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ICPE Awards the Medal for Excellence to Paul J. Black

The International Commission on Physics Education awarded the medal for excellence to Paul J. Black last August 31, 2000 at Barcelona, Spain. Professor Paul Black was awarded the ICPE medal because his remarkable contributions to physics education have been outstanding and international in scope and influence. ICPE,2

In this issue

Citation for the Presentation of the Medal of the International Commission on Physics Education

to

PAUL J. BLACK

The medal of the International Commission on Physics Education of the International Union of Pure and Applied Physics was established in 1979 for the purpose of recognizing contributions to international physics education which are "major in scope and impact and which have extended over a considerable period." At its meeting in Barcelona, Spain in August 2000 the International Commission on Physics Education awarded its medal for excellence to Paul J. Black.

Throughout his long career, Paul Black has devoted himself unstintingly to the cause of science and of physics education. Through his work as a researcher, as a teacher, as an author and as an editor he has made seminal contributions to the literature, and through his leadership in international physics education organizations he has been most influential in advancing the cause of physics education world wide.

2001 ICPE Conference in Cultural Contexts (ICPEC)

Beyond classrooms into the 21st Century: Teaching and Learning of Physics in Cultural Contexts is the theme of the upcoming International Conference, which will be held in Korea National University of Education (KNUE) on August 13-17, 2001. The conference aims to: explore the ways towards open and divergent physics learning beyond school boundaries, and improve physics education between different cultures. Topics to be discussed include: what are the effective ways of bringing physics and culture together, how can cultural aspects, past and present, be reflected into physics education and how can we make physics education relevant to the features of global, national and local levels. Ω

Citation for the Presentation of the ICPE Medal To Professor Paul BLACK, Kings College, LONDON, UK Barcelona – Thursday, August 31,2000

Professor Paul Black, born on September 10, 1930 is awarded the ICPE medal because his remarkable contributions to physics education have been outstanding and international in their scope and influence, and have extended over a considerable period of time.

He started his scientific career in Cambridge and in Birmingham, in the beginning focusing on crystallography. But as a lecturer and reader in Physics he became more and more interested in educational problems and then switched to this challenging scientific field. As a Professor of science education at Chelsea College, later Kings College, London, he became a recognized authority in science education world wide. He was active and successful as a researcher and shared his ideas as an author and as an editor, as well. Assessment and testing have been a special focus of his work over years.

Because of his competence he took the lead in several science curriculum projects sponsored by the Nuffield Foundation, was director of several research and development project and co-directed the work in science of the UK government™s national survey of school science performance for ten years (1978 to 1988). He served on the Research Grants Board of the UK Economic and Social Research Council and was chair of the Task Group on Assessment and Testing in 1987/88, which advised the education minister on the new policy for national testing.

But there were not only national activities. Paul Black has been successful, too, when working in an international frame, in this way influencing and bringing forward the cause of physics education worldwide. So he served as consultant to the O.E.C.D. project on Innovation in Science, Mathematics and Technology Education. For six years (1985 to 1991) he was president of GIREP, i.e. Groupe International de récherche sur l™Enseignement de la Physique. For another six years (1993 to1999) he was chair of the International Commission on Physics Education, the ICPE, and Vice-president of the International Union of Pure and Applied Physics from 1996 to 1999. For the same time (1996- 99) he was a member of the US National Academy of Science Board on Testing and Assessment.

Currently, he is a visiting Professor at the School of Education at Stanford University, California, director of a U.K. project on developing formative assessment practices in school, and director of a joint Stanford-King's project on formative assessment in science funded by the National Science Foundation. Last but not least, he is a member of the National Academy of Science Committee on the Cognitive Foundations of Assessment. Summarizing Paul Black™s activities, he may be characterized as an ambassador of physics education who enjoys an extremely high reputation among the scientific community. His published ideas as well as his contributions to national and international policies in science education have a lasting influence to the development of physics education.

Barcelona, August 2000 Jürgen Sahm, Chairman of ICPE

Proceedings of the 1999 International Conference of Physics Teachers and Educators on Turning the Challenge into Opportunities: The Historic Mission of Physics Teacher for the Next Millennium is now available at:

http://www.ipe.gxnu.edu.cn

or

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Securing the Future of Physics

Securing the Future of Physics was the bold title of a seminar on school physics education and public awareness, held at Malvern College prior to the European Physical Society Conference in London in September 1999. Together with the EPS President, close to 30 present and past presidents of European national physical societies participated. The 75 delegates represented 31 European countries as well as USA. The former EPS treasurer John Lewis, on behalf of the EPS Forum on Education organized the seminar.

