

PHYSICS TEACHER TRAINING AND RESEARCH IN PHYSICS EDUCATION: RESULTS OF AN INQUIRY BY THE EUROPEAN PHYSICAL SOCIETY

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1. Introduction:

In many countries, different types of teachers are trained at different institutions. Teachers for high schools that give access to university may be trained at universities, teachers for elementary, vocational or "lower type" high schools sometimes at universities, sometimes at non-university "academies". The necessity for detailed information of physics teacher training and physics education in general within European countries has become obvious recently and there have been many initiatives to gather information on this topic (e.g. [1-6]). Such data might be helpful in analysing the results of the international student achievement studies TIMMS and PISA, which were having a lot of political impact in some European countries, as recently in Germany. Furthermore, a comparison of the various physics education systems within Europe is very important with regard to open borders and attempts to introduce a comparable system of education according to the Bologna declaration.

One purpose of the present work, initiated by the division of education (university section) of the European Physical Society [4], was to collect data on a European scale on the status quo of physics teacher training at universities by professionals and on the wide spectrum of duties of the professionals working in this field. In addition, special emphasis was put on research in physics education and the relation of physics education researchers to those in fundamental and applied physics. The idea behind the study was to get more detailed information on problems faced by professionals in physics education. As was reported in earlier studies by EUPEN, a lack of communication exists between the two communities, physicists on one side and physics education professionals on the other. These problems were tentatively attributed to the feeling that the one *group does not really appreciate and/or master the issues and methods used in the other group* [1].

The present inquiry is based on a questionnaire, dealing with the following topics:

- How is physics teacher training organized ?
- How many universities train future physics teachers ?
- What are the main tasks of the professionals in physics education ?
- What type of research in physics education is performed and what are its perspectives ?
- Are there any independent centers for physics education research and does a scientific community exist?
- How is the political interest?

This questionnaire was sent out via email at the end of 2001 to the national presidential representatives as known to the division of education /university section of the European Physical Society. Since the return rate was low, those representatives were reminded twice. In order to further increase the number of answers, the questionnaire was also sent to people, known as experts in physics education in their country. Those experts were chosen from the representatives who attended a meeting on Teaching physics : a European confrontation, held in Les Houches / France in June 2002.

Overall, the questionnaire was sent to representatives in 30 European countries. Germany was treated separately since each of the 16 Bundesländer (states) has its own school system not regulated by the federal government. Thus, Germany, on a smaller scale, shows a diversity similar to Europe as a whole. Therefore questionnaires were sent to experts of didactics of physics in each of the 16 Bundesländer.

The overall international return rate was 25 answers from 22 European countries (see Fig. 1). In detail, answers from the following countries were used (see Table 1)

Table 1: participating countries in Europe:

| | | | | |
|----------|----------------|-------------|----------|--------|
| Albania | Croatia | Greece | Poland | Sweden |
| Austria | Czech Republic | Italy | Romania | UK |
| Belarus | Denmark | Lithuania | Russia | |
| Belgium | France | Netherlands | Slovenia | |
| Bulgaria | Germany | Norway | Spain | |

In addition, there were 22 answers from 16 out of 16 Bundesländer within Germany (Fig. 2). In the European analysis, Germany was treated as single response with averaged answers. The same was done for UK, Sweden and Russia, were more than one answer was available. The German situation is described in more detail elsewhere [7].

The present paper gives a preliminary analysis of the international results as presented at the EGF meeting in Varna / Bulgaria in September 2002. It includes a discussion also with respect to earlier investigations of physics

education research within Europe. Provided more answers are forthcoming from the non-responding countries, a final analysis will be published later.

2. The questionnaire

The questionnaire consisted of 11 questions organized in six sections. Technically it was a Word document. The first section dealt with the organization of teacher training, i.e. how teachers get their training and who does the teaching as well as research in physics education. Second, some statistical facts on universities offering physics and physics teacher training were sought for. The third section concerned the main tasks of professionals in physics education divided into teaching, teacher training and research. The fourth set of questions dealt with various aspects of research in physics education. Fifth, it was asked whether there exist physics education communities; the final section concerned the perception of the political interest in physics education. The questions were of multiple choice type, but, ample space was given for free comments on each of them. The full text of the questionnaire can be found in the appendix.

3. Results:

In the present section, the answers received are presented, partly in graphical form, with some first comments. A more detailed analysis and discussion will be given in the next section. All data refer to the full set of responses from all N=22 countries unless otherwise stated.

Occasionally the numbers in the figures do not add up to 22: some respondents did not answer all questions, and some questions allowed for multiple answers. Some uncertainty may also have been introduced by our procedure. Except in Germany, where experts from each of the 16 states were consulted, a single expert was asked for an answer characterising the situation in his or her country as a whole. Especially in larger countries, some guesswork may have been necessary.

