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AN INTERRELATED APPROACH TO
TEACHING MATHEMATICS IN SECONDARY SCHOOLS.

by
R M BOND, MSc

A doctoral thesis submitted in partial fulfilment of
the requirements for the award of Doctor of Philosophy
of the Loughborough University of Technology, 1986

Supervisor: Professor A C Bajpai
Director of CAMET and Head of
Department of Engineering Mathematics
Loughborough University of Technology

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This thesis is primarily concerned with the production and evaluation of ideas and materials, based upon an interrelated approach to teaching, which is aimed at arousing curiosity and interest in pupils in secondary schools from the age of fourteen upwards.

A case is presented for the consideration of such an approach and a brief account given of how early ideas were formulated. These ideas resulted in the establishment of positive guidelines and strategies upon which the research was to be based.

Much emphasis is placed on the significance of effective and attractive written materials for pupils with one chapter being specifically aimed at outlining important aspects of general module preparation.

The thesis presents in some detail evaluations of trials carried out with groups of students studying a variety of topics involving mathematical principles.

It attempts to describe the successes and failures of various modules of study devised during the research programme and takes special account of comments made by pupils and staff who participated in trials.
With the recommendation for a new approach to teaching, effective in-service training of teachers is an essential exercise. Various in-service training programmes organised for teachers and ideas produced during these sessions by enthusiastic, stimulated participants are reported. In addition, the thesis contains proposals for the establishment of a professional centre for mathematical education in schools and colleges within Leicestershire where ideas produced from research projects such as this can be extended, developed fully and subsequently disseminated in an effective manner. In conclusion, the achievements of the research programme are discussed and recommendations and suggestions made for wider use of the interrelated approach to teaching in secondary schools.

Key words

Secondary schools, teaching strategies, team teaching, interrelated teaching, teaching modules, mathematical education, communication, teacher training, training officers.
ACKNOWLEDGEMENTS

I would like to express my sincere thanks to Professor A.C. Bajpai, OBE, for his help, support and counsel throughout this research project. His vision and enthusiasm inspired many of the ideas contained in this thesis.

In addition, I am grateful to my fellow research student, Stan Turner, for his friendly, helpful collaboration.

I am indebted to the staff and students at Burleigh Community College, Loughborough, for their help and co-operation. In particular John Bowles, former Mathematics Curriculum Area Co-ordinator, provided encouragement and advice which was much appreciated.

During the course of the project I received a considerable amount of assistance from a number of industrial training officers, for which I am extremely grateful.

I would like to acknowledge with gratitude the interest shown in the research programme by the Leicestershire County Mathematics Advisers, Dr. M. Edwards and Mr. S. Friis (now retired), who have facilitated debate between the author and many other teachers within the County.

Finally I would like to thank my wife for her patience, encouragement and help with many aspects of the work.
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1.1 Introduction

Holt (1) poses the question "Why do children fail". He gives his explanation as:

"They fail because they are afraid, bored and confused. They are afraid, above all else, of failing, of disappointing or displeasing the many anxious adults around them whose limitless hopes and expectations for them hang over their heads like a cloud. They are bored because the things they are given and told to do in school are so trivial, so dull and make such limited and narrow demands on the wide spectrum of their intelligence, capability and talents. They are confused because most of the torrent of words that pours over them in school makes little or no sense. It often flatly contradicts other things they have been told, and hardly ever has any relation to what they really know - to the rough model of reality that they carry around in their minds."

In his summary (p 166), he sadly concludes:

"We encourage children to feel that the end and aim of all they do in school is nothing more than to get a good mark in a test, or to impress someone with what they seem to know. We kill not only their curiosity but their feelings that it is a good and admirable thing to be curious, so that by the age of ten most of them will not ask questions and will show a good deal of scorn for the few who do."

Perhaps the ways to overcome situations such as this might be suggested by pupils themselves. One suggestion comes from a
seventeen year old boy whose ideas for schools of the future are quoted by Blishen (2):

"The object is to promote creative ability in the individual, and not simply to present facts. In the future the school will try to present material so that the student will become deeply involved and interested in his work; for the student who enjoys his work is always the one who makes good progress and understands his work as opposed to simply learning it. To this end there would be no such things as set 'lessons' and boundaries between subjects would be freely crossed.

Now, the development of creativity is a difficult task and cannot be taught in the conventional sense. A mind cannot be made to produce creative thoughts; it can only be shown, and given practice in the conditions which are likely to produce creativity ... "

This thesis describes work carried out in schools which attempts to arouse interest and curiosity in pupils. All the work which was developed and tested contained, in varying degrees, aspects of mathematics which were interrelated with other areas of the curriculum. Wherever possible teaching topics have been given a sense of realism by the involvement of personnel from commercial and industrial companies.

1.2 Education At Secondary Level: Some Observations

Any new initiative in terms of educational innovation requires a reasonable amount of support in terms of staff time and money if a fair evaluation of a proposal is to take place.

In 1986 most teachers find the debate centred upon educational change both stimulating and worthwhile. It has become apparent, however, over the past few years, that without adequate support for new courses, problems are arising and will continue to do so in the future. In his presidential address to the Annual
Conference of the National Association of Schoolmasters/Union of Women Teachers, Boone (3) sums up the thoughts of many teachers concerning the sea of innovation currently in the pipeline:

"Money will have to be made available to provide a proper base for all our schools to ensure that there is an adequate level of staffing to meet existing requirements, let alone all the new initiatives which Sir Keith produces. Review of the 5–16 curriculum, major changes in exams, GCSE with its massive workload implications, CPVE, AS Levels, pupil profiles, graded tests, TVEI, not to mention curricular changes in multi-cultural education, new technology, craft, design and technology, science in primary schools and a systematic review of existing curricular areas already published and there are others on the way."

Hargreaves (4) puts some of the blame for increased pressures on teachers down to the reorganisation of secondary education into comprehensive schools. The reorganisation has, he says:

"... been accompanied by a startling dissensus on educational matters. Primary schools have, for the most part, been left to get on with their work in relative peace, but almost every aspect of secondary education has been the subject of dispute, bitter fighting and (too often) uninformed debate."

There is an increasing awareness amongst teachers that current rates of change within education necessitates dialogue between teachers. In the interests of both pupils and teachers, time has to be found for cross-curricula exchanges especially in relation to mathematics, science, technology and design in order that discussions regarding method, approaches, content, context and assessment can be discussed. This is not a new idea and was strongly advocated by Matthews and Seed (5) in 1970 who described co-existence between some teachers in mathematics and science curriculum areas as "you stay in your..."
corner and I'll stay in mine". Lack of co-operation, they say, can lead to disharmony amongst teachers with comments occurring such as "Why haven't they done ratios?" and "They don't know about π".

1.2.1. Dialogue Between Pupils And Teachers

In an editorial in Education and Training (6), youth problems in the western world can, they say, be evidenced from:

" - high truancy and drop out

- the failure in many cases to provide opportunities for school leavers to develop useful work habits

- the absence among too many youngsters of the requisite basic skills in literacy and numeracy

- the failure to create other forms of service opportunities for young people."

In the United States, the Carnegie Council issued a report "Giving Youth A Better Chance: Opportunities For Education, Work And Service." The report (6) states that the Council found that both junior and senior high school students:

"are getting little out of school because they simply do not see the relevance to their future lives of what the school is attempting to teach them."

Furthermore the report concluded: "There has been too much emphasis, in our judgement, on targeting programmes to the disadvantaged."

There appears to be a need, therefore, for teachers to have the time and support to be able to look at both teaching content and teaching process. An integral part of this is
to take note of the feeling and experiences of pupils in order that effective communication between teacher and pupil can take place. As Downey and Kelly (7) suggested:

"The kind of verbal interaction that goes on in school suggests that learning is inevitably a social process where each individual concerned is striving to incorporate new meanings into his own frame of reference. One of the teachers' tasks then is to create appropriate opportunities for children to do this; by providing situations where an exchange of experience is possible through language and other kinds of activity, he is facilitating the process of interaction which is all-important in a real learning situation."

Larcombe (8), when discussing learning difficulties in mathematics, advocates that teacher dialogue with pupils is essential if meaningful tasks are to be organised for them in the classroom situation:

"Those who set a lot of store by 'making the mathematics relevant' by making it environmental or based upon the world of work or sport are in danger of finding that their eyes are focused on quite different things to those of their pupils. It is easy to compose a list of things that we think pupils 'ought' to find interesting or 'necessary' to their lives, but those teachers who have spent time listening to their pupils and talking about the world as they see it, will have found that there is an enormous margin for mismatch. If our list does happen to coincide with the pupil's view of the world then motivation may well follow from this relevance. If, however, as is all too often the case, we seem to have been thinking about a quite different world to that of the pupils we are in great danger of appearing ignorant or foolish to the pupils."

Pupils' ideas for modules are recorded in Chapters 4 and 5.
1.2.2 The TVEI – A Success Story?

One example which shows that curriculum innovation can work successfully is the Technical and Vocational Education Initiative (TVEI). This offers four year courses of technical and vocational education for students between the ages of 14 – 18 and aims to include children of all abilities and both sexes. The scale and cost of the "pilot" project is itself remarkable, according to Jamieson (9), dwarfing that of any schools-industry initiative. The Government's determination to provide a large and radical initiative to change the balance of the curriculum can be seen by the way in which the change was instituted. The programme was announced in a written answer to a (planted) Parliamentary Question. There was no consultation with the usual professional interest groups. Moon and Richardson (10) argue that:

"the devisers of the TVEI were seemingly determined to act quickly and wanted to avoid having their radical ideas smothered in a consultative morass, or at least amended out of all recognition."

The results within schools have been impressive and, with a few exceptions based upon political views, the input of financial support welcomed by teachers. The finance awarded to schools has resulted in an extra allocation of teachers which has supported:

(a) in-service training courses for content and personal development;

(b) time allocations for course development, for example for writing materials and preparing practical work;

(c) administrative roles needed to operate the scheme.
In addition teachers have seen a huge input into schools of modern technological aids especially in respect of information technology.

Courses organised as part of the TVEI have also improved personal relationships between teachers and pupils. In a recent newsletter, the TVEI co-ordinator at one school (source not quoted) spoke with pride about the residential experiences organised for the 70 pupils involved in the pilot project in the fourth year at the school. She talked about the definite improvement in staff-student and student-student relationships when they went on the residential experience component of the course, each student choosing from one of the following options:

(a) A skiing trip in Scotland, staying in a Youth Hostel;

(b) Exploring the Midlands canals by canal boat;

(c) Youth hostelling in Snowdonia;

(d) Finding out about getting around in London and exploring what the city has to offer.

In her report she said that a maximum of £30 per head was allowed from TVEI funding.

Obviously this was a most welcome and useful exercise. In the cold light of reality, however, 70 pupils at £30 per head puts a maximum cost of £2100 on the exercise, a figure which is in excess of the amount allocated to some large school departments for capitation using which they purchase stationery, text books and equipment, etc. for over 1300 pupils for a whole year!

The TVEI scheme with its funding and support from the Government looks certain to succeed and in doing so may produce the type of pupil described in "Better Schools" (11):
"The best secondary schools turn out young people with self-confidence, self-respect and respect for others, who are enterprising, adaptable and eager to face the demands of the adult world, and who are equipped to face it by a sound and broad grounding in knowledge, skills and understanding to a depth commensurate with their abilities."

Perhaps with the TVEI the Government have acknowledged that to obtain this sort of young person finance must be made available to support projects such as this rather than expect teachers to cope with this challenge in addition to their existing duties.

1.3 Author's Background

After leaving school the author was accepted for a technical apprenticeship in mechanical engineering at a large company manufacturing hosiery machines. This, and his post apprenticeship positions, gave him the opportunity to work in many areas of the hosiery machine company alongside a diverse range of skilled and unskilled employees from labourers to managing directors. In addition to work experience he was able to study at a technical college, the results of which were subsequently accepted by the Department of Education and Science as being of degree equivalence.

As well as working in the hosiery machine manufacturing company, the author gained further experience with companies manufacturing cranes, electrical machines and hosiery.

After ten years in industry the author was accepted for a post-graduate certificate in education course in 1973 and, following a successful completion of this, has taught mainly mathematics and a small amount of technical drawing in a comprehensive upper school which caters for pupils in the 14 - 18 year old age range. During the course of his teaching career the author was fortunate to be able to study for a
higher degree working under the direction of Professor A. C. Bajaj, the award having been conferred in 1978.

The author believes that the period of time spent in industry has given him a broad outlook and helped to provide him with a realistic down-to-earth approach to both his teaching and his academic studies.

Teachers, he believes, can learn much from the clever, imaginative industrial workers who, though often lacking in academic qualifications, apply ingenuity and common sense to solve problems. In many cases their team spirit, warmth and pride in the product which they are producing create a most pleasant working atmosphere. Perhaps one of the marked differences the author has found between industry and education is accountability. In industry common phrases are to be found such as "time means money" and "waste means money". Mistakes and errors of judgement can cost thousands of pounds and jobs. In education within schools, some experiments and trials which are carried out in haste may have detrimental effects upon pupils and yet teachers can sometimes put down the errors to inexperience with the conclusion that "they should try something else next year". The author values greatly the experiences gained in his years spent in industry.

In his teaching career, the author has become aware of the problems faced by many teachers in motivating adolescents to achieve goals compatible with their abilities. The research work produced enthusiasm and interest from the author and his teaching colleagues when devising student assignments.

1.3.1 Understanding The Views Of Training Officers

In 1976/77, as part of his previous M Sc research programme, the author carried out a survey of opinions of industrial training officers regarding the mathematical needs of young people entering craft employment. Accompanying a completed
questionnaire was enclosed a sincere and emotional letter from a training officer. He summed up the views of many industrialists consulted during the course of the author's current research programme outlined in this thesis. An extract from the letter follows.

"I am of the considered opinion that the overall abilities - numeracy, literacy, etc. - have declined at an alarming rate since 1968/69 for two main reasons.

1. Social and political influences having produced vast school complexes that leave the individual pupil nothing with which to indentify himself, resulting in boredom and disinterest. This could be reflected in the seemingly large staff movements that do take place, my own son having had three English teachers - all new - in one year.

2. The advent of the modern educationalist outlook which does not pay due regard to the facts of working life and the needs of industry, and adopts the most unrealistic attitudes when attempts are made at serious discussion between teachers and industry to try and resolve the problems that beset us.

I have taken part in a number of these latter discussions, and find that the only factor, and divisive at that, to emerge is that opinions are polarised.

Industry, I believe, welcomes new approaches and methods provided that they are beneficial and necessary, and not merely an inferior substitute. I have heard it said that industry must follow education. The tragedy is that experiments in education affect people for life, and can also affect the industrial future of a society in a detrimental manner. It would seem that dogma is the main armourment of the educationalist and inexperienced young teacher. It does not
occur to some that in science based industries, dealing in matters controlled by scientific laws and facts - and, incidentally, backed up by inescapable mathematic proof in the 'traditional' sense - that approximations, probabilities and general overall concepts are just not on! Basic principles have to be understood even to the point that $1 + 1 = 2$ is vital to the efficient running of any business, and that communication of any kind between people is just as important."

Hopefully some aspects outlined in this training officer's comments have been improved with the emergence of such schemes as TVEI, CPVE, YTS, etc. where consultative committees comprised of members from both industry and education are being used. An important element in the research work described in this thesis has been the help given and contributions made by personnel from industry and commerce.

Teachers with no industrial experience have great difficulty in comprehending standard codes of practice within industry. Having worked for a long period in industry, the author has found this experience invaluable in conducting dialogue and module planning with industrial training officers. He has come to value their sincerity and willingness to help with work related topics and also has much sympathy for the views and fears which they express about many aspects of the school system and its end results.

1.4 Synopsis Of The Thesis

The remainder of this Chapter is devoted to an overview of the rest of the thesis. Chapter 2 describes the formative stages of the research programme where initial ideas were discussed at length and policies and directions for future work decided. The case study showing how measurement has a most important part to play in the work carried out in a first year engineering training workshop illustrates the type of involvement and support offered by training personnel throughout the course of the research programme.
One important aspect of the education process often overlooked by teachers is the quality and appeal of written materials offered to students. In the world outside school, pupils encounter high-powered advertising techniques which have visual appeal. Much of the work prepared by teachers using, for example, "banda" sheets, comes to pupils in a variety of forms, for example: handwriting may be difficult to read; the sheets may be faded due to the condition of the machine used; the teacher may have crammed as much information as possible onto sheets to save money by using less paper; the words may be too difficult for pupils to understand, etc.

Chapter 3 attempts to discuss aspects of module preparation which, as the research progressed, assumed greater importance in promoting successful pupil-orientated tasks.

The main report relating to the evaluation of teaching modules is contained in Chapters 4, 5 and 6. Information is presented to show how tasks based upon an interrelated approach can be applied in classes designated as: (a) mathematics; (b) English; and (c) one year sixth form.

Included in the analyses of results are detailed comments from pupils and staff which illustrate vividly their attitudes and feelings towards the approach being evaluated. In the modules produced, ideas and support from personnel from industry and commerce have provided realistic tasks and given an extra motivation factor to students and staff.

Along with the recommendation for a new approach to teaching, effective in-service training of teachers is an essential exercise. Chapter 7 describes various in-service training programmes organised for teachers and gives examples of ideas produced during the sessions by enthusiastic, stimulated participants. In addition, Chapter 8 presents a case for the establishment of a professional centre for mathematical education in schools and colleges within Leicestershire where ideas produced from research projects such as this can be extended, developed fully and subsequently disseminated in an efficient manner. It is proposed that a centre such as
this would make contributions towards both initial and in-service courses for teachers and hence would help to form strong bonds between teacher trainers and practising teachers.

Links such as the ones proposed are strongly supported by the James Report (12) and also by the current Secretary of State for Education and Science who propounds the following (13):

"The teacher training system must continue to be responsive to changes in pupil numbers, the school curriculum and the society served by schools."

"The initial teacher training of all qualified teachers should include studies closely linked with practical experience in school, and involve the active participation of experienced practising school teachers."

"We commend the principle of joint teacher/lecturer appointments and of teacher/lecturer exchange and believe that training institutions should have close working relationships with local education authorities."

In conclusion, the achievements of the research programme are discussed and recommendations and suggestions made for possible continuation of the research.

1.4.1 Advancement Of The Interrelated Approach To Teaching

The author was most fortunate in several aspects of this research work:

(a) he could see a definite need within schools for ideas and materials of the type described in this thesis, the ideas having been proposed initially by his director of research;

(b) he was granted a one year secondment to CAMET in the academic year 1984/85;

(c) he had the support and valuable advice of fellow teachers at his school who made every effort to help and assist wherever possible;
(d) reprographics for use with classes in his school were produced using finance from school departments and the TVEI;

(e) he had support and help from his wife, an experienced typist, whose expertise was invaluable.

If the interrelated approach suggested in this thesis is to be developed further in schools on a large scale then teacher time, money and secretarial support must be made available to enable the tasks to be attempted in a professional manner.

In addition, once ideas have been proven, means of effective dissemination of materials must be set up similar to ideas proposed in Chapters 7 and 8. With reference to the teaching of English, the Schools Council (14) illustrates types of problems experienced in schools with regard to resources:

"Over all our suggestions hangs a cloud: the problem of whom schools can ask for advice in collating ideas and procedures in our field. If school focussed in-service education is to be effective, to whom can the school turn? Has the LEA adviser (when there is one) sufficient resources to help facilitate the school's curricular section, choice of materials, decision making and retraining? We doubt it. We therefore recommend that the question of establishing a national English centre as proposed in the Bullock Report (15) should be taken up again by mounting a feasibility study."

Schools Council's recommendations are compatible with ideas proposed in Chapter 8, where a case is presented for the establishment of a professional centre for mathematical education in schools and colleges in Leicestershire.
CHAPTER 2

FORMULATION OF IDEAS

2.1 Current Methods Of Learning

Before advocating any change within the educational system, it is necessary and beneficial to look briefly at current methods of learning.

2.1.1 Informal Learning

People of all ages work and learn in social groups such as scouts and guides, youth clubs, sports teams, musical groups, associations formed for the pursuance of hobbies like photography, drama, BMX bikes, etc., where activities are carried out with interest and enthusiasm with participants usually behaving in a responsible manner towards their peers and also the fabric of their environment.

2.1.2 Infant Learning

Children at home with parents happily become involved with making pastry, caring for the garden, decorating, learning the rules of games and learning manners, etc.