Plenary lectures were given on various topics such as: the 1998 Irish/ EU Colloquium in Cork called Attainment in Physics and the Project Bridges from Physics (series of TV/ video programs which will be distributed in selected schools in Europe). Other lectures were on a new Dutch 200 hours course on General Science. An attempt at an innovative way of training science teachers in Sweden was presented and the many initiatives taken by the British Institute of Physics for contacts between schools and the academe were discussed. The latter also include several items of in-service training for physics teachers. The seminars have five working groups, dealing with Public Understanding of Physics, Physics and the Human condition, Physics and Wealth Creation, and The Case for Physics Research, Physics Education and Teacher training. **Ω**

Recommendations made for EPS Executive Committee can be seen at: *www.malcol.org/eps* ***seminar****.*

EU's Science Teacher Education Book

If a reader wants to know about the significant differences in science teacher education in some European countries like Italy, Germany, United Kingdom and France, he/she must read this book. The book shows the distinction between regions with diverse educational traditions. It also displays some patterns in teacher training models for primary and secondary levels, and also for vocational education. Moreover, common features in teacher training curricula can be identified in this book. It also provides information on how teacher education and especially science and mathematics teachers respond to various new educational challenges. The book was edited by Jósefina Turto (ISBN 83-86875-21-6) Published by: Top Kurier 87-100 Torun, Poland 10/5, Lindego Street. Ω

Proceedings of the Colloquium on Attainment in Physics at 16+

by Richard Coughlan
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The Irish Department of Education and Science organized the Colloquium on Attainment in Physics at 16+. The participating countries funded the colloquium with the assistance of the European Union Socrates program.

The Irish Department of Education and Science proposal for the Colloquium on Attainment in Physics at 16+ was a response to a call for proposals from the European Commission. The general aim of the application for Socrates funding was to carry out an analysis of approaches to physics education at 16+ within the general education systems of participating countries and to investigate methods of comparing standards in physics at 16+. From this examination it was hoped that an insight would be gained into how European countries could co-operate in improving physics education at upper second level.

The participants in the colloquium were Denmark, England and Wales, Finland, France, Greece, Ireland, Netherlands, Scotland and Northern Ireland. The European network for Policymakers on the Evaluation of Education systems was the forum through which the representatives of these countries indicated their interest in participating in the colloquium.

Principal recommendations from the colloquium include:

A concise database on physics education practices in the various European countries should be prepared as it would be very useful to education policymakers in a country to have a "window" into both the priorities and the practices of other national systems.

Further research should be undertaken at the European level with regard to aspects of physics education, including clarification of what physics at 16+ can offer to students who study it. There should be more collaboration between countries in communicating the nature and results of their efforts to innovate in physics teaching and to make physics more interesting to pupils.

Lowering of standards of the intended curriculum in physics may lead to increasing standards in the attained curriculum, i.e. if physics syllabuses are reduced somewhat in content and level, students'attainment levels may rise.

A variety of physics courses is required at 16+. The physics curriculum should not be only an education 'in physics' but also an education 'about physics.' In particular, in courses for students who do not wish or need to pursue physics to more advanced levels, greater attention should be given to important issues. The issues are the nature of physics, the development of knowledge, the relations with other disciplines, the technological connections, and the implications for society and career aspects.

Further studies are required to evaluate specific applications of Information and Communication Technologies (ICT) in physics teaching.

National education policies should be directed in seeking ways of improving classroom practices and, as part of this, improving formative assessment of students.

Practical work, some of which should be investigative in nature, should be assessed.

Some components of 'high-stakes' examination systems will have to be assessed by teachers within the context of normal classroom learning.

A collection of well tried examples of the assessment of student performance in the Science Technology and Society (STS) aspects of physics should be compiled and distributed. Ω

Multimedia in Teaching and Learning

Multimedia in Physics and Learning must carry on; that is what most Physics educators are most concerned with nowadays. A well-timed workshop on Multimedia in Physics Teaching and Learning was held at AMSTEL Institute at the University of Amsterdam last November 22-23, 1999.