Regarding the following analysis, one should keep in mind that curricula tend to change in certain periods from 5 to 20 years, depending on politics. Many countries in Eastern Europe changed their systems within the last 10 to 15 years. Currently, several countries plan to change their systems. Hence, all results refer to the status quo in 2002.

Physics Education is mostly abbreviated by *PE* and the field of *physics education research* by *PER* in the following.

3.1) Organization of Teacher Training

Fig. 3 shows the variety of different answers to question 1: how do physics teachers get their training? The most obvious feature is the huge variety of different systems, students have to go through to become a physics teacher.

The overall number of replies is much larger than the number of countries (N=22) since more than one answer could be checked. This may be due to different teacher training systems depending on the type of physics teacher. In Germany, e.g., future teachers of physics have quite different training depending on whether they are going to primary, vocational, lower secondary or upper secondary school. Also, the length of the so called "postgraduate year" may differ appreciably, e.g. from 18 months to two years in Germany.

The variety within Europe is quite remarkable and should be kept in mind when discussing common minimum standards for physics teacher training within Europe.

Closely related to the training of physics teachers is question 2: who is actually teaching and doing research in PE (again, multiple answers were possible)? Similarly to question 1, the answers (Fig. 4) show a broad spectrum. Depending on country and/or university: everything seems possible. Teaching is often done by professionals in the field, however, it may also be done by physics teachers or even by regular physicists. This fact will become more clear, when considering statistics.

3.2) Statistics

The section on statistics (Quest. 3) dealt with the number of universities in the country, how many of them offer physics degrees, how many of them train future physics teachers and how many of them employ at least one professor of physics education? For the latter it was asked, where this position is located. Obviously, the questionnaire was weak in question 3 in not defining university unambiguously. In many countries, there are different types of higher education besides regular universities, which also show up in the general statistics on universities. For example, the Hochschulrektorenkonferenz (HRK) in Germany lists 329 universities (Hochschulen). Of those, only 89 are regular universities; in addition there are universities of applied sciences (Fachhochschulen), pedagogical universities, universities of the church and professional academies. In other countries it was noted that, although currently the number of so called universities is still high, it will decrease when some kind of quality standard by accreditation has been introduced. Therefore, and in order not to get lost in the jungle of different types of universities within each country, only the part concerning physics teacher training was analyzed here.

Fig. 5 depicts the number of universities per country, training physics teachers (a) as well as how many universities were employing at least one professor for physics education (b). Since many European countries are small, it is no surprise to find only a few countries with more than 20 universities training physics teachers (France, Spain, Germany and the UK; no answer from Italy was available).

Unfortunately, only a fraction of those do, however, also employ a professor for physics education. As a consequence, at many universities future physics teachers never meet a professional in physics education, but are trained exclusively by regular physicists and/or by physics teachers.

A very interesting point concerns where the positions of the professors of physics education are actually located. Fig. 6a shows that in the majority of countries, PE is located within the physics department. Sometimes, however, it is located in the department of education. In Germany, the situation is even more in favor of the physics department (Fig. 6b). This is important when considering the field to which those professionals feel they primarily belong : a first guess is that location in the physics department could give rise to a closer contact to the discipline of physics. Hints on the real situation will be discussed in the context of Questions 7 and 8.

3.3) Main tasks of Professionals in Physics Education

Question 4 referred to the main tasks of professionals in physics education, as divided into the three categories teaching (what subjects), teacher training (students, in service training, ...) and research. The real activities associated with these tasks are teaching of students at the university, in service training of teachers at universities or other institutions, visiting schools and physics education research.

Fig. 7a shows, that professionals in physics education mostly teach didactics of physics and to a good deal also the discipline of physics, but only very little general didactics (the latter is usually a duty of the department of education). Obviously (Fig. 7b), nearly all professionals teach physics teacher students, but overall, the in service training of physics teachers in the form of courses or seminars for teachers as well as visiting teachers in schools is also very important.

These facts stress the importance of employing professionals in physics education. Usually, experimental physicists do not feel competent to teach theoretical physics courses and vice versa. The same should, however, also apply to teaching physics education for teacher students. These students need more than just physics lectures: they need special education in physics didactics from experts in the field. In addition, teachers need in service training. On physics topics this should of course, be carried out, at least in part, by professional physicists, but physics education topics are equally important, and they should be taught by professionals in physics education.

The main areas of research of professionals in physics education can be divided into three major fields, first empirical research , e.g. on the success of new concepts and methods etc., second curriculum development and third research closer to the discipline of physics, e.g. development of new experiments etc. Fig. 8 shows a nearly equal distribution between these activities within Europe. Within Germany, the situation is similar.