2.1.3 Formal Levels Of Education

(a) Pre-School

Between the ages of 3 and 5 many children attend pre-school playgroups. Here they are encouraged to work and play happily together. The teachers try to make a balance in the programme given to the children by varying the activities. Even at this early stage the children deal with centres of interest. For example, a centre of interest may be "Animals Which Help Us", which can be dealt with over a number of weeks.
A subset of this could be "dogs".

Making pictures and models of dogs

How dogs help us, e.g. guide dogs for blind persons, mountain rescue, guard dogs.

Stories about dogs

Types of dogs

Songs/dances associated with dogs

Food which dogs eat

How we look after dogs

The children are encouraged to look at the many aspects relating to dogs. This topic-based approach for young children generates both interest and curiosity and introduces them to a diverse range of skills in association with the topic.

Undoubtedly the most important aspect of a topic such as this is "hands-on" experience where, for example, the children meet and touch a real guide dog.
(b) **Infant/Junior**

Teachers are trained to teach a variety of subjects to one class; in some cases specialists are provided for certain subjects such as music and physical education. An example of the advantage in one teacher having control over the teaching of a range of subjects at this level can be seen in Chadwick's experiment (16) in the teaching of science subjects through the technology of concrete.

(c) **Secondary**

At the secondary level the use of specialist teachers is almost universal; exceptions occur when some schools operate an integrated science programme for the first two years, one teacher then being responsible for more than one subject such as chemistry and physics.

Within the last few years steps have been taken to integrate the work of the various curriculum areas especially within vocationally biased courses such as TVEI, CPVE, City and Guilds Vocational Preparation (General) course, etc. Further details of these are given in Chapter 6. It is sad to report, however, that for many pupils in schools the isolation of the various subjects coupled with uninspiring routine exercises often presents a picture of irrelevance to their current and projected experiences. Too often, in schools, reports of disenchantment and disruption are written. One could argue that the social climate and parental influences have a great effect on students' attitudes to the classroom. Teachers must ask themselves, however, if the academic and practical tasks given to the students arouse curiosity, interest and enthusiasm. Perhaps if our school curriculum achieved this then teachers may be ideally placed to exploit each individual's talents, thus enabling each one to get the most out of time spent in the classroom and develop a more friendly attitude to teachers, their aims and their curricula. This has important implications for the future because learning and training in new technologies will become part of the working way of life for many.
(d) **Further Education**

(i) **Training In Employment**

In the post-school period when young people start work and receive "on the job" training they have to learn and cope with many tasks associated with their job. Subject areas such as mathematics, communication, science, technology, etc. amalgamate and are encountered collectively. This approach lasts throughout an adult's working life. For example, consider the job descriptions for a secretary and paint sprayer in the engineering industry (17) shown on the next page.

One important aspect of any job is communication. During the course of their training, young people are required to develop communication skills which cut across subject boundaries. For example (18), communication and the trainee engineering craftsman.

![Diagram showing various aspects of communication during training](attachment://diagram.png)
SECRETARY

Responsible to: Office Manager/Supervisor or individual Managers

Function:
To assist and support managers and other departmental personnel in commercial practices.

Job Description:
- Receive incoming mail and sort into priorities
- Use telephone, place, receive and transfer calls
- Use of word processor
- File and retrieve correspondence
- Acknowledge correspondence and invitations, draft replies
- Take dictation, using shorthand; obtain further relevant information and type correspondence
- Deal with correspondence or recording tape, etc.
- Collate and distribute finished work
- Keep diary and make appointments
- Make travel arrangements, obtain tickets, passports, currency, hotel bookings
- Organise meetings, take minutes
- Receive company visitors
- Handle and record petty cash claims, expense claims, other statistics
- Maintain stationery stocks

Knowledge:
- Company organisation
- Company postal and filing systems
- External and internal telephone/Telex procedures and directories
- Standard company format for correspondence and letter composition
- Audio systems and office machines used by the company
- Travel agents, timetables, hotels
- Catering facilities
- Presentation of reports and minutes of meetings
- Sources of stationery and methods of obtaining same
- Machine and office safety
- Petty cash systems, methods of processing claims or other statistics

Skill:
- Communications, oral and written and social skills
- Business arrangements for managers — eg, arrange meetings, travel, visitors, telephone callers, etc
- Developing good relations within company and outside
- Maintaining confidentiality
- Effective shorthand and conversion to transcript

PAINT SPRAYER

Department: Production (Paint Section)
Responsible to: Supervisor

Function:
Apply specified or standard paint finishes to products/components

Job Description:
- Sprays paint on all specified surfaces utilising company spraying equipment and processes
- Sprays paint to the right quality standard
- Recognises atmospheric changes, faults or variations in performance of equipment likely to affect quality
- Informs supervisor of equipment malfunction or deterioration
- Works to all aspects of safety relevant to the equipment materials and processes used
- Uses protective equipment such as face masks, gloves, overalls
- Maintains work record

Knowledge:
- The functions and operations of spray guns and associated parts
- Maintenance and cleaning methods
- Spray booth conditions and mechanical handling equipment
- The effect on paint being sprayed, of viscosity, temperature, pressure and volume of compressed air
- Paint and pre-paint processes
- Recognition of faults
- Quality specification
- Safety regulations and correct use of protective clothing, etc.

Skill:
- Effective use of equipment
- Recognising slight colour differences
- Good colour discrimination
- Correct handling of equipment
- Assessment of density and coverage of paints
- Spraying sequences
- Dismantling, cleaning, lubricating and re-assembling equipment used
- Recognition of faults
(ii) Technician Education

The Haslegrave Report (19) resulted in the establishment of the Technician Education Council (20) in 1973 with the following objectives:

- to provide an improved system of technician education;
- to provide an education "ladder" from craftsman to graduate;
- to give technicians the status they deserve;

with a time scale of six years for complete implementation of the new system. Twenty-two programme committees were set up to formulate programmes of study for technician training in defined areas which were grouped into sectors, for example Plant, Process and Control Engineering in Sector A. Standard units for particular subjects were devised and a selection of these made up a study programme at some particular level starting with Level 1 which is a little lower than "O" level. Colleges could write and submit for approval their own devised units. In spite of the involvement of some four hundred committee members drawn from colleges, industry, professional institutions, technician organisations and industrial training boards, a diet of subjects separately taught emerged. A relevant comment on the system, in a report by a group of further education inspectors on mathematics in further education, in respect of TEC mathematics (21) is:

"... only in a few cases was there any attempt to relate mathematics to any other subject of the curriculum or to the main discipline of the course. Indeed it seemed doubtful in many programmes whether the mathematics units were in any way determined by the technician employment of the young people."

This comment leaves little doubt as to the importance of and the omission of interrelationships in the TEC system. Again,
the Cockcroft Report (22) in respect of further education commented on the mismatch between the mathematics covered in further education and that likely to be needed in the job. It is quite likely that a similar investigation for subjects other than mathematics would yield a similar comment. Perhaps therefore the subjects of a teaching programme could be made more relevant to the student if they were interrelated through some topic connected with the industry in which he/she was employed. The student does not need to have "present" experience in this because it is predicted that jobs will change many times during a person's working life.

In addition to the TEC, the Business Education Council was established in May 1974 with the role of planning, administering and keeping under review a unified national system of non-degree courses for people whose occupations fell within the broad areas of business and public administration. The underlying philosophy of the BEC (23) included statements such as: "students should complete a course in which there is a positive attempt to interrelate the contents".

From October 1983 a new body, the Business and Technician Education Council (24) has replaced the separate Business and Technician Education Councils and the new body now has two "Cross Sector Committees" whose function is to co-ordinate work in development and review and continuing education. A co-ordinating committee provides a vital link between the Boards and Cross Sector Committees. The complete structure is shown on the next page.
The Cross Sector Committees could play an important part in establishing interrelationships between various disciplines.

The National Foundation for Educational Research in its first stage report on the evaluation of TEC programmes (25) suggests a need for further improvement in communication between colleges and employers, perhaps resulting in some modules of study which interrelate subjects through a theme common to industry.

As with schools, the coming of courses such as CPVE and TVEI will prove to be a spur in providing an interrelated approach as mentioned above.

(iii) New Opportunities

The evolving technological world in which we live relies upon a marriage of disciplines for its success. Page (26) gives a model of technology adopted by the "Modular Courses in Technology Project" which illustrates the need for an interdisciplinary approach:
In the field of robotics, Baldwin and Hack (27) voice the opinion that "it will probably not be possible for one person to possess all the knowledge needed to assemble robots – undoubtedly teams of people will work together, each sharing his or her own special skill."

For anyone contemplating a career in robotics they attempt to define areas of knowledge:

- **Computer Science**
  - hardware and software

- **Linguistics**
  - the science of language
  - good grammar
  - sentence structure
  - writing instructions in a clear concise manner

- **Mathematics**
  - geometry
  - algebra
  - trigonometry
  - calculus

- **Physics**
  - responses by robots to the physical world

- **Cognitive Psychology**
  - how humans think
ethics - what humans consider to be right or wrong

sociology - how humans act as a society and how they interact with machines

mechanical and electrical engineering

human physiology - the science of the human body

material science

Above all else, they say, imagination is the key to the future of robotics.

2.1.4 Discussion

Throughout the structures of education and training a variety of patterns emerge, some successful, others being relatively ineffective.

With reference to mathematics, Cockcroft (22) remarks:

"The experiences of young children do not come in separate packages with 'subject labels': as children explore the world around many mathematical experiences present themselves alongside others."

For young children the primary and junior schools are places which are colourful and attractive and where, in the experience of the author, interest is aroused with enthusiasm and honest endeavour in abundance. Perhaps this is mainly due to the fact that much of the work covered is carried out in the form of topic work.

In secondary schools, especially in the later stages, the rigidity and inflexibility of the academic diet offered to students can produce disillusionment and frustration. Teachers
are constantly conscious of "the syllabus" and "the final exam", and are required to teach with these in mind. The author has witnessed how the confidence of some pupils can be totally destroyed. For example, at the age of fourteen some pupils cannot cope with fractions after years of tuition and countless attempts to explain meaning and techniques. Fractions may appear on the syllabus and so the teacher will attempt once again to deal with the topic of fractions sometimes using the same resource materials and textbooks that have been previously used. In the end the pupil may still not succeed and in the process may be convinced that he is inadequate at mathematics and always will be. Perhaps for this type of pupil a different approach is needed, an approach which shows how fractions are used in an applicable context. Above all the approach must be one where the pupil can be given praise and encouragement to increase both self-confidence and self-esteem.

For older pupils with learning and motivational difficulties the material presented for their use must be, in itself, worth doing in their opinions and must be enthusiastically presented by the teacher. Larcombe (8, p27) gives a model for producing high motivation within pupils studying mathematics:

![Diagram of motivation model](image-url)
Another striking difference between infant/junior and secondary education is the relationships between pupils and teachers. In the early years each pupil has an affinity with usually one member of staff who is in control for most of the week. In the secondary setting, pupils have only short periods of time with numerous teachers and relationships may not be as profound as in the infant/junior phase.

A brief comparison of aspects of infant/junior and secondary approaches has been made. It is interesting to compare approaches between secondary schools and the early years of industrial training for young people. In the working environment few examples of misbehaviour occur even though employees are at their place of work for much longer periods of time than pupils within schools. It would seem that substantial differences occur between the approaches adopted within schools and those within places of work.

Perhaps the most noticeable contrast may be in the stability of working groups, especially the closeness of the relationship between employees and supervisors in the work situation compared with that of pupils and teachers in schools. In secondary schools, either the "supervisors" change every so often or else the whole working group and the "supervisors" change leading to disrupted relationships throughout the day. It would appear that working situations give employees a basic level of security in terms of working relationships and environment. In addition the fact that all employees are paid gives them a sign of being valued. This, of course, does not happen with pupils in schools whose sense of value only comes from encouragement and praise from the teacher.

The essential differences between the experience of school life and work life may be compared as shown on the following page.
School

working groups of 20–30 members in most cases

groups made up of members all the same age, with the exception of the supervisor

frequently changing supervisors (i.e. about every 35 – 70 minutes)

change of colleagues every 35 – 70 minutes)

working as individuals

normally distant relationship with supervisors because of above factors

supervisors and group members disagree on the aims and objectives of the organisation (supervisors talk of maturity, appreciation of good things of life, etc.; group members talk about qualifications, not getting jobs, etc.)

Employment

working groups of 5–15 members in most cases

groups made up of members of different ages

same supervisor all the time

same colleagues day-by-day

working as individuals and in teams

normally close contact with supervisor because of above

supervisors and group members agree about aims and objectives of the organisation (to make a profit) – they do not necessarily like these but agree about what they are
School

no generally acceptable ways whereby group members could challenge the aims and views of the supervisors - even when they are seriously believed to be wrong by group members or those concerned for their interest

Employment

agreed procedures whereby disputes with supervisors could be taken up without conflict necessarily getting out of hand, i.e. trades unions or other representative systems

- attendance enforced by law
- not paid for attendance
- role associated with childhood

attendance not enforced by law
paid for attendance
role associated with adulthood

Examples of young people at work are given in section 2.5.

Method of learning is important if facts, techniques and skills are to be acquired. Writing about youth training schemes, Hilgendorf and Welchman (28) describe the learning process for young people in an industrial/commercial placement as:

"Learning in a work experience scheme is first and foremost learning by doing. Sometimes young people need to be instructed, but much of their learning happens because learners find things out for themselves, imitate what they see other people doing and talk about what is going on around them. Both the doing of the tasks and the experience of being in a workplace provide opportunities for learning."

In many ways the approaches adopted by infant/junior schools and training departments with industry are similar. Secondary schools and their compartmentalised curricula differ in terms of approach and human relationships.
Bearing in mind what has been written, it seemed appropriate to research new ways of teaching in the secondary sector; ways which would be compatible with both earlier experiences of students and also practices currently in use in employment situations. This, inevitably, would involve some form of interrelationship between curriculum areas. The author was, however, mindful of constraints on curriculum development especially in terms of examination pressures on courses, teachers and students and also timetabling and staffing structures within schools.

In addition a need exists to carry out investigations into courses offered by further education establishments and their relevance to young people and industry/commerce. With so many young people currently on YTS schemes, the importance of effectively integrating college and working experience is a priority. Unfortunately the East Midlands Further Education Council (29) points out that, so far, integration generally has not been effective.

2.2 Interchange Of Ideas Between Teachers

Having determined that an investigation into the teaching of science, mathematics, technical and vocational subjects in an interrelated way may prove to be a useful research exercise, a research team was formed. This team was led by Professor Bajpai, a person who, for many years, has been a strong advocate of an interrelated approach to teaching. His "Integrated Approach" or "Bajpai Approach" to teaching mathematics for engineers and scientists was first suggested as long ago as 1970 (30) and has subsequently gained world wide approval and acclaim. Professor Bajpai directed the work of two researchers:

Stanley Turner, Senior Lecturer, Wirral Metropolitan College, Birkenhead, who had the task of investigating the feasibility of this approach in further education;

and
the author, a member of the mathematics curriculum area, Burleigh Community College, Loughborough, who would carry out a similar study but would direct his attentions mainly at pupils in their final two years within secondary schools.

2.2.1 Objectives And Strategies

After lengthy initial discussions, the team outlined objectives and supporting teaching strategies which they believed should be considered when discussions regarding an interrelated approach take place. The author was especially determined to investigate how mathematics could contribute to the interrelated approach. Objectives and supporting teaching strategies are presented as follows:

(a) To assemble a team of specialists from a teaching establishment who are sufficiently interested and motivated to co-operate in the use of interrelated curricula.

Strategy: Identification of a co-ordinator who has specialist knowledge and teaching experience in one or more of the related areas. There must be a full acceptance of the new subject INTERRELATED STUDIES within the establishment. This would not mean that specialist subjects would no longer exist in the timetable any more than one would expect, for example, mathematics, science, English and other topics would not exist for students studying "A" level general studies in the United Kingdom.

(b) To motivate students to learn.

Strategy: Use of colourful, attractive and well-prepared materials which relate to the real-life experiences of students. The co-operation of local commercial and industrial organisations must be sought - it is the experience of the authors that a considerable amount of support is usually available.
The prepared material should take into account teaching strategies, programme planning, laboratory management and assessment. Teachers need help in these strategies right at the start so that they can develop new curricula.

(c) To ensure that teachers are sufficiently prepared to cope with an interrelated approach, by means of an available teacher/pupil module and separate pupil modules.

Strategy: Preparation of separate teacher and student modules. The teacher module, while containing the student's material will be much more comprehensive in respect of background information, and the use and variation of this material will be at the discretion of the teacher. Solutions, hints, etc. for student exercises will also be provided. The format of the teacher module will clearly show the separation of teacher and pupil material. The teacher/user must understand that the content of the module will require regular updating by the teacher.

(d) To draw on the experiences and particular interests of students.

Strategy: Teachers and students will need to bring together skills, experiences, knowledge, understanding, imagination and judgement in order to solve a problem. The teaching of these will be a difficult task but it is hoped that students will learn through experience and practice under supervision by the teacher.

Student's experiences, though sometimes not first-hand, are always relevant, for example space travel through television broadcasts. It is important to give guidance on the collation and recording of experiences and interest material. An example is that of newspapers, being particularly useful as they regularly report on developments in commerce, industry and technology.
(e) To ensure that the treatment of important phenomena is at a level of explanation suited to the students.

Strategy: Demonstrations will help to show the results of theoretically derived relationships. Actual experiments carried out by the students should be encouraged for them to understand the explanations of the phenomena under investigation. Where results are to be expressed graphically, a linear graph should be used and, where appropriate, a log-scaled graph (detailed explanation of logarithms may be left until a later stage).

(f) To consolidate learning processes by suitable student exercises.

Strategy: The exercises should be requested as the response to key questions and in simplest form this could imply a descriptive essay. At the other end of the scale problems requiring numerically calculated answers should be applicable to real-life situations, whenever possible. Practical and investigative assignments would need to be carefully structured and checked for continuity with particular attention paid to the time for completion by the average student. Where there are weaknesses in pedagogic, arithmetical and algebraic processes, suitable practice exercises (with self-checking facilities if possible) must be available. Using these strategies teachers should guide students towards independence in their learning as a preparation for the world of work.

(g) To produce modules which are sufficiently flexible for a variety of teaching methods to be employed.

Strategy: There must be regular discussions between members of the teaching team to promote a greater use of audio/visual aids. If such aids are in short supply,
for example, micro-computers, it is acceptable to have a single piece of apparatus for use with a class. As an extreme example of the non-availability of apparatus for student use, the teaching of atomic energy generation has to depend entirely on slides, films, models and diagrams.

2.2.2 Guidelines For The Production Of Teaching Modules

The research team felt that suggested guidelines for the production of teaching materials would be useful to teachers. Ideas were debated and written down with the intention that they would form a useful basis for discussion at future meetings of teachers.

Guidelines

1. Assemble the teaching team

2. Have brainstorming sessions

3. Outline the plan of action using a flow/schematic diagram, decide the title (which may be revised) and set the time schedules for module construction

4. Formulate the general and specific objectives

5. Produce motivational material to show teachers and students the relevance and interrelationships of the topic

Note

This could be achieved through illustrations, purposeful in style and related to practical settings. Suitable material could be obtained by:

contacting commercial/industrial establishments to gather advertising, audio/visual materials;

seeking the co-operation of parents of students to obtain support material/equipment;
encouraging teachers and students to explore the local environment for pictures, specimens (biological, physical, chemical, geological and ecological), and locally available material in order to make low-cost equipment to support the practical content of the module.

6. Allocate the following to the members of the team as individual or group assignments:

- Preparing motivational materials in the form of texts, charts and tables, pictures (in colour or black and white)
- Overhead transparencies
- Slides/audio tapes
- Films/video tapes
- Teacher modules in text form (with diagrams, illustrations)
- Student modules in text form (with diagrams, illustrations)

7. Assemble selected draft material, ensuring that the key points in the modules are suitably highlighted.

8. Discuss the final draft within the team and consult external bodies/persons. Modify as necessary.

9. Formulate procedures for testing and evaluation in a "Pilot Study". Agree procedures with students/teachers/parents/education authorities and any other parties whose involvement is essential for the success of this approach.

Note

It would be highly desirable to supply at least one original set with the multiple copies, so that
participating teachers and students could see the module in its original form.

10. Test the final version before making it available for general use.

11. Explore the possibilities of getting the module published so that a larger body of students and teachers could use it.