Twenty-nine participants joined the workshop and gave lectures related to the following topics: Distance Learning and Web-Technologies, Didactical Aspects and Research and Using Internet for Communication with Teachers, Students and the General Public. Ω

Teaching New (SMART) Materials at Schools

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In this article we shall analyze the possibility of teaching a new subject matter in the courses of science at secondary schools in Greece, and we'll justify the selection of "smart materials" as the new content. Smart materials come from solid state Physics and Materials Science. These materials will be broadly used in technological applications in the future decades and their extraordinary properties could whip students' interest to science. For such a policy a preliminary research has been carried out in order to find out students' ideas about materials. Such a research may help teachers with the adoption of such subject matter in science teaching.

New Subject Matter in Science Courses at Schools

The new conditions in Europe concern all aspects of life, such as political, social and technological and they have already started to affect life in Greece. People who are required in jobs have to be very well qualified, able to analyze developments around them and eager to increase their educational level through life [1], [2]. The European Committee is interested in developing specializations in fields such as biotechnology, automation and especially new materials [2]. In order to attract young people to these fields, it is necessary for students in secondary school to attend programs of teaching. This can help them to understand the relation between technology and productivity. Programs of teaching could be made by adapting subject matter of science and technology that can be utilized for future needs. Also, make it more interesting for students so as to become a motivation for them to learn science.

The new subject matter should contribute to the attainment of the following aims [i]: Students will have the scientific and technological information background to study the field of new materials and their technological applications which will be broadly used in the future decades. ii) Students will learn the basic discoveries of science and will be accustomed to everyday applications of technology while experimental skills, imagination, observation and so on will be cultivated.

Considering the above reflections, we propose as a new subject matter in the course of science the new materials and precisely "smart materials." The "smart materials" respond to external stimulations of the environment such as heat, pH and so on in an "intelligent" behavior. We believe that their spectacular properties (shown in the following description) could spark students' interest in science.

Description of Some "Smart Materials"

From the above mentioned smart materials we propose specially as subject matter: a) shape memory materials b) electrorheological fluids and c) polymer gels, because in the future the technological applications of these smart materials will probably be used in every day life. Some short description of the above materials are:

Shape Memory Materials. Shape memory (SM) materials is the generic name given to a series of materials that exhibit the unusual property of mechanical memory that can be triggered either mechanically or thermally. If such materials are deformed at one temperature, they will completely recover their original shape at a higher temperature. The memory element therefore "remembers" its shape prior to deformation [5]. As for the applications of shape memory materials, in Japan, artificial teeth roots have been manufactured from the Nitinol (Ni-Ti) elements. These memory roots bear against the bone and provide excellent support to the attached teeth. Furthermore, engineers are using Nitinol in Micromanipulators and robotics actuators to mimic the smooth motions of human muscles [5], [6].

Electrorheological Fluids. An electrorheological fluid is a substance whose form changes in the presence of electric fields. Depending on the strength of the field to which it is subjected, an electrorheological fluid can flow freely like water, ooze like honey or solidify like gelatin [7], [8]. Although the electrorheological fluids are not yet ready for commercial applications as they exhibit some problems, their future looks rather bright. The electrorheological fluids offer the possibility of a shock absorber that provides response times of milliseconds and does not require mechanical adjustments. Such fast control could adapt the absorber to a variety of vehicles and operating condition [8].

Polymer Gels. This name refers to soft aggregations of long chain molecules that can shrink or swell in response to stimuli and can change both their size and shape, thereby coverting chemical energy directly into mechanical work. They may form the basis of new kind of machines, inspired from nature, based on biomimetic systems. As for the applications of the polymer gels, a "gel valve" may serve as a general purpose "chemical valve." Gel valve could be used to deliver medication to organs that need it in required doses at any given moment. Gels could also be used to produce motive power. In contrast to conventional motors and pumps, gels are gentle and flexible and their movement is more reminiscent of muscle than that of metallic machine [9].

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Students' Ideas about States of Matter. We decided to continue a research among students of secondary education (n=320 students). To help teachers plan an initial teaching strategy for the previously mentioned smart materials, it was decided to study students' ideas about solid, fluid and gel state of matter because the phenomena that correlate to shape memory materials are close to solid state matter. As well, electrorheological fluids and polymers gels are close to fluids and gels, respectively. Secondly, students' ideas about these three states of matter are fundamental knowledge for teachers' instructional strategy. The information obtained from this elaboration was used to recommend a rationalized sequence for teaching new materials.

