CHAPTER 4: INTERRELATIONSHIPS OF CURRICULA AT SECONDARY LEVEL

J. Holbrook and J. Grant*

Introduction

The rapid development of scientific, mathematical and technological knowledge over the last few decades has led to many changes in lifestyle in many countries. Calculators are commonplace in many classrooms, computers are invading commercial and business practices and satellite communication around the world is no longer a dream.

Education within schools must change to take account of these new developments and to prepare students for the real world of the 1980s, 1990s and into the 21st century. Yet changes in school education that have already been introduced - in the waves of curriculum development in the 1960s and 1970s - have not been wholly successful. Mathematics has suffered from methodological problems (e.g. the 'new' maths. versus the 'old'), teacher reticence and remoteness from reality. Science has suffered from an identity problem (the separate scientific disciplines versus a holistic view), a tendency to trivialise (e.g. by equating science with a series of 'experiments') and a tendency to teach facts rather than processes. Technology has suffered from oversimplification (often being equated with manual skills and reserved for the 'less academic' students) and from a lack of clear objectives. All too often the science class is expected to apply mathematical knowledge not yet covered in the mathematics class or the method of approach adopted by the science teacher differs from that taught by the mathematics teacher. Technology is seen as a subject for specialist rooms with large expensive machinery rather than any degree of emphasis on an extension of cognitive skills. Furthermore, discontinuities occur when young people move from primary to secondary education through lack of a total view of the curriculum for students in favour of a discrete division of educational packages at primary and secondary level. But, above all, a huge gap tends to occur between the science, mathematics and technical skills in the classroom and those needed for the world of work.

Curriculum Overlap

An examination of curricula from several countries shows that within a given subject area there is evidence of: common content, similar objectives and similar teaching methods. Thus at junior secondary level in science many curricula have topics in energy, particles, living things and measurement. Likewise, in mathematics there are topics such as angles, statistics, indices, coordinates, ratio and proportion, mensuration, algebra and Pythagoras occurring widely.

---

*Contributing author

Not only is there considerable similarity between curricula in various countries, there is, across the subject areas of science, mathematics, technical and vocational curricula, evidence of common content, objective, and teaching methods. For example, it is easy to see overlap in such areas as energy, electricity, materials, health, and the use of measurement. In each case these topics occur in two or more of biology, chemistry, physics, engineering science, health science, human biology and design and technology curricula in many countries.

Besides overlap of content, there is also considerable overlap of objectives. The ability to apply understanding to new situations is a feature of many curricula; so also is the ability to analyse and deduce from experimental results. The acquisition of skills and techniques and the ability to communicate results in written or graphical form are specifically mentioned in many curricula and in many countries.

Thus there are opportunities between countries, but more particularly within countries, for links in science, mathematics, technical and vocational curricula. Interrelated curricula are desirable because

(a) each of the individual subjects is a component of the curriculum, even if not necessarily so for all students; each adds to the sum of knowledge and each cannot be taught in its entirety;

(b) the subject content and the objectives for the separate subjects invariably, even if unintentionally, overlap;

(c) the knowledge and skills applying to each subject area, no matter how elementary, will be called upon in everyday life;

(d) each subject has much to gain from each other - in other words, the whole is more than the sum of the parts.

Interrelated Curricula - Content and Concepts

The linking of present subject areas, although a useful exercise in uniting the education of the student, may not be at the heart of the problem. A marriage of science and technology has been consummated in society, but this is rarely achieved in the classroom. If science and technology education are to be more relevant to society then they should be concerned with the topics with which society is concerned. For the average citizen to be equipped to function in and contribute effectively to life in an increasingly technological society, it will be necessary to ensure that he or she is not only able to read and write and to count and calculate, but also to manage the materials and processes of technology.

These materials and processes, which of course affect national development, include health, food and agriculture, natural resources, nutrition and sanitation, energy, transport, population control, industrialisation and technology information systems. Very little attention is given to these areas in current science, mathematics, technical and vocational curricula. In other words, the curricula of the future must be less inward looking and more conscious of how science, mathematics and vocational subjects learned at school relate to society, to the world beyond the classroom or the laboratory.