2.3 Initial Terms Of Reference

In the early stages Professor Bajpai provided his researchers with terms of reference:

"The essential tasks will be to:

(a) Identify ways and circumstances in which the topic of measurement is taught in science, mathematics, technical and vocational education.

(b) Use information from (a) above to develop a module (a unit of curriculum material) on measurement (containing both teacher and pupil materials) based on sound educational principles.

(c) Provide guidelines for the design of other modules identified for interrelated treatment, i.e. energy, environment, materials and resources, and communication.

(d) Propose practical measures to assist teaching of modules in an interrelated way (e.g. curriculum organisation, co-ordination among teachers on a day to day basis, design and construction of class/work rooms, provision of equipment, formation of interdisciplinary teams in curriculum development, in-service education of teachers).
(e) Collect, analyse and provide information on how inter-related teaching of science, mathematics, technical and vocational education can be facilitated by the use of educational technology.

(f) Collect and analyse relevant information in order to provide guidelines on distance methods which would make modules accessible to a wider range of students.

When investigating the ways and circumstances in which the topic of measurement is taught, the researchers found that it is an aspect which occurs continually in all forms of activity. Specific areas relating to science and technology are outlined in section 2.3.1.

2.3.1 Measurement In Science And Technology

In all science and technology subjects the measurement of physical properties is an essential objective, or a necessary component of an objective.

Physics and Chemistry are taught as a set of principles and practical phenomena, the latter being quantified by fundamental measures (count, time, length and mass) or as derivatives, for example:

specific heat from volume (length), mass and temperature

modulus of elasticity from mass and length

melting point directly from temperature

co-efficient of thermal expansion (length, area or volume) all in terms of length and time

electric charge from mass and time in a chemical cell
molecular weight from atomic weight and a count of atoms

density from mass and volume (length)

**Biology** takes account of the fundamental cell structure of animal and human forms, the macro-components of which have identifiable properties and specific structures which relate to particular species. The following examples illustrate some ways in which measurement occurs within biology:

counting is used to establish and verify laws of genetics

time is used to measure (with counting) pulse rates and heart beats

cells are identified by colour and shape as determined by the configuration of lengths and angles

cell multiplication is determined by counting and measured against temperature

count of macro-components, e.g. number of ribs, vertebrae, etc.

**Technical Education** supports the fundamental industrial processes namely design and manufacture. Measurement takes place at all stages varying from the use of elementary instruments to automatic, continuous monitoring devices. Examples of measurement are as follows:

counting and classification

shape, angle and size are measured with geometrical instruments

smoothness is measured by the abrasiveness of filing and sanding devices

automated machine tools can be programmed to produce a finished product having predetermined measures
temperature is measured continuously and automatically regulated in order to maintain a constant temperature in the heat treatment process

hardness of metals is measured on a variety of scales

**Mathematical Education** is such that mathematics is essentially taught in a "pure" form and where possible reduced to rules and formulae. Some examples of how these concepts are used to produce measure are:

- in transposition of a formula the subject is the measured quantity expressed in terms of the other more fundamental ones
- empirical statistical measures are compared with those expected from an assumed mathematical model
- simple numbers are used to convert practical measures to more meaningful values, for example 304m is 300m to the nearest 10m gradient, etc., derived by means of graphical measures

**Vocational Education** is concerned with the training of clerical, operative, retail and wholesale distributive trades. Formal education is usually available, for example in the office skills. Examples of measurement are:

- shorthand/typewriting speed; teaching tabulations to typists
- money calculations as taught to clerks, cashiers, hotel receptionists, etc.
- reading electricity supply meters
- making clothes and other items in small businesses/cottage industries
weighing of raw materials by process workers

measuring of customers in shoe and clothes shops to obtain appropriate sizes

measurement involved in buying home improvement materials, e.g. timber, screws and various fittings

2.4 Brainstorming Sessions

When discussions first took place about the benefits of an interrelated approach many ideas for student modules were formulated during brainstorming sessions.

2.4.1 Help From Industry And Commerce

Ideas in broad outline were written and copies sent to training officers in companies to obtain advice and comments about the content and format. After obtaining expert advice from personnel in industry, ideas were revised and reproduced. Block diagrams like the ones shown on the next three pages were produced to give teachers an insight into the many possibilities associated with particular topics. The help and support given by personnel in industry was overwhelming. In all cases a deep desire to help in the school education process was evident. Busy people in industry were willing to devote time and energy towards assisting with ideas for the topics. For example, a report was produced by the author after visits to 3M Health Care Limited. The report, in Appendix 2.1 gives an indication of the information received and ideas obtained for a module of study dealing with the pharmaceutical industry. It also illustrates the warmth and support offered by personnel in industry to the author. Some of the suggestions made were evaluated in schools as reported in Chapters 4, 5 and 6.

Throughout the course of the brainstorming sessions, many occasions yielded ideas as to how mathematical topics could be effectively attempted by students in conjunction with aspects of science, technology and communication.
Measurement and the Pharmaceutical Industry

Measurement is concerned with: Count, Time, Length, Mass, Area, Volume, Chemical, Physical and Biological Properties, Cost, Public and Medical Demand, Product Effectiveness

Packaging
- Measurement of Areas
- Volumes
- Costs
- Properties of Packaging Materials

Storage
- Measurement of Area
- Volume
- Mass
- Safety Factors
- Security

Transport
- Measurement of Distance
- Time
- Speed
- Volume
- Cost

Medical Practitioners
- Measurement of Pulse Rate
- Blood Pressure
- Body Temperature
- and other biological tests

Market Research
- Measurement of Public and Medical Demand
- Competitor's Performance
- Forecasts
- Market Estimates - actual v. budget
- - strategies
- - limiting agents

Research and Evaluation
- Measurement of Cost
- Efficiency
- Success Rate
- Aesthetic Appeal of Product
- Performance characteristics
- Design of Inhalers, Syringes, etc
- Safety Evaluation

Specifications
- Measurement of Mass
- Volume
- Ratio of Ingredients
- Physical, Chemical and Biological
- Properties of Ingredients

Interrelationships can also be found between elements within different rectangles.

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MEASUREMENT AND THE MOTOR CAR

Measurement is concerned with: Speed, Distance, Time, Power, Rotation, Capacity, Temperature, Current, Voltage, Pressure, Noise, Pollution, etc.

CARBURATION
Measurement of Combustion
Air/Fuel Ratio
Compression
Engine Size
Oil Pressure

ELECTRICAL SYSTEM
Measurement of Current
Voltage
Electrical Power
Electrical Rating
Charts of Battery

DESIGN OF SHAPE
Measurement of Visibility
Weight of Car
Properties of Materials Used
Corrosion
Corrosion Prevention
Drag Coefficient

FUEL
Measurement of Volume (Fuel in Fuel Tank)
Fuel Consumption
Economical Driving ('In Town' or 'On A Run')
Octane Rating of Fuel
Petroleum Production
Fuel Cost

OILS AND FLUIDS
Measurement of Properties
Viscosity

COOLING SYSTEM
Measurement of Temperature
Humidity (Heating System)
Thermostatic Control
Antifreeze

GEARBOX
Measurement of Gear Ratios

TYRES
The Various Types
Measurement of Tyre Size
Tyre Pressure
Tread Depth

THE EXHAUST SYSTEM
Measurement of Noise
Content of Exhaust Gases
Pollution

ROAD SURFACES
Measurement of Safety
Stopping Distances
The Effects on Suspension

ACCESSORIES
Tow Rope (Strength)
Jack - Screw
Fire Extinguisher
Battery Charger
First Aid Kit
Spare Parts

INTERRELATIONS CAN ALSO BE FOUND BETWEEN ELEMENTS WITHIN DIFFERENT RECTANGLES

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Turner (31) quotes numerous cases of help received from industry and commerce in developing various courses. Company representatives were helpful in granting interviews, discussing ideas relating to his work and allowing factory visits. His case study involving the Cammell Laird Training School illustrates this helpful dialogue.

2.4.2 A Tape-Slide Programme

The brainstorming sessions revealed a wealth of ideas involving measurement. The team felt that a promotional tape-slide programme would help them to clearly explain ideas and philosophies to students, teachers and teacher trainers.

Turner was largely responsible for production and development of the programme. He was supported by ideas, materials and constructive suggestions supplied by the other team members. Specimen slides and dialogue are given in Appendix 2.2.

The programme has been well received by teachers, students and teacher trainers within this country and abroad.

2.5 A Case Study - Measurement Within The First Year Training Workshop Of An Engineering Company

In June 1983, the author organised a visit to the Training Department at Brush Electrical Machines Limited, Loughborough, for a group of teachers who had recently become heads of mathematics departments in Leicestershire (or who aspired to reach such positions). The objective of the visit was to give teachers a practical awareness of how mathematics and modern technology is an important part of current training programmes.
This section tries to highlight aspects of measurement. The ideas are not exhaustive, just a sample of the many facets of measurement to be found in the workshop. In addition it became apparent that the whole nature of the trainees' work revolved around a totally interrelated approach. Mathematics, science, design, technology, communication, etc., all had a place in daily tasks allotted to trainees.

2.5.1 Acknowledgements

The author would like to thank Peter Morley and David Bushell of the Training Department at Brush Electrical Machines, Loughborough, for their help, enthusiasm and constructive ideas in building links between schools, colleges of further education and industry. Thanks must also go to their staff and trainees within their Training Centre, who were both open and most helpful in explaining the work of the Centre.

2.5.2 In The Workshop

1. Measurement By Eye

Trainees were observed checking angles by eye after bending operations. Constant visual inspections of quality of machined surface finish are made throughout machining processes. Measurement by eye is important when setting cutting tools relative to given datums.


Trainees need to take many measurements. They need to be competent in the use of instruments such as micrometers, vernier calipers and dial test indicators.

3. Materials Technology

Measurements are relevant to a range of materials. Employees need to have and apply knowledge of the properties of various materials in respect of cutting speeds/feeds, etc. They need to be aware of the many types of cutting tools and when to use coolants.
4. Measurement And The Production Process

In the actual machining process, measurements are continually being made. The Training Centre contained lathes and milling machines fitted with scales calibrated in both imperial and metric units.

Imperial units are still in use and will be for many years in the future (especially in relation to export and spare part orders). Measurements in the workshop involve both imperial and metric units. Trainees require the skills needed to convert from one to the other.

Another important aspect of measurement emerging from the machining process is the importance of tolerances - an aspect often overlooked within school teaching programmes.

One skill which has to be acquired is the ability to read and understand engineering drawings and to work from them to produce finished items. The drawings provide the measurements (and tolerances); the craftsman makes the finished article.

Trainees must be able to carry out basic calculations in relation to machine tools. They also have to be able to read tables of information and select correct readings.

Oxy-acetylene cutting is used for cutting plate materials. Profiles can be cut using a pantograph mechanism and a template - the template must be accurately measured, marked out and cut to size.

During welding processes, measurements of pressures of oxygen and acetylene have to be taken and regulated to suit various welding blowpipe nozzle sizes.
5. Modern Technology

Modern technology brings about easier but very accurate measurements on machine tools. Microprocessor control systems enable measurements in the x, y and z directions to be made very accurately.

A control panel is shown which displays measurements in the x and y directions. Note the terminology ± and also the dual imperial/metric facility.

6. Safety

Safety is a most important aspect of workshop training. Safety measures have to be continually reviewed and monitored. Some safety measures observed during the visit were overalls, protective eye glasses, guards on machines, clear gangways, hair cut short or tied back, the use of protective hand creams, etc.
7. Working Environment

There are many "hidden" factors concerning measurement which are usually taken for granted.

One could not fail to be impressed by the cleanliness and orderliness of this Training Centre. A good working environment was clearly important, and in order to maintain this there was a need to measure and monitor lighting, heating, ventilation, noise levels, cleanliness, and size and accessibility of gangways, etc.

8. Communication

Another "hidden" factor is the need for trainees to be able to work effectively as a team and to have the ability to communicate ideas verbally to others in a concise, constructive manner.

The trainees in their first year at Brush Electrical Machines were open, enthusiastic and articulate when discussing their work with teachers.
Communication skills are difficult to measure but are so important. Another form of communication is by using written words and diagrams. Measurement of effectiveness is difficult and has to be subjective.

9. Other Observations

Other qualities/skills that are required of the trainees include:

- punctuality and reliability;
- the ability to communicate using the written word when writing up training exercises;
- the need to use the microprocessor for recording details of current/past training exercises.

2.5.3 Discussion

The types of measurement inherent in running an efficient training workshop are numerous. Measurement is involved in mathematical, scientific, technical, vocational and social aspects of the training programme; on most occasions measurements are straightforward, easy to make and easy to check. On other occasions, however, important measurements can only be made subjectively, for example measurement of effectiveness to work as a member of a team or to communicate at various levels and in various ways - difficult tasks resulting from the thorough and well thought out training schemes in operation in today's engineering industry.

The visit and the diverse nature of tasks attempted by young trainees gives support to the views of Fitzgerald (32) who expresses the opinion that engineering employers now need to produce "multi-skilled craftsmen" who can cope with the intricacies of new technology. With this in mind he says employers are looking for pupils with higher levels of achievement in mathematics than a few years ago.
An illustrated report of the visit was presented to the company and was well received. Further discussions with the training officers involved resulted in ideas for audio/visual programmes for use in schools, colleges and training departments which would highlight the importance of measurement. These programmes, it was intended, could be used as both a teaching aid to various aspects of the workshop or purely as an informative insight into the many tasks encountered by trainees.

The programmes were not made owing to lack of time and the financial backing needed to produce professional packages. Ideas which emerged are shown on the next page.

2.6 An Early Trial – The Car Park

After discussions centred upon developing a topic of study concerned with measurement, the author decided to carry out a small exercise with a group of secondary students to obtain their initial reactions.

It is generally accepted that one of the aims of teachers should be to make the content of their teaching material, where appropriate, relevant to their students' current and future experiences in order to show that many of the concepts taught in schools may have uses in life outside the classroom.

Car parks are plentiful in all forms of industrial, commercial and domestic premises (including all pharmaceutical companies). The car park is something that is taken for granted and yet its design has to be carefully planned to ensure maximum utilization of space and ease of use for employees/customers.

It seemed appropriate to use the car park as a means whereby measurement could be discussed in a low ability mathematics group of 14/15 year old students. Even with this age range, the concept of "how long is a metre?" is one which causes difficulty. An evaluation of this trial can be found in Appendix 2.3.
MEASUREMENT AND THE FIRST YEAR TRAINING PROGRAMME
FOR ENGINEERING TRAINEES

Outline of Audio Visual Programmes A - I

MEASUREMENT AND COMMUNICATIONS (B)
Written - as in log books
Verbal - with instructors/fellow trainees
Using engineering drawings
etc

MEASUREMENT AND MODERN TECHNOLOGY (I)
Numerical control on lathes, drilling and milling machines
Modern inspection devices
Use of the microprocessor in training programmes
etc

MEASUREMENT AND MACHINE OPERATIONS (3)
Microimeters
Vernier callipers
Dial test indicators
Screw gauges
Speeds and feeds
Imperial/metric measures
Surface finish
etc

MEASUREMENT AND WELDING (D)
Ratios - oxygen/acetylene
Electric welding
Diameters of welding rods
Temperatures
Pressures
etc

MEASUREMENT AND SHEET METAL WORK (E)
Developments
Marking out
Bending allowances
etc

MEASUREMENT AND ELECTRICAL TRAINING (C)
Amps
Volts
Ohms
Oscilloscopes
etc

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2.7 Modules And Measurement

Professor Bajpai had been specific in requesting the researchers to develop a module on measurement in which an interrelated approach was to be employed. After thought and consideration of ideas it soon became apparent that measurement occurred in all situations in which we find ourselves. Any topic chosen for development must contain aspects of measurement in various forms. The modules developed during the course of this research project, therefore, have not been given the title "Measurement". They have a variety of titles but within each one measurement can be found in abundance, whether it be measuring lengths, people's opinions, sound, light, temperature, aesthetic appeal, etc.
CHAPTER 3

GENERAL MODULE PREPARATION

3.1 Study Skills

3.1.1 Introduction

Never before has so much information been available to so many and never before have our lives depended so much on our ability to handle information successfully. We need to be able to search out what we require, to assess critically the ideas and facts offered to us, and to make use of our findings.

The Schools Council (33) found that:

"Schools, which are concerned with learning above all else, find great difficulty in teaching pupils how to learn. Although some pupils are able to use the full range of learning resources which the school can offer, most are not, and it is a central responsibility of the school to help its pupils cope with learning."

Hamblin (34) lists ten areas of skill which should be built into teaching programmes in ways related to age, ability and background of the pupil:

"1. Listening: this will be treated in a way which links it with recall.

2. Reading: the mechanics as well as recall and the development of inferences will receive attention. Reading as a way of generating new ideas will be stressed.

3. Presentation of work: this is a skill which is often disregarded or has not been developed by pupils. Yet it is closely associated with competence and the growth of respect for oneself as a learner."
4. Active methods of homework: consistent training in homework methods is necessary if negative attitudes are not to develop. Pupils not only underfunction in school, but in their homework.

5. Planning and target setting: a key skill in which peer support will be essential.

6. Essay writing and answering questions: continuous attention has to be paid to these skills if pupils and teachers are to benefit from their hard work.

7. Revision and examination techniques; an area which will be treated in different ways at different ages, but one which progressively becomes more important.


9. Raising the level of aspiration and inculcating the motive to succeed: vital, yet an area which is rarely dealt with systematically.

10. Evaluation: a skill which is not the prerogative of the teacher; pupils must be taught to evaluate their own work."

Communication between teacher and student is vital in the learning process. Consideration of study skills must stretch across the curriculum. In a recent small study, Tabberer and Allman (35) show that some curriculum areas in schools and colleges tended not to involve themselves in study skills. The mathematicians, for example, appear to leave discussions relating to study skills in the hands of humanities and English staff.
Main teaching subjects of those staff closely involved in provision of study skills (from the small study)

<table>
<thead>
<tr>
<th>Subject</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>19</td>
</tr>
<tr>
<td>Mathematics</td>
<td>6</td>
</tr>
<tr>
<td>Humanities</td>
<td>32</td>
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<tr>
<td>General Studies</td>
<td>6</td>
</tr>
<tr>
<td>Science</td>
<td>14</td>
</tr>
<tr>
<td>Languages</td>
<td>8</td>
</tr>
<tr>
<td>Technical Craft</td>
<td>2</td>
</tr>
<tr>
<td>Creative Arts</td>
<td>2</td>
</tr>
<tr>
<td>Office Business</td>
<td>1</td>
</tr>
<tr>
<td>Other*</td>
<td>11</td>
</tr>
</tbody>
</table>

N = 180

* including careers and remedial teachers, librarians and counsellors

3.1.2 Study Skills And Module Preparation

When writing the modules described in this thesis, the author became increasingly aware of the importance of study skills. The actual process of learning required as much, if not more, attention as preparation of content. Process relates to all aspects of preparation and structure of work, working environment, etc.

Bruner (36) suggests that the following features constitute the minimum framework of a learning theory: predispositions towards learning, a structure about which the materials or ideas are organized, the sequence in which the materials or ideas are presented, and the nature of rewards and punishments. Cohen (37) uses essentially the same factors but amplifies the first to "environment or set of experiences which implant a predisposition to learn." He also uses "the most effective mode of presentation" as his third component.
Lawton (38) adds weight to this by saying: "One of the most neglected aspects of teaching and learning is the art of structuring subject matter."

With well planned structure, sequence and presentation, classroom organisation and subsequent teacher relationships with pupils will be improved. As Marland (39) says:

"Good organisation in the classroom avoids confrontation, and allows the teacher to establish the warm relationships with most of his pupils that he wants."

"A well-organized teacher is in a better position to be pleasant to his pupils."

The need for good study skills and material preparation by teachers was mentioned by HMI (40) in a small scale survey of some aspects of the life and work of ten secondary schools carried out in the summer term of 1975:

"It is commonly held that able pupils as they grow older require opportunities to study in depth ... and to become increasingly responsible for their own habits of study and their own progress."

"Good preparation, variety of approach, regular and constructive correction of pupils' work and consistent encouragement are the hallmarks of successful teaching seen."

Variety of approach is essential especially with the less able student. The tasks set must have a reasonable target time for completion so that pupils gain a sense of achievement in completing each task. Many slow learners invariably produce work which is disorganised in presentation. It is important to give students work which requires them to provide answers in a variety of ways.
Ways which could be considered include:

(a) writing passages on sheets of paper;

(b) copy and complete;

(c) fill in the missing spaces on a worksheet.