3.1 Students' ideas about solids

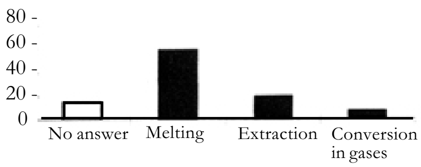

Figure 1. Percentage distribution of students' ideas about the results of great amount of heat at solids

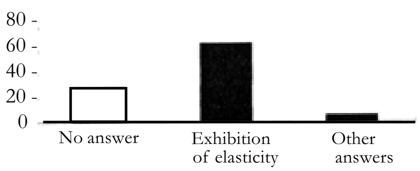

Figure 2. Percentage distribution of students' ideas about solid's elasticity while they are forced

3.2 Students' ideas about fluids

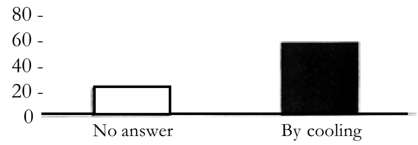

Figure 3. Percentage distribution of students' ideas about fluids conversion to solids

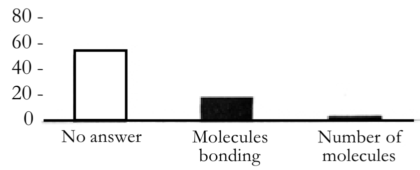

Figure 4. Percentage distribution of students' ideas about the factors which characterize the structure of thick and thin fluids

3.3 Students' ideas about fluids

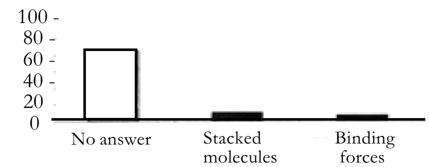

Figure 5. Percentage distribution of students' ideas about factors which characterize the structure of gels (toothpaste)

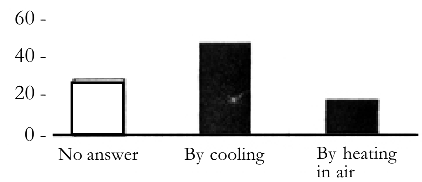

Figure 6. Percentage distribution of students' ideas about gels conversion to solids

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Tools and Strategies Netcourse

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This research project was designed to improve inservice physics teacher education using new methods and new tools. The research group was composed of seven research teams of different Italian Universities. The features of the developed materials and the preliminary results of the project pilot test describes the project objectives and structure. The project uses networking through the implementation of Net-Seminars (on line seminars that utilize on-line discussion groups) tailored to train teachers in transforming their teaching by promoting: (i) a constructivistic teaching practice, (ii) computer-enhanced instructional approaches that will enable students to learn the process of modeling physical phenomena. A relevant point of the instructional approach is the development of the metacognitive knowledge and skills: teachers are engaged in a reflective process in which they evaluate their own and each other's activities and reasoning. The Net-Seminar supports the learning by a scaffolded apprenticeship model: teachers experience a first-hand virtual education that includes downloading of electronic documents, participating in group discussions, creating shared knowledge spaces and other activities which they can carry out with assistance and then use by themselves in their own classrooms. The pilot Net-Seminars we have experimented with involve two different subject matters: Newtonian modeling of dynamical systems and the modeling of heat transfer. Results of the network discussion characteristics among teachers and the different way they use the teaching materials in their classrooms will be reported. Conclusions will be drawn about the ways of improving the network and the interactivity of Net-Seminars.

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Introduction

This paper reports a research project current underway in Italy aimed to test ICT for teacher training in introducing new physics contents and teaching methods at high school level. The following paper [3] and [4].

The project is designed to understand teacher's need in the area of ICT; prepare new pedagogical environments for teacher education; and analyze teachers' competencies in the use of ICT.

This paper describes the structure of Introduction to Modeling in Physics Education (I.MO.PHY), a Course delivered through digital Network (Net-Course) and some preliminary results of its pilot test involving 50 experienced teachers attending the Net-Course an optional basis.

The Innovations

Our approach to physics teaching is based on the framework derived from the physical world . We consider model building as a superordinate process skill and the introduction of modeling activities as a support, enabling students to see similarities and differences among a wide range of phenomena.

This approach involves a construction of the physics content structure that has to be taught not solely oriented to physics issues, but also including educational issues and pupils' conceptions. These two issues, student's spontaneous models and statements of the scientific knowledge, are therefore accepted to be of the same relevance and treated as resources for physics education. In this way the physics content to be taught is reconstructed in order to realize the main goal: to allow students to gain a fruitful knowledge of the physical world. This involves substantial modifications in learning sequences as well as in the teacher's role and teaching methods.

