CHAPTER 2: INTERRELATED TEACHING OF SCIENCE, MATHEMATICS AND TECHNICAL/VOCATIONAL SUBJECTS AS A PREPARATION FOR THE WORLD OF WORK

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Introduction

There are two basic issues to be raised when considering the links between school and the world of work. First, can the curricula at school level be more sharply focused to prepare students for the world of work? How can the right balance be achieved between academic subjects and the development of relevant skills? Secondly, is there adequate understanding and co-operation among those responsible for academic and vocational subjects? Are there positive measures that can be taken to make this relationship and understanding more effective in terms of the development and education of youth and adults?

A consideration of education for the world of work will, therefore, include a number of aspects. First, the acquisition of skills and knowledge relevant to the needs of the society; secondly, motivation to learn; thirdly, the development of character, values and ethics in order to learn how to live and work together in society; and fourthly the development of judgement and wisdom, attributes that may be acquired through experience and example.

Lack of co-operation between education and the world of work is a matter of deep concern to those involved in the development of young people.

There is considerable room for experimentation, but many government planners, educators, and parents are naturally cautious about new methods to link education and work. There is an understandable fear that the needs of modern work processes are sometimes narrowly prescribed and are therefore detrimental to the long-term interests of the learner, employer, and his society. However, science, mathematics, technical and vocational education must be associated with the world of work and the interaction between these subjects and employment should provide a mechanism for curriculum innovation and renewal.

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Matching Curricula to the World of Work

Two major problems face educators who wish to establish innovations in curricula to link science, mathematics, technical and vocational education with the world of work. First, to decide the most appropriate level in the school curriculum for the introduction of the innovative material, bearing in mind that the number of years spent in formal education could vary for different pupils. Secondly, to determine the impact of innovative curricula on accepted cultural values.

The design of curricula that interrelates the teaching of science, mathematics, technical and vocational subjects with the needs of work should be based on in-depth assessments of national technological development needs. This assessment will enable curriculum designers to set broad objectives which will endure in the post-school period. In the design of innovative curricula close attention should be given to environmental and cultural dimensions - for example, how can we deal with pollution and desertification?

Models of Interrelated Curricula

For a long time science has suffered from an identity problem because the subject area is divided into several separate disciplines, and although there are common topics - particularly in physics and chemistry - the teaching of each subject is generally confined within well-defined theoretical boundaries. Individual science subjects are often taught in a way that puts undue emphasis on factual knowledge, rather than the solution of problems through the practical application of science and technology. In everyday life the boundaries between science and technology merge and overlap and the artificial divisions between subjects in school curricula disappear. If the applications of science and technology are to have a real meaning to boys and girls in the world of work their educational experience in these subjects should be based on an interrelated curricula approach. The following models illustrate two possible ways to interrelate the separate subjects that make up the broad areas of mathematics, science, technical and vocational education.

MODEL I.

