GIREP newsletter

Groupe international de recherche sur l'enseignement de la physique
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Increasing the efficiency of mathematics and science instruction: Report of a national quality development program

Manfred Prenzel, Reinders Duit and Manfred Euler
Institute for Science Education (IPN) at the University of Kiel

Objectives

German students did not do well in the TIMS studies. Their results in science and mathematics were just mediocre (Baumert, Lehmann, Lehrke, et al., 1997). What was even more worrying, however, was the fact that relatively large numbers of German students had problems solving the more demanding tasks, especially those requiring conceptual understanding. The heterogenity of achievement is unusually high. From a longitudinal point of view there are relatively limited increases in competency in the course of compulsory education in Germany. These results clearly indicate that science and mathematics education in Germany is far less successful than expected and necessary to guarantee a minimum of scientific and mathematic literacy. The deficiencies of German students have been hotly debated not only among the educational specialists and those responsible for science and mathematics education in the ministries of education but also by the broader public. The ground then was prepared for actions to increase the quality of science and mathematics instruction in Germany.

As a reaction to the insufficient results of German students in the TIMS-studies a nation-wide program to increase the efficiency of mathematics and science teaching started in the autumn of 1998. The goal of the program is to stimulate, promote and scientifically guide processes ensuring quality and optimizing teaching and learning in mathematics and science in an interstate network of schools. The conception of the program is based on an expertise worked out by a national group of science and mathematics educators on the one hand and educational psychologists on the other hand (BLK, 1997). 30 pilot schools, connected with another 150 network schools, will work on selected modules which concern key problem areas in mathematics and science teaching as identified by the expertise.

Key problem areas in German science and mathematics education

The expertise (BLK, 1997) developed by a group of experts identified and described the following main problem areas in mathematics and science teaching in Germany: The science content taught at different grade levels is only loosely connected, and there are only rather limited connections between the different school subjects. Typical for German lessons is the following very limited interplay of teachers' questions and students' answers. Usually, the teacher directs the students' answers towards one single correct answer. In this way emphasis is given to routines and short-term retrieval achievement. The limited cumulative instruction in mathematics and the sciences hinders students in experiencing growth in competency and disturbs the development of subject-oriented learning motivation and interest. The systematic introduction of scientific work and argumentation patterns as well as the consequent use of the potential offered by scientific experiments are further issues that are seldom given sufficient attention. The main problem areas identified by the expert group were summarized in the following eleven modules:

(1) Further development of the task culture in science education.
(2) Towards more adequate views of scientific work and experiments.
(3) Learning from mistakes - Towards admitting that mistakes are not just impediments of learning.
(4) Towards securing basic knowledge - meaningful learning at different levels.
(5) Making students aware of their increase of competence - cumulative learning.
(6) Making students aware of the limited view of a particular science subject - towards integrative features in biology, chemistry and physics instruction.
(7) Promoting girls and boys - towards gender equity in science teaching.
(8) Towards co-operative learning in science.
(9) Strengthening students' responsibility for their learning.
(10) Assessment: Measuring and feedback of progress of competencies.
(11) Quality development within and across schools.

The program to increase the efficiency of science and mathematics instruction

A large program funded by "Bund-Laender-Kommission" (an interstate commission to improve education in Germany) started in autumn 1998 to address key limitations of science and mathematics education as elaborated by the above expert group. The set of eleven modules has provided the framework for the work in 30 pilot schools and the network of another 150 schools connected to the pilot schools. Working groups focus on a certain selection of modules, i.e., they work on means to address the deficiencies identified. The project is school based. Input to support the teachers' work is provided by the institutions responsible for the project. The IPN serves as co-ordinator for science education, the Bavarian institute for teacher education and curriculum development (ISB) in co-operation with the mathematics educator Peter Baptist (University of Bayreuth) co-ordinates the work in mathematics. The input provided includes seminars to introduce teachers the philosophy of the program and to make them familiar with the above modules and papers summarizing major findings of research concerning the particular modules as well as ideas and examples to improve the situation. These materials are available to all participants of the program on an internet server.

Co-operation among teachers is a fundamental principle of work in the program. The teachers have to document their work plans and the goals achieved to make the information available to their co-operation partners. The new approaches developed are tested in the individual schools and school networks and evaluated by the teachers. In order to allow for compensation for the considerable amount of extra work, the teachers involved give fewer lessons. The work in the schools is co-ordinated and supported locally, regionally and supra regionally.