For many students the last option is the most attractive. They can usually attempt the work and obtain a sense of achievement by presenting a number of completed sheets which have the appearance of being neat and well ordered. The benefits of encouraging students to produce attractive work in mathematics are outlined by Larcombe (8, pp 89-90).

"So very often the work produced by the least able lacks not only in accuracy but also in neatness. After a while many pupils become convinced of the unacceptability of their own work on the basis of appearance alone. Whether this is the adverse consequence of the endeavours of successive teachers to encourage pupils to produce model work by displaying only fine, neat and attractive examples on classroom walls does not, perhaps, matter. I have noted, however, that the impact of producing really attractive work on pupils whose work is generally indifferent and whose confidence is low, can be quite remarkable."

Throughout this research project the author has attempted to produce tasks for students in a variety of styles from fairly structured programmes as in the "Packaging for Coffee" exercise (reference Chapter 5) to open, student-centred assignments which require students to be responsible for their own learning and require them to use initiative in obtaining resources, etc. A typical assignment of the latter type is shown in Appendix 3.1. This was an exercise suitable for pupils in developing countries which illustrates
an interrelated approach to teaching. This assignment was included as an appendix to a paper presented by Professor Bajpai at a conference for educationalists in Malawi in 1984.

3.1.3 The Effectiveness Of Using Worksheets

The effectiveness of worksheets is difficult to gauge. Irving (41) describes the effect of appealing, well designed worksheets for third year secondary pupils in geography lessons. With reference to a worksheet called "Movie Mogul 1910" (please see next page), comments from staff included:

"It made the pupils use a variety of maps and use them successfully."

"This worksheet motivated the pupils. Whilst they were using an atlas extensively, they didn't really feel that was what they were having to do."

This comment typifies the reaction of pupils to well presented worksheets. Aspects of graphic design dealing with attractiveness of worksheets are covered in section 3.2.

3.1.4 The Working Environment

The environment in which the pupil studies is another important contributor to successful learning strategies. Marland (39, pp 24-27) makes the observation that:

"The general cleanliness and tidiness of the room will affect the pupils' attitude and behaviour."
"Hi there! My name is Darryl B. Hamerstein Jnr. I make movies here in New York but I want you to search the U.S.A. for me to find a better place for my film units."

Problems with New York
Summer temperatures up to 37°C, very humid—not good for film.
Winter temperatures well below 0°C, blizzards—hand cranked cameras freeze up.
Also, big crowds make filming difficult.

Films to make

Good things about New York
Good for city scenes, harbour and dock scenes.
Easy for Police Crime movies, Big City movies, movies based on Broadway musicals.

STAGE COACH ADVENTURE
Arabian Nights
Gold Rush
Earthquake
The Abominable Snowman
Trapped in the Sierra Nevadas
The Giant Redwoods

CHINATOWN STORY
HIGH CHAPARRAL

"A scout of mine has suggested California as a good place. He said that any fool with an atlas could see why. I can't understand these fancy-coloured maps, can you help?"

1
Find an atlas map of the U.S.A. which is a physical map. Look near California.
What can you find to help you make the films:
Arabian Nights
The Abominable Snowman
Trapped in the Sierra Nevadas
Explain your reasons.

3
What do you know about California that will help you make the films:
Earthquake City
Chinatown Story
Gold Rush
Apache Warpath
Stagecoach Adventure
Explain your reasons.

2
Find an atlas map of the U.S.A. which shows natural vegetation. Look near California.
What can you find to help you make the films:
High Chaparral
The Giant Redwoods
Explain your reasons.

4
The climate of California is better for the type of film used in 1910. Explain your reasons:
If the climate doesn't often fall below freezing and is warm with little rainfall then you can film outside most of the year round.
Find a map which shows January and July temperatures and rainfall.
Write some sentences about why the climate of California is good for filming and the film and cameras.
The layout of chairs and tables can contribute profoundly to the success or otherwise of a classroom teaching situation. Jones (42) has the view that the shape of a teaching group can:

(a) reinforce communication styles;
(b) influence the degree of formality;
(c) affect the control of a meeting;
(d) help make a person feel part of a group.

He gives advantages and disadvantages of various configurations of tables and chairs, for example:

<table>
<thead>
<tr>
<th>Rows</th>
</tr>
</thead>
<tbody>
<tr>
<td>O O O O O O</td>
</tr>
<tr>
<td>O O O O O O</td>
</tr>
<tr>
<td>O O O O O O</td>
</tr>
</tbody>
</table>

Advantages
1. The leader is clearly in charge.
2. Facilitates attendance of large numbers.

Disadvantages
1. Discourages two way conversation.
2. Encourages side conversation.

Herringbone

<table>
<thead>
<tr>
<th>U Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Outer &quot;U&quot;</td>
</tr>
<tr>
<td>x</td>
</tr>
</tbody>
</table>

Advantages
1. Easy for leader to have eye contact with all.
2. Convenient for 6-20 persons.
3. There is equality of membership, and clear-cut leadership.

Disadvantages
1. More difficult to get to know other participants.
2. Non-verbal communication is weakened.
3. Discourages small group team building.

| B. Outer & Inner "U" |
| x |

This arrangement results in more visual contact, and brings the entire group into closer proximity.
The Bullock Report (15, p 234) supports the view that the learning process can be enhanced by consideration being given to position and layout of pupil seating arrangements:

"In our visits to schools rarely did we see pupils with space to spread their papers, or the degree of 'psychological insulation' for individual reading and writing that adults would expect for themselves. Group work requires the space to allow tables and chairs to be rearranged into clusters. Discussion operates best when the pupils are sitting round a group of tables or in a horseshoe of chairs."

Throughout the author's research project teachers were urged to carefully consider suitable seating arrangements for pupils. This fact would be a contributory factor in the success or failure of teaching modules.

3.2 Graphic Design

3.2.1 Introduction

Graphic design is a most important aspect of worksheet production. Lowndes (43) emphasises that many pupils will not bother to read or take seriously something that looks uninteresting. Even a very simple typewritten sheet run off on a duplicator can, she says, be made to look interesting by using columns of type or different typefaces to break up the printing together with sub-headings and cartoons or illustrations.

In society pupils are exposed to graphic design in all spheres of activity. As Dalley (44) says:

"Today virtually everything one can buy - from a new car to a packet of soap powder - has been designed, and the graphic designer will have been involved at some point in the design process, whether working out the promotional material for the new car or the package and format for the soap."
It must be quite a dulling experience for some pupils to receive poorly typed, badly reproduced worksheets crammed with information and questions.

3.2.2 Simple Techniques

The main constraints on teachers with reference to the production of teaching materials are time and money. There are many basic aids currently available which can be used to make pupils' worksheets both attractive and appealing. Teachers are advised to make use of their local teachers' centres where they will usually find helpful advice, technical assistance and the hardware needed to produce attractive work.

As an example, consider the use of illustrations on worksheets. Many teachers do not have the skill or the time to produce appealing illustrations. At most teachers' centres a supply of "non-copyright" illustrations are available which can be openly copied and then stuck onto worksheet masters ready for duplication. The process is quick and effective. Examples of available illustrations are:
In addition, professional lettering can be readily available by using a range of resources such as stencils, Letraset, lettering machines, photo-type setters, etc., for example:

C.S.E.
Mathematics
1234567890
INTERRELATED WAY

Given the inclination and a small amount of time teachers can produce very appealing worksheets.

3.2.3 Cartoons, Photographs And Illustrations

Cartoons, photographs and illustrations can often make a point better than words. A well thought out arrangement of a piece of text using illustrations or cartoons can help the reader follow an argument as well as make the presentation appealing and interesting. Even in serious articles designed for academics, cartoons may be used as an attractive way in which to introduce important points. Freeman (Director of the National Extension College, Cambridge) highlights this point in his book "Mastering Study Skills" (45). Please see the next page.

3.2.4 The Need For A Basic Simple Guide To Good Graphics For Teachers

Many teachers have no knowledge of the simple design techniques which could help to make their worksheets much more attractive
and appealing. The author, throughout his research project, has become more aware of the need to exercise care with the presentation of students' work.

In recent discussions with the resources co-ordinator at his school, the author learned that a text dealing with such techniques in a simple format was not available. The resources co-ordinator, himself a trained graphic designer with much experience of working in industry and commerce, suggested that he and the author should attempt to co-write a short book on the subject. The idea of the combination of the two teachers was for the resources co-ordinator to provide technical expertise and the author, a non-specialist in graphic design, to write the material in a simple format which would easily be understood by other non-specialists. Important concepts and skills were identified and a structure for the book formulated as follows:

Title: Basic Graphics For Teachers

Contents:

Preface

Table of Contents

Introduction - the need for a book of this type
  - what we are trying to achieve
  - target audiences

Module 1 - Hand Tools and Associated Equipment Used In Graphic Design
  - a list and description of tools/equipment
  - pictures and explanations
Module 2 - Obtaining Good Lettering

- typewriter - manual
  - electric
  - electronic
  - jumbo
- word processor
- Letraset
- Kroy letterer
- photo-type setter
- commercial type setter
- handwriting
- stencils

Module 3 - Obtaining Good Illustrations

- non-copyright material
- accurate tracing
- use of the photocopier for enlargement/reduction
- use of episcope to enlarge
- use of photographic techniques:
  - drawing from photographs; process camera
- a cautionary note about copyright laws

Module 4 - Simple Techniques For Graphic Design

- cut and paste
- legibility - types and mix of type/lettering
  - sizes of lettering and illustrations
- layout
- margins and line spaces
- level of language
Module 5  - Analysing And Solving Problems

This is to be covered by the use of 10-20 case studies which would include pages of text, workbook covers, simple posters, directional signs, departmental letter headings, etc.

Module 6  - Types And Sizes Of Paper And Card

Module 7  - Poster And Display Work

Module 8  - Graphics For The Overhead Projector

Module 9  - Graphics And The Microcomputer

Module 10  - Methods of Duplication Of Materials

- spirit duplicators
- using stencils
- offset litho

Module 11  - Methods of Binding And Protecting Materials

- stapling
- using glue
- spiral binding
- lamination
- storage of art work

Module 12  - A Valuable Resource: Teachers' Centres

- their role
- types of facilities

Module 13  - Services Offered By Commercial "Instant Print" Shops
A rationale, chapter headings and specimen pages for the book were sent to a leading publishing company. The company "liked the approach" but felt that "a book of this kind has a very limited market". They stated that "in the last 18 months (1984/85) the supplementary book market has been hit quite badly and sales of teachers' books and similar publications have fared very poorly".

Possibly a student booklet may have more sales appeal and this is currently under investigation.

### 3.3 Level Of Language

Many schools have moved away from the textbook towards the worksheet. In the experience of the author and his colleagues failure to solve problems in mathematics or to assimilate knowledge in other subject areas arises, in some cases, from the pupils' inability to cope with the reading level of instructions and exposition on the worksheets. It would seem, therefore, that teachers may be making comprehension difficult.

Bailey (46) suggests that teachers should keep certain questions in mind when preparing worksheets. He lists the following:

"1. Is the language used so abstract that it is likely to cause a reading problem?"
2. Have I avoided long complex sentence structures? Limit sentence length to a maximum of 10 words (average length 7 words).

3. Have I where possible chosen the simpler of two words to make the meaning clearer to the reader? (for example instead of 'determine' use 'find out', or instead of 'predict' use 'guess'.)

4. Have I reduced the technical jargon or expressions and phrases which contain unnecessary words? It is often difficult to substitute words for technical vocabulary, so ensure that they have been covered in previous discussions. Try not to use more than five of the specialised vocabulary words or difficult concepts per 100 words.

5. Have I given sufficient simple illustrations, pictures, charts, tables or diagrams to help clarify the written word? Illustrations are especially helpful when pupils have to produce an end product; labels of parts of apparatus and machinery are very helpful.

6. Can I use colour or underlining to focus attention on Keywords and specialised vocabulary?

7. Is the worksheet legible? Sometimes written worksheets are poorly duplicated, have inadequate print size and inadequate use of space. Typewritten worksheets using a large print typewriter have much to commend them.

8. Is there help in the pronunciation of difficult words, such as phonetic spelling in brackets? Turn written numbers into numerals.
9. Have I considered starring questions to be answered according to their level of difficulty? In a mixed ability situation, the literal comprehension questions might have one star, the Inferential questions two stars, and the Evaluative questions three stars. All pupils would respond to the one star question. Average and above average pupils should be able to respond to the two and three star questions.

10. Have I allowed my less able pupils to produce written work in their own words (i.e. related to their own experiences and their conceptual level of development) rather than in the more objective language of the subject? This is an important consideration in the sciences.

11. Have I used the written reports of more able pupils as starting points for my passage of information on my worksheets?

12. Have I checked the reading level of my worksheets with a readability formula?"

He goes on to say:

"Unless these criteria are borne in mind when producing worksheets, instructions may be too complex and the quality of learning consequently reduced. It is often helpful to ask a colleague from a different subject discipline to look at your worksheets and comment on whether they match up to these criteria."

When describing junior children's attitudes to mathematics, Shuard and Rothery (47) comment that:

"from the beginning of the junior school years onwards, children are reading books in all subject areas, and teachers often expect them to read mathematics books. This, they say,
is often a stage in which children seem "to have no difficulty with the maths", but they struggle in interpreting instructions from written material. They found that teachers ascribed these difficulties to a number of causes, and list the following examples of teachers' comments:

**Understanding**

"They could read the card but the words did not convey any meaning."

"Although the children knew the words they seemed unable to comprehend the questions."

**Concentration**

"There are too many questions on the one page for them to concentrate adequately."

"Many of the reading difficulties originated from a lack of concentration."

**Vocabulary**

"Specific problems with decoding the words 'estimate and record' ... when the meaning had been discussed one child commented 'Why didn't they use guess and write down?' The wording 'copy and complete' means very little to any of the children."

**Phraseology**

"She read the card easily and then said 'It's got here fill in the missing number. But if it's missing I can't, can I? Where is it? After explanation of what to do she got on easily."
"There were questions from the children: 'What do we have to do?' Most of them needed an explanation and reassurance; the confident ones didn't ask."

In their investigations, Shuard and Rothery (47) discovered that the idea that some of the pupils' problems might be ascribed to reading difficulties seemed to be new to many of the secondary teachers. Their responses showed less awareness of language difficulties than did the responses of the general teachers of younger children, all of whom taught language as well as mathematics. They give a typical response from a secondary teacher which concerned the use of text by pupils in a CSE group. "There were no reading difficulties, only in the interpretation of what the question meant."

The problems caused by language difficulties in mathematics is discussed by HMI (48), who conclude that these are often a barrier to pupils' mathematical progress. Lawton (38) stresses the importance of developing language skills in pupils. One of the most important functions of a teacher, in his opinion, in encouraging learning, is the ability to manipulate language. He emphasises that there are usually cultural differences between pupils and teachers. He illustrates the need for teachers to communicate with pupils at their level by saying:

"Very few children are without language, but their language may be different from the language of the school."

Turner (31) also found that inappropriate levels of language had an adverse effect upon the learning process. He quotes a typical response from a bricklaying student presented with a difficult piece of text as "It's mind-boggling - someone from Cambridge must have written this."
The author has been aware of the need to carefully consider level of language throughout the course of this research project. His recognition of the importance of this aspect of learning and knowledge of difficulties caused has been greatly helped by discussion and planning of student tasks in conjunction with an English specialist (reference Chapter 5). In the final analysis there were sections of all modules used by students where the level of language was inappropriate and which required revision.

3.4 The Use Of Audio/Visual Aids

3.4.1 Use Within Teaching Programmes

Audio/visual aids in the form of videos, films, tape/slide programmes, overhead transparencies, etc. help to arouse interest and curiosity and often break the monotony of written work for pupils. Use of films, videos and tape/slide programmes does, however, require availability of specialised pieces of equipment which, in schools, usually have to be booked in advance, used and then promptly returned to a central resource area. There are many excellent films and videos which are available from large organisations such as Shell, BP, Volkswagen, etc. Once again the teacher needs to forward-plan activities, order the film/video and then return promptly.

Several of the modules outlined in this thesis have required students to work individually or in small groups, thus necessitating audio/visual aids and equipment to be permanently based within a classroom area in order that pupils can use materials when required. Within the research programme the only film/videos used were in the section dealing with the pharmaceutical industry (reference Chapter 6). These were organised by outside speakers and were well received by pupils.
3.5. The Involvement Of Personnel From Industry And Commerce

3.5.1 The "Schools-Industry Movement"

It is now common to refer to "the schools-industry movement" in this country. This is of relatively recent origin, although it was built on the foundations of a series of older schools-industry infrastructures which according to Reeder (49) dates back to the beginning of the nineteenth century.

Whilst many employers say that they want schools to adopt a more industrially relevant curriculum in order that industry might ultimately be more productive, there are considerable divisions within their ranks. Some larger national organisations such as BP, ICI and the Bank Information Service have supported initiatives where a revision of the school curriculum embraces more experiential learning, a greater emphasis on economic literacy and more relevant assessment systems. Other organisations concentrate upon making the school curriculum congruent with the needs of industry.

Joseph (50) outlined what he thought the "schools-industry movement" should be aiming to achieve in a written Parliamentary answer which subsequently was circulated to all chief education officers in England and Wales:

"Schools and industry need to understand each other better. Business should be helped to appreciate the aims of the schools and the context in which these seek to achieve them. Conversely, schools and pupils need to be helped to understand how the nation earns its living in the world. This involves helping pupils to understand how industry and commerce are organised; the relationship of producers and consumers; the process of wealth creation; the role played by choice, competition and profit; and the traditional liberal view of the interdependence of political and economic freedom, as well as rival theories of how production and distribution should be organised and the moral basis commonly adduced by those theories."
One of the strongest claims made on behalf of the "schools-industry movement" is that it brings a more relevant education to young people. Jamieson (9) has the view that "the claim to relevance is a complex one". He poses an important question: "more relevant to whom?", and follows this by saying:

"Much of the schools-industry rhetoric is based on the assertion that young people do indeed see the relevance of studying subjects like English, mathematics and science when they are applied to problems in the adult world of work; that furthermore they respond positively to new modes of learning that stress the active role of the learner, and the importance of learning by experience (the traditional adult mode of learning)."

It was clear from the Scottish report "An Education For Life And Work" (51) that the majority of young people respond to what the report calls the "vocational impulse".

Industrial awareness through experiential learning helps teachers to bring a certain degree of realism into their teaching. Teachers, through experience, begin to realise the interrelated nature of the various skills required by personnel in industry. As Everard (52) pointed out:

"It is dangerously misleading to forget how heterogeneous industry is."

3.5.2 Curriculum Development Within Schools Mathematics Departments

With reference to mathematics, there have been a number of successful initiatives which have emerged over the past few years.
The Dacorum Education and Training Forum (Dacorum is the western "corner" of Hertfordshire - Hemel Hemstead, Berkhamstead, Tring and the surrounding countryside) is a loose association of training officers, careers officers, schoolteachers and others. Their formulated guidelines for the organisation of links are expressed by Stanier (53):

"(a) A member of staff in each school should be responsible for co-ordinating the scheme. We have found that at our local level it works best if a teacher makes the first approach.

(b) That member of staff should make a preliminary visit to the firm involved, the main aim of which should be to identify possible areas of interest and to get some ideas for worksheets.

(c) Arrangements should then be made for as many teachers of mathematics as possible to visit the firm, having in mind a particular pre-arranged aspect for investigation. Each teacher is then asked to produce one (or more!) relevant worksheets which they feel able to use straight away with a class and which should fit in with the existing scheme of work.

(d) When a series of worksheets have been produced they should be shown to the firm before being used in the classroom.

(e) Arrangements should then be made for industrialists to visit the school, preferably to see the worksheets being used in the classroom - not always possible but extremely worthwhile when it can be done."

Stanier expressed the view that their work has resulted in considerably improved relationships between employers and teachers of mathematics and, as understanding of what is
happening in schools increases, a lessening of criticism of mathematics teaching from employers has become apparent. Stanier is able to provide advice for anyone thinking of starting a similar scheme. She advocates (53, p23):

"(a) try to establish contact with employers – they are interested!

(b) avoid arguments about standards of arithmetic at all costs;

(c) encourage ordinary classroom teachers to visit and talk to people in industry wherever possible;

(d) encourage people from industry to visit your classrooms;

(e) and, most important, set yourself and everybody else reasonable deadlines or you will never get round to doing anything at all."