The overall message is to devise curricula that have as the main aim education for the improvement of the quality of life. At the basic level, quality of life means a life which is healthy, free from disease, which implies an adequate supply of basic foods, adequate nutrition, housing, shelter, clothing, clean water and hygiene (sanitation). It also implies the understanding of the dignity of human relations and an appreciation of attitudes to work and community. At the more sophisticated level, it implies aesthetic values - a pleasing environment with acceptable interactions between people and nature (ecology). The aesthetics of urban and rural communities will be different, but both depend on social ambience and an understanding of the work environment and community development. At all levels, the quality of life is enhanced if the individuals in the society can better understand their environment - and can develop satisfactory attitudes towards each other and towards the work environment. It can also help individuals to make decisions and choices about this environment and way of life.

Major conceptual or subject areas can also be considered in an interrelated way. Typical areas are: energy, resources/materials, communication and measurement.

In considering energy interrelationships, science lessons should concentrate on the uses of energy and the interchange of forms of energy rather than the definition of energy as such. Graphical communication would be the main mathematical contribution, whilst technology would consider the control of energy. Safety, social, environment, personal and economic aspects of energy would be treated by all subjects in linking the concept with society.

In considering resources/materials, science lessons would emphasise the availability of local materials and how they are obtained, whilst the mathematics would concentrate on measurement of manufactured resources. Technical studies would highlight the use of local materials and the skills used in manufacturing articles.

Communication in its many forms is clearly a unifying interdisciplinary topic for the school curriculum. It encommpasses oral and written skills and the acquisition of the vocabulary of science, mathematics, technical and vocational subjects. Graphs, spatial and numerical skills, and skills related to the representation of qualitative ideas and the analysis of data can all be interrelated within communication.

Measurement, in the area of science, is linked to observation and comparison. Extensive use of estimation is seen as important to all disciplines and this aids interrelationships. Estimation leads to a feeling for quantity, size and proportionality and would be stressed in mathematics. Practical use of measurement is emphasised in technical and vocational subjects.

Objectives for Interrelated Curricula

Common objectives and teaching methods are also important in the interrelation of subjects. In terms of objectives there will be common cognitive skills, practical skills, and attitudes; these will lead to teacher practices based on problem solving, inquiry, discovery, as well as in basic methodologies of teaching. Much interrelating of curricula can be based on problem-solving approaches. A study of the problem-solving steps commonly used in technology can provide an interesting basis for interrelated approaches. In this sense the relevant steps are:

Data collecting and processes	- linked to mathematics
Market surveys	- linked to mathematics
Ergonomic studies and experimentation	- linked to science and mathematics
Mathematics of materials) Environmental/economic/ethical) social/political researches)	- linked to science
Proposed design solutions) Selected of best solutions)	- linked to mathematics and science
Choice of materials and production	- linked to science and vocational studies
Mock-up simulations	- linked to vocational studies

Proposed solutions/refinement	- linked to science
Finalised design, solution and execution	- linked to science, mathematics and vocational studies
Testing	- linked to science and vocational studies
Communication	- linked to science, mathematics and vocational studies

Approaches to Interrelated Curricula - Implementation

A commitment to interrelation need not necessarily imply a threat to traditional subject disciplines. There could be three broad approaches to implementation of interrelated curricula:

(a) An attempt to co-ordinate the introduction of common concepts in the various subject areas,

(b) The introduction of an 'integrated studies' component into the curriculum (probably based on problem-solving),

(c) Re-organising the whole curriculum so that the subjects lose their separate identity.

A school might decide to adopt for the present only the first method so as to assess whether the outcomes are positive. Indeed, this may be the preferred approach where there is a strong tradition of separate subjects. If the experience proves beneficial, it could lead to the development of further ideas for the interrelation of subjects.

To initiate any such interrelation within the school, two basic approaches appear possible. The first is for committed individual teachers to set about showing how this can be achieved in their own schools and classrooms. Any success achieved would be likely to attract other teachers to seek similar results. The second is for the whole school or school system to adopt a planned approach to the interrelation of subject areas.

The first approach utilised a concept commonly adopted as part of the rationale for in-service training. This is to develop in selected individuals (school co-ordinators) certain skills which, it is hoped, they in turn pass on to others by their example and influence in the school. It is a model which has become less favoured in many places because of the inertia in the system which individuals find difficulty in overcoming.

