GIREP newsletter

Groupe international de recherche sur l'enseignement de la physique
International Research Group on Physics Teaching
Internationaler Arbeitskreis zur Förderung des Physikunterrichtes

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GIREP HOME PAGE: http://www.pef.uni-lj.si/girep

PHYSICS EDUCATION IN THE USA

Contrary to what one might expect in a democratic nation, U.S. science education is poor at the lower levels and for the broad mass of people, and better at higher levels and for scientific specialists.

There is practically no physics in grade school (kindergarten and grades 1-6). Worse yet, many teachers dislike and fear science, and they communicate - often unconsciously - these attitudes to their students. Thus, studies show that most children enter grade school full of enthusiasm and questions about the natural world, but are hostile and bored with science by the time they leave. There is widespread agreement that the solution lies in providing good science and science-teaching educations for grade school teachers, and that university physics teachers and university departments of education need to take responsibility for doing this. But there has been little progress.

The situation is not much better in junior high school (grades 7-9). In about grade 9, students take one course in "physical science." It is seldom taught by a physicist.

Although many students drop out during senior high school (grades 10-12), most complete grade 12 and graduate with a high school degree. High school students take only 2 or 3 one-year science courses - typically one year of biology, followed by one year of chemistry, and perhaps one more science course. For some students, this is a physics course, taken in grade 12. In a recent survey, only 24% of high school graduates had taken a physics course - an increase from the 20% who took physics during the 1980s. The high school physics course is usually narrowly technical (no social, philosophical, or historical topics), mathematical, and designed as a foundation for further technical university physics courses. Traditionally, there has been no high school physics course for the great majority of students who will not go to a university, or who will go to a university and major in a subject outside of science. Furthermore, there is evidence that the "university preparation" physics course does not actually help students in their later university courses. Most of the teachers of this course are not qualified physics teachers, but are instead qualified in biology or chemistry or perhaps not in any science.

The situation is somewhat similar at the undergraduate university level (grades 13-16): Science students (biology, geology, engineering, mathematics, etc.) take a rather demanding one-year technical course, using algebra and/or calculus, covering all of pre-20th-century physics. This course covers little or none of the physics of our own century. Although it is a difficult and discouraging course for many non-physics students, physics students often excell in it. Physics students then take a variety of physics and math courses designed to prepare them for graduate study and, eventually, the PhD. However, only 30% of our physics undergraduates go on to graduate school, and only 40% of these graduate students go on to traditional careers in physics research. This fact is finally being recognized by the establishment of undergraduate physics programs designed for students who will use their physics degrees in various non-traditional ways, such as physics teaching, industrial applications, engineering, science journalism, management of science-related businesses, environmental law, and medicine. One of the biggest gaps in university-level education in physics is our failure to prepare very many physicists to teach at either the grade school, high school, or university level. This of course only perpetuates our physics education difficulties.

At the other end of the university education spectrum, the 90% of our university students who are majoring in history, business, education, and other non-scientific subjects, take little or no physics. Most universities put little effort into teaching such courses. This also perpetuates the physics profession's problems.

At the highest level, following university graduation, U.S. graduate physics education is renowned for its excellence. This is a consequence of the emphasis, rewards, and prestige that the U.S. places on independent research.

The distinguished physicist and educator David Goodstein (Vice Provost of the California Institute of Technology) has stated that "The great American experiment in mass higher education has failed completely in the sciences, where we have a small educated elite and an illiterate general public. Our graduate education in science is the best in the world .... However, the rest of our educational system is bad enough to constitute a threat to the ideal of Jeffersonian democracy. ... 95% of the American public is illiterate in science by any rational definition of what we mean by science literacy."

Science education is influenced by several national characteristics and trends. Our nation's emphasis on the political freedom of every state, county, town, and individual, results in a fragmented system with little national guidance. There are few national standards. Local school boards often determine what will be taught, within guidelines set by each of the 50 states. As one important example (although it is outside of physics), the theory of evolution is widely ignored in grades 1-12, because of opposition from fundamentalist religious groups who exert their power through local school boards. As a result, nearly 50% of the population believes that humans were created separately rather than evolving from other animals!