The basic principles of the Net-Course are the following:

Teachers also need to be learners and need to provide to students the kind of learning that they had to experienced; to be engaged in using the pedagogical tools designed to help learners in conceptualizing physics models and in gaining the abilities connected with modeling procedures, and must be involved in activities aimed at stimulating hands-on learning and metareflection. As well, teacher education has to be connected with classroom experimentation of the involved innovations.

The I.MO. PHY.NET-Course

A telemetric learning environment, used for teacher training, demands a thorough rethinking of the content and the teaching/learning activities of the involved learners (in our case the Teachers (Ts) and trainers (in our case the Researchers (Rs) of the projects). Interactions and teaching/learning activities are delivered in a setting that it is very different from a classroom and/ or a laboratory. Our Net-Course takes into account the results and the experiences rising from previous projects showing that three main categories of functionality seem to be critical for the design and the development of telematic learning environments. These are related to: information such as documents and other materials including images and sound; interactivity defined as human-machine interaction; and communication taking place among learners and teachers, peers and others.

These functions have been supplied, in an integrated way, in the three phases of our Net-Course: 1. Face- to-face workshops where Ts were trained by the Rs of their local university group to get acquainted with Internet, e-mail facilities and software involved in the project-- Excel, microcomputer-based laboratories(MBL) software and Interactive Physics). 2. Net-Seminars where Ts were supposed to analyze the educational materials supplied by internet, discuss them using e-mail and/ or forum facilities and, at the end, to program a classroom experimentation of one Learning Unit (one activity concerning the modeling of a chosen category of phenomena). 3. Experimentation in the classroom of the chosen Learning Unit and collection of evaluation elements (Ts' logbooks and students' reports).

The physics content IMOPHY involves modeling activities in different fields of mechanics and thermodynamics. The materials and the pedagogical tools used in the Net-Course had been tried in real high school classrooms by the researchers and /or experienced teachers. The learning material structured in modules aimed to support teachers, through Teacher Guides (TGs) and Student Sheets (SSs), in implementing the modeling activities in their classrooms. The organization of each Teacher Guide intends to engage teachers in their own investigation in order to gain the prerequisite skills and knowledge, concerning the physics content as well as the pedagogical tools. For each module a Net-Seminar has been organized; each term spends approximately 15 days to finish the experiment depending on the materials to be analyzed and/or on the software and experiments to be performed.

The Net-Seminar Structure

The relevant points of our teacher preparation process are the following:

Deep analysis of the physics content structure; evaluation of the pupils spontaneous models; and construction of pilot classroom instructional sequences through metareflection on the learning requirements involved.

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The starting point of each physics modeling procedure is the analysis of some easily observable phenomena and the TGs lead from observations to models through four different sections:

In the first section, some examples of pupils' common conceptions (the spontaneous models) are analyzed and research results are supplied; in the second section, observations about common phenomena that can constitute the ground of pupils' spontaneous models are pointed out; in the third section, some experiments, that can be easily performed, are described; and in the fourth section, different aspects of the modeling procedure and the gradual enlargement of the experimental field, for further presentation of more powerful conceptual models, are analyzed.

The Net-Seminar audience was constituted by 12 project researchers (6 local coordinators supporting teachers) and the involved teachers. Two or three moderators (the project coordinator and the authors of the education materials) stimulated discussions and reflection concerning the materials they transfer in a classroom setting. They tried to stimulate a reflective domain, relevant for the object of learning.

Fundamentals of coaching for reflective teaching, stimulating opinion on a question of action, criticism, descriptions of learning situations, demonstrations of cause/effect relationships, etc., are the activities that aimed to help teachers become aware of the learning skills applied in various phases of their work and how these strategies and skills were related to learning goals.

Research Design and Preliminary Outcomes

The scope of the pilot test was limited: a case study approach has been employed using a qualitative method of data gathering and analysis. This method involves constant reflection through the observation and data in order to identify key analytical themes grounded in the data. Various data collection sets have been used:

The analysis of the communication, including frequencies and structure of messages, their peculiarities and so on; the analysis of the forum's discussion; a questionnaire concerning individual timings; an anonymous structured questionnaire; and the Ts' logbooks and the students' report of the classroom work.

