of Switzerland). It will be a paper and pencil test (P&P); each student will answer 4 to 6 problems (each of them of 10' duration).. A P&P and experimental test for the 2nd year level will follow in autumn 2007. In winter 2008, the results of the new PISA assessment are expected and will be incorporated into the HarmoS test design. The experimental tests by the 6th and 9th year will take place in 2008, followed by the final report to the government.

## 4) Conclusions and Implications

The Swiss project HarmoS is a governmental issue of high relevance realized by four consortiums of Swiss educational professionals. Based on experiences in other countries concerning educational standards it follows a new approach by connecting models of competence directly with a suitable test instrument. The results of the assessment process will be of interest not only for the Swiss project itself but for similar international projects as well.

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Contribution to the symposium "constructing, analyzing and applying models of competence in science classrooms" of Hans E. Fischer et al.



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