Research on science education in Europe; Improvement of research activities and results*

The purpose of this contact workshop was to make provision for improvising research in science education in member states and for disseminating and applying its results more effectively.

For the first time such research was systematically documented on a European basis. The national reports were then analysed to show the current state of this research, to highlight research tasks and needs and to indicate what action should be taken.

This paper is an attempt to summarise the documents and the proceedings in a non-technical way without making reference to particular reports or individual countries, and to encourage discussion of some of the more general issues that were raised. A more detailed account, together with the workshop papers edited by the organiser, Professor Karl Frey, Director of the Institute for Science Education (IPN) in the University of Kiel, is expected to be *published* in the Spring of 1977 by *Swets Publishing Company of Heereweg 347b, Lisse, Netherlands*. That report will be the most complete description to date on research in science education in CCC Countries.

2. *What is science education?*

'Teaching in science' usually starts from an analysis of what pupils need from scientific subjects: whatever is put into the curriculum should be justified by assessing such needs. It is generally accepted that children should have an understanding of the physical world around them, to learn to deal with natural resources in a responsible manner and to act independently in a world that is based on scientific technology. It is further agreed that they need a knowledge not only of their bodies and their effective functioning, but also of the relationship between biology and social problems – commonly called social biology. Pupils should have information on which to base their choice of future studies, and their employment on which eventually the economic well-being of their countries might be based.

If the objectives in the different countries are the same why then do many of them develop their own curricula to reach these goals? Could there not be an international core curriculum graded according to age and ability which each country could adopt or adapt?

It is frequently argued that science makes a unique contribution to pupils' development since it gives them a knowledge and understanding of objective facts as well as an approach to acquiring this knowledge and understanding that no other subject can rival. If it be true that every European should know a second language then it is even more true that each should have competence in dealing with the scientifically determined world. Such is the claim. Is it true? If so, why do so many children find science unsatisfying and why are so many places in the science or technology faculties in higher education unfilled? Do not other disciplines teach scientific method? Has science education any claim for preferential status in the curriculum? How does one combine the expectations of pupils, parents and employers from the science education provided in schools and colleges with the enormous and rapidly expanding sphere of scientific knowledge? On what criteria can a teacher determine which aspects of science are crucial? Should all science teaching be in unified science or would this cause a loss of intellectual rigour? Should all 'arts' students at least until the age of sixteen learn 'in science' and be taught

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'through science' so that they can recognise and evaluate assumptions, examine evidence critically and develop and test hypotheses in a methodical way, realising that the experimental method is only one of several ways of reaching decisions?

3. *Research in science education*

This is a relatively new branch of study that has grown rapidly during the past ten years to determine optimum conditions for science education. It is therefore concerned with all aspects of the learning situation, for pupils of all ages and at all levels and must draw heavily on findings from other disciplines, particularly from psychology, theory of science, sociology and from educational practice on how people learn.

To be successful research in science education must be based on the involvement of teachers. It finds many of its problems in the classroom and many of its answers must be tested there.

4. *The current situation*

In many member states far-reaching changes are talking place in the structure of educational systems, in the curricula to be followed and in the teaching methods to be adopted. Education in general, and science in particular, is seen as the key to national well-being and to international status. In the last fifty years technology has transformed peoples' lives. To be worthwhile science teaching must respond to these developments, to social pressures and to changes in society. Yet research in science education is still embryonic.

In many member states its main efforts have been directed towards developing and evaluating new science curricula. But there are wide differences between countries with regard to curriculum objectives and the proportion of pupils to whom the new course of study are intended to apply. There is also considerable contrast between member states in the methods of curriculum development and evaluation employed, between the types of institutes involved and between the number of researchers and the funds that are available for such enquiries. In some countries there is virtually no research in science education and they depend heavily on imported materials and publications. In others there are highly developed procedures for curriculum innovation and evaluation backed by the financial and administrative support of government departments and independent foundations, and centred on highly organised and influential research institutions.

In some countries there is no curriculum evaluation of even the most rudimentary kind whilst in others there are procedures for strict assessment. And similarly the publications range from individual research reports, through leaflets of guidance to teachers, to lengthy series of curriculum materials that have been intensively developed and tested. Although these curricula have been principally designed for pupils of primary and secondary schools there is also some activity for students in university and certain branchers of adult education.

In psychological studies connected with science education particular attention has been paid to concept development. Within very broad margins there appear to be certain age limits for the formation of certain concepts. Perhaps the best known evidence of this comes from the work of Piaget on a variety of concepts such as 'conservation'. Increasing interest is being shown by young people in such abstract terms as evolution and dynamic equilibrium. Parallel enquiries have also been carried out in the humanities and social sciences with such concepts as goodness, justice and prejudice. This type of study has been particularly important in helping to determine the subject matter that is appropriate to pupils in the various stages of intellectual development.

Enquiries into styles of thinking are also of special relevance to science education. Many, perhaps most, children find science, difficult to learn. Is this because the subject is intrinsically difficult or is presented in an inappropriate form? Or is it a matter of a qualitative intellectual difference involving a particular mental approach or special cognitive style? And, if they exist, are such qualitative differences in learning ability inborn or are they the result of experience and training? If they can be taught, how can you teach them?
On the other hand if science is intrinsically difficult can it be made easy? Can the material be structured in such ways that the pupil passes easily from one step to the next? What methods are best employed? What should be the role of the laboratory and what place have investigatory methods of learning?

To formulate the questions in this manner is, however, to look at them solely from a psychological viewpoint and not from that of education or science. The argument from research into science education is that physics is not difficult. It is the way in which teachers have been teaching it which leads to the special highly formalised method of learning. This, however, has nothing at all to do with physics as a science. The same is true for chemistry and biology.