The analysis is in progress, yet some preliminary results can be drawn:

Teachers of our sample ranged from 35 to 55 years old; their experience with information technology (IT) had been on optional individual basis and their classroom use of IT had been short and fragmentary. The majority was not accustomed to working with the physics colleagues in studying teaching approaches and classworks.

Only 70% of teachers who had signed up for the net-course completed the work. Those who have given up met two kinds of problems: technical problems and lack of time. The second problem is a consequence of the first since they declared to have under-estimated the required technical competencies. Two kinds of technical problems have been met: access to the web and problems in managing software and hardware. Teachers actively attending all the Net-Seminars had home access to web; access from schools usually was not easy because time problems as well as for computer availability. Many teachers revealed that the face-to-face meetings have not been enough to gain the necessary familiarity with software and hardware in order to actively use them and to actively participate to discussion.

One hundred fifty-three e-mail messages have been exchanged using the listserver, during all phase of the Net-Seminars, but 30% of people sent no more than one message. More structured and complete messages were sent to the forum; it registered 35 messages. It is interesting to note that the project coordinators received 48 messages from their private e-mail addresses, some from teachers that usually did not participate in the group discussions and others from teachers asking for a private evaluation of the results of their modeling activities and/or experimental data. Most of the teachers who had been absent from the on-line discussions declared to their local coordinators that they did not participate in discussions because they are not competent in the physics content. This involves the need to reflect about the composition of discussion groups (homogeneous or heterogeneous). Both choices present advantages and disadvantages.

The analysis of e-mails shows that the computer-mediated communication, that is communication in writing presents many advantages in-service teacher training. It involves greater degree of synthesis and clarification than in face-to-face oral communications. Moreover, on-line education provides professional teacher the opportunity to share their personal experience related to the subjects.

Some basic principles of metacognitive instruction have shown their validity for teacher education. Among these: To emphasize learning activities and processes, rather than learning outcomes; and to spend sufficient time in reflecting on learning strategies and self-regulation skills.

The application of some aspects of Shön's reflective practitioner in teachers' education helped Ts to think about new ways of planning, teaching and classroom management. They, through reflection, gained a framework in order to build metalearning awareness in terms of both the content and process of learning. In our opinion, this framework helped them to generate significant changes in their teaching/learning approach.

A preliminary analysis of the anonymous questionnaire shows that teachers perceive that experience in metacognitive instruction most important for improvement. However, it must be taken into account that for a more effective use of ICT for teacher

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training, a deep teacher knowledge of the involved technology is a prerequisite.

By a large majority, teachers asked to repeat the Net Course (also amplifying the physics content). In our opinion, the fruitful sense of belonging to a community has been the main factor to stimulate the active participation of teachers.

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Increasing the Efficiency of Instruction

by Manfred Prenzel, Reinders Duit & Manfred Euler - Institute for Science Education at the University of Kiel

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 the relatively large numbers of German students had problems solving the more demanding tasks, especially those requiring conceptual understanding. The heterogeneity 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 mathematics 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). Thirty 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 introductions 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 aims 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.

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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 Institute for Science Education (IPN) serves as the coordinator for science education, and the Bavarian institute for teacher education and curriculum development (ISB) in cooperation with the mathematics educator peter Baptist (university of Bayreuth) coordinates the work in mathematics. The input included seminars to introduce teachers to 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.

Cooperation 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 cooperation 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 coordinated and supported locally, regionally and supra regionally.

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

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 learning and teaching 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 problem and afterwards becoming familiar with ideas of solving the problems (based on findings of research) is seen as the key to the success of the program (cf. Munby and 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 guidelines 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 the 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 an early stage. Results will be reported in the future.

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Manfred Prenzel, Reinders Duit and Manfred Euler.

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Spain Hosts 6th International Conference on Teaching Astronomy

The Unitat de Formació de Formadors, Universitat Politèctnica de Catalunya organized an International Conference on teaching Astronomy last November 23-25, 2000 at Vilanova ila Geltrú, Spain.

Various speakers from different countries came and shared their knowledge on the subject. The conference aimed is to provide an exchange of knowledge and experiences between teachers and researchers at Primary, Secondary and University levels so as to facilitate the development of astronomy in the various curricula. Ω

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Simple and Effective Demonstrations in Physics

by A. Kawakami & H. Kawada

Simple and effective demonstrations are important in teaching the concept of physics. When the students watched and did such demonstrations, they wondered, contemplated and at last understood the concept. We made some devices for such demonstrations. These are “The Newcomen’s engine using a syringe and a flask,” “The proper vibration of a soap bubble,” “Detect radioactivity using a mantlepiece and Polaroid film,” “The new type linear motor,” “Coin jump using eddy current.”