The end of the cold war, and federal budget reductions, have made it harder to find traditional physics employment in research and in higher education. Physics employment, university physics enrollments, and physics graduation rates, have all dropped during the past few years.

The system takes a "top-down" approach to education. Beginning shortly after World War II, and stimulated by wartime research and the cold war, universities shifted their focus from undergraduate education toward financially rewarding research, government grants, and PhD production. Thus physicists tended to ignore undergraduates, non-scientists, public school teachers, and public school education.

Many educators and social experts have observed that America has two public school systems, one for the rich and one for the poor. Many Americans live in poverty, many of them in city centers. Inner-city schools thus have problems of poverty, discipline, apathy, crime, violence, drugs, and they have no firm tax base for support (American schools are supported largely by local taxes). Middle- and upper-class parents flee from the inner cities to surrounding suburbs. Thus suburban schools have a good tax base, and far fewer problems. This stratified social structure works against educational reforms.

There are efforts to fix all of this. Physics educators are trying to reform the one-year introductory university physics course. One successful approach is the "peer instruction" or "interactive engagement" technique associated with Eric Mazur and others. It recognizes that students are often the best teachers, by allowing them to think and interact with each other and with the instructor. Another hopeful sign is the "concepts first" approach of David Hestenes and others, in which conceptual understanding is valued above calculations. The American Physical Society's "Introductory University Physics Project" has promoted "trimming the bloated elephant" by removing non-essential topics from the course and focusing on the fundamentals, while also teaching more of the physics of our own century.

These reforms all help to overcome many of the problems of introductory university physics courses. Unfortunately, they are not yet in wide use in universities, and there has been little such reform at the public school (grades 1-12) level.

Educators agree that the fundamental problem is the science illiteracy of the general public. Several fine national organizations have worked long and hard at general public school science education reform: The American Association for the Advancement of Science, the National Science Teachers Association, the American Association of Physics Teachers, and the Carnegie Foundation. Despite much effort and many demonstration projects, the results are not yet apparent in America's bewildering and stratified educational system.

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SCIENCE EDUCATION IN ITALY

These notes describe the situation at the beginning of 1998. The entire Italian school system is now on the verge of reform: so we don’t know how our children will be educated tomorrow.

The structure of the educational system is regulated by law. The primary and middle school curricula were changed in a significative way in the ’60s but the overall secondary school structure still stands as it was 70 years ago. The lack of continuity at the interface between compulsory and post-compulsory education is one of the main problems due to this situation.

Talk of reforming secondary education is in the air since the late ’70s but, until now, the politicians were unable to reach agreement about a problem so charged with social implications.

Notwithstanding, under the pressure of new needs the educational system underwent a quite original process of evolution mainly through a number of partial actions and measures that, starting in the ’70s, are known as “sperimentazioni”. The were initiated by local groups of teachers in response to student unrest and teacher discomfort and were taken up in the ’80s and ’90s by the Ministery of Education in response to social and technological evolution (Piano Nazionale per l’Informatica - PNI in 1986, Progetto Brocca in 1992). While PNI projects mainly bore on maths and physics, the scope of Progetto Brocca is the entire curriculum.

As of today the situation is very fuzzy: the “experimentations” coexist, often in the same school building, with the traditional curricula. The view is varied and difficult to analyse. There is no one way of teaching science or physics and a precise description is impossible.

It is now strongly perceived that the whole system does not respond to today’s needs nor is it consistent with the school systems of other European countries. The political side that now governs the country has a strong educational programme and is preparing to restructure the school system completely, from primary school to higher education. We expect this to happen in the next few years, so what I write today will probably be obsolete quite soon.

The school system

After three years of optional infant school and 8 years of compulsory primary and middle school, at age 14 the children can choose between continuing in different types of secondary school or quitting. The vast majority chooses not to leave the educational system yet: especially more so in view of today’s generally increasing unavailability of jobs for unqualified workers.

The organisation of secondary education is markedly vertical. The three main types of schools providing general, technical and vocational education depend from different sections of the Ministery of Education (Ministero della Pubblica Istruzione - MPI).