Hubbard (54) uses quotations from the Cockcroft Report (22) to highlight why there is a need for dialogue between industrialists and mathematics teachers in schools:

"Computation skills should be related to practical situations and applied to problems. (Para. 803)"

"We have drawn attention ... to the need for curriculum development of various kinds leading to the preparation of material for use in the classroom ... . (Para. 808)"

" ... the preparation of classroom materials related to the world of work is more difficult than might be expected. (Para. 108)"

"It is essential that, in any scheme for liaison between schools and employers, the two-way nature of the relationship is accepted by both sides. (Para. 112)"
"The laying of adequate mathematical foundations at school will, moreover, remain of central importance so as to provide a basis for any further training which career development or change of employment may require ... . In any event it will be of the utmost importance to maintain and develop liaison between schools and industry. (Paras. 118-119)"

Hubbard writes about the work of the Working Mathematics Group. Some years ago the full-time co-ordinator of this group came to the conclusion that:

"there was just one thing wrong with mathematicians when it came to motivating youngsters. Mathematicians saw their discipline as interesting in its own right and assumed the same interest of others; they tended in fact to see what they wished to teach entirely in mathematical terms. On occasion they would agree that mathematics should be made relevant, but all too often this ended up as taking the traditional examples and dressing them up in terms of football and the like."

In his article, Hubbard outlines the method adopted by the group to produce written materials:

"an essential feature was that all the work of the group was done by teams in which teachers and the commercial and industrial members worked together and shared the work equally. In fact, the starting point has always been from the industrial and commercial members - 'This is a real use of mathematics in my company' - and from that basis the team works up material which, though still clearly and explicitly founded on the real-life example, is, thanks to the influence and experience of a teacher partner, acceptable in schools and colleges and seen by teachers as contributing to their aims.

As a way of producing relevant and usable material for teaching, the arrangement undoubtedly worked."
Bajpai and Bond have shown how the co-operation and help from industry can be put to good use in the preparation of teaching materials. Their books "Apprentice Maths" (55) and "Applied Math" (56) were written in response to the needs of engineering employers and emerged as a by-product of the Royal Society/Council of Engineering Institutions' Joint Education Committee's Working Party's Report on school mathematics in relation to craft and technician apprenticeships in the engineering industry (57).

In addition to helping teachers with the production of motivational material for use in schools, good liaison patterns are beneficial to training personnel within industry. Ignorance of the school system often encourages fear and misunderstanding amongst training officers. Dialogue can alleviate these fears and create a much better, harmonious atmosphere. For example, the Committee for the Development of Co-operation between Industry and Schools in the Burton-on-Trent area (58) concluded:

"... a meeting of teachers, head-teachers and employers to discuss the problems associated with mathematics, particularly modern maths, could serve a useful purpose."

The skills of teachers of mathematics could also help training officers with their internal training programmes. There still remains uncertainty on the part of many training officers about the mathematical needs of their trainees. On the basis of a 1977 survey of 100 firms in South Yorkshire, Jesson of Sheffield University (59) contends that:

"Far from it being the case that employers present a consistent view of mathematical needs ... they disagree even about some of the most fundamental items."

In the opinion of the author, if schools are to introduce a vocational orientation into their courses it is important that the orientation is widely based and provides young people with
a preparation for work in general or for broad occupational areas. A narrow vocational orientation limits rather than extends opportunities and will not improve young people's transition into a world of work which requires greater flexibility than ever before. This is a view supported by Stafford, Jackson and Banks (60).

It would appear that liaison and dialogue between industrial training personnel and teachers can be most beneficial in helping to produce motivational materials for pupils within schools and, in addition, can be of great benefit to training officers especially in their work with young trainees.

3.5.3 Conclusions

Interchange of ideas between schools and personnel from industry and commerce has been proved to be beneficial to all parties concerned. Industry appears to be anxious to contribute towards the curriculum in schools and teachers should be prepared to take advantage of the goodwill and generosity shown by companies in providing advice, speakers, films and literature in order to make the curriculum more relevant to today's society. The author's article (61) dealing with such ideas (published in 1981) received an enthusiastic response from teachers.

3.6 Summary

Research into the factors to be considered when producing teaching materials revealed many interdependent facets which the teacher must consider in order to be successful. It made the author and his teaching colleagues aware of the lack of thought currently put into the production of many worksheets/booklets found within schools.

The research highlighted the fact that, in addition to subject content, the way in which tasks are presented affects the
response of the pupils. The planning and production of modules devised as part of the author's research work took into account the factors outlined in this Chapter.

This thesis contains examples and evaluations of modules presented to pupils in a written format. It contrasts with the work of Turner (31) who exploited the use of tape/slide programmes, overhead transparencies and the computer.
4.1 Introduction

4.1.1 Attitudes To The Teaching Of Mathematics

There is no doubt that the Cockcroft Report (22) impressed teachers and inspired many of them to re-think their whole approach to mathematics. The Report came after a period of time when many people had voiced disquiet about current mathematics teaching at all levels. In 1975 Bajpai, Mustoe and Walker (62) illustrated the thoughts of a number of mathematics teachers when they defined inadequacies in the system for the mathematical education of engineers which was in operation at that time. Their criticism of mathematics teaching included:

"uninspired teaching

lack of liaison

a 'cook-book' approach (i.e. a student repertoire of standard techniques)

too much rigour

too little individual help

unimaginative examinations

no suitable textbooks

isolation of mathematics

wide range of student ability, etc."
Many of the problems experienced by students are attributable to attitudes of teachers and teaching styles. HMI (63) expressed the view that:

"Through the curriculum, pupils learn two things: attitudes to the subject and the content which the teacher selects for study. Attitude largely depends upon the approaches used by the teacher, while the pupil's retention of the content depends not only on what the teacher chooses to present but also on what he decided to emphasize and consolidate."

The quality of mathematical education is ultimately determined by the teacher's work in the classroom and the effect of an individual teacher may far outweigh the effect of the particular way that the syllabus has been determined.

Mathematical education has become more complex in recent years. It is becoming increasingly important to have knowledge of the psychology of learning, the nature of mathematics in society at all levels, techniques of resource management, curriculum evaluation and assessment procedures. The mathematics educator is essentially concerned with the maintenance and extension of knowledge in these areas as well as of the subject matter of mathematics itself at a variety of levels of difficulty.

Skemp (64) stressed that communication by the teacher is of the utmost importance especially with students of low ability:

"Now, to know mathematics is one thing, and to be able to teach it - to communicate it to those at a lower conceptual level - is quite another; and I believe it is the latter which is most lacking at the moment. As a result, many people acquire at school a lifelong dislike, even fear of mathematics."

A large proportion of teachers feel that for a majority of students the most important aspect of their teaching is the actual process. The learning process, they claim, is
enhanced by creating a friendly working environment in which students are given a great deal of encouragement. The teachers' opinions concur with those expressed by The Schools Council in their book "Mixed Ability Teaching In Mathematics" (65). After visiting a number of schools the authors of this book concluded:

"The teacher needs to establish a relaxed classroom atmosphere so that he has time to think on the job, has time to listen to what the pupils are saying (the best method of assessment) and to talk with the pupils."

Watson (66) became convinced that the material covered is much less important than the spirit in which it is approached. When talking with not unintelligent children he was saddened, not by the fact that they didn't understand mathematics, but that they had stopped expecting to understand it.

Rosenbloom (67) agrees with Watson. He believes that the functions of a mathematics curriculum seem to be dependent upon how we organize mathematics learning experiences and how we perceive the nature of mathematics and its related pedagogy.

The changing nature of education and current restraints are noted by Trivett (68) who implies in his article that educational processes must be in line with the development of society in general. He says:

"In school mathematics we are still inhibited by striving so much of the time for 'answers'. This narrow goal arose from the Victorian needs for young workers in the factories, shops and farms to accept the societal standard names for numbers for economic purposes. Today, however, we want a broader education. We want children to be educated taking into consideration their great potentials for creativity, individual contributions, co-operative needs and self-respect - in addition to the needed standard practices in appropriate contexts."
Certainly this is a view supported by several eminent educationalists. Matthews (69) gives a concise objective for teachers of older "ordinary" children by suggesting that they should "foster transfer, generalisation and creativity".

4.1.2 The Results Of Ineffective Teaching On Pupils And Adults

In the opinion of Maxwell (70), there are some teachers who like to preserve the mystique of mathematics and who do not see clarity and understanding as a teaching aim. Attitudes of teachers, she says, result in many adults speaking of fear of mathematics in their childhood. They had fear of asking questions when they didn't understand and of being wrong, fear because of sarcastic remarks by the teacher, fear of being embarrassed in front of their peers and a fear of violence resulting from their misunderstanding or the submission of incorrect answers. This type of feeling towards the subject has resulted in many people responding to mathematics with dislike, horror and feelings that it is difficult, unpleasant and incomprehensible.

Poor teaching techniques were blamed for mathematical inabilitys in London Transport craft apprentices in a case study carried out by Dickson (71) who analysed the achievements and experiences of ten apprentices. She concluded:

"It was found that most of the ten apprentices had suffered some serious shortcomings in their schooling which they attributed mainly to ineffective class control and low motivation through lack of practical application of the mathematics encountered. The content and depth of topics in the school mathematics syllabus should have been adequate preparation for the first year of training at London Transport, but the opportunity at school for repetitive exercise and practice in basic arithmetic computation*, on the whole, was found to be inadequate."

*Note the emphasis by employers on the need for exercise and practice in basic computation.
When pupils are consulted about their mathematics lessons they are usually found to be astute and constructive. Perhaps we as teachers underestimate their intellect and do not pay enough heed to their opinions. In 1981, Dickins and Wood (72) interviewed 55 fifth form pupils from mixed comprehensive schools. Their findings reported in "A View Of Mathematics From The Fifth Form" offer an interesting insight into how pupils think. Comments by pupils included:

"There's no discussion in maths - at all ... There's only really one straight line through things: in maths it's either right or it's wrong ... and you can't have any other ideas about it, whereas in history a lot of it can be what you believe in ..."

"Teachers should try to involve pupils as much as possible - say, try to get a particular child to teach for a while just to see how it goes - it'd be different ... just something I've thought of."

The researchers then tried to find out why certain teachers stood out in the pupils' minds. One of the points most frequently mentioned was willingness to explain again, perhaps individually, when a pupil was stuck, and the patience which made the pupil feel it possible to ask for such help: comments of this kind were made on about half the good teachers, for example:

"He was very patient, and if you did ask while you were doing an exercise he would stay with you until you did understand it - he didn't lose his temper at all, and he'd try teaching it from all sorts of angles to try and make you understand."

The contrasts with:

"(The teacher says) 'Never mind, just don't answer questions on that in the exam' - (I) can't take that - doesn't make me feel very confident ... I like to sort it out."
"Feeling you could ask" was important, but some pupils in the survey thought they were more inhibited by worry about other pupils thinking them stupid than by fear of the teacher's reaction. A number of teachers were praised for their willingness to offer help outside lesson time.

The teacher's expectations were another crucial area of concern for pupils. Repeated praise of "strict" teachers seemed to refer more to insistence on academic standards than on disciplinary ones. Thus a "strict" teacher who always marked pupils' books and "made you work hard" was contrasted favourably with one who:

"Wasn't very good - he didn't mark our books - he didn't show any interest in our work - we didn't used to work - you know we didn't think he cared about how we did."

Although some teachers were praised for their tight control and organization, the survey found a number of the fifth formers who seemed ready for a rather different style. They appreciated the way their teachers were now prepared to give greater responsibility to pupils for organizing their own work schedule. For pupils going into the sixth form this style of teaching would seem to be a valuable preparation, and some pupils who were leaving school for college gave as a reason the desire for such increased responsibility. Perhaps we do not always sufficiently adjust our teaching style to the increasing maturity of our pupils?

The Advisory Council for Adult and Continuing Education conducted a detailed enquiry (73) in order to provide evidence and information on the mathematical needs of adults in daily life, so as to identify the fundamental skills and understanding needed in order to cope in adult life, and derive implications for the teaching of mathematics to both children and adults. Their report found that:
"many of the people interviewed during the enquiry were inhibited about using mathematics. This has led them to avoid it as much as possible and, in some instances, it has affected their careers."

It goes on to offer reasons for such attitudes:

"Among the suggested causes of this inhibition were teachers' attitudes, the formality of much mathematics teaching, the seeming lack of relevance of mathematics to everyday contexts, fear of the subject, literacy problems, gaps in schooling and parental expectations."

4.1.3 Written Teaching Materials For Mathematics Classes

Throughout the course of this research project, the author became increasingly aware of the importance of clarity, simplicity and appeal of text written for students.

One of the identifiable changes in mathematics teaching over the past twenty years has been the increasing demand on pupils to read and write in mathematics lessons (74). Texts are used not only as a source of examples, but as a medium of instruction. The use of work-cards and independent learning has emphasized this even more.

Written communication is a major component of the methods of teaching mathematics used in most schools today. Textbooks, worksheets and workcards, either commercially produced or home-made, form an integral part of the resources which teachers of mathematics use with their pupils. A printed page of mathematical text may communicate comparatively easily with children, or it may fail to communicate; it is important for teachers of mathematics in both primary and secondary schools to recognise whether children are likely to be able to read the page easily.
The importance of good visual appeal and carefully conceived written ideas is emphasized by Shuard and Rothery (47, p89) who offer sound basic advice on the format of mathematical text:

"It seems likely that the visual appearance of a good page of text will be;

easy for the reader to find his way about;

pleasing to look at.

These qualities can be achieved through a careful choice of:

the layout of the page;

the type style used in printing;

the use of colour."

"The visual appearance of a book can make a considerable difference to the enthusiasm or otherwise with which pupils approach it."

Mathematicians generally would benefit from close liaison with colleagues in English departments when producing written texts. Shuard and Rothery (47, p 104) strongly recommend that much attention be paid to presentation of text in a clear, uncluttered manner:

"It is most important to ensure that the flow of meaning in the text is clear, and to consider how the graphic material complements and fits in with the verbal material. A careful balancing of graphic and verbal material may sometimes seem wasteful of space on the page, but work with children has convinced us that the visual arrangement of the page is vital."
The language used in mathematics lessons is often technical, sometimes needlessly so. For example, it became apparent to Hart (75) when interviewing 14 year olds that the words 'perimeter' and 'area' were not part of their normal vocabulary and had to be redefined. Other words may have taken on a limited (and incorrect) meaning. She gives examples from an interview with Faith (aged 14) which illustrate two of these misconceptions:

"1. Interviewer: 10 sweets are shared between two boys so that one has 4 more than the other. How many does each get?

Faith: That's wrong, if you share they each have 5, one can't have 4 more.

2. Interviewer: I think of a whole number, add one to it. Can the result be divided by two?

Faith: If you had a whole number and added 1, it would be odd. It won't work.

Interviewer: Will it work anywhere?

Faith: No. Adding on 1 makes it odd, even if its thousands.

Interviewer: How about starting with 5?

Faith: I thought whole number meant even."

Another term often used incorrectly is "straight": for many children a slanting line cannot be straight because it is not perpendicular to the edge of the page.

In addition to content, presentation and syntax, the writer of text must have consideration for the way in which it is to be
used. Here there are many advocates of systems which allow students to progress at their own pace. For example, Dienes (67, pp 62-63) claims that:

"... different rates of progress are evidenced in different areas of the same concept structure by different children. This means that collective instruction is highly impractical and inefficient. If thirty different children in the classroom were treated in exactly the same way, some would be wasting their time, others would receive presentations unsuitable to their ways of thinking and others would not follow at all."

One hidden factor which tends to influence the overall effectiveness of text is the competence, flair and enthusiasm of the writer.

Bajpai and Calus (76), though writing in the context of higher mathematics, advise that the writing of the programmed texts must be done by someone:

"who has a thorough understanding of the topic programmed:

who has the ability and desire to communicate it to others;

who has experience of teaching the topic at that level;

whose knowledge of the subject area extends beyond the bounds of the programmed material."

These, they remark, surely are the attributes of the successful teacher.

To summarise, if teachers of mathematics are to interest and excite their students there must be, among the teaching profession, a growing awareness of the importance of both the content and presentation of written work given to pupils.
Too often, in the experience of the author, teachers receive inadequate instruction in this aspect of their work during initial and in-service training. In schools one can find many examples of ill-prepared and totally unattractive mathematics work-sheets where the number one priority is to cram as much writing on a page as possible in order to be "economical".

The need for improvement in the "professional studies" section of initial teacher training courses is expressed by HMI Butterworth (77) who, when referring to current trends in teaching in schools, points out:

"Courses in the methodology of mathematics teaching need more than ever before to take account of diversifying patterns of teaching and learning. The growing amount of mixed-ability teaching, and developments in the production of resources for mathematical learning outside the realm of the textbook, are matters which sometimes receive less consideration within professional studies than they might. Such issues are, of course, for inclusion within priorities for in-service as well as initial teacher training."

One of the aims of the author has been to attempt to produce attractive, appealing modules suitable for use in mathematics classes, having regard to suggestions and recommendations made in this section and the work outlined in Chapter 3.

4.1.4 An Interrelated Approach In Mathematics Teaching In Schools

Peter Reynolds, a member of the Cockcroft Committee, gave an address (78) at the University of Leicester in 1983 on the implications of the Cockcroft Report(22) for the teaching of the less able pupil.
In his address, Reynolds pointed out that not many people in society enjoyed mathematics. The curriculum, he felt, was too difficult and proved to be boring to many young people. Equally the "back to basics" approach was totally unattractive to many. For the least able pupils a sense of pride was important together with tastes of success which subsequently improved confidence rather than a continual confirmation of pupils' failure due to an inappropriate diet of work. Too often in our schools, he said, the remedy for failing at a particular topic was to give the pupil more of the same which subsequently was tackled incorrectly thus reinforcing the failure of the pupil. He felt that imaginative, practical, applications-oriented questions would prove to be a better policy and may arouse both interest and a degree of enthusiasm.

The Cockcroft report (22, p4) itself pointed teachers towards the importance of applications and relevance when it stated that:

"The mathematics teacher has the task

of enabling each pupil to develop, within his capabilities, the mathematical skills and understanding required for adult life, for employment and for further study and training, while remaining aware of the difficulties which some pupils will experience in trying to gain such an appropriate understanding:

of providing each pupil with such mathematics as may be needed for his study of other subjects;

of helping each pupil to develop, so far as is possible, his appreciation and enjoyment of mathematics itself and his realisation of the role which it has played and will continue to play both in the development of science and technology and of our civilisation;
above all, of making each pupil aware that mathematics provides him with a powerful means of communication.

Key phrases can be selected, such as:

understanding required for adult life;

mathematics needed for the study of other subjects;

appreciation and enjoyment of mathematics;

a powerful means of communication."

The report was emphatic in stating that development of mathematics courses should be "from the bottom upwards by considering the range of work which is appropriate for lower-attaining pupils and extending this range as the level of attainment of pupils rises".

An interrelated approach to the teaching of mathematics is supported by many leading educationalists. The Assistant Masters' Association (79) gave support to this approach in 1973 by claiming:

"... knowledge is only compartmentalized to assist the presentation of the material; understanding would be improved and time saved if learning cut across subject barriers and the breakdown into subject areas was less rigid. Some degree of cross-reference between subjects is a definite help in the learning process, but teachers of all subjects should be prepared to adopt syllabuses and methods in an endeavour to present knowledge as a unity."

The Royal Society Report in 1976 dealing with the training and professional life of mathematics teachers (80) expressed the view that mathematics is central to education of all children. They recommended that mathematics has an important part to play in the development of society:
"First, a knowledge of mathematics is an essential requirement for everyday life in modern society; mathematics is the servant not only of the sciences but also of industry and commerce. Mathematically educated manpower is essential to the well-being of society. Secondly, mathematics can in itself be a fascinating study for pupils, both as a means by which they may better their understanding of their environment, and as a way in which their powers of problem-solving, reasoning and conceptualisation may develop and they may gain access to new areas of thinking."

Matthews (81) introduced a note of caution to the prospect of a totally interrelated approach by saying:

"We have had a glimpse of the way ahead: 'maths with everything'. But in our enthusiasm we must not submerge mathematics totally within the general curriculum. There are still topics which are straight mathematics and there are still times when honest practice is necessary. But if mathematics and biology, economics ... are to retain their individual fortresses let us now explore the highways between them - that is the message for the next few years."