Introduction

It seems that rapid progress of science and technology has alienated the common people from science and technology. This situation lets students think physics exists only in the textbook and special instruments. We have been thinking simple, interesting and essential experiments are important. And we have been investigating them.

Our life is filled with physics in the world and physical phenomena can be seen everywhere. It is effective to use some things around us and to present simple experiments. We should demonstrate to students various experiments by changing the materials. Students try to do the hands-on experiments. They build, decompose and modify the instruments at their own will in their own way. They understand the concepts and rules more profoundly through their cognitive activities. The simpler the experiments become, the more clearly its essential qualities can be seen. And simplification expands the scope of application [1].

Investigated Devices

The Newcomen’s Engine using a Syringe and a Flask. This engine was made of a syringe, a flask and a hand spray. Cut off the top of a syringe. Set up the apparatus for Newcomen’s engine using a syringe, a flask, a gas burner, a hand spray, a beaker, a cock, some pieces of glass tube, some pieces of poly tube and a rubber plug like Figure 1. So boil water in a flask, and the steam goes into the syringe. Then the piston moves up. After that jet water into the syringe, the steam will be condensed, and the piston comes back by the atmospheric pressure. As long as you repeat the same procedures the strokes of the piston continue.

Take off the spray and replace the beaker for a flasks as a condenser like Figure 2. It is similar to the Watt’s engine but not the same, because the pressure of the atmosphere moves its piston. It is thought to be a simpler model than the Newcomen’s model as a typical thermal engine for physics education. And then if you wish, you can make the Watt’s engine using a syringe and two flasks.

Atmosphere and steam had moved the Newcomen’s engine. My Newcomen’s engine is very simple and its inside is visible. So it is easy to understand how to move the engine. The students understand that both heat and cold sources are necessary for thermal engine.

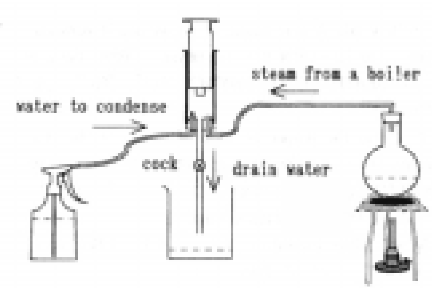

Figure 1 Newcomen’s atmospheric engine

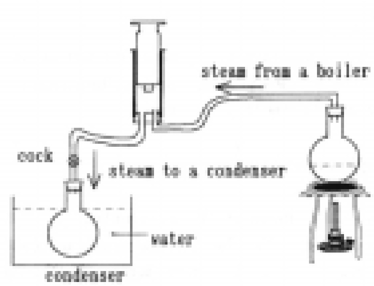

Figure 2 Separating condenser from Newcomen’s atmospheric engine

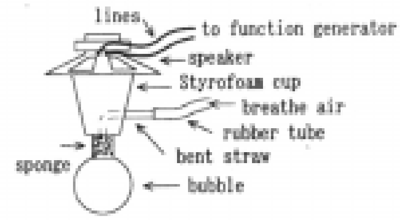

Figure 3 The device for proper vibration of soap bubble

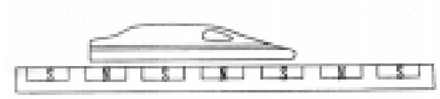

Figure 4 Linear motor car

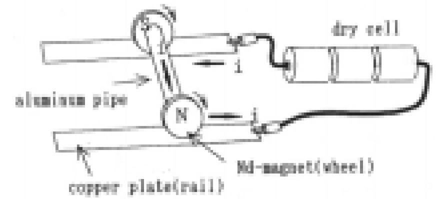

Figure 5 New type linear motor

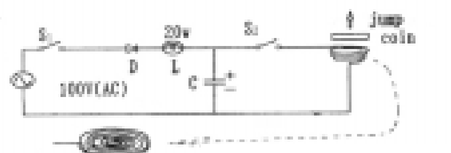

Figure 6 Jumping coin

Proper Vibration of a Soap Bubble. Set up the device for proper vibration of soap bubble with a speaker, Styrofoam cup, sponge, a bent straw, and rubber tube like Figure 3. Connect the speaker with a function generator. Next soak the sponge into the soapy water. Turn on the function generator. Keep the frequency constant (ex. 30 Hz). And breathe air carefully into the rubber tube to make a bubble. If the soap bubble size satisfies the condition of spherical surface harmonics, the standing waves on it will come out one by one [2].