3.4) Research in Physics Education

Maybe the most important part with four questions of the questionnaire concerned the status quo and perspectives for research in physics education. In detail, the experts were asked to judge the possibilities of acquiring research grants for projects in physics education, to give numbers of PhD's in physics education with trends, to judge the relations between researchers in PE and those in fundamental or applied physics and finally to judge the relation between physics departments and research groups in PE.

Fig. 9 depicts the spectrum of answers on the possibilities for acquiring research grants for physics education research (PER). While this is judged to be rather easy in a few European countries, the majority of experts rate it as difficult or very difficult to obtain PER grants. The average answer value of 4.6 on a scale from 1 to 6 indicates the seriousness of the problem. The results within Germany are even worse (average value 4.8).

A direct consequence is the very small number of PhD theses completed in the field of PER within the last five years (Fig. 10). Concerning trends, overall in Europe the number of these students is about constant. There are only 5 countries where more than 5, but less than 40 PhD's were completed, which refers to a rate between 1 and 8 theses per year in the whole country ! Obviously total numbers are not a good measure due to the varying total populations of the participating European countries. The importance of PhD's in PER can however be judged, when comparing them to the numbers of PhD theses in fundamental or applied physics within each country. For example, in Germany, this number was about 1400 - 1500 theses per year in the same period ! Without further proof, it seems reasonable to assume that the ratio of pure or applied physics PhD's to physics education research PhD's within Europe is a large number also in other European countries.

Fig. 11 depicts the experiences of the experts in PE, who were filling out the questionnaires, concerning the relation between researchers in PE and those in fundamental or applied research. Obviously, only very few experts have a lot of contact with colleagues from the discipline of physics. The average value of 3.4 on a six graded scale indicates, that there is much room for improvement. This will be discussed in more detail below.

The relation to physics departments is judged to be even worse, when assessed in terms of support for PE by way of allocated resources and /or positions (Fig. 12). Here the average value decreased to about 4.4 on a six graded scale. Mostly, good support comes from personal contacts within the department, but overall, PE is not supported like other parts of physics.

3.5) Physics Education Communities

Since, if at all, there is at most one position for a professional in physics education per department, PE researchers usually lack communication with other experts. Self esteem of scientists , however, often comes from identification with a community of similarly thinking and acting people.

Therefore two more questions were asked: whether there is a community of specialists in PE within the country, be it informal or organised, and whether there are centers for PER. Figs. 13 and 14 depict the results. In most countries, specialists in PER at the university level are organised. Centres for PER - which allow more extensive investigations - exist only in a few countries, however.

3.6) Political Interest in Physics Education

The last question again asked for a personal judgement of the experts: they were asked about a decreasing or increasing interest by the authorities at university and ministry level in PER or science education research, in general. Fig. 15 shows, that both at the university level (a), and at the ministry level (b) increasing or decreasing interest strongly depends on the country. The spread in the answers might be due to a number of reasons ranging from reactions to the international studies TIMSS and PISA to forthcoming elections and so forth.

4. Discussion

The focus of the following discussion will be on the problem areas in physics education. From the analysis of the questionnaire, in particular referring to Figs. 8-12 and 15, the topics will be physics research and possibilities for grants, the relation between PE and pure or applied physics and the future interest in PE at the university and ministry level. In this context, several comments from various national experts will be cited (*corrected for grammar and highlighted in italics*) and discussed; they will demonstrate that these areas are interconnected.

4.1) physics education research and possibilities for grants

Professionals working in the field of PE have a huge variety of different duties, ranging from actually teaching students via in service training of teachers to visiting teachers in schools. One comment from Belgium stresses the fact, that there is *at most one professor for PE per university*, and *they will have many other duties besides PE*. Due to the small number of professionals working in the field, PE professors usually have more other duties (academic committees, contact with ministries of education etc.) than their colleagues from basic or applied physics. Obviously, the amount of time available for research is low. Still, there are many projects in the three different fields empirical studies, curriculum development and projects closer to the discipline physics.

Problems arise, however, when applying for grants. In Germany, e.g., empirical research is well funded, research close to physics and curriculum research get nearly no grants at all. *Research grants for developments closer to the content (physics) are nearly impossible to obtain*. Germany might still be an example where it is at least possible to get some grants. Eastern European countries like Poland or Romania complain, that *when various groups compete for money, PE is looked upon unfavourable* or openly state that *education research is unsupported and unfunded*. Similarly, *Italian researchers in PE have many problems for their advancement*, therefore they *usually begin with research in different field of physics*.

What are the reasons for the extremely small number of successful grants in PER?