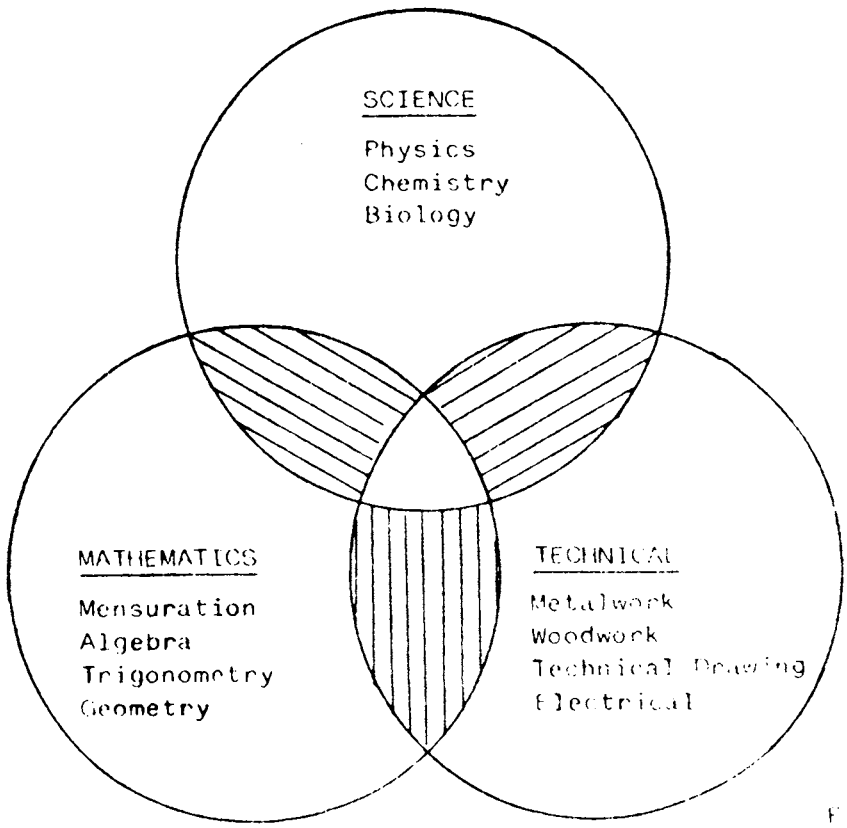

FIG.1

In this model the three curriculum areas of science, mathematics, technical and vocational education maintain their separate identity but overlap, as shown in Fig.1. The area of overlap between two subject areas contains topics of a common interest - for example the overlap sector between mathematics and technical areas could contain applications of trignometrical functions applicable to both subjects. In the overlap sector between science and mathematics the use of graphical solutions to problems in physics is an obvious interrelated topic.

In the sector where all the subjects areas overlap the interrelated topics are likely to have a direct relation to applications of science and technology in the world of work. Topics such as the transfer of heat could be treated so as to draw on scientific laws, the use of mathematics to derive formula, and the practical applications of heat transfer in, say, motor vehicle technology. Other topics in this sector could include the relationship between energy and power - using teaching methods that link science, mathematics, and technology elements of energy transfer and power transmission.

The design of curricula in this model could include the use of project work in the interrelated sectors. Such project work, based on a problem-solving approach, would draw on a wide range of subject matter from more than one main area of study. Furthermore, project work of this nature could be designed around practical applications of science, mathematics and technology in the world of work - for example, the use of portable forms of electrical energy, effects of an electric current, and the care and maintenance of electrical appliances.

One of the advantages of interrelating curricula in this manner is that the degree of interrelation (extent of overlap) can increase in gradual steps, commensurate with the availability of educational resources. Thus, in the early stages of a change from separate to interrelated curricula, the sectors of overlap may be small, and confined to those topics that can be immediately identified as common elements in more than one subject area. Such an approach would also allay fears among subject specialists that the separate identity of their discipline was being threatened by a wholesale curriculum renewal. A second advantage in this gradual approach would be that topics in the central sector - where all subject areas merge - could be examined in detail in order to identify relationships between school curricula and the world of work.