This demonstration let the students get the idea that spherical surface has proper vibration states with many demonstrations and experiments about proper vibration.

next page

Detect Radioactivity Using a Mantelpiece and Polaroid Film. Put a key on a package of Polaroid film (ISO 3000), and cover the key with a mantelpiece. After leaving them for a week or over, develop the film. We'll be able to see the picture of the mantelpiece and the shadow of the key like H. Becquerel did [3].

The New Type Linear Motor. The principle of linear motor car is that it is propelled by a lot of coils, as shown in Figure 4. The new type linear motor car that we invented last autumn is very simple, as shown in Figure 5. This new type linear motor car doesn't need any coils. The characteristic of this car is that the wheels are made of magnets.

Coin Jump Using Eddy Current. First, switch S1 on, then capacitor is charged to 100 volts. Second, switch S2 on, big electric currents are sent to the coil and big magnetic field shoots coin up in the air (refer to Figure 6) [4].

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SMART, from 5

Conclusions: Educational Implications

The data described above attest to the following conclusions and educational implications that may help teachers to obtain useful information on planning their instructional strategy.

a) As for teaching shape memory materials, teachers should be aware of students' knowledge about solids heating and elasticity (see figures 1 and 2). Many students believe that solids melt or extract, when they are strongly heated and they are able to recognize the elasticity of solids as a result of force.

b) The instruction of electrorheological fluids could be first focused on the conversion of these fluids to solids, because many students seem to have ideas that refer to the conversion of fluids to solids (see Figure 3). As far as teaching of structure of electrorheological fluids and the microscopic explanation of their properties is concerned, teachers should know that few students have ideas about the great number of molecules and their bindings (see Figure 4).

c) During the teaching of polymer gels, teachers are recommended to refer firstly to the macroscopic conversion of gel to solid state and then to the microscopic because a small number of students have ideas about the function of molecules (see Figures 5 and 6).

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The 14th International Young Physicist Tournament (IYPT) will be held next year 2001 in Espoo, just outside of Helsinki, Finland.

The Thirteenth IYPT in Budapest

Attempting to define what is IYPT is like trying to recount the 13th International Young Physicist Tournament in Budapest, which was held this July. Dr. Zsuzsanna Rajkovits from the Eotvos Roland University and her collaborators had successfully organized the tournament. The tournament was participated by high school students, team leaders and international jury members.

This year there were 19 teams from 17 different countries who joined the competition. Mexico and Australia were also present in this year's IYPT. Majority of the international jury consisted of University physicists. Participating teams were informed before November of this year that there were 17 problems prepared for them. An internationally composed group of physicists selected the problems last October.

All teams are qualified to participate in the tournament, which starts with several qualifying "fights." Three teams take part in each event, and in turn, during the event, they take the roles of reporter, opponent and receiver. The nine best teams be screened will automatically be among the three semi-finalists. The finalists include teams from Poland 2, followed by Germany and lastly, from Russia. The finalists are free to choose the problem and present their solutions to the other two competing teams. While the opponent teams challenges the reporting team with a problem. The reporter, however, can refuse a problem twice, without deducting any points from his earned score. These sets of rules regulate the procedure in each part of a "fight." The three teams would take an average of three teams, would take an average of three hours to assure the three roles in the competition.

At the end of this year the three teams have chosen the following problems from the list. Poland 2 has selected this problem. Two identical open glasses, filled with hot and warm water, respectively, begin to cool under normal room conditions. Is it possible that the glass filled with hot water will ever reach a lower temperature than the glass filled with warm water? Make an experiment and explain the result.

The team from Russia has chosen this problem. Using a bulb, construct the optimum transmitter of signals without any modulation of the light beam between transmitter and receiver. Investigate the parameters of your device. The product of the information rate (bits/sec) and the distance between transmitter and receiver define the quality of the device.

And lastly, the team from Germany has picked out this problem. Use efficient methods to collect as much radioactive material as you can in a room. Measure the half-life of the material you have collected. Ω

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