First, researchers in PER have to compete with pure and applied physics. Since grants are usually oriented on the success of the scientific research, criteria being the number and quality of published scientific papers, professionals in PER may have problems. They tend to publish their work in their own language and mostly in unrefereed journals, since they address mostly physics teachers, who very seldomly read research journals, and even less so in a foreign language. As a consequence, research in PE is often not considered to be real research.

Second, even if the scientific quality of the applicant is obvious, PE applications often only have a chance if they deal with empirical studies. This is due to the fact, that in some countries, e.g. in Germany, most referees for PE grant applications believe that studies which do not contain empirical studies are just no real PE research. This is e.g. the reason, why research closer to physics is nearly not funded at all in Germany. Obviously, it is necessary to think about the categories into which PER projects fit and about suitable referees for this field who are not prejudiced in one way or another.

4.2) relation between physics education and physics

In a healthy scientific environment, professionals working in the same department should have a lot of contact and support each other for the common goal of good teaching and good research. For such a case, Figs. 11 and 12 would show narrow distributions centered at small average values. Obviously, physics education is not considered an equal partner in physics departments. This is supported by many comments to the questionnaire. Such comments were received from many different countries, and there were more comments on this topic than on any other one. Thus, even if one allows for the fact that criticism is more easily uttered than praise, it is safe to assume, that there must be a lot of truth to them.

In Belgium, *some physics professors think PE research useless; they teach so well that every student understands everything*. For those physicists, the logical consequence is to think about the necessity for PE in general. Fortunately, there are also *others who are more supportive*. Very similarly, *many research physicists in Poland find a PhD in PE inconceivable. Student and advisor have to be very strong-hearted*. In France, there also seems to be a *general consensus among university physicists that research in PE is not useful*. The reasons given are that *the career of a physicist depends on the rate of publication, not on efforts to improve the quality of teaching*. Not surprisingly, *didactics groups are usually not seen as regular research groups* also in other countries like e.g. the Netherlands. Some German comment tried to explain the rather low support of physics departments : *Research scientist in general stick to the naive belief, that being an excellent physicist is the only prerequisite for becoming a good teacher. Research in physics education has a bad reputation among physicists*.

As these people know everything by profession, they do not see the need for research. There are also some countries where the relation is not really bad, but where - as in the UK - the teacher training is so separate from physics research, that there is *no hostility*, but *simply a lack of interaction*.

Of course, exceptions to the generally bad relations exist. These contacts and/or supports (as is noted from France) depend on individuals in the physics departments, who have an interest in PE. The question obviously is, how professionals in physics education can convince their colleagues from physics, that they are also an important part of the department, and that (as noted by Sweden) PE is not just about producing physics teachers. Instead it should be seen as an integral part of the discipline of physics. This recognition obviously also has a lot to do with the quality of the field, as perceived by physicists when discussing PER.

All the present results strongly support the impression that was tentatively formulated in the reports of the EUPEN group on Research in Physics Education [1]. There is a lack of communication between the two communities, physicists and physics educators. It is due first to the belief of scientists in the validity of the traditional way of teaching, second to a lack of motivation in the collaboration on the part of the researchers in education who feel their work is not considered as valuable by the scientists and third to a similar lack of motivation by the scientists who feel that the physics knowledge of the researchers in education is not up to date. This is accompanied by quite different teaching interests. The physicists teach physics at university level whereas PER people are often more concerned with the school level. In summary, the lack of trust between the two communities was supposed to be due to the *feeling that the one group does not really appreciate and/or master the issues and methods used in the other group*.

4.3) Perspectives for physics education: conclusions and recommendations

Comparative international studies of student achievements (TIMSS, PISA) usually lead to political actions like reforms of the curricula. In many countries, national bodies discussed the future of physics or science teaching. For example, the Wissenschaftsrat in Germany [8] published recommendations for the future of teacher training, which also apply to physics. In summary, the bad situation of didactics in education as to resources and the low level of research grants was critically assessed, agreeing well with the scheme of the results discussed here. Furthermore proposals for improving the situation were given.

However, although in many places the importance of didactics is recognised more and more, the number of scientists working in it diminishes rapidly. Briefly stated: the interest may be growing, but the funding is not. Or as one comment said: *on a general level, interest (for PE) has increased; but as soon as it comes to financial decisions about providing a suitable working base for the physics education department, the interest breaks down*.

The first action would obviously be to take all political actions necessary to stop and, if possible, to reverse the downward trend in the number of PE professors.

