

IFUSP/P-719
B.I.F. - USP

UNIVERSIDADE DE SÃO PAULO

INSTITUTO DE FÍSICA
CAIXA POSTAL 20516
01498 - SÃO PAULO - SP
BRASIL

PUBLICAÇÕES

IFUSP/P-719

25 AGO 1988



NETWORKS, PHYSICS EDUCATION AND DEVELOPMENT

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(Paper presented at the Congresso Inter-Americano de Ensenanza de Física, Oaxpetec, Mexico, July 1987).

Junho/1988

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Como não falo bem o espanhol, eu pretendia falar hoje em "portinhol"; entretanto verifiquei que isto traria dificuldades para a tradução simultânea. Vou então falar em inglês, mas as transparências são em português.

I- INTRODUCTION

The theme which was proposed to me is very general. Education is a subject which depends very much on the specific situation in each country. At this conference I was again struck by the great lack of information which most of us have about even the simplest aspects of school systems and education in other countries. I certainly do not have enough knowledge to say much about education in other countries.

The role of conferences such as this one is to get to know people in other countries who work on physics education problems and to know what they are thinking and doing. Contact after the conference is difficult to maintain in a regular fashion, and I am somewhat sceptical about the establishment of permanent networks in between conferences. However the reports of the working groups this morning show an enthusiasm which may prove me unduly pessimistic.

Thinking about what to say to you, it seemed that the best I could do was to tell you a little of our own work at the Universidade de São Paulo, as a sort of "case study" of the development of activities in physics education in one institution - you can call it a local network. Perhaps in examining the history of

this group, we can learn from our mistakes and from what we did right (ref. 1).

2. The "Teaching Group" at the Instituto de Física da Universidade de São Paulo.

Figure 1 shows a block diagram of the working of the "teaching group" of the Instituto de Física, and table 1 gives some of the pertinent numbers. The Instituto de Física has about 180 faculty and teaches undergraduate physics courses (please note that in portuguese these are called "de graduação", while graduate is "de pós-graduação") to students of engineering, chemistry, mathematics, biology, physics (a degree for work in research and industry and another degree for secondary school teaching). The physics teaching degree is taught jointly by the "Instituto de Física", the "Faculdade de Educação" and the Institutes of Mathematics and Chemistry. The "Instituto" also maintains a post graduate program in many branches of physics, and about ninety percent of the research efforts go into "pure" and applied physics. The diagram gives details only of the small part of the total activities of the Instituto devoted to research and development on physics teaching. A post graduate program in physics teaching is offered jointly with the school of education, and contains courses and seminars, and research along several lines. Also connected to the program are curricular development projects, a program of in service training of teachers, and science popularization activities, particularly scientific and technological exhibitions. The coexistence of the teacher training and curriculum activities with the research on teaching has proved very fruitful. The ideas developed in the research can be discussed and tried out in the training courses, providing rapid critical feedback for the research.

Some of the external connections of the physics teaching group are shown in the lower part of the figure. Not shown are connections with the educational authorities of the state of São Paulo, concerning teacher training and curricular matters, nor the connections with the federal Ministry Education, which supports financially much of the program. The academic intercourse is furthered by the Sociedade Brasileira de Física (SBF) (ref. 2), which has as members both physicists and physics teachers (in U.S. terms, it is as if APS and AAPT formed one society). The annual meetings of the SBF always include sessions on teaching on physics, and every two years a special meeting on the subject is convened, with about 800 participants. The SBF publishes a journal on physics teaching - Revista de Ensino de Física - separate from its bulletin and physics journals.

Other firmly established and active groups in physics teaching research and development exist at several universities (in parenthesis the name of a member of each group): Universidade Federal do Rio de Janeiro (Susana Souza Barros), Universidade Federal Fluminense, Niterói (Célia D. Ure), Universidade Federal de Minas Gerais, Belo Horizonte (Beatriz A. Alvares), Universidade Federal do Rio Grande do Sul, Porto Alegre (Marco A. Moreira).

International contacts in Latin America have been mostly through the CLAF- Centro Latino Americano de Física (ref. 3). Unfortunately the activities of CLAF have decreased in recent years - it is important to revitalize them. General international contacts have been much influenced by the conferences organized by ICPE.

The post-graduate program in physics teaching has profited from visits by Brazilian and foreign workers in the field who have given courses and seminars and participated in research.