Increasingly over recent years teachers have been aware of complaints from industry and commerce that the mathematics taught in schools is irrelevant and that young people taking up employment are unable to apply what they learnt at school. One of the main reasons for this, according to Bird and Hiscox (82) is thought to be that "examples found in standard textbooks are hardly ever taken from the real world and rarely reflect the problems or solutions which will face the young school leaver once he starts working."

Writing in an article dealing with the All India Mathematics Education at CAMET (AIMEC) Project at Loughborough University of Technology, Bajpai (83) remarked:
"Mathematics has to be meaningful to the student and relevant to his needs. The student must have implanted in him the desire to learn the subject and also to become proficient in the ways in which mathematics can be used to understand technological subjects and to solve the 'real' problems that arise in industry and commerce. This means that a different attitude to that which existed in the past with regard to mathematical education has to be developed. Mathematics has to be made 'alive' and 'meaningful' ...".

He went on to pose four important questions:

"(i) why teach mathematics?

(ii) what mathematics to teach?

(iii) when to teach mathematics?

(iv) how to teach it?"

He pointed out that "These questions are of the greatest concern and interest to the mathematics educator/innovator."

Perhaps these questions are relevant to any group of teachers embarking upon the task of preparing curriculum material. In addition, teachers need to think carefully about the teaching process. The model offered by Scopes (84) appears to be both straightforward and logical (please see the next page).
What are we trying to achieve?

Three main categories:
(i) SKILLS: what we hope children will be able to do
(ii) CONCEPTS: what we hope children will come to know and understand
(iii) ATTITUDES: how we hope children will feel towards mathematics and how they will react in different situations

To consider:
(i) why any particular topic is included
(ii) for whom it is appropriate
(iii) it what way it can best be presented

Depends upon:
(i) the topic itself
(ii) the class in our care
(iii) the overall objectives
(iv) known procedures
(v) aids
(vi) classroom techniques

conventional blackboard approach
work cards
group discussion
small group activities
films, film strips, video

our effectiveness as teachers
level of understanding and attainment reached by students by
(i) tests
(ii) exercises
(iii) written work
(iv) project work
(v) discussion
Having discussed the benefits of an interrelated approach to the teaching of mathematics, the rest of this Chapter is devoted to details of the preparation and evaluation of teaching materials for pupils within schools.

4.2 The TVEI

The Technical and Vocational Education Initiative was announced by the Prime Minister in the autumn of 1982 with the stated aim of "stimulating technical and vocational education for 14 - 18 year olds across the ability range within the education system".

The Manpower Services Commission was given the task of managing the scheme and a special high powered National Steering Group was appointed to establish criteria and to monitor progress.

The entire project is firmly underpinned by the aims of the Marshall Report - "A Basis For Choice" (85). Originally intended as a curriculum framework for a one year post-16 course for uncommitted (to a particular vocational area) and largely unqualified students, the report is relevant to all 14 - 18 year olds because it:

(a) identifies generic (process) transfer skills which all students should have; these include communication, numeracy, learning, practical and manipulative including keyboard, decision making, problem solving and planning interpersonal, basic coping.

(b) identifies broad areas of knowledge which are similarly essential preparation for adult life in a rapidly changing technological society - economic, political and computer literacy, in particular to be aware of computer applications in industry and commerce, and new developments in Information Technology.
Unlike other pre-vocational courses, TVEI has no closely defined core of skills, aims and objectives. This is to allow local education authorities to develop their own curricula. Each programme, however, must fulfill the following criteria (86):

"equal opportunities for both sexes;

a four year curriculum designed to prepare the student for employment in a rapidly changing society;

general and technical/vocational elements throughout the course;

the course should develop problem-solving skills and initiative in the students;

the technical/vocational aspects should be related to job opportunities, both within and outside the local area;

planned work experience from the age of 15;

links with further training and/or education;

regular written assessment and good careers counselling."

The criteria and philosophy of the TVEI is very much in line with many of the objectives considered to be important when teaching topics in an interrelated way.

At Burleigh College, Loughborough, where the author is a member of the Mathematics Curriculum Area, a submission of a TVEI pilot scheme was devised early in 1983. This was a co-operative venture involving Rawlins Community College, Quorn, and Loughborough Technical College. The submission was accepted by the Leicestershire Education Authority and subsequently the LEA was chosen to be one of 14 pilot projects out of over 60 local education authorities who applied.
Two of the underlying aims of TVEI which evolved from the aims of the common core in "A Basis For Choice" (85) were:

"(a) We aim to break down subject barriers where appropriate - this will be particularly important in the integrated approach to the world of work and eventually in computer literacy across the curriculum;

(b) We aim to make the approach more student centred - by making the students more responsible for their own learning by participatory learning and experiential learning where appropriate."

In the local submission existing and planned developments were outlined.

Existing developments included:

a well established programme of work experience; the introduction of a programme of social and personal education; the introduction of an option in control technology; work on study skills modules.

Planned developments included:

the introduction of "O" and "A" level Business Studies; the introduction on a "cluster" basis of post-16 pre-vocational link courses with the Technical College involving C & G 365, BEC General and Technician Studies scheme; the introduction of core humanities and within it the possibility of devising a module under the heading "People and Work".

4.2.1 Mathematics And The TVEI

No mention was made in the above proposals about developments in the teaching of mathematics as part of the TVEI.
An approach was made to the TVEI co-ordinator at Burleigh College regarding testing and evaluation in mathematics classes of material being developed at CAMET. The suggestion was received with enthusiasm and financial support was provided to enable reprographic costs to be met as well as enabling small purchases of equipment and books. To our knowledge this was to be the only mathematics initiative in all of the Leicestershire pilot schemes.

The main problem facing the mathematics team at Burleigh College was to determine which groups of students should be used to evaluate the new approach bearing in mind that students came to the College at the age of 14 and within two years would be awarded CSE or "O" level examination grades. The team also had to remember that, at the end of any course within their department, a mathematical qualification would be awarded and hence any course provided for students would need to have a strong mathematical bias.

Teachers were reassured about proposals to evaluate an interrelated approach within mathematics classes by the recommendations given in the Cockcroft Report (22). Subsequently they decided that an interrelated approach should initially be introduced as part of the course of study for pupils of lower ability. This is a priority recognised in many schools. The Mathematics Supplement of the HMI survey of secondary schools (63, p 42) revealed that "A need to organise new courses for less able pupils was perceived in 68 per cent of all comprehensive schools and in 60 per cent of all secondary modern schools. In almost three quarters of these cases the recommendation was a strong one."

This Chapter describes attempts to provide such a course for the less able students at Burleigh College as part of the curriculum area's contribution to the TVEI. In doing this the opportunity arose to incorporate an interrelated approach in certain sections of the course.
4.3 Certificated Courses Of Study

4.3.1 Syllabuses

In 1982 two options for courses of study for the less able student were discussed. Students could follow either:

(a) a Mode 3 syllabus;
or
(b) one of the syllabuses currently offered by the East Midlands Regional Examinations Board (these are shown below).

--- Diagram ----

**SYLLABUS 1**

- **PAPER 1** - 1 HOUR
  - BASIC MATHEMATICS 30%

- **PAPER 2(a)** - 1½ HOURS
  - COMMON CORE MATHEMATICS 30%

EITHER

- **PAPER 3** - 2½ Hours
  - Candidates will be tested on ONE only of the following Options:
    - OPTION A Further Traditional Mathematics
    - OPTION B Further Modern Mathematics
    - OPTION C Integrated Modern and Traditional Mathematics
    - OPTION D Commercial and Domestic Mathematics
    - OPTION E Mathematics with a calculator 40%

OR

**COURSE WORK** - 40%

--- Diagram ----

**SYLLABUS 2**

- **PAPER 2(b)** - 1 HOUR
  - SET TOPICS 20%

EITHER

- **PAPER 3L** - 2½ HOURS 50%

OR

**COURSE WORK** - 50%
After much discussion between members of the Mathematics Curriculum Area it was finally agreed that low ability students should undertake a course of study which would be assessed by two written papers and course work. This is a limited grade CSE course where candidates may be awarded CSE grades 3, 4, 5 or U, with grade 3 being awarded in exceptional circumstances. The course work element, amounting to 50% of the final mark, offered scope for teachers to "cover topics in a variety of ways and in a range of applications" (22, pp 66-80) as well as "making pupils aware of the interrelationships between mathematics and other subjects of the curriculum", a point forcibly expressed by HMI (63).

From 1984 the course work element offered scope for students to use material being developed by Professor Bajpai's team at Loughborough University of Technology. Staff in the Mathematics Curriculum Area at the College readily agreed to co-operate in testing the materials and ideas produced by the research team.

4.3.2 Aims And Objectives Of The EMREB Courses

Aims

1. To ensure that all candidates who are awarded a grade have achieved a basic level of numeracy.

2. To assess the mathematical attainment of candidates.

Objectives

The emphasis on the particular objectives will differ according to the syllabus or scheme of assessment for which the candidate is entered.
The schemes of assessment are designed to test the extent to which the candidate is able to:

1. do basic arithmetic, including making reasonable estimates;
2. recall basic facts and principles as outlined in the syllabus;
3. apply these facts and principles to a variety of everyday situations;
4. understand, use and manipulate mathematical symbols;
5. draw accurate diagrams, to scale if appropriate;
6. think logically;
7. sustain a piece of mathematics through several steps;
8. appreciate order, pattern and relationships;
9. investigate, explain and, if possible, solve a problem;
10. collect and interpret data;
11. generalise and develop a mathematical situation;
12. recognise the appropriate method to tackle a problem, including possible use of computer;
13. hypothesise and then test the hypothesis;
14. use books of reference;
15. show initiative and create or invent valid methods new to them;
16. adapt and apply mathematics in unfamiliar situations.
4.3.3 Limited Grade CSE Courses As Part Of The TVEI

In addition to the aims and objectives set out by EMREB, Burleigh mathematics staff felt that a set of aims and objectives in line with the TVEI should be written as a solid foundation for future curriculum planning and development at this level. These were debated and are set out below.

Aims

1. To endeavour to make students happy in their work.
2. To create a pleasant, friendly, industrious atmosphere in the classroom with good relationships between students and between students and teacher.
3. To arouse both curiosity and interest in students by giving them a varied diet of work at the relevant levels incorporating, wherever possible, modern educational technology.
4. To improve the self esteem of students and make them realise, in some cases, that mathematics is not "impossible to do".
5. To familiarise students with areas of knowledge which will be of use in adult life.
6. To help to prepare the student for entering the world of work.
7. To enable the student to become more self-directioning and more responsible for his/her own actions.

Objectives

1. To use, wherever possible, modern educational technology.
2. To produce/use well written, appealing materials for use by students together with comprehensive teachers' notes and assessment schemes.

3. To develop in students an awareness of the computer as an aid to both learning and living.

4. To relate subject matter to its practical uses outside the classroom wherever possible.

5. To provide work for students which will break down the rigid lines of demarcation between subject disciplines so that mathematics is no longer treated in isolation but is shown to be an integral part of science, technology and the humanities.

6. To make students cognisant of the role of mathematics in adult life.

7. To provide schemes of work suitable for both individualised and group working.

8. To incorporate into courses, wherever possible, practical work both inside and outside the classroom.

9. To bring investigative work into lessons and to develop open-ended problem solving situations.

4.4 Teaching Method And Organisation

From September 1984 students were timetabled to attend 5 x 35 minute periods per week for mathematics. This took the form of two double lessons and one single lesson. Staff felt that students should have variety in their lessons. Teaching time was planned as follows:
This was not intended as a rigid system and, in practice, some teachers decided to alternate between core work and topic work on a weekly basis spending both double periods on either one or the other. The core work would prepare students for written papers 1 and 2. The topic work would cover the 50% course work element. The period devoted to mental arithmetic has been a feature of the diet given to students for a number of years and was incorporated after discussions with training officers in local industry and commerce.

Staff elected to keep teaching group sizes to a maximum of 20 despite the fact that this would put considerable strain, in terms of numbers, on other mathematics classes.

A team of teachers held "brainstorming" sessions where ideas for the topic work were discussed and developed. Only mathematics teachers (with a collective wide background) were involved. Plans for the future included negotiation with other curriculum areas to enlarge and enrich the team.

Material for the core work was prepared by one member of staff.

4.5 Resource Material - Topic And Core Work (Phase 1)

4.5.1 Topic Work - Phase 1*

The topic work written between 1982 and 1984 involved students in traffic surveys off the campus, planning holidays, discovering what bar codes are, analysing the cost of various foodstuffs in the shops, etc. The initial set of topics devised in conjunction with the University team were "Fast And Furious" (speed, distance and time), "The Kitchen", "Electricity In The Home", and "Our Water Supply" (see next page).

* Phase 1 and later Phase 2 modules may be inspected at CAMET.
INTERRELATIONSHIPS IN THE TOPIC "OUR WATER SUPPLY"
Each of these topics was presented to the students in a booklet form with extra resource material stored on shelves. The material was written with the previously stated aims and objectives in mind. Three of these topics featured:

(a) the inclusion of work involving aspects of science, technology and the humanities;

(b) the use of attractive, commercially produced pamphlets/booklets which were generously provided by a number of local and national companies.

The remaining topic, "Fast And Furious", was textbook orientated with some practical work outside the classroom.

For Phase 1 topics, teachers attempted to make the classroom attractive and appealing by supporting each topic with wall displays.

Topics identified for development at a later date included:

- Packaging
- The Motor Car
- Gas And Oil
- Surveying and Building Foundations
- Fashion
- Pets And Their Homes
- Codes And Number Patterns
- Investigations

4.5.2 Core Work

The core work was divided into sections, based on either text books or work cards or both. As with the topic work, the material available was used by students either on an individualised basis or as a teacher-led exercise.

Both the core and topic work encouraged each student to have self-discipline in organising his/her own individualised programme of work.
4.6 Room Allocation And Layout

During any one period two parallel groups were timetabled to follow the limited grade CSE course, with two rooms available. It was decided by the teaching team that one room should be resourced for core work and the other for topic work with the classes working in each room at some time in the week, thus reducing the resources required and also the amount of storage space needed. The teachers gave a great amount of thought to the arrangement of desks which, in their view, would significantly affect the response of the students and their subsequent attitudes.

Suggested layouts of desks included:
The final layout for both rooms consisted of desks in blocks of four or six adjacent to various resource storage units, for example:

![Diagram](image)

(diagram not to scale)

It was felt that this was much less formal than the other arrangements and gave students the opportunity to have group discussions, interchange of ideas and mutual self help.

Desks were arranged in blocks rather than in rows and columns. This brought informality to student groupings yet was organised to complement storage arrangements of resource materials. Attractive wall charts were used to enrich the working environment in the rooms, each topic being supported by a wall display.
4.7 Storage Facilities

It was important for staff to consider three main points when organising the storage of resources. Resources should be:

(a) easily accessible;

(b) well organised for student use;

(c) secure and easily checked if appropriate.

Experience has shown that, without a simple storage system for resources, student frustration may emerge causing unnecessary work for both student and teacher.

Students' question booklets and resource material were clearly labelled within the classrooms using existing lockers and cheap yet effective "bankers' boxes".
4.8 Evaluation Of Teaching Modules (Phase 1) And Approach – By Students

4.8.1 Early Oral Comments To Teachers

During the first four weeks in which the Phase 1 modules were used, teaching staff kept a close check on student reactions. Early oral comments from students to staff were pleasing. These included:

(a) Rachel - "It's nice to have questions which are not just numbers and sums."

(b) Michael - a rather slow, introverted character who was tackling a kitchen planning exercise with both enthusiasm and accuracy much to the amazement of the teacher - "I've just finished making some cupboards like this in my kitchen."

(c) Bharat - "Maths is my favourite lesson - I've never done anything like this before."

4.8.2 Written Comments On Individual Topics

For each of the three topics incorporating an interrelated approach, i.e. "The Kitchen", "Electricity In The Home" and "Our Water Supply", students were asked to complete a feedback sheet. This would reveal which sections had been attempted and how each section had been rated together with comments about the "good" and "bad" points of the topic. For each of the three topics the feedback sheets had the same instructions. Appendix 4.1 gives details of the results from the information supplied by students.
4.8.3 General Conclusions

1. Student comments and ratings were made at the end of the trials with, in some cases, work on topics having been completed up to 4 months previously. Assessment should have been requested immediately after each topic had been completed when facts and feelings were fresh in the minds of students. Some comments and ratings therefore may not be valid.

2. The modules were not an overwhelming success but there were encouraging comments made by many students. The comments were pleasing as the approach used was different to that which students had experienced in their mathematics classes on previous occasions. Ratings may reflect a comparison of their expectations in mathematics classes (good or bad) compared with the diet given to them, for example several people felt that "pages of fractions and decimals" would be more appropriate.

3. It was pleasing to hear from staff that, when attempting the modules, levels of behaviour were good which may result from students' interest in the work and the fact that they were doing something different from their experiences in the past.

4. Teachers commented during the period of trials that students were not reading the instructions for each module. Generally, they were starting at the beginning and working through the booklets. This is supported by the values in the "not attempted" columns.

5. Students were originally allocated 5/6 x 70 minute periods plus homeworks to attempt each module. This proved to be inadequate and, in practice, extra time was given. Students were, however, under pressure to complete work in a given time which caused anxiety.
6. Practical work was very appealing.

7. Drawing was popular with many students.

8. Some students valued the incidental information provided for them in the modules.

9. Perhaps the modules contained too much written work and not enough "real maths" for some students.

10. The modules had no appeal for a few students. The intention was to create interest and show how mathematics is applied. Clearly for some people we failed but, however, the question could be posed "What would appeal, mathematically, to the totally disenchanted student?".

4.9 Written Comments On General Issues

4.9.1 A Survey Of Students' Opinions

Student opinions about certain aspects of their mathematics course (limited grade CSE) were obtained by means of a questionnaire. Students completed their responses on an individual basis and were not allowed to discuss questions or answers with their friends. Completed forms were received from 80 boys and 65 girls. Instructions at the top of the questionnaire are shown below.

---

**MATHS AND ME**

<table>
<thead>
<tr>
<th>NAME ..................</th>
<th>TUTOR ..................</th>
<th>MATHS TEACHER ...............</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOY</td>
<td>GIRL</td>
<td></td>
</tr>
</tbody>
</table>

Where you see boxes like this

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

you are asked to tick ONE box only.

A tick in box 1 means definitely NO
A tick in box 5 means definitely YES

Questions and responses are outlined on the next few sheets.
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>BOYS (%)</th>
<th>GIRLS (%)</th>
<th>BOYS &amp; GIRLS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>1. Do you enjoy doing core work?</td>
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<td></td>
<td>16</td>
<td>11</td>
<td>35</td>
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<tr>
<td>2. Do you enjoy doing mental arithmetic?</td>
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<tr>
<td></td>
<td>19</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>3. Do you enjoy doing topic work?</td>
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<td></td>
<td>7</td>
<td>4</td>
<td>24</td>
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<tr>
<td>4. In the topic work we try to mix the maths with some science, design and</td>
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<tr>
<td>English work in order to show how maths is used. Would you like this to</td>
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<tr>
<td>be carried on in future topic work?</td>
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<td></td>
<td>7</td>
<td>8</td>
<td>29</td>
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<tr>
<td>5. Do you think that it would make your maths lessons more interesting to</td>
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<tr>
<td>include work involving maths and:</td>
<td></td>
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<tr>
<td>(a) science?</td>
<td></td>
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<td></td>
<td>13</td>
<td>13</td>
<td>15</td>
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<tr>
<td>(b) design?</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>9</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>(c) technology? (i.e. learning about how things work, the latest equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>(d) English?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>21</td>
<td>34</td>
</tr>
<tr>
<td>6. In the topic work would you like to see more computing?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would you like to do more practical work (e.g. using equipment)?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>7. When you are doing the topic work are the booklets, worksheets,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>equipment etc. easy to find on the shelves?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>10</td>
<td>19</td>
</tr>
</tbody>
</table>

**RESULTS OF SURVEY**

(Responses to each question are indicated by a percentage)
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>BOYS (%)</th>
<th>GIRLS (%)</th>
<th>BOYS &amp; GIRLS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8. Are the typed topic booklets easy to read</td>
<td></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>(i.e. not too many big words that you don't understand)?</td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>9. What about the published booklets that were used with the topic</td>
<td></td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>booklets - do you find them easy to read?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Do you like the way in which the typed topic booklets are set out?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Are there any particularly good points about the topic booklets?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SAMPLE OF BOYS' COMMENTS
- You could work at your own speed.
- The topic booklets were set out good and in good order.
- They are quite straightforward and simple.
- The pictures.
- They were very interesting and better than ordinary maths.
- They involve a variety of work.