Second, the bad reputation of PER among physicists should be improved by getting rid of mutual prejudices. From the side of PE this requires a lot of work, discussions, common projects with regular physicists and efforts to demonstrate the scientific character of PER to all physicists. One way to achieve this would, e.g., be to follow the common standards for quality of research, i.e. submitting papers increasingly to refereed international journals like, e.g., American Journal of Physics (USA) or European Journal of Physics (GB). Alternatively, the introduction of refereed national journals, like e.g. the internet based new journal *phydid* [9] in Germany should be promoted, which would allow that research results would easily be available for the teachers in the respective countries. Furthermore, the quality of national and international meetings/conferences could be improved in so far as research based sections are more clearly divided from those that report teaching everyday experiences, inventing the wheel for the 1000th time or so. Common projects with physicists could include research projects, but also increased involvement in departmental student recruitment programmes and outreach activities of research groups as well as invited talks and special sessions on physics education research at general physics conferences.

Third, the resources for PER should be increased to provide more research grants. In my personal opinion, this will happen as soon as there is success in establishing a real partnership with scientists in pure and applied physics involving mutual respect and recognition of scientific achievements.

Presently, PE sometimes also gets some support from the universities and the national physical societies which were becoming involved in the last decade, due to the rapid decrease in student enrolment in the natural sciences.

The relatively favourable political climate for physics education just sketched may not last, so it becomes all the more urgent for professionals in science education to make good use of it to initiate a lasting improvement in science education in general and physics education in particular. A number of attractive initiatives can provide stimuli towards this goal in the near future, e.g. the GIREP regional forum on the quality of physics education in Udine in September 2003. The EPS with its division of education as well as EUPEN will continue to work along these lines. In addition, international science events like the next Physics on Stage in November 2003 in the Netherlands or the planned World Year of Physics 2005 will attract much interest towards the hopefully common goal, that physics education in school is not just important for the enrolment numbers in natural sciences at the universities but that it should provide physics for everybody as part of our scientific culture.

Acknowledgements

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6. References:

- [1] Report of Working Group 5 - Research in physics teaching, M. Vincentini et al. in *Inquiries into European Higher Education in Physics*, European Physics Education Network Series Vol. 1, 81-104 (1997), ed. by H. Ferdinande & A. Petit; Vol. 2, 143-168 (1998), ed. by H. Ferdinande & A. Petit; Vol. 3, 95-106 (1999), ed. by H. Ferdinande
- [2] In 1999, an EPS founded seminar took place in Malvern (UK), with the title *Securing the future of physics*. It gathered many presidents of the European physical societies and dealt with the status of physics education in Europe and the public understanding of physics. See http://www.malcol.org/eps_seminar/
- [3] information on the physics on stage initiative can be found on various national homepages (e.g. in Germany <http://opal.physik.uni-bonn.de/~mkobel/pos/welcome.htm>) or on the international one: <http://www.estec.esa.nl/outreach/pos/>
- [4] general information on the European Physical Society EPS can be found at <http://www.eps.org/>; the homepage of the division of education is www.nikhef.nl/~ed/EDUCATION
- [5] Conference, on *Teaching physics : a european confrontation*, held in Les Houches in June 2002; after the meeting, a questionnaire was developed which shall gather all relevant data on the system of PE in Europe. See also contribution to this proceedings, contact: jacques.treiner@noos.fr
- [6] 2nd International Girep Seminar 2003 on Quality in teacher education, September 1-6 2003 in Udine (Italy), for details on this and earlier meetings see <http://www.uniud.it/cird/>; general information on GIREP can be found at the site <http://www.girep.org/>
- [7] M. Vollmer, Results of the analysis of the EPS questionnaire within Germany, to be published
- [8] <http://www.wissenschaftsrat.de/texte/5065-01.pdf>
- [9] <http://www.phydid.de>

Figure Captions :

- 1) Political map of Europe (after <http://www.lib.utexas.edu/maps/>) with those countries marked, where experts replied to the questionnaire.
- 2) Political map of Germany (after <http://www.lib.utexas.edu/maps/>): experts from all 16 states (Bundesländer) replied to the questionnaire.
- 3) Spectrum of answers to the question: how do physics teachers get their training.
- 4) Teaching and research in PE is actually done by professionals in the field, physics teachers as well as physicists.
- 5) Number of universities per country training physics teachers (a) and number of those universities employing at least one professor for physics education (b).
- 6) the position of the professors of physics education is often located within the physics department in Europe (a), and even more so in Germany (b).
- 7) Professionals in physics education teach mostly didactics of physics and to a good deal also the discipline of physics, but only very little general didactics (a). The contact does not only take place while teaching physics teacher students, but also during in service training of teachers as well as while visiting teachers in schools (b).
- 8) The main fields of research of professionals in physics education in Europe are empirical studies, curriculum development and research closer to the discipline of physics.
- 9) Acquiring research grants for physics education research is more or less difficult.
- 10) Number of PhD thesis, completed in the field of PER within the last five years.
- 11) Personal experiences of experts in PE concerning the relation between researchers in PE and those in fundamental or applied research.
- 12) Judgement on support of PER by physics departments.
- 13) In many countries, communities of specialists in PE exist.
- 14) Only very few centers for PER do exist in Europe.
- 15) Interest of the authorities at university and ministry level in PER.