The curricula differ appreciably from the start. Changing school is difficult and requires passing exams in the subjects that were not taught in the former school. So, if after a few years a student realizes that his/her choice was inappropriate, he or she will usually decide to continue. On the other hand, all university courses (in some cases after an entrance examination) are open to all students, whichever school they come from.

The provision of science

Compulsory education

Primary school children (6 to 10) are taught by two and in some instances three specialistic teachers. All teachers, however, have the same educational background and are expected to be able to teach any subject. Specialisation mainly concerns Science and Mathematics against Humanities and Social Sciences (History and Geography). In practice, who teaches what is agreed among the teachers of each school on the basis of personal preference and local needs. The official curriculum prescribes a minimum amount of time that must be allotted to each subject area: for Science-Technology-Mathematics subjects it is 6 hours/week.

In middle school (11 to 13) General Science and Maths are taught by the same teacher who can hold a university degree in physics or chemistry or geology or biology or mathematics (more frequently the last two). The timetable allots 3 hours/week to science and 3 to maths. The sciences can be taught separately or combined. The teachers are free to organize their teaching, so it is impossible to say how time is subdivided among the different sciences.

The curricular suggestions for teaching science in primary and middle schools state that science must start from observation. In the middle school the pupils must be gradually lead towards formalization without losing the connection between the natural phenomena and their formal description. But in practice the schools have very little money for buying even simple equipment and many middle schools lack science labs altogether, so children's science often is only talk, paperwork and books.

Upper secondary education (14 to 19)

The pattern of science education differs in the General Education highschools (Licei) and in the Technical schools. In both types of schools science is considered a formative and informative subject, but while in the Technical schools it is taught in the first two or three years (because the last years are devoted to professional training), in the Licei it is mostly studied in the last years.

Moreover, although the provision of science in the traditional Classical and Scientific Licei is not the same, the difference is not as marked as the two names would suggest. For example, in the traditional scientific highschool physics is taught for a scanty 2 periods/week in the 3rd year, 3 in the 4th and 5th years. In the classical highschool it is taught for 2 periods/week in the 4th year, 3 in the 5th. It is noteworthy that, even in a humanistic school, all students are expected to be exposed to physics during their late school years when in many other countries they would be following more specialized curricula. On the other hand, the scientific liceo student studies latin.

From the point of view of science learning the main weaknesses of the traditional General Education highschools are the small or unexistent science provision in the first two years and the qualifications of teachers. In fact Biology, Chemistry and Earth Science are usually taught by a teacher with a university degree in biology, Maths and Physics by a teacher with a degree in physics or in mathematics - more that 50% are mathematicians. So, in practice, very often the “harder” sciences - chemistry and physics - are not taught by specialists. For what concerns physics in the scientific liceo moreover, especially in the 5th year its teaching is often cut away in favour of more maths because the maths final examination is written while physics is only oral, and not always present! The heavy influence of examinations on what is actually studied in schools is well known.

Concerning the teaching methods, talk and chalk have been the rule for many years and still are when the subject is taught by teachers who are not prepared for the experimental aspects and have such a limited time (2 periods/week!) to spend with classes.

In the technical schools, usually, physics and maths are taught separately. The time allocated to physics and the provision of labs depend on the type of school, the best situation being found in the Industrial Technical schools.

PNI and Brocca Projects

Although the PNI was geared to the introduction of computers in education, it made an impact on physics teaching because Maths and Physics were separately chosen as target disciplines, in the sense that a school could choose to implement the maths or the physics project or both, usually depending on the willingness of its teachers. The Licei that, starting from 1985, adopted the physics part of PNI introduced physics in the curriculum from the first year. In spite of its limited impact, the PNI produced important changes in how to think about physics curricula and teaching methods. Not only did it enforce the statement that physics should be taught since the first years, thus closing the gap between middle school and secondary school science, but it also stated that physics cannot be taught without engaging pupils in practical work. It prescribed that at least 30% of the physics timetable be devoted to labs. Later, partial surveys showed that this prescription had been largely unattended: most of the money allotted to the schools had been spent on computers and not on lab equipment. But at least the principle had been established.