The program aims at a long-term, a continuous, and - finally - a professional process of optimizing mathematics and science education using stimulation and support by providing the actual state of research on teaching and learning. This process may be described as a cycle of the following three stages which will usually be closely linked:

Stage 1: Identification and description of a problem
Stage 2: Generation of solutions
Stage 3: Setting solutions into practice, evaluation of the effects

Theoretical framework and modes of inquiring

The program outlined above draws on school based approaches of quality development (cf. Prenzel, 1998). The basic view of teaching and learning is constructivist in a broad sense (Duit,1999). On the teacher side the aim is the reflective practitioner (as described, for instance, by Schoen, 1983). Making teachers aware of the problems and afterwards familiar with ideas on solving the problems (based on findings of research) is seen as the key to the success of the program (cf. Munby & Russel, 1998). On the student side the constructivist view of an active self-reflective learner is adopted. In the program this view also holds for the teachers. Therefore, most modules do not only describe guidlines for reflective and efficient learning on the student side but also on the teacher side.

The processes and conditions of professional reflection and quality development are the focal points of research on the impact of the program. The documentations, evaluations and co-operation reports at the school level serve as the data basis. These are supplemented by targeted and theory guided questionnaires, interviews and observations. Research on implementation and evaluation will be closely linked to other research programs, as, for instance, studies within the OECD/PISA program (PISA, 1999) and a large program funded by the German Science Foundation on improving learning science and mathematics for the next six years.

The program is in an early stage. Results will be reported in the future.

References

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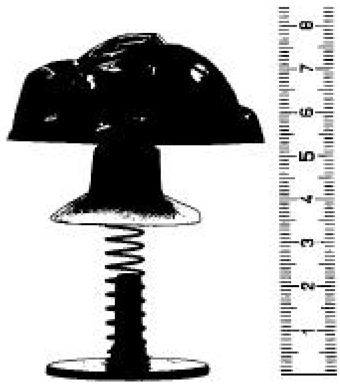
Schoen, D.A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* San Francisco, CA: Jossey Bass.

Jumping animals and toys

A flea jumps about half a meter high. At a distance of about d = 2mm it accelerates. This leads to an acceleration of *a = h· g/d = 0,5m· g/0.002m » 250g* (g = $10ms^{-2}$; uniform acceleration assumed). Since the jumping height of a flea is strongly influenced by air resistance, it has, in reality, a greater acceleration. There are other animals with an even higher acceleration. A man can only achieve up to 3g with a standing high jump.



m = 14,46g

A small toy known as jumping animal or pop-up allows some investigations that can illuminate the physics of jumping. The toy itself consists of a base, a spring, a rubber cup and a head. You have to press the cup onto the base and thus load the spring. After some time the cup will loosen itself and the toy will jump up. The first experiment is, of course, to measure the jumping height. Sometimes you have to wait very long for the jump . With the same toy under the same conditions the height is about 1.20m and varies about 10%. The energy comes from the compressed spring, and you probably wonder how you can measure this. In a quick experiment you can press the toy on a simple balance. The result is about F ≈ 19N. The spring is compressed about d ≈ 3.5cm. Thus a spring constant of *c » 19N/0.035m =* $550Nm^{-1}$ *results.* A more accurate measurement is given with c = $500Nm^{-1}$ and d = 3.2cm. The energy stored in the spring *is* $E = 0.5\cdot\ 500Nm^{-1}\cdot\ 0.032^2m^2 = 0.26J$. The toy should reach a height of $h = E/mg = 0{,}26J/(10ms^{-2}0.0145kg) = 1.79m$ (mass of the whole toy m = 0.0145kg). This is a great difference from reality. The explanation is seen if you remove the plastic head from the rubber cup. Several turns of the spring are pressed in the top of the rubber cup and can only move with great friction. Here mechanical energy is dissipated to heat.

Calculating the initial acceleration of the head of the toy is an interesting task: *a = F/m - g = 19N/0.01kg - g » 190g.* For the total mass only the sum of the mass of the head, the rubber cup and one third of the spring are used. This acceleration is quite good whencompared with that of the flea.

If you assume a constant decrease in the acceleration from the beginning according to *a(y) = c(d-y)/m -g,* the final velocity of the head at the end of the acceleration phase is

$$v = \sqrt{2\int_0^d ady} = \sqrt{\frac{cd^2}{m} - 2gd} \approx 7ms^{-1}$$

This can be verified only with some effort. With colleagues I made digital videos of the jump with 1000 and 2000 pictures per second [1]. The analysis of these pictures confirmed the calculated velocity.