Pages 7 ff : appendix: the questionnaire

Questions to the national expert on physics education research and teaching

Physical Society:
Country:
National expert:
Address:

Telephone:
Fax:
Email:

Introductory remarks

In many countries, different types of teachers are trained at different institutions, e.g. teachers for high schools that give access to university are often trained at universities, teachers for elementary, vocational or "lower type" high schools are trained in some countries at universities, in others at non-university "academies". In this questionnaire we want to collect data on a European scale on

- the situation of physics teacher training at universities by professionals as well as
- research activities by professionals in the field of physics education.

In some countries such professionals are professors for physics education, in other countries they may belong to the senior staff. The latter - in the context of this questionnaire – should be counted as professors when they are engaged in largely unsupervised research and teaching.

Unfortunately, the nature of the activities of these professionals is many-fold and therefore also described in different words in various countries, sometimes even within one country. For example, professors for physics education in Germany have at least three types of duties: firstly education of students who want to become physics teachers, which includes didactics of physics as well as teaching of physics, secondly continuing education of physics teachers and thirdly physics education research. For this reason, this questionnaire covers all of these areas.

Please feel free to add any comments. There is some space left below each question; you may also add them at the end of the questionnaire.

A) How is the physics teacher training organised in your country

1) How do physics teachers get their training ? (multiple answers possible)

- a) they follow a special programme for physics teachers (maybe in combination with another subject) at a regular university
- b) they follow a special programme for physics teachers (maybe in combination with another subject) at a specialised university (e.g. University of Education, Teachers College)
- c) they have to complete a regular physics degree, to be followed by a "postgraduate" year, also taken at a regular university.
- d) they have to complete a regular physics degree, to be followed by a "postgraduate" year, which is taken at a specialised academic/ non-academic institution
- e) other system, please specify

Comments:

2) Who does the teaching and research in physics education? (multiple answers are possible)

- a) Professors/staff members especially trained and/ or appointed for this task
- b) University physicists from various groups who developed an interest in it and devote part of their teaching and research to it
- c) High school teachers hired to teach didactics courses (no research)

Comments:

b) Are there trends in the number of such students?

| | | |
|------------|----------|------------|
| decreasing | constant | increasing |
| | | |

Comments:

7) What is your experience of the relations between researchers in physics education and those in fundamental or applied research at the universities?

| | |
|------------------|-------------------|
| a lot of contact | no contact at all |
| | |

Comments:

8) Are physics departments supportive of groups working in physics education in allocating positions and resources?

a) there is a general trend:

| | |
|-----------|------------|
| very much | not at all |
| | |

b) it strongly depends on the physics department.

Comments:

E) Physics education community (university level)

9) Is there a community of people who are specialists in physics education? yes no

If yes: it is informal

it is organised (please provide contact person)

Comments:

10) Are there any centers for physics education research outside the universities in your country? yes no

If yes: could you give details on size and importance

Comments:

F) Political Interest in Physics Education

11) Do you sense a growing or diminishing interest among authorities for including science didactics or science education research in universities in your country?

At the university level (rector/ president)

| | |
|---------------------|------------------|
| Interest decreasing | interest growing |
| | |

at the ministry level

| | |
|---------------------|------------------|
| Interest decreasing | interest growing |
| | |

Comments:



Fig. 1

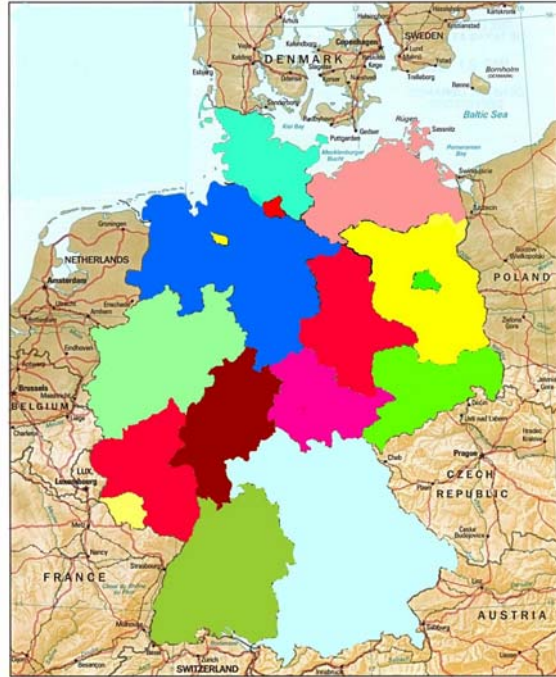


Fig.2

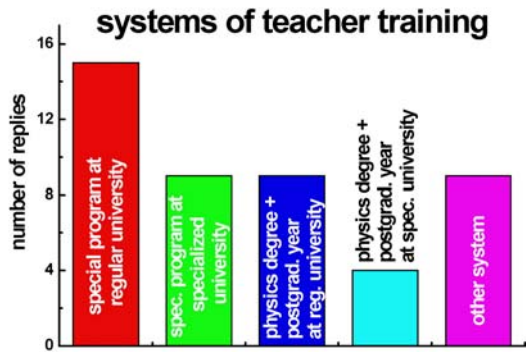


Fig.3

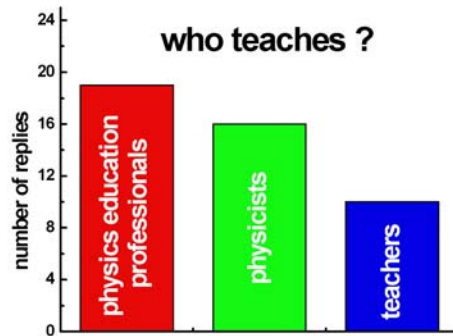


Fig. 4

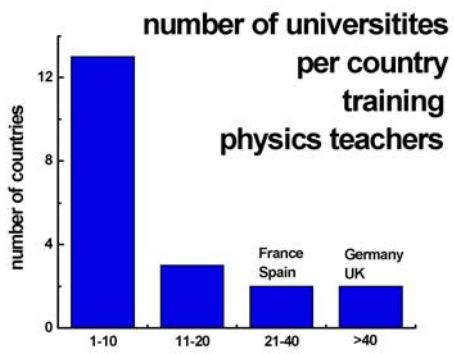


Fig.5a

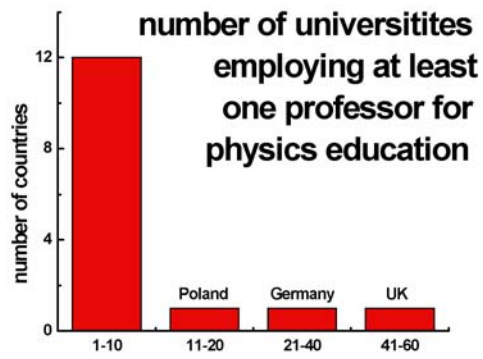


Fig. 5b

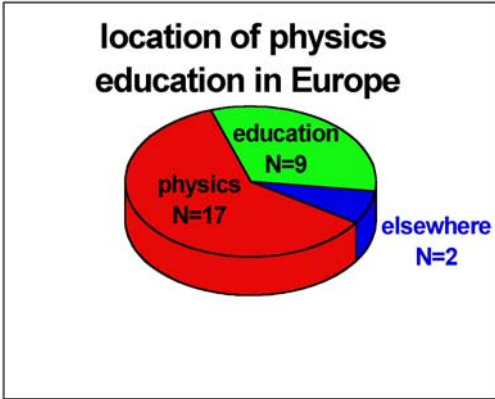


Fig. 6a

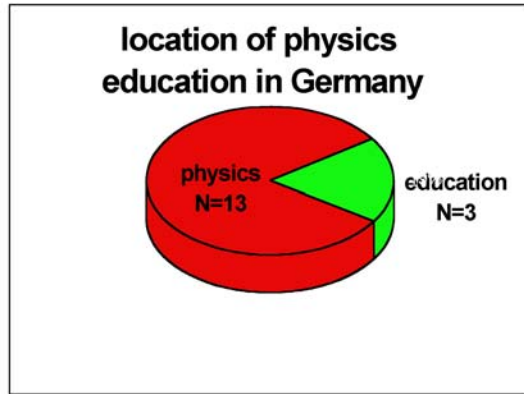


Fig. 6b

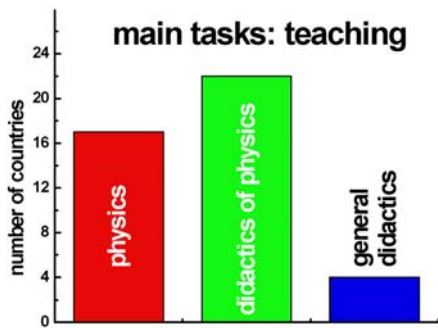


Fig. 7a

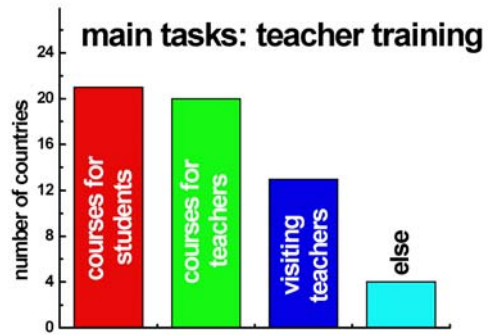