The Brocca experimentation (so called for the decisional commission chairman’s name) was launched in the early ’90s. It introduced five professionally oriented channels: Classical, Modern Languages, Socio-psycho-pedagogical, Scientific, Science with Technology, into the texture of the traditional General Education highschools. The channels have a common core and specific subjects: the common core shrinks and differentiation between channels increases as progress is made through the years. With respect to the traditional curriculum, in the humanistic channels the provision of physics is more or less the same. In the scientific and technological channels it is enhanced: in 1st and 2nd year physics and chemistry are taught together as combined sciences - i.e. science of matter - as “Physics and Chemistry Lab” (labs being scheduled for at least 50% of the timetable); physics acquires disciplinary autonomy in the last three years.

But a timetable can be misleading: who, in fact, teaches Physics and Chemistry Lab? I mentioned that in the traditional general education schools chemistry is usually taught by a biologist; physics is often taught by a mathematician. New appointments are first offered to teachers who already teach in the school. The consequence is that it is possible to find a mathematician who is teaching chemistry or a biologist who is teaching physics - in the lab! This surely requires a good deal of mind-stretching!

Teachers' education

An anomaly of Italy's educational system has been, until now, the absence of a university qualification for teaching. Teachers are qualified through public examinations. Under this system, until now following a pedagogical faculty is not mandatory for primary school teachers, who can teach with a secondary school diploma and, from middle school onwards, the disciplinary knowledge derived from a specialistic university degree is considered enough. In the early '90s a law was passed requiring that the initial formation of all teachers must be at the university or post-university level: teachers of specialistic subjects must specialize in education after their university degree. This requirement will start to be implemented for new teachers next year.

By now it is evident that the time of experiments must end. The entire educational panorama, from primary school to teacher education, is being reviewed. The government has publicized its plans for a complete reorganisation and renewal of the school system. The major issues that face us appear to be connected with the schools' more pronounced financial and decisional autonomy in matter of what to teach and how, in the framework of the general aims that will continue to be decided by the central authority. Compulsory education will be raised from 8 to 10 years (from age 5 to 15). Secondary school will probably end at age 18. The last 3 years of the upper secondary schools will be more pronouncedly professionalizing.

What will become of physics education? We are concerned with questions about the education of the general public. Will physics, as we would wish, be included in the common core of upper education? If not, will the offering until 15 be enough to equip the young citizen with adequate understanding? There is talk of teaching school subjects in four-month modules. This approach is beyond our experience and imagination: what does it imply? How will we cope? We badly need documentation about real experiences in this field, made in other countries. I would very much appreciate receiving information!

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EPS FORUM ON EDUCATION

It is now nearly six years since the Executive Committee of the European Physical Society with Maurice Jacob as President decided to set up a Forum on Education. The Forum is a part of the EPS Interdivisional Group on Education. Many of the National Physical Societies have pre-university teachers as members and EPS wanted to develop its activities towards education. The intentions were rather general and the Executive Committee asked professor Gunnar Tibell, Sweden, and professor George Marx, Hungary, to take the leading roles, to select actions and to ”start the ball rolling”. They were also asked to find names for a board. The aims and the goals of the Forum were listed in Florence 1993 and it became later a part of the EPS Interdivisional Group on Physics Education.

In order to map the situation in different member countries Gunnar Tibell sent a questionnaire to the national societies where he also asked for names of persons willing to work in the Forum on Education. The aim of the questionnaire was to find out to what extent the national societies engaged themselves in questions of pre-university education. The answers showed that the national societies were interested in an increasing EPS activity concerning pre-university teaching. A board consisting of 10 members from 9 different countries was nominated. The first steps of the Forum activities were reported in Europhysics News (March-April 1996) by Gunnar Tibell.

The board had its first meeting during the 10:th General Conference of EPS, Trends in Physics, in Sevilla 1996. At this conference there was also a parallell session on Physics Education where the Forum took active part and had a chance to present itself to the conference participants. An investigation of Trends in Physics Education was presented at this symposium by the author of this article. It was also printed in Europhysics News (September/October 1996). One conclusion of this investigation is that there is a trend towards ”Physics in context” in the curricula of all countries.

The board of the Forum on Education under the chairmanship of Gunnar Tibell is now involved in different projects concerning physics education.