It takes a highly competent and charismatic individual to achieve change in an institution or a system without organised support. A way must be found to encourage such teachers, for example, by giving them access to special resources, giving them time for carrying out the tasks and perhaps awarding financial incentives. The importance of an active professional teacher association cannot be understated in giving both moral and material support to such teachers. Frequent contact with outside organisations also plays an important role for both encouragement and feedback. Where such systems have been encouraged, success has been shown to be very dependent on the enthusiasm and support of teachers.

The second approach is only likely to be effective if it is not imposed as a fait accompli, but rather seen as a movement which involves the co-operation of all participants. Again the support of teachers cannot be overemphasised. In a given school a typical approach might be as follows:

(a) An evaluation of the curriculum would be undertaken to determine the extent to which it is meeting student needs. This evaluation should involve all staff of the school with outside assistance only when necessary.

(b) The interrelationship of subjects would arise as part of this evaluation and information should be available to the school from outside curriculum units to suggest ways of improving the subject areas.

(c) The school should decide itself how it wishes to improve its curriculum and it may decide to adopt any of the basic methods of interrelation mentioned above.

(d) Support should be available to assist schools in their efforts by way of staff development programmes, curriculum development expertise and appropriate curriculum materials. Morale boosting must be seen as essential.

(e) The examination methods used must ensure that they allow for the assessment of interrelated knowledge and skills.

Pre-service teacher education will, of course, have an important bearing on what is taught in schools. Consequently immediate attention should be given to breaking down rigid subject boundaries in the preparation of teachers and to developing teaching techniques which integrate the knowledge and skills in practical ways. In-service education of practising teachers must be seen as crucial at the same time so that:

(a) experienced teachers take a leading role in new educational developments,

(b) new, inexperienced teachers are not disillusioned on entry to schools by the attitude of teachers,

(c) better links are established between schools, and curriculum development units.

Organisational Aspects

Success in any educational process depends ultimately on the teacher. So often, in the past, many projects have failed to attain the desired objective owing to a failure on the part of teachers to appreciate the philosophy behind the change or through lack of teacher enthusiasm for implementation of the project.

The morale of the teacher is crucial to curriculum development. Organisational support is required to boost this morale. In one aspect this means linkage of teachers and teacher educators through science teacher associations at the national level and through organisations such as CASTME (Commonwealth Association of Science, Technology and Mathematics Educators) and ICASE (International Council of Associations for Science Education) at the international level.

In another sense the morale of teachers can be lifted through an adequate organisation of support facilities. Sufficient resource materials and back-up facilities such as use of the mass media are essential for maintaining the enthusiasm of the teacher and encouraging effective teaching. Active encouragement and support should also be given for teachers wishing to improve their teaching.

Guidelines for school planning should provide for bringing teachers together. It is only through working together on the analysis of objectives, content and teaching practices that common understandings will develop and the interrelationship of subjects brought about. Given that teachers rely to a large extent on learning materials which are developed outside the school, it will also be necessary to bring together the curriculum developers and textbook writers from the various subject areas, setting them the task of devising projects of discovery, inquiry and problem solving which can assist teachers once these teachers have made some commitment to the interrelationship of subjects.

To facilitate the development of interrelated curricula at the junior secondary level, it may prove beneficial to consider adaptable, non-specialist rooms that can serve for practical work, data collection and design activities. Such activities can, of course, also be conducted outside the classroom. In this way constraints on time allocation for the various disciplines can be minimised and the heavy reliance on specialist apparatus and machinery is avoided. A greater reliance on project work at the upper secondary level may have a similar effect particularly towards the end of the course where the knowledge and skills learned can be interrelated between subject areas.

The interrelating of subjects should be encouraged through the appointment of teachers to co-ordinator roles. In-service education opportunities for co-ordinators should be considered of vital importance and the co-ordinator seen as the major agent of change within the school. The co-ordinator should initiate and continue school-based-in-service education for other staff and this should be a planned activity on the school timetable. The curriculum should take into account the requirements of both the local situation and any external examination and maintain a balance between them. Serious consideration should be given to school-organised curricula which would reflect the interests of the individual teachers and thus make better use of such expertise and boost morale. Where school curricula are seen to remain isolated and not in keeping with developments, then persuasion through outside motivation and in-service education, especially through co-ordinators, should be encouraged. In this development the head of the school must assume an important responsibility.