Fig. 7b

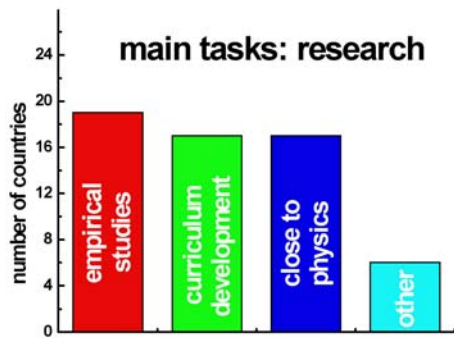


Fig. 8

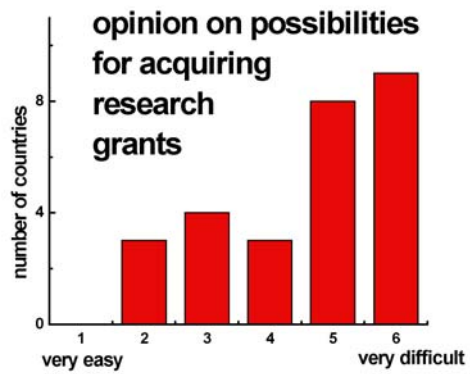


Fig. 9



Fig. 10

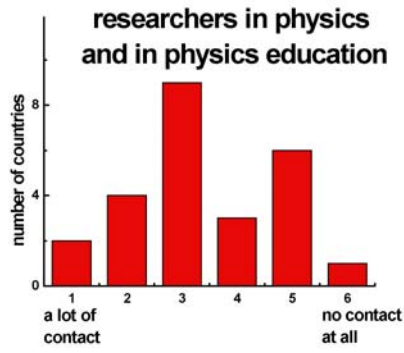


Fig. 11

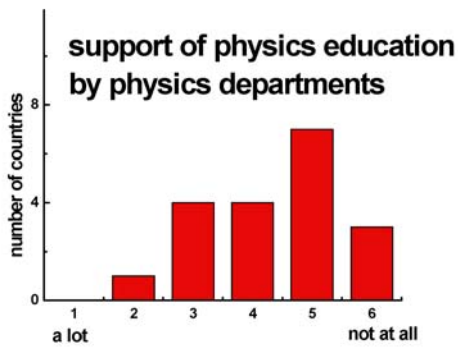


Fig. 12

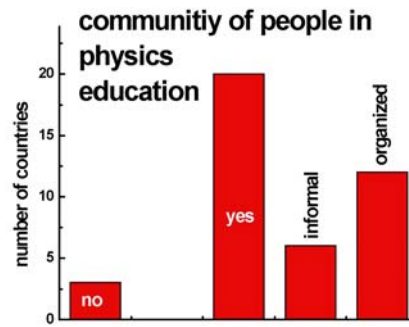


Fig. 13

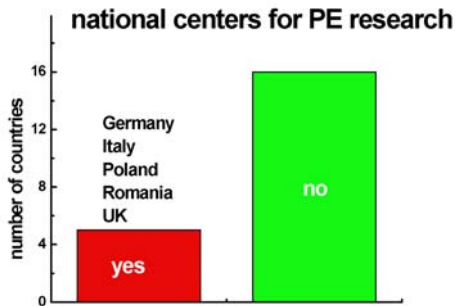


Fig. 14

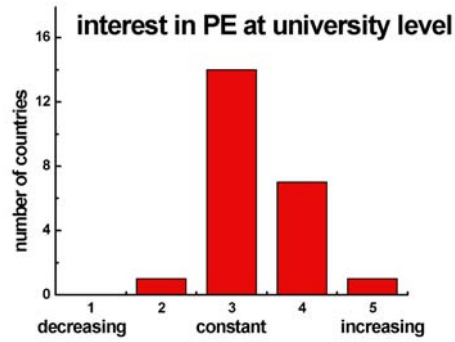


Fig. 15a

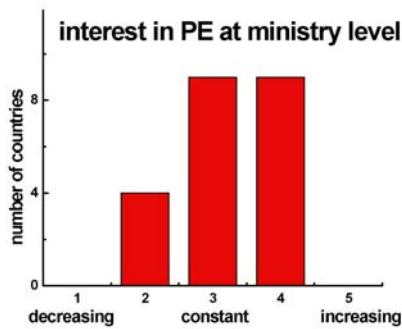


Fig. 15b