- One of the projects is to present the physics education in schools in some of the countries of Europe. The presentations will be printed in Europhysics News.
- A second on-going project is teacher exchanges between different countries. The model of the exchange program is that a contact is established between two schools through the EPS Forum on Education. The exchange involves two teachers from each school and takes place at two different occasions. The visiting teacher takes part in the teaching at the school. This is organised by the host teacher. All practical arrangements are made by

the participating teachers. EPS Forum coordinates and pays the travel expenses for the teachers. The first exchange started in November 1997 between Gullstrandsskolan in Landskrona, Sweden and The King´s School in Worcester, UK. The second part of this exchange will take place during the spring 1998. New exchanges are planned for 1998 and 1999. More information is available from the author of this article.

- The Forum is involved in the planning of the 11:th General Conference of EPS in London 1999 where we also want to take part.
- The Forum supports physics contests, especially those of European dimensions, e. g. , by participation in jury work.
- To promote teacher participation in physics education conferences by distributing some ”EPS scholarships” for partial coverage of expenses.

We appreciate this possibility given to us to present the EPS Forum on Education. We share the interest of education with GIREP and there is no doubt that we need all kinds of efforts to encourage and support physics teachers in their educational work. Our firm belief is that international contacts are very important to achieve these aims.

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Information about EPS under the URL: http//epswww.epfl.ch

SCICON 98

1998 New Zealand Association of Science Educators' Conference 5 - 9 July

Conference organisers: Conferences &Events
PO Box 1254 Nelson New Zealand Fax 64 3 546 6020 E-mail conferences @confer.co.nz

http: //nzase.org.nz/scicon.htm

ICPE/GIREP conference 1998

The conference preparations are well in hand. Please have a look on the WEB-Site (http://www.uni-duisburg.de/FB10/DDPH/girep/girepeng.html). We publish and update our information there.

Here we present only a brief summary.

We (the Local Organising Committee) have invited only a few plenary lectures, following strong recommendations of our Advisory Board. We want to focus more on panel talks, posters and workshops. The participants should have better opportunities to discuss special topics in small groups or to do experiments in workshops.

The content of these lectures will cover educational implications of hands-on experiments, hands-on experiments in schools, in universities, in science centers, on television and at home.

International Conference

Hands-On Experiments in Physics Education

August 23 - 28, 1998, Duisburg, Germany

http://www.uni-duisburg.de/FB10/DDPH/girep/girepeng.html

Professor Wolfgang Buerger will hold an entertaining evening lecture on physics toys. Although his lecture will be in German, English hands-outs, bilingual transparencies and the experiments themselves will help non-German-speaking participants to follow the presentation.

For the workshops, we hope to cover a broad spectrum: activities on how to interest girls and women in science, the use of toys in physics education, hands-on quantum mechanics, Low Cost - High Tech-experiments, hands-on approach to astronomy and more.

The social program will include visits to local museums (e.g. Roentgen-Museum), to local tourist sites as well as an excursion cruise on the Rhine including a conference dinner.

Please remember to register!
A registration form can be downloaded from the WEB-Site or obtained from the Organisation Committee (Local Organisation Committee ICPE/GIREP conference, Gerhard-Mercator-Universitaet, FB 10/Sektion Didaktik der Physik, Lotharstr. 1, 47048 Duisburg, Germany, Tel. ++49-203-3792237, Fax ++49-203-3791679, e-mail: girep@uni-duisburg.de)

http://www.uni-duisburg.de/FB10/DDPH/girep/girepeng.html

Deadlines

- April 1, 1998 Registration and submission of abstracts for papers and/or posters
- May 15, 1998 Registration for those not presenting papers at the conference

Local Organisation Committee: Prof. Dr. Gernot Born, Prof. Dr. Horst Harreis, Prof. Dr. Hans-Joachim Schlichting, Prof. Dr. Norbert Treitz, Dr. Christian Ucke

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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 (1996) is 12 GBP (GBP = British Pounds Sterling) 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 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).
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.
If you prefer to reduce bank expenses, you may pay several years fees in advance.
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 last 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.
Italian members: There is no more special arrangement for Italian members because of the new possibilities.