SAMPLE OF GIRLS' COMMENTS
- Work about relevant things, e.g. a buffet and the food you would need.
- It is more interesting than having to work from a maths book.
- They were clearly written and not too many big words were given.
- They are interesting and you can do them in your own time.

RESULTS OF SURVEY (continued)
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>SAMPLE OF BOYS' COMMENTS</th>
<th>SAMPLE OF GIRLS' COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. (continued) Are there any particularly good points about the topic booklets?</td>
<td>Good fun sometimes.</td>
<td>I think it was good because you got to think about lots of different subjects as well as maths.</td>
</tr>
<tr>
<td></td>
<td>Nothing.</td>
<td>Well designed front sheets.</td>
</tr>
<tr>
<td></td>
<td>They explain things well.</td>
<td>This gave the booklet an interesting look.</td>
</tr>
<tr>
<td></td>
<td>You don't have to have the teacher standing over you so much.</td>
<td>They are not all for boys, e.g. the Kitchen.</td>
</tr>
<tr>
<td></td>
<td>You learn something new in each booklet.</td>
<td>We need more posters in the rooms and better tables and chairs.</td>
</tr>
<tr>
<td></td>
<td>The practical work.</td>
<td>You could have some more mental arithmetic and have no topics because I didn't like it much.</td>
</tr>
<tr>
<td></td>
<td>It is things about everyday life.</td>
<td>Comical pictures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A good choice of things to do.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The science parts and reading parts were good.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I found out about things I never knew as well as doing maths.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>They use pictures as well to make it exciting.</td>
</tr>
<tr>
<td>QUESTION</td>
<td>SAMPLE OF BOYS' COMMENTS</td>
<td>SAMPLE OF GIRLS' COMMENTS</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>12. Are there any particularly bad points about the topic booklets?</td>
<td>I think they should include more maths.</td>
<td>They were a bit tatty after a while.</td>
</tr>
<tr>
<td></td>
<td>Everything.</td>
<td>We need more time.</td>
</tr>
<tr>
<td></td>
<td>No computers used, not enough time given for each topic.</td>
<td>Inside the booklets were too plain.</td>
</tr>
<tr>
<td></td>
<td>There should be more diagrams.</td>
<td>Not enough booklets to go around the class.</td>
</tr>
<tr>
<td></td>
<td>Boring.</td>
<td>In some of the booklets there was too much writing and not many pictures.</td>
</tr>
<tr>
<td></td>
<td>Hard to understand,</td>
<td>There was some difficult work to do.</td>
</tr>
<tr>
<td></td>
<td>Some topics just seemed to keep on going.</td>
<td>The work is too easy.</td>
</tr>
<tr>
<td></td>
<td>No - I like the booklets.</td>
<td>Some of the topics were more for boys than girls.</td>
</tr>
<tr>
<td></td>
<td>Not enough use of equipment.</td>
<td>Too much writing and hardly any maths.</td>
</tr>
<tr>
<td></td>
<td>Some projects were childish.</td>
<td></td>
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<tr>
<td></td>
<td>I don't think the work that I do will go to my exams.</td>
<td></td>
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<tr>
<td></td>
<td>Doing a lot of finding out.</td>
<td></td>
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<tr>
<td></td>
<td>There was too much writing.</td>
<td></td>
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<tr>
<td>QUESTION</td>
<td>BOYS (%)</td>
<td>GIRLS (%)</td>
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<tr>
<td>------------------------------------------------------------------------</td>
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<tr>
<td>13. Do you like the system we use, where you must do some parts of the</td>
<td></td>
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<tr>
<td>booklet and you can then choose to do other parts if you wish to</td>
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<tr>
<td>gain extra marks, or would you prefer to have no choice at all in</td>
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<tr>
<td>the booklets?</td>
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<td></td>
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<tr>
<td>must do some</td>
<td>96</td>
<td>94</td>
</tr>
<tr>
<td>then choice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>must do all</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>- no choice</td>
<td></td>
<td></td>
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<tr>
<td>14. When doing topic work, do you prefer working on your own, in a</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>group with a small number of friends or being taught as a class by</td>
<td>76</td>
<td>68</td>
</tr>
<tr>
<td>the teacher?</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>15. Could you suggest the titles of any topics for your maths classes</td>
<td></td>
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<tr>
<td>which would interest you and which could be written in the future?</td>
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<td>making small vehicles</td>
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<td>air travel</td>
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<td>fishing</td>
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<td>electronics</td>
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<td>the human body</td>
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<td>weather</td>
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<td>town life</td>
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<td>hobbies</td>
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<td>clothes</td>
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<td>the bank</td>
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<td>football</td>
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<td>jobs</td>
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<td>farming</td>
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<td>pop music</td>
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<td>industry and commerce</td>
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<td>cooking</td>
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<td>nature</td>
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<td>family trees</td>
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<td>the home</td>
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<td>fashion</td>
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<td>animals</td>
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<td>bikes</td>
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<td>computing</td>
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<td>wild life</td>
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<td>motors</td>
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<td>pottery</td>
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<td>cookery</td>
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<td>motor bikes</td>
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<td>work</td>
<td></td>
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<td>horse racing</td>
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<tr>
<td>transport</td>
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</tbody>
</table>

RESULTS OF SURVEY (continued)
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>BOYS (%)</th>
<th>GIRLS (%)</th>
<th>BOYS &amp; GIRLS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. Which room do you like working in the best;</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>a small room like G109 (7.2m x 5.9m)</td>
<td>small (G109)</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>or a larger room like G110? (8.4m x 7.2m)</td>
<td>large (G110)</td>
<td>58</td>
<td>29</td>
</tr>
<tr>
<td>or don't mind</td>
<td>don't mind</td>
<td>37</td>
<td>54</td>
</tr>
<tr>
<td>17. Have you done any work in the computer room?</td>
<td>YES</td>
<td>89</td>
<td>91</td>
</tr>
<tr>
<td>NO</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>18. If you have done some computer work, how does it compare with the topic work - is it better, about the same or worse? (percentages given are relative to the numbers of students who have worked in the computer room)</td>
<td>computer work</td>
<td>52</td>
<td>.31</td>
</tr>
<tr>
<td></td>
<td>better than topic work</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>about the same topic work</td>
<td>37</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>better than computer work</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>19. When doing your work, do you prefer to:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) write answers on typed handout sheets, e.g. fill in the missing spaces?</td>
<td></td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>(b) write answers neatly on file paper?</td>
<td>7</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>(c) have a mixture of both?</td>
<td>69</td>
<td>63</td>
<td>66</td>
</tr>
</tbody>
</table>

RESULTS OF SURVEY (continued)
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>SAMPLE OF BOYS' RESPONSES</th>
<th>SAMPLE OF GIRLS' RESPONSES</th>
</tr>
</thead>
</table>
| 20. Have you any suggestions about how we can make your maths lessons better? | Have more teachers in the class.  
Go out a lot more.  
Doing more experiments.  
No comment - I think it's alright.  
I think we should have a computer.  
We should be allowed to play music and eat.  
Not so many lessons.  
More interesting work.  
Doing maths not topics.  
More computer work.  
Make them more fun.  
More class discussion.  
By doing proper maths not topics.  
Watch some films sometimes.  
Have darts every week.  
Have some work done on the board.  
More strictness from teachers.  
More videos.  
More and better maths, such as additions, subtractions etc.  
More individual work.  
More everyday maths.  
Having a wider choice of topics. | More choice in the work.  
By letting students go out more.  
More interesting work to do.  
No - maths lessons are O.K.  
Have more activities.  
Have discussions on the topics instead of just getting on with the work.  
To be able to talk to the teacher as a friend.  
More maths in the work.  
Let us have music in the lessons.  
I think that you should teach us more maths (factors etc.)  
More work on fractions and percentages.  
The topic booklets are too long.  
By taking the students out on trips.  
By doing more projects and surveys.  
Replace damaged booklets more often.  
Let us choose our own kind of topics.  
More class discussion.  
The teacher should work out more things on the blackboard.  
More serious maths lessons so we learn more because I am not learning very much at the moment.  
More practical work.  
Put more hobbies in the topics.  
You should find out what the pupils like doing most from this sheet and let them work on the things they enjoy most.  
Brighten up the rooms. |
4.9.2 Comments Relating To The Survey

1. Teachers were impressed by the sincere manner which students displayed when asked to give their opinions via the questionnaire.

2. Students' attitudes to mental arithmetic varied greatly. The system of using a particular book on a weekly basis may prove to be monotonous for some people. Perhaps a more varied approach should be adopted with more oral questions being used.

3. Topic work was generally well received.

   Of the boys:

   16% rated core work higher than topic work;

   30% gave core work and topic work an equal rating;

   54% rated topic work higher than core work.

   Of the girls:

   21% rated core work higher than topic work;

   28% gave core work and topic work an equal rating;

   51% rated topic work higher than core work.

4. Students gave support to the inclusion of aspects of science, design and technology in their topic work. There was, however, only limited support for more work involving English skills.

5. One omission in the topic work produced at this stage was the use of the computer. Students indicated strongly
that they would like to see the computer used in the work. The inclusion of practical tasks in the topics was also considered to be desirable.

6. Organisation of worksheets and resources was found to be satisfactory by the majority of students.

7. When monitoring students' attempts at topic work, teachers commented upon the students' difficulty with the levels of language of both topic booklets and published resource materials. The results of the survey indicate that this anxiety was not shared by the vast majority of students. This, however, is an area which requires much closer examination and is an aspect of education frequently overlooked by teachers. (reference Chapter 3).

8. Comments about "good points" and "bad points" relating to the topic booklets were diverse in nature. Most students presented constructive comments as can be seen from the table.

9. The system of employing compulsory and optional sections for each topic was preferred to a situation where students must attempt all the work. From a teacher's viewpoint, this system enabled the more conscientious students to receive recognition for their efforts.

10. Classroom organisation in terms of the position of desks and resources was acknowledged to be acceptable to students with 72% preferring to work in small groups. This system also enabled the few who wished to work on their own to do so (by simply moving their desks from a block). Size of classroom is also important with larger classrooms preferred to small ones.
11. When asked about possible topic titles, the students produced an interesting and varied list of suggestions. It highlights the fact that students are a tremendous "resource". Their ideas, views and opinions should be exploited by teachers as a bridge to effective communication, for example "The Water Supply" might look to be an interesting topic to the teacher but how is it received in the mind of the child?

12. In the past the standard way of presenting solutions has been by using an exercise book. For many students, especially those of low ability, the end result is messy and not substantial in quantity hence giving little return for their efforts. Students' responses to the questionnaire indicated that they would prefer to give some answers on file paper and some on typed sheets where they "fill in the missing spaces". Again this is an important aspect often overlooked by teachers.

13. Question 20 was open to silly remarks. To the students' credit, very few were written. Most comments were honest reflections of what they felt. Several points emerged:

(a) Many students believe mathematics lessons should consist of working through pages of fractions, decimals, percentages, factors, etc. - this is "real" maths. They cannot see that within the topics these mathematical concepts are being applied to various situations. Perhaps the teachers need to explain more thoroughly to students the aims of the topic work.

(b) Common requests in the suggestions made by students were:

more computing;

more practical work;
more work where students are required to attempt tasks away from the classroom, for example surveys;

some class discussion;

more "maths" in the topics;

for students to be able to eat and play the radio in the classroom;

for topic booklets to be replaced more often as and when they become worn and damaged.

4.10 Transcript Of Taped Interviews With Small Groups Of Students

A number of students were interviewed in small groups after they had completed the questionnaire. Comments made are typified by the following extract.

R.B. What's your name please?

C. Claire.

RB What about your suggestions how we can make your maths lessons better?

C. Well ... now we've got four topics to do. I think that we should have, say, five or six and just do four of them. I think that we should choose our topics.

R.B. That's a good suggestion. So if you had to do ten topics in all over the two years, we could have fifteen or twenty available and you had to pick ten to do.

C. I think that would be better because we've all got different interests ... it's better if we've got more choice.
R.B. Has the approach to maths at Burleigh been different to the approach to maths at Limehurst*?

C. Yes.

R.B. In what way for you?

C. Well ... it's like, topics here, and at Limehurst you just did the SMP books ... and everything else out of books.

R.B. Do you prefer to do the topic work and some bits out of books rather than working out of books all the time?

C. Yes.

R.B. Why?

C. Well, it's just boring working out of one book ... going through it ... but like the topics you are doing different things ... I mean like if you had a book you'd probably just ... say multiplications and then you've got to do that all the time but now you've got the topics you've got all different sorts of maths in it ... and you probably learn more.

(* Claire's feeder high school.)

4.11 Evaluation Of Teaching Modules (Phase 1) And Approach - By Teaching Staff

4.11.1 A Survey Of Teachers' Opinions

In a similar exercise to that carried out with students (reference section 4.8.2), teaching staff were asked to complete feedback sheets for each of the three topics incorporating an interrelated approach, i.e. "The Kitchen", "Electricity In The Home" and "Our Water Supply". This was intended as a means whereby student and staff feelings could be compared as well
as giving vital information needed to modify and improve the modules for future students.

For each of the three topics the feedback sheets had the same instructions, for example

C.S.E. LIMITED GRADE

FEEDBACK SHEET

STAFF

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>THE KITCHEN</th>
</tr>
</thead>
</table>

1. In your opinion how did each section appeal to the students? Please insert ✓ in the boxes below on a 1 - 5 scale.

1 means "DEFINITELY DID NOT APPEAL"
5 means "WAS WELL RECEIVED AND WELL ATTEMPTED"

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>very few attempts</th>
</tr>
</thead>
</table>

In addition space was provided to answer:

2. What Were The Good And Successful Points About The Topic?

3. What Were The Bad And Unsuccessful Points About The Topic?

4. Have You Any Suggestions For Improvement?

Results of the survey are shown in Appendix 4.2.

4.11.2 Conclusions

1. In many cases units of work were too lengthy. Staff indicated the need for realistic tasks to be set which could be completed in, for example, a double period (70 minutes) in order to give students a sense of pace and progress.
2. Short, easy, introductory pieces of work have proved to be successful.

3. Some topics required students to read a great amount. This caused problems bearing in mind the ability of the students.

4. Some topics required students to produce written descriptive answers. This caused a little resentment from a few students who questioned the reasoning behind such examples.

5. Practical work was very well received by students.

6. Work involving drawing was popular and attempted with enthusiasm.

7. Teachers indicated the need for more structured questions in some parts of the work.

8. Marking schemes need to be improved especially in relation to the assessment of written passages.

9. Video films were not used in the topic work. Teachers suggested that their inclusion would enrich topics and help to create interest amongst the students.

4.12 Assessment

4.12.1 Assessment Of Students' Work

The core work was assessed by examination at the end of the two year course. For course work students were required to attempt at least ten topics, each topic being marked in accordance with the following scale:
Correctness of work 20

Development and content of topic 15

Completion of topic 5

Independence (of help from teacher or fellow pupils) 5

Presentation and logical progression 5

50

In the past, mathematics topic marking and moderation had proved to be very time consuming. Teachers involved with planning Phase 1 modules took great care to devise a more efficient method of organising and presenting students' work. For each topic attempted students were given two front sheets as shown in Appendix 4.3. This enabled teachers to enter marks as the student completed a section of work and also to give a total mark at the end of each topic. This mark was then moderated by a designated person.

4.12.2 Teachers' Assessment Of The Work Prepared For Students

It was difficult to be objective about the success or failure of the course. Members of the mathematics curriculum area voiced the opinion that, at that early stage, there was a big improvement in terms of content and student motivation compared with the previous provision for the less able student, i.e. an all grade CSE course which was too difficult or a "non-exam" course where, according to many students, "there is nothing to work for". Assessment of the course was carried out continuously by means of regular departmental meetings where ideas and materials in use were discussed and proposals for change made if necessary. In addition teaching staff and students completed feedback sheets which were analysed. Information received was used in a modification process.
4.13 Resource Materials - Topic Work (Phase 2)

After considering oral comments made by both students and teachers during the testing procedure for the four modules, a further four topics were written:

The Motor Car

Packaging

Codes And Number Patterns

Investigations

The first three topics included aspects of science, technology and the humanities. "Investigations" was purely mathematical and fulfilled a need to present students with investigative work as recommended by the Cockcroft Report.

The broad general approach of the "Motor Car" module contrasts with Turner's "Measurement And The Motor Car" (31) which had a distinct vocational bias towards the work of a motor mechanic.

The booklets were an improvement on the first four modules for the following reasons:

(a) The amount of work included was reduced and was more realistic in relation to the amount of time available for student study.

(b) A colour code was used to indicate to students compulsory and optional sections, for example yellow sheets must be attempted and white sheets may be attempted.

(c) An effort was made to produce more typed sheets on which students would "fill in answers". It was felt that this would help the pace of the work and would assist teaching staff with homework assignments.
(d) The life and appearance of the booklets were enhanced by laminating their covers and also spiral binding the sheets together rather than using a stapler. Much use was made of the reprographics/resources department within the College as well as using the facilities available at the local teachers' resource centre.

In addition the first four topics were revised to comply with the positive suggestions made by students and teachers. Feedback from all concerned suggested that the revisions made had improved the topics.

4.14 Acceptance Of Topic Work By Other Teachers And Establishments

4.14.1 Comments From A County Mathematics Adviser

Throughout the course of the research project, the whole concept of an interrelated approach to the teaching of mathematics was warmly welcomed and encouraged by the Leicestershire County Mathematics Advisers.

When asked to comment about the mathematics modules written in an interrelated way, Dr. Maurice Edwards wrote (September 1985):

"Thank you for letting me preview your modules. Their reception by the Heads of Mathematics Departments at the last INSET day* was infectious! Too many children, for too much of their time do too much mathematics - and if I really say what I mean - most of this is non-contextual, i.e. children do not see the use and relevance in situations other than maths books!!

Your modules begin to redress this balance - can we really begin to look over the barriers that surround maths - barriers often self-imposed by many teachers?

* reference Chapter 7
Many thanks and please keep me informed. Your resource is long awaited by me - how do we now influence the others?"

At the INSET sessions in which the author introduced his ideas regarding an interrelated approach to the teaching of mathematics, many requests were made by teachers for copies of the modules.

In response to the large number of enquiries the County Mathematics Advisers eventually decided to reproduce 50 copies of each booklet for circulation within schools and colleges in Leicestershire.

Within Leicestershire the author has visited a number of schools at their request to talk about the ideas contained within his research project. This led to the schools adapting some of the ideas offered. Examples of typical responses follow.

4.14.2 Work At King Edward VII Upper School, Melton Mowbray, Leicestershire (14 - 18 Comprehensive)

In a recent interview (September 1985), Pam Farquharson, Head of Mathematics, remarked:

"We have used and tested three of your modules so far - Electricity In The Home, Our Water Supply and The Kitchen. My staff were delighted with the material and felt that it was a lovely way to deal with mathematical topics. The pupils reacted very favourably to the work offered to them.

In the past we have tended to use CSE Greer with staff working through the various sections. Your booklets, however, were most attractively presented and had much appeal to both pupils and staff.

Colleagues in my department have been inspired to write their own modules in a similar style. We intend, however, to present our modules in A5 booklets for ease of carriage."
The Melton teachers gave feedback about student reactions to the rather abstract Investigations Topic compared with their reactions to the more contextual type of topic. Comments from students included:

"The investigations were altogether boring. I don't see what they were helping us do. When do we need to know these in later life? I would much prefer going back to the other sort of work."

Helen (aged 14)

"I enjoy playing about with the calculator and being able to find the conclusion."

Sarah (aged 14)

The staff at the Melton school asked to be kept informed of any further development in the written materials produced as part of this research project.

Outside Leicestershire, the modules are being used in Derby and Market Drayton, Shropshire. Initial requests were made to the author for information about the modules produced which subsequently led to teachers within the schools gaining enthusiasm for and interest in an interrelated approach to the teaching of mathematics.