3. Brief Historical Sketch

We will now sketch briefly the development of the group since its beginnings. (see fig. 2)

The Universidade de São Paulo was established in 1934, although some of its component schools, like law and engineering, are much older. At the same time a Physics Department was established in the new "Faculdade de Filosofia, Ciências e Letras". It is interesting to remark, in connection with Prof. Kerwin's lecture this morning, that this new school had as its objectives to educate researchers and school teachers, in the same institution. Two physicists were brought from Italy to start the Department, Gleb Wataghin and Giuseppe Occhialini. They started research on cosmic rays, and already in 1936 significant results were published in international journals, in collaboration with several Brazilian students, among them Mario Schenberg and Marcelo Damy S. Santos. The rapidity of the establishment of a research group in São Paulo has been noted by historians of science, indicating that very favourable conditions existed there in 1934. It is also interesting that many of the pioneer Brazilian physicists, mathematicians and chemists came from the city of Recife, and were strongly influenced by a teacher and professor there, Luis Freire. In São Paulo, Mario Schenberg belonged to this group (ref. 4).

In 1937 the Vargas fascist-like dictatorship began in Brazil, and shortly thereafter the world war in Europe. In 1940 Brazilian ships were sunk by German submarines and Brazil entered the war in 1941. The Physics Department collaborated in the development of sonar to protect the ships, and later also radar. The explosion of atomic bombs in 1945 increased the importance, of physics activities from the point of view of the government and of society.

After the world war democracy was reestablished in Brazil and physics, and science in general, was

furthered. New physics institutes were established in Rio de Janeiro, in São Paulo and in other cities, the Sociedade Brasileira para o Progresso da Ciência - SBPC (similar to the British BAAS or U.S. AAAS) was founded, and the "Conselho Nacional de Pesquisas" (National Research Council) was established as the first funding and policy agency of the federal government for science. At this time also the first nuclear accelerator, a Betatron, was established at the physics department of the Universidade de São Paulo.

In 1953 the first training course for secondary school physics teachers was held. This was not held in São Paulo, where the emphasis was all on research, but in an Air force engineering school in a nearby town. The proceedings of this course, and of another one held two years later, are interesting because they contain a diagnosis of physics teaching in Brazilian schools at the time: bookish, far from reality, rote learning, no laboratory or practical work. One feels a desire of the participants to change this situation, and here is probably one of the reasons why the PSSC course was received with so much enthusiasm and hope in Brazil a few years later. At this time also a local institute affiliated to UNESCO, IBECC, was established, and soon became active in science education, emphasizing practical activities.

In 1956 the PSSC curriculum project started in the U.S., and, soon after the launching of the Sputnik artificial satellite by the USSR, led to the establishment of several multi-million-dollar projects for science education in the U.S. and later in other countries.

Brazil was one of the first countries to translate the PSSC course. After a few years, however, it became clear that the course was not appropriate for the schools: it was too difficult, and most teachers did not understand it well.

In 1963 UNESCO organized a Pilot Project in physics teaching in Latin America, mentioned in an

earlier talk by Al Baez, which had its headquarters in São Paulo, initially at IBECC and later in the Physics Department. In this project several European and North American experts worked with Latin Americans to develop a curriculum on optics for schools. Educational technology was used, programmed instruction, teaching films and simple lab equipment were produced, but the material was never widely distributed.

In the same year two conferences on physics teaching were held in Rio de Janeiro, one interamerican, the other international, sponsored by ICPE-IUPAP.

In 1964 there was a coup d'etat and a military regime was established in Brazil. The Sociedade Brasileira de Física was founded in 1966. In 1968 there were many student protests throughout the country, and especially in São Paulo. Partly as a consequence, the University Reform law was finally enacted, after several years in Congress. The law had several modernising features, but it dissolved the teacher training Faculdade de Filosofia, Ciências e Letras into several scientific institutes and a Faculty of Education, which was bad for teacher training courses. At the end of that year a new coup d'etat caused a transition from dictatorship to tyranny. Repression on student movements became very strong and many professors were removed from the Universities for political reasons, among them several leading physicists and directors of the Soc. Bras. de Física. Those were difficult times for the whole country, and for physics.