Only from the videos another property of the toy could be derived. Immediately after the toy jumps up, the whole toy oscillates due to the spring. The frequency could be measured and was f ≈ 74Hz. The frequency can also be calculated

$$f = \frac{1}{2\pi}\sqrt{\frac{c}{\mu}} = \frac{1}{2\pi}\sqrt{\frac{500Nm^{-1}}{0,0021kg}} = 78Hz \quad with\ \mu = \frac{m_1 \cdot m_2}{m_1 + m_2}$$

$$m_1 = 0,0089kg;\ \ m_2 = 0,00275kg$$

This small toy allows even more investigations if you vary the masses of the head or of the base. Children and physicists will also find out very quickly that they can shoot the base if they loosen the base from the spring. There is a certain danger involved.

[1] The video (AVI-File) can be downloaded under the URL:
http://www.e20.physik.tu-muenchen.de/~cucke/ftp/lectures/jump2.avi

Christian Ucke, Techn. Univ. Munich, Physics Dept. E20, 85747 Garching, Germany

During the GIREP 2000 conference in Barcelona, general assembly of GIREP members will be held. Please send proposals for the timetable to the committee. As you probably remember, the president was elected in 1998 till the year 2002; in the year 2000 elections are due for vicepresidents, secretary and treasurer.

Please send contributions for GIREP Newsletter!

Second European Conference on
'Physics Teaching in Engineering Education' PTEE 2000
14-17 June 2000, Budapest, Hungary

Conference e-mail: ptee2000@phy.bme.hu
Conference website: http://www.bme.hu/ptee2000

PHYSICS TEACHER EDUCATION BEYOND 2000

The XVIII edition of the GIREP International Conference will be held in **Barcelona** from the **27th of August to the 1st of September of the year 2000**, with the collaboration of ICPE.

Conference Topics

The Conference will be divided in three main topics:

- Physics beyond 2000: **New contents for a new conception of Physics Teaching.**
- Teacher Education beyond 2000: **Improving Physics Teacher Education**
- Physics Education beyond 2000: **Physics Education, new methods and tools**

Types of Contribution

Three general types of contributions are expected:

- research reports: resulting from a research work.
- design and/or implementation of innovations: reporting experiences carried out in some Primary or Secondary Schools, Teacher Training Colleges or Universities.
- new proposals for teaching specific topics: coming from theoretical revisions or reflections about scientifical or didactical aspects.

Presentation Formats

- Communication, 15-20 minutes assigned.
- Short contribution, 5-10 minutes assigned.
- Poster presentation: Two poster sessions will be held, and participants will have the opportunity to interact with the authors.
- Computer Display: New programs and computer utilities designed by authors can be displayed.
- Exhibition: A room will be available for exhibition of devices, experiments and innovations related to the conference topics.

Plenary Lectures

Plenary lectures that will be held during the conference.

- Reinders Duit
  On benefits and pitfalls of analogies in teaching and learning physics
- Daniel Gil
  The state of the world: a missing dimension in physics teacher education
- Dick Gunstone
  The education of teachers of physics: contents PLUS pedagogy PLUS reflective practice
- Jon Ogborn
  Choosing the science curriculum
- Edward Redish
  Who needs to study Physics in the 21th century and why?
- Elena Sassi
  Labwork in physics education and informatic tools: advantages and problems
- Laurence Viennot
  Anticipating teacher's reactions to innovative sequences: examples in geometrical optics and waves

Round Tables

During the Conference, there will be different Round Tables, where personalities related to each of the exposed topics will have a forum to discuss and exchange ideas. These round tables also have the objective to encourage the interaction between discussants and participants.

Round Table 1: **Contribution of Institutions to the improvement of physics teaching**

The role played by different institutions to improve physics teaching will be discussed and exposed here.

The Round Table will be co-ordinated by David Jou, Spain. The discussants invited to participate in this Round Table are:

Marisa Michelini, Italy. (GIREP)
Representative from ESERA
Gunnar Tibell, Sweden. (EPS)
Spanish representative from (RSEF)
Juergen Sahm, Germany. (ICPE)
Ferdinande Hendrik (EUPEN)

Round Table 2: **Basic and fundamental contents for physics teaching at secondary school for the next millenium**

What physics contents should be considered as the most relevant for a new physics curriculum at secondary school? Which criteria should be used to make a selection of these contents? This Round Table will be co-ordinated by Rufina Gutierrez, Spain. The discussants invited to participate in this Round Table are:

Jon Ogborn, United Kingdom.
Janchai Yingprayoon, Thailand.
V.S. Varma, India.