4.14.3 Work At The Merrill School, Derby (11 - 18 Comprehensive)

The author visited the school on several occasions and worked with an interdisciplinary group of teachers. Initially the mathematics department used the CAMET modules with pupils working on the limited grade mathematics course. In a short time it became apparent to the teachers that this approach had merit. In September 1985 the school opted to replace the limited grade CSE course with an "integrated" City and Guilds 365 Vocational Preparation (General) course where pupils would
combine their mathematics and communication courses and would work on topics in an interrelated way. Topics being developed include:

- Packaging
- Motor Cars
- Newspapers
- Holidays

The Wild West
Setting Up Home
Safety

One request from the teachers at Derby was for a simple hints sheet giving ideas about module preparation. This was duly prepared and is shown in Appendix 4.4.

Keith Furniss, Head of the Mathematics Faculty at the Merrill School, provided the author with a progress report on the new course. He wrote (October 1985):

"When I heard of the coursework that was being used at Burleigh College, Loughborough, I visited the maths department and saw the booklets being used with several classes. I was most impressed with both the content of the booklets and the method of use and organisation within the classroom. This work was of particular interest to me as at my own school we were looking into the possibility of producing some material for use with low ability pupils intending to use examples of Maths and English that would be of use in everyday situations. The booklets that we saw, 'The Motor Car', 'Packaging', 'Electricity' to 'Our Water Supply', showed us the quality of work that could be produced for our target groups of pupils, and although these booklets were written for mathematics coursework, they offered the advantage of using other areas of knowledge together with published leaflets which increased the pupils' interest. On returning to my own school we tested 'Electricity' and 'Water Supply' with classes of low ability fourth year pupils and found an improvement in motivation for both topics. The 'Water Supply' booklet was more successful than 'Electricity'.

"
Based on our experience with these booklets we decided to design a course using the City and Guilds 365 course as the core. But believing that the examination syllabus in numeracy and communication was not an adequate course alone for Mathematics and English, we agreed to build the course on booklets of a similar type to those we had seen at Burleigh College.

Rod Bond visited us at the Merrill and was a great source of help, ideas and encouragement.

Pupils following the course took this work on the booklets to both their Maths and English lessons which were timetabled in the same room. In 2 out of 3 Maths lessons and 2 out of 3 English lessons per week the pupils were working on the booklets.

We were showing the pupils topics in which examples of Maths and English would naturally occur and in which the subject boundaries had been broken down. The initial topics we used were: A topic on finding their way round the school; 'Motor Car', 'Setting Up Home' and 'Newspapers'. Following the first half term of this course we have made the following observation. The pupils thoroughly enjoyed the work they were doing and were highly motivated by it.

We felt that half a term was too long on one topic.

Keeping on top of the marking was difficult as the class was taught by 2 people. They were areas that could be improved within the content of each topic. Concern was expressed that the ability of the current 4th year pupils was significantly lower than that of previous equivalent groups.

It was felt worthwhile to provide an answer book for pupils to work in, so as to keep their work tidier within their folders.
Other minor teething troubles were discussed, but it was felt that in view of the lower ability of the pupils compared to previous groups we would spend the half term from October to Christmas working on basic concepts using Maths Counts on TV and other lively sources, and revising the booklets for continuation in January.

As a group of teachers within the school we are pleased at the level of motivation provided by the booklets, but recognise, as we expected to find, that there are areas within the topics that we should improve.

My thanks are due especially to Rod Bond for the invaluable help he has been to us in developing this course."

Examples of modules produced by teachers at the Merrill School are available from the author.

4.14.4 Work At The Grove School, Market Drayton, Shropshire (11 - 18 Comprehensive)

The author received a request from Brian Robinson, deputy head of the Mathematics Department of the Grove School, for copies of the mathematics modules. He intended to use the ideas as part of a new course which he was organising for 14 year old pupils of low mathematical ability. The pupils would study a limited grade CSE course of which 50% of the marks would be obtained through course work. Robinson tested the revised version of the "Electricity In The Home' module with a group of 24 pupils (set 7 out of 8). The booklet was used in its entirety with a number of additions:

(a) the pupils carried out a survey of lighting provision within the school;

(b) the pupils read the school's electricity meters and worked out the cost of electricity used over a short period;
(c) videos dealing with electricity and electricity charges were shown;

(d) a visitor from the Energy Marketing Section of the Electricity Board came to the school; during the visit she judged the safety posters designed by the pupils - the pupils had paid 10p each to enter a poster competition with the winner receiving a record token;

(e) when pupils wired the plug it was connected to an appliance for testing purposes.

On completion of the topic, pupils were asked to fill in a simple questionnaire to give feedback to the author. Replies from the questionnaire are analysed in Appendix 4.5.

Pupil Interviews

Both the author and the teacher involved in this exercise intended to interview pupils in depth to ascertain their feelings and opinions regarding the success/failure of the topic. This was not carried out due to the severe industrial action within schools which placed limitations upon teacher contact time with pupils and also restricted teacher absence from school for research purposes (in the case of the author).

Conclusions

1. The responses from the pupils involved suggested that the new approach was well received.

2. Once again practical work, for example wiring the plug, the poster design, proved to be very popular. Pupils appeared to appreciate the variety of tasks and activities employed within the topic.
3. The mathematics involved was substantive and yet was tackled well. For low ability pupils such as these the apparent dilution of mathematics with, to them, more interesting activities, helped to maintain their interest and generated enthusiasm for what might have been "boring maths lessons".

4. Pupils indicated that they liked the format of the work booklets.

5. At least one pupil was uncertain about the new approach and indicated that he preferred "proper maths, e.g. sums, fractions, etc.". Perhaps it will take a long time to convince parents and some pupils of the merits of an interrelated approach.

6. The teacher involved with this trial has a caring, enthusiastic and dynamic approach to his work. Some of the success of the trial must be attributed to his personality and flair. In the author's opinion the results may have been much less favourable if the trial had been conducted with a dull, unimaginative teacher.

4.14.5 Topic Work Display

In November 1984 the Director of Education in Leicestershire decided that elected representatives on the County Council should be better informed about the many good current practices in both primary and secondary schools. It was decided to mount a series of small standing exhibitions near to the elected members' lounge at County Hall. The first exhibition planned was intended to show examples of good practice in English and Mathematics within the County.

It was very pleasing that samples of topic work developed by the research team at CAMET and teachers at Burleigh College were chosen for one of the six display panels allocated to mathematics. Details of the display are presented in Appendix 4.6.
4.15 Conclusions

1. Phase 1 and 2 modules were well received by students.

2. The results were pleasing, bearing in mind that the interrelated approach used was different to students' previous experiences and their concepts of what mathematics lessons should be about.

HMI (48, p 25) strongly suggest that:

"It is necessary to take action to encourage a more positive attitude made up of the following features:

fascination with the subject;

interest and motivation;

pleasure and enjoyment from mathematical activities;

appreciation of the purpose, power and relevance of mathematics;

satisfaction derived from a sense of achievement;

confidence in an ability to do mathematics at an appropriate level."

In addition they say (48, p 30) "The mathematical needs of the whole curriculum provide excellent opportunities for placing mathematics in context."

The modules produced have incorporated the above features in varying degrees and form an excellent base for future developments.
3. Testing and evaluation of the modules produced useful feedback from students and staff in terms of both teaching content and teaching method. Information and experiences gained helped when producing revised Phase 1 and Phase 2 modules.

4. The attitude of the students at Burleigh College can be commended. They gave their opinions and comments in a sincere and honest manner (with just a few exceptions as expected). Teachers can learn much from student feedback. Perhaps it is an aspect often overlooked in schools mainly through pressures of time.

5. An interrelated approach does have a place within the curriculum. The Cockcroft Report(22) supports work of this type.

The modules produced generated both interest and enthusiasm from teachers in a number of schools in Leicestershire and elsewhere. This enthusiasm has resulted in the preparation of topics directed towards the specific needs of the pupils.

Towards the end of the research project severe industrial action within the author's school and in the other schools mentioned in the Chapter meant that visiting schools and talking to staff and pupils proved to be impossible. The enthusiasm and interest shown by teachers from these other schools was highlighted by their willingness to provide both written and oral feedback to the author.

4.16 Recommendations For Future Topic Work

1. Teacher/Student Collaboration

When a group of students were asked by a teacher for their ideas about a topic on "Fashion", their immediate response was "great" and "what a good idea". They were keen to discuss
the topic and were forthright in suggesting items which they felt should be included. Here was a situation where the students were quite excited at the thought of tackling the topic. The problem for the mathematics teacher would be, of course, to incorporate an adequate mathematical content. The point proves, however, that to achieve a harmonious relationship between teacher and students the PROCESS must be right and then the learning will follow.

Student involvement in curriculum planning appears to have many benefits.

2. Development Of Resources

For future topics and core work efforts should be made to increase:

(a) the use of the microprocessor;

(b) practical and field work;

(c) the use of audio/visual aids.

Teachers must exploit modern technological aids. In addition, rooming and fixtures should be investigated with a view to setting up a multi-disciplinary mathematics laboratory where both experimental science and practical design problems can be incorporated into mathematical programmes.

HMI recommends that (48, p 43):

"Audio visual materials can enrich many mathematical activities. The atmosphere in which mathematics is taught ought to be conducive to learning, with stimulating and attractive display of resources, together with the display of pupils' work and of objects and posters of interest."

Every effort should be made to improve further the attractiveness of the classroom.
3. Development Of Written Materials

The material written dealing with topics in an interrelated way can only be developed properly by means of regular meetings of small interdisciplinary teams. If progress is to be made such meetings should be given a degree of priority. Also a strong case could be made for the inclusion of representatives of outside agencies, for example industrialists, parents, etc., into the teams.

4. Teacher In-Service Training

To promote an interrelated approach there is a need for in-service training sessions for teachers to enable discussion to take place regarding aims and objectives, syllabuses, material content, teaching styles and assessment procedures. In addition there is a need for discussion regarding:

(a) the effective use of audio/visual equipment;

(b) the effective use of the computer;

(c) the importance of good graphic design and relevant techniques which could be used easily by the teacher;

(d) the format of written material and durability/costs of various forms of presentation;

(e) basic communication by the written word (for example, many worksheets written for students have as much on them as possible - much to the detriment of the learning process);

(f) level of language;

(g) study skills;
(h) how to make use of three most important and effective sources of ideas and resource material:

(i) students
(ii) parents
(iii) representatives from industry and commerce;

(i) the sharing and exchange of ideas between teachers in different schools (the motto here might be SHARE IDEAS - SAVE ENERGY);

(j) attractive classroom design together with the effective storage of and easy access to resources.

5. Dispersion Of Ideas

Every effort should be made to share ideas and material once it has been proved to be successful. Teachers should be encouraged to participate in the imaginative and varied in-service training programmes organised by County Mathematics Advisers. These afford the opportunity to hear new ideas and new approaches as well as giving teachers a chance to share their views and voice their opinions. Without co-operation and a spirit of compromise in terms of course content and method, teachers will find themselves working in a vacuum, repeating tasks which have been developed, tested and evaluated elsewhere. The time has come to make concerted attempts for groups of schools/teachers to collaborate on specific tasks relating to their teaching.

4.17 Recommendations For Future 16+ GCSE Mathematics Courses

The 16+ National Criteria for Mathematics (87) stated that "any scheme of assessment will have regard to the need for examination tasks to relate, where appropriate, to the use of mathematics in everyday situations." Amongst the stated aims are:
"use mathematics as a means of communication with emphasis on the use of clear expression;

develop an ability to apply mathematics in other subjects, particularly science and technology;

produce and appreciate imaginative and creative work arising from mathematical ideas."

These statements are relevant to students of all abilities and yet symbolise the aims and objectives of work being developed at CAMET as part of this research project. In addition, from 1991 all schemes of assessment must include a coursework element giving students the opportunity to demonstrate initiative and ingenuity. The work carried out with low ability students can now be expanded to cater for those of higher ability. The lessons learned from the experiences gained will be a valuable asset in future planning.
5.1 Introduction - Current Educational Philosophy Regarding English Language Teaching

During the past few years, HMI have produced a number of important papers relating to language components of the school curriculum. There is an underlying desire to improve and update language provision in schools and, in doing so, relate the work carried out to other curriculum areas and also students' future needs in adult life.

One of the latest papers, The Curriculum From 5 to 16, points out (88):

"Pupils need to achieve a working knowledge of language so that they have a vocabulary for discussing it and are able to use it with greater awareness and control. That which characterises the achievement of older pupils is not only the accumulation of new knowledge or skills, but an increased ability to use language with sensitivity, sophistication and discrimination and to deal with more demanding forms of spoken and written language used by others."

The importance of language covering a variety of different situations is strongly emphasized in English From 5 to 16 (89) where HMI states:

"Achieving competence in the many and varied uses of our language is a vital part of the education of pupils in our schools."

"The aims of writing should be to enable pupils:

(a) to write for a range of purposes;
(b) to organise the content of what is written in ways appropriate to the purpose;

(c) to use styles of writing appropriate to the purposes and the intended readership;

(d) to use spelling, punctuation and syntax accurately and with confidence."

Realism should be a significant factor when setting student tasks. HMI (89) continue by saying:

"The objectives stated in English can best be attained by setting tasks which require communication for real or realistic purposes and in which particular skills need to be used."

Realism in language teaching necessitates consideration of the environment in which we live. Adams (90) believes that:

"The English curriculum of the future will have to concern itself more and more with the context of the world in which school students are growing up and that we cannot allow English teaching simply to exist within a museum of the past."

He goes on to outline suggestions for a revision of assessment procedures (p 97):

"One invariable component of the examination system in English has been the writing of the formal essay, though our growing awareness of the need to be aware of the importance of context in writing, the development of a sense of audience, purpose and awareness of form in the writer, makes the usefulness of the formal essay as a means of assessment of increasingly doubtful value. It seems clear that we shall have to come to
recognize the necessity of course work assessment as the only available means of examining pupils' writing across a wide range of purposes."

The views of Adams are supported by HMI (63) in an earlier document when they relate language to the society in which we live:

"We need to make children aware of the conventional aspects, but not bind them tightly with the conventions. To understand how language works for individuals in society is not to neglect the grammatical and formal qualities: it is to put these qualities into a fuller understanding of the context, the 'audience' and the specific task."

"A 16 year old at the end of his education can be expected to talk, listen, read and write effectively in a range of situations, and not merely to pass some formal tests in a limited range of language skills."

Certainly cause for concern has been expressed in recent years with regard to the ability of young people to cope with language skills associated with their employment. Caudrey (91) reports that:

"A recent survey, Goals of Engineering Education, found that engineers considered communication the single most important ability that their job demanded, with 66 per cent of those questioned saying that 50 per cent of their time was spent on oral or written communications. Despite that, 62 per cent of engineers and 67 per cent of their colleagues believed that engineers' 'inability to express and communicate, both verbally and in writing, was a problem'. The Association for Verbal Arts, based at Sheffield Polytechnic, is also arguing that reforms are needed in the teaching of English. It says 'Precise and creative use of language is of major importance
for the maintenance of our complex intellectual, industrial and democratic structures."

When evaluating his "Measurement and the Motor Car Industry" module, Turner (31) found that written and spoken communication are closely related to mathematics, for example when calculating and explaining the customer's motor car bill.

It is encouraging to learn that there are now available a number of useful positive examples of teachers and workplaces getting together, re-defining the basic language skills and seeking out the most effective ways of achieving technical competence. These include, in published form, "Engineering Your Communications"(18) and "Communication Skills in Employment and the Young School Leaver" (92), an account of work in the Coventry Education Authority by Torbe.

Jackson comments upon these examples in "Is This Proper English We're Doing, Sir?: Images of English 2" (93):

"Instead of the surface features of an instrumental approach to language growth, there is an emerging emphasis on the making of meaning through talking, writing and reading, and on the primary value of independent initiative in the learning process. So, in Engineering Your Communications, within a list of basic speaking and listening skills, we find:

'To participate with confidence, and influence discussions and conversations';

and then in a key to effective listening:

'Think while listening, mentally challenging and summarising the content.'

The other advances are in the recognition that spoken fluency and sensitivity come before formal correctness in writing ('Since the predominant medium of communication is speech ...')
and in the growing concern for the issue of whether the context and purpose for communications are meaningful and motivating for the language user."

Darch (94) adds a word of caution to those teachers who might be tempted to drift towards a situation where they use only real-life situations in their language teaching. He advocates a skills based approach:

"I am not asking for teaching materials which fall over backwards to be of the children's culture or language or which the children can immediately see as close to their everyday experience. I am asking for an analysis of the skills required for children to function now as effective members of our society, not of course in all the roles of an adult but in several which are very important: such as the role of consumer. The analysis should be followed by a conscious teaching of these skills - not just by thrusting children into 'real-life' situations but by building up a range of abilities in the most effective way."

The growing significance of "language across the curriculum" is illustrated by Robertson (95) who, in four case studies, covers a whole range of initiatives involving language in mathematics, humanities, science, physical education, etc.

Teachers themselves are becoming more critical of existing practices where subjects are taught in isolation. Allen (96) has strong views on this:

"The rigid separation of the curriculum into subjects in the secondary school has led to an inbuilt failure to work in the fruitful areas between subjects ... The recent moves to break down the barriers between subjects and within subjects has led to a ferment of ideas, a revaluation of established practice, a discovery of many more suitable materials, more suitable that is to the pupils, the times and the kind of
learning being sought. No good teacher can afford to ignore the wealth of ideas that have emerged, particularly under the conception of the 'unity of English'."

Perhaps the recent moves mentioned by Allen are a result of the Bullock Report (15) which came out strongly in support of a 'language across the curriculum' policy by saying (p 514):

"Every school should have an organised policy for language across the curriculum establishing every teacher's involvement in language and reading development throughout the years of schooling."

The importance of English skills across the curriculum is also supported by teachers in further and higher education. BEC unequivocally stated its belief in the importance of English in all courses at the outset (97) identifying it as one of the four central themes expressed in its "underlying philosophy":

"The ability to speak and write simple English is of major importance in the conduct of affairs at any level. Council believes that the inability to do this effectively is at the root of many problems in business. It is, therefore, of paramount importance that students should be actively encouraged to develop this ability and learn to use the form of communication appropriate to the task."

The way to avoid "compartmentalized" English lessons and their obvious limitations is by adopting a thematic approach to learning, an approach which, according to Abrahams (98) has been misunderstood by some teachers whose interpretation of "themes" have been vague and confused. She highlights her own opinions of how a thematic approach should be attempted and gives advantages and disadvantages of such an approach:

"Tightly-structured themes need careful forward-planning by a team of teachers, who in the first stage of planning will
look at the questions and issues arising from the choice of titles and their potentialities, closely related to the age-groups concerned and their own experience. They will quickly discard abstract, or over-broad or over-narrow titles in favour of more central and obvious themes. They will be aware of the intended outcomes - the development of intellectual understanding, sympathies, self-awareness and insight as well as the development of language skills. An initial check-list of what might be explored will be prepared and each teacher will be informed about the books, media and resources available. Where possible, all the resources should be centralized and it is not difficult to devise a simple filing-system for easy location of worksheets or relevant printed material. Work-folders will probably be kept and lessons will be organised so that there is adequate time for feed-back and display of outcomes. Where themes can be integrated with other subjects, there will be regular meetings with the specialist teachers, whose co-operation (and trust) is essential. Selection of materials and resources can be made from books, magazines, newspapers, records, tape, television, etc., and audio-visual aids can be used with great effect from the simple tape-recording of talk, to making a short 8mm film. The most obvious advantage of the team approach to tightly-structured themes (which can be... planned to co-ordinate work from year to year throughout the school), is that newly qualified, inexperienced teachers can draw on the experience of other teachers and are offered a framework within which they are able to develop their own insights. The disadvantage of the structured thematic approach is that it might impose individual constraints on some teachers who feel that they are compelled to pursue a theme in which they have no personal interest, or that there might well be overlapping areas of exploration from year to year which could result in repetition and boredom (on the part of both teacher and client). Communication and co-operation between all teachers concerned are vital factors, together with the fact that whether a theme is tightly-
structured and planned, or has been spontaneously motivated, it must allow for flexibility ... . For a thematic approach to be successful, the teacher needs to be able to assess the potentialities of the theme and the potentialities of the students. Goals, such as the anticipated language acquisition and the kinds of written outcome, need to be established. There must be a clear structure within the framework of specific terms of reference."

In view of the encouraging developments in language thinking and teaching in recent years, English Language classes appeared to be an excellent vehicle in which to evaluate an interrelated approach. In 1983, the author, in conjunction with an English specialist and a mathematics specialist, set about devising a programme of work for a group of fourth year students in a class labelled