The first national symposium on physics teaching was held in São Paulo in 1970 and was a great success. Several hundred teachers and professors from the whole country attended and discussion was very lively. There was a consensus that new national curricula must be developed. Soon thereafter a curricular project called PEF- "Projeto de Ensino de Física", started at the

"Instituto de Física" with support for the Ministry of Education. This project, designed for secondary schools, produced four volumes on Mechanics, Electricity, and Eletromagnetism, with kits to make experiments in class. The material was of good quality, with some very creative solutions: for example a sandclock-chronometer with 0,2 second precision, and a very simple model electric motor.

Shortly afterwards we also started producing teaching films (film-loops), in collaboration with the cinema department of the University, and with initial help from Al Baez.

Another independent group developed texts for secondary schools as programmed instruction.

At this time the journal "Revista Brasileira de Física" started publication, containing a section on teaching. In 1972 the first degrees in physics for work in teaching were granted to Claudio Z. Dib in São Paulo (Doctorate) and to Marco A. Moreira in Porto Alegre (Master).

In 1973 the post graduate program in physics teaching started in São Paulo; a previous attempt in 1969 had not been approved by the University authorities because it was located only in the Instituto de Física. In 1973 the Faculdade de Educação also participated. It took several years for the first degrees to be awarded but by now about 40 master's thesis have been approved, some of them quite good. Initially there were few advisers, I bore some 80% of the load, but now I am down to something like 10%. Several of the masters have gone on to a Doctor's degree in Education or in Physics.

The political situation in the country started to liberalize slowly in 1974; amnesty was granted in 1979 and a civilian government was elected in 1985.

In 1979 the SBF started publishing a separate journal for physics teaching. At about this time at the Instituto de Física we started organizing apparatus exhibitions for secondary schools. The early eighties

were years of little money for research and development, and the level of activity was low. However in 1985 a special financing program for science teaching was established, and several large programs started at the Instituto de Física: a curriculum program developed with a group of teachers and starting from everyday life problems, a program of teacher training courses, in collaboration with the state government, a scientific exhibition about Halley's Comet in 1986, which was a great success and gave much contact between university and schools, and another, larger, exhibition on Energy, in 1987.

The national symposia on physics teaching have been held every three or two years, the most recent one in São Paulo this year. Weekly seminars on physics teaching have existed since 1973 at the Instituto de Física.

Table 2 lists some of the research programs, and table 3 some of the dissertation themes. The tables show a great variety of lines of work. The group started out with a strong behaviorist influence in the seventies, but other lines of thought soon appeared, such as Piaget and "spontaneous concepts", which is presently a popular theme. The ideas of Paulo Freire also influenced several dissertations. Historical and philosophical studies of physics concepts also are being done.

4. Overview

We will now make some general comments about this story.

The group specially devoted to studies and research in physics teaching developed at the Universidade de São Paulo after physics research was already firmly established. It started with curriculum

development, including texts, laboratory apparatus and films. The post graduate program came afterwards, after several research and development projects were under way. This program is a joint program with the school of Education, which emphasizes the fact that although physics education depends in an essential way on physics, it is not physics.

The basic ideas, the initiative and the effort to establish the group were all local. For sure, international ideas and experts furnished ideas, advice and help, but these were ancillary. Foreign visitors gave courses, ideas for projects, good advice. However the establishment of such a group is clearly a local task.

Education is an activity where national and local conditions differ widely and make a big difference. We have had several examples, in Brazil, where ideas from international organizations, led to serious mistakes in educational policy (ref. 5).

Now some critical comments, where I think the group has not done well: There are very few publications about the Group's work, particularly the master's dissertations are unpublished (ref. 6). The research in this field is not yet on a firm footing, in my view; this is not a criticism of our group only, but more general. The courses in our post graduate program are not adequate, and must be improved. On the other hand, so far only the Master's program has been established, and it is necessary to establish the doctorate.

Perhaps the greatest criticism is that the external effects of the group's work are still very small: the teaching at our own institute, in secondary schools and in other universities has as yet improved very little as a consequence of our work.

5. Conclusion

Networks can have positive effects if they represent collaboration of independent groups. They depend on the existence of strong local groups and national networks must be strong before international networks can be useful. It must be borne in mind also that networks can be instruments of domination.

Different countries have divergent interests and great tensions exist between them. Present examples are the foreign debt of Latin American countries to the rich countries in North America and Europe, and the situation in Nicaragua. International collaboration in physics education, as in any other field, cannot ignore these tensions.

Fig. 1

11.

References

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3. Adress: Centro Latino Americano de Física, Av. Wenceslau Braz 71, Z.C. 82, Rio de Janeiro, RJ - Brasil.
4. Ivone F.M. e Albuquerque e Amélia Império Hamburger, Retratos de Luis de Barros Freire como Pioneiro da Ciência no Brasil, Publicação IFUSP/P-628, Fev. 1987.
5. For example, the attempt to introduce "integrated science" as the preferential way to train teachers of scientific subjects.
6. We are at present preparing a book containing twenty page resumes of the dissertations. Helyny U. Gama e E.W. Hamburger, to be published.

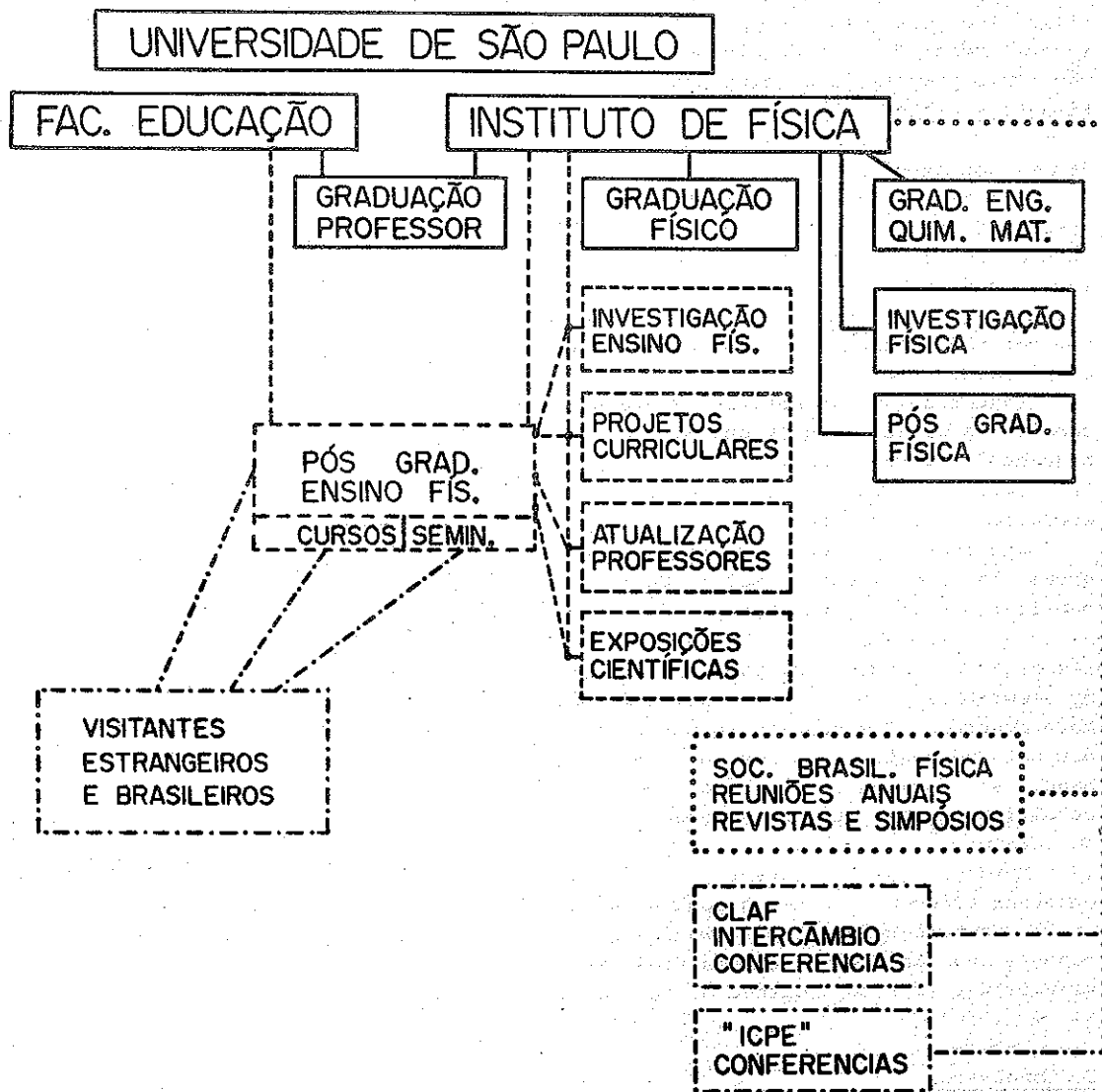


FIGURA 2 - Development of Physics Teaching at USP in parallel with national and international events

| | | |
|------------------------------|------|--|
| Vargas | 1931 | |
| | 1934 | Universidade de São Paulo (USP). Departamento de Física. |
| | 1936 | Raios Cósmicos. Wataghin, Occhialini, Schenberg, M.D.S. Santos et al. |
| Ditadura Estado Novo | | |
| Guerra Mundial Bomba Atômica | 1940 | Sonar (marinha) |
| | 1948 | SBPC (Sociedade Brasileira para o Progresso da Ciência) Betatron |
| | 1951 | CNPq (Conselho Nacional de Pesquisas). |
| | 1953 | 1º Curso Treinamento Professores Física - Diagnóstico: Ensino Livresco, sem realidade, sem laboratório. |
| PSSC | | |
| Sputnik | | Ensino de Laboratório. IBECC (UNESCO). |
| | 1960 | Tradução Brasileira PSSC. |
| | 1963 | Projeto Piloto UNESCO. Tecnologia Educacional. Instrução Programada. Filmes. Conferências Ensino de Física, Rio, OEA, UIPPA (IUPAP). |
| Ditadura Militar | 1964 | |
| | 1966 | Sociedade Brasileira de Física (SBF) |
| Tiranía Repressão | 1968 | Movimentos Estudantis. Reforma Universitária. Tentativa - Pós-Graduação em Ensino. |
| Expulsão de Professores | 1970 | I Simpósio Nacional de Ensino de Física. Projeto Curricular: PEF. Produção de filmes didáticos. Instrução Programada (FAI). Revista Brasileira de Física C.Z. Dib, M.A. Moreira (teses de ensino de Física). |
| | 1973 | Pós-Graduação em Ensino de Física |
| Abertura Política | | |
| | 1977 | Primeiros Mestrados em Ensino de Física em São Paulo. Exposição Experimentos de Física. Revista de Ensino de Física (SBF). |
| Anistia | | |
| Governo Civil | 1985 | \$\$ Para Projetos de Ensino. Currículo. Atualização Professores. Exposição Halley. |
| | 1987 | Exposição Energia VII Simpósio Nacional de Ensino de Física |

TABELA 1 - Dados Numéricos sobre Física e USP (1986)

| | | | |
|-------------------------------|------------------|---------------|--------|
| Alunos (total) | USP | Graduação | 35.000 |
| | USP | Pós-Graduação | 12.000 |
| Alunos Ingressantes (por ano) | USP | Graduação | 6.000 |
| | Física | Graduação | 260 |
| | Física | Pós-Graduação | 50 |
| | Ensino de Física | Pós-Graduação | 10 |

Professores: USP 5.000, Instituto de Física 180, Ensino de Física 12

Diplomas (por ano): Graduação Físico (Bacharel) 60, Professor Física 20, total 80
Pós-Graduação Física (M) 20, Dr. 10, Ensino de Física (M) 4

Atualização de Professores: 30 cursos para 900 professores

TABELA 2Linhas de Trabalho

Desenvolvimento e Avaliação de Currículos
Produção e Avaliação de Filmes e Aparelhos
Formação de Professores
Atualização de Professores
Estudos Históricos e Epistemológicos
Conceitos Espontâneos
Tecnologia Educacional
Instrução Programada e Personalizada
Ensino de Laboratório

TABELA 3Alguns Temas de Dissertações

- O "PEF" individualizado (met. Keller)
- Avaliação do "PEF-Projeto de Ensino de Física"
- Laboratório didático na Universidade
- Análise dos exames vestibulares
- Laboratório para escolas médias
- Graduação em Física na USP
- Ensino de Ciências a partir dos problemas da comunidade
- O currículo de Física nas escolas
- Conceitos intuitivos de Força, Velocidade, Aceleração
- Origem do conceito de Entropia e 2a. Lei da Termodinâmica