MODEL II

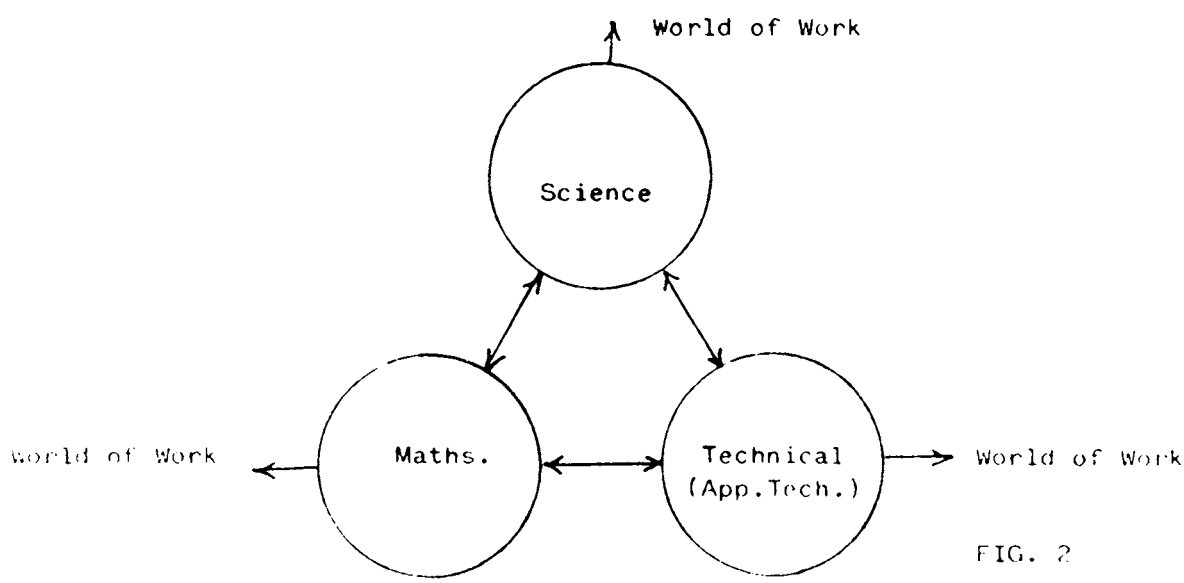

FIG. 2

In this model the three curriculum areas - science, mathematics, technical and vocational education - maintain a separate identity, but in each case the curriculum is directly related to the world of work. This method would enable teachers to introduce topics in each curriculum area to provide appropriate skills and knowledge for employment, for example mathematics for self-employment, and science for rural and urban development. The third curriculum area - applied technology - would be designed to complement the other two areas and also to complete the inter-relation of all subjects. Although this curriculum model does not offer the close interrelation of subject matter as in Model 1, it does provide an opportunity for curriculum designers and teachers to focus specific topics in the curriculum on work experience. By careful management of the total curricula it should be possible to draw on the threads of these relationships between the main areas of curricula and the world of work in order to reinforce interrelation. For example, the relationships between calculations on fuel costs (mathematics), conservation of energy (science), and the design of heating appliances (technology) could be interwoven so as to provide a comprehensive understanding of efficiency in the utilisation of fuel.

In both of the models described there are four essential common factors to consider:

(a) The various subject disciplines are interdependent.

(b) Knowledge and skills which are common to several subjects will be used in practical work.

(c) The interrelation of science, mathematics, technical and vocational curricula must be balanced with other school curricula.

(d) The interrelation of curricula should provide the kind of experience that enriches the development of pupils, and encourages creativity and imagination.

Implementation of Interrelated Curricula

In order to effect a smooth transition from traditional curricula to an interrelated approach to the teaching of science, mathematics, technical and vocational education it is advisable to set out guidelines for action, based on a number of important issues.

(a) Interrelated curricula, covering science, mathematics, technical and vocational education, should not be developed in isolation from other school curricula. There is a need to review the whole curricula in a school so that the design of interrelated curricula for science and technology subjects is balanced between the needs of employment and a need for close matching with other important school subjects. Curriculum development and implementation should therefore involve all teaching staff. A failure to involve all staff in the transition process could isolate science and technology subjects from the educational objectives and goals of a school.

(b) Adoption of interrelated curricula will cause new demands for educational material and equipment. Such demands must be carefully considered in the light of available resources at the design stage in the development of interrelated curricula.

(c) Because cooperation between staff, and close coordination of teaching programmes are essential requirements for the successful implementation of interrelated curricula it may be useful to set up teacher working groups to organise the transition process.

(d) Whenever possible the interrelated curricula should use practical problem-solving methods - involving the use of materials to develop cognitive and manipulative skills. Such methods will allow the translation of ideas into practical realities by:

(i) identifying a problem,

(ii) selecting an appropriate solution,

(iii) implementing practical outcomes,

(iv) developing an awareness of the interrelationship with other subjects in the school curriculum.

(e) Every effort should be made to phase in topics in one subject so that they assist learning in other subjects. For example, mathematical processes should be introduced at an appropriate time to match the needs of work in the science and technology curricula. In this way pupils are made aware that subjects are not taught in the isolation of separate disciplines, but are part of a total curriculum.

(f) The traditional divisions between arts and science could be removed by the implementation of inter-related curricula. Many of the topics in science and technology have a direct relation with arts subjects, for example the use of technical drawing techniques in artwork, and technical report writing as an English language exercise.

(g) The implementation of interrelated curricula will make new demands on teaching skills. The use of innovative teaching methods - an essential feature of interrelated curricula - will require teachers to modity their traditional attitudes and role. In-service training organised at local and national levels will be required to develop new teaching technqiues and to foster positive attitudes among teachers and administrators.

(h) Pupils and parents should be encouraged to take a positive view over the introduction of interrelated curricula. Pupils must be actively involved in practical activities connected with preparations to implement the new curricula, and meetings between parents and teachers should be organised to discuss the implications of curriculum change. In addition, the cooperation of the parents should be sought in efforts to relate curriculum to the world of work. Some parents may have the kind of work experience relevant to particular topics in the interrelated curriculum, and their interest and help could be useful to teachers.

(i) Industry and commerce, in the public and private sectors, should play an active part in the implementation of interrelated curricula. Work-study programmes, drawn up by school and employers, could reinforce the teaching of science and technology and also provide a bridge between school and the world of work. Such on-the-job teaching experience involves pupils in real work situations and conditions and offers an opportunity to understand adult roles and responsibilities.

The implementation of interrelated curricula for science, mathematics, technical and vocational education that interacts with the world of work provides a new and exciting challenge to teachers, pupils, parents and employers. Interaction of curricula demands interaction of effort on the part of all those who wish to ensure that young people are given the best possible educational preparation for the world of work - a world of constant change and increasing complexity.