Round Table 3: **Physics Teacher Education. Appropriate approaches for a new way to educate secondary school physics teachers.**

What are the main features of a reviewed physics teacher education? Different perspectives will be discussed here. This Round Table will be co-ordinated by Helmut Kühnelt, Austria. The personalities invited to participate in this Round Table are:

Seta Oblak, Slovenia.
Dick Gunstone, Australia.
Vivien Talisayon, Philipines.
Matilde Vicentini, Italy.

CONFERENCE LOCATION

The Conference will be held in Barcelona City**, Edifici Vèrtex, Campus Nord**. It is a new construction with facilities, like an auditorium with capacity for more than 500 participants, an assembly hall, lecture rooms and computer rooms. The whole building is equipped with air conditioning.
The place is five minutes away from the subway (Zona Universitària station, green line), and there are many bus connections.

DEADLINES

March 15	Submission of abstracts.
April 15	Notification acceptance contributions.
April 30	Deadline for advanced registration
June 15	Deadline submission of contributions

The deadline for the submission of abstracts is exceptionally extended until the 31 of March for the Girep members.

REGISTRATION FEES

	Before April 30	After May 1
Girep Members	160 euro	210 euro
Non-Members	180 euro	230 euro
*Student**	100 euro	not accepted

Registration fees include the booklet of abstracts, Conference Proceedings (CD version), coffee breaks and reception.
(*) Must be under 30 year. Curriculum Vitae required with the inscription form.

The conference begins on August 27 afternoon (registrations and conference reception) and ends on September 1 not later than 17h.

More updated information in our Homepage. Please visit us at:
http://www.blues.uab.es/phyteb

The co-ordinators of the PHYTEB Conference are:
Dra. Roser Pintó and **Dr. Santiago Suriñach**.

Contact the Organising Committee by **e-mail** at:
phyteb@blues.uab.es

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President: *Manfred Euler*, Department of Physics Education, IPN (Institute for Science Education), Olshausenstr. 62, 24098 Kiel, Germany (tel 49-431-880-3147, fax –3148, e-mail: euler@ipn.uni-kiel.de)
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FEES

The accounting year runs from January 1 to January 1. Fees paid after September in any year will be credited on the following year, unless the applicant specifies otherwise.
The current fee (1999) is 12 GBP (GBP = British Pounds Sterling), EURO 17 or USD 18 preferably paid into the following account:
Christian Ucke, Postbank (GIRO) Muenchen, Account No. 355 28-808, BLZ 700 100 80.
BLZ (= BankLeitZahl) means a special sort of code for the Postbank in Germany.
Please do not pay into other accounts.
The members should pay their own bank charges and mailing costs. At the same time, please send a note (by letter, fax or e-mail) to the Treasurer, confirming how much money you sent and when and for what years.
In some countries, it is possible to transfer money from the national **Post**bank with EUROGIRO free of charge (Belgium, Germany, Japan, Luxembourg, Switzerland, Spain) or with a small charge (Denmark, Finland, France, Great Britain, Netherlands, Austria, Sweden).
If you send a EUROCHEQUE filled out in DEM, there are no expenses at all for the Treasurer. If you send a cheque filled in your local currency, there are DEM 3 (Euro 1.50) expenses for the Treasurer. Please do not send cheques drawn on a bank from your country (except UK) but filled out in GBP (horrible expenses then).
If you prefer to reduce bank expenses, you may pay several years fees in advance.
It is also possible to pay by credit card (EURO-/MASTERCARD or VISA; no others). Please write or fax to the Treasurer your full card number, expiration date and the amount. Add 5% expenses to the amount. The Treasurer will convert that amount into DEM and then charge your credit card account in DEM.
It is not recommended to use e-mail for sending credit card numbers.
In cases of real difficulty to arrange payment, please contact the Secretary or the Treasurer who are ready to advise whether special arrangements can be made.
The General Assembly of GIREP members in Udine (August 1995) accepted the following supplementary new article for the GIREP statutes:
Each year in October, those members who have not paid for the previous two years will be removed from the membership list.

Look at our home page http://www.pef.uni-lj.si/girep and fill in the members' form!
User name: girep, password: duis98