Do the conditions under which children study science create unfavourable attitudes which lead in their turn to lack of success and a swing away from science? Psychological studies of attitude formation are especially relevant here. So too are those of linguistics. If it be true that school demands a vocabulary that less able children from less cultured homes do not use normally this is particularly so in the sciences (and in mathematics) where the language is highly specialised and often symbolic. To what extent might this determine an attitude against science?

Such studies are intrinsically linked with aspects of sociology, but in member states there appears to be little research into the sociological aspects of science education except in one country where sociological factors which affect student interest in science are being studied.

5. *Some problems and their solutions*

To such research tasks as those suggested above one might add the reluctance of girls to study natural science, how to develop inventiveness and imagination in science, and the possible conflicts between ethical and scientific issues, and between the demands of society and the demands of the individual.

These questions are of evident importance but they cannot be investigated without money and trained researchers. At the moment both are in short supply. Furthermore there is generally little stimulus from traditional faculties of education at universities. In many countries research in science education has been low on the list of educational priorities. In some countries the place of science education in the curriculum is not fully accepted and there is virtually no funding of research in science education. In only two or three member states is there any career opportunity in such research.

Members of the workshop at Malente recommended that when research grants are available funding agencies should be able to seek the opinion of advisory groups on the proposals submitted. Such panels should most importantly contain teachers, researchers and representatives of the public and of industry. It was also recommended that smaller countries should be able to seek advice on research projects from well-developed research centres in other member states.

This suggestion on co-operation was strengthened by discussions on bases for co-operation on current projects, and arrangements for the exchange of young researchers.

With the financial support of IPN a pilot exchange programme will be initiated and in due course IPN will report on its effectiveness. A number of researchers will spend two to four months in a co-operating institution on a reciprocal basis. They will not follow a special programme but will join in current research. This it is hoped will spread information on research activities, will help avoid unwitting duplication of effort and will give the host institution a source of 'outside advice'. In particular such exchanges will help in preparing and carrying out co-operative projects.

Research in education can so often become divorced from the work of the classroom. Usually this is because the researcher must renew and remodel the problem in order to formulate an effective research design. But by so doing he often makes his work remote from the problems which the teacher is conscious of facing every day in school. In many cases too even if the research information would be helpful, the teacher does not know where to find it, nor how to understand it or apply it when he has found it.

The workshop therefore stressed the need for the in-service training of teachers on a regular basis. Schemes whereby teachers might be released for two or three half days a week to engage in research programmes, possibly leading to masters' or doctors' degrees were particularly commended. School inspectors and advisers could also be encouraged to take part in such programmes. Such people who are actively engaged in science education might help to overcome the difficulty that research in science education cannot be effectively carried out by investigators who are competent only in the natural sciences. They need the help of specialists in educational theory and practice. They need the active support of teachers. This has yet to be gained in many areas.

Teacher training, co-operative research and the exchange of researchers are all aspects of improving the information flow. Perhaps the biggest problem facing contemporary society is that of communication and information exchange.

6. *Information exchange*

The first step in research is to review the relevant literature in order to learn from the enquiries of others, but generally within Europe, there is little exchange of ideas on research in science education. Language barriers are knowledge barriers.

The workshop therefore recommended that a

national correspondent should be appointed for each country and among his responsibilities should be that of ensuring that researchers in science education are included in the national surveys and are linked into the EUDISED system.

Under the initiative of the Council of Europe, fourteen of the member states currently publish for national needs an annual or biennial survey of ongoing or recently completed educational research. Details are listed in accordance with a scheme agreed between national editors and they are indexed according to a multi-lingual thesaurus. The survey reports are distributed internationally on an exchange or commercial basis according to an international mailing list. The more important of the researches selected by the editor are included also in the form of computer printouts in the Bulletins of EUDISED R & D (European Documentation and Information System in Education, Research and Development). The Council of Europe has offered to devote one issue of the EUDISED R & D Bulletin in 1977 to research in science education.

Bulletins and surveys can be compiled, printed, distributed and widely publicised but this does not ensure that they contain all the researches that should be included nor that those who need them know they exist nor that when they are available those who should refer to them will in fact do so. The Council of Europe has undertaken to inform all members of the workshop of the titles of the national surveys currently available and the names and addresses of all the editors. It will be the responsibility of the national correspondent for research on science education to offer his help to the national editor in ensuring that details of appropriate researches in science education are included in the national registers. The IPN together with the Council of Europe will co-ordinate this procedure. It will also be the duty of this national correspondent or a suitable colleague to prepare from the national registers a current awareness list for possible circulation within the proposed International Journal of Research in Science Education.

7. *International Journal*

The members of the workshop agreed that there was a need for a journal that would gather the important results of European research into science education and would publish them in English. They recommended that such a journal should contain original articles, abstracts, reviews, descriptions of research centres, information about funding agencies, news of exchange opportunities and letters to the editor. It was envisaged that each issue should also contain a resource letter of 6 to 15 pages which would be a source of ready reference on some particular issue. It would be written by a small team and in addition to encapsulating the main aspects of the subject would give a short annotated bibliography and a list of relevant audio-visual teaching materials.

The Journal might possibly become the official publication of a European Association for Research in Science Education. The feasibility of both these ventures will be investigated further by an international ad hoc group.

8. *Follow-up*

It is expected that in two or three years time a further workshop will be held for researchers in science education to assess the progress made in the areas described above. But in the meantime administrators, specialists in teacher training and others may be interested to discuss some of these issues. Readers who would like to suggest that such a meeting be held are invited to inform the Secretariat (Division for General and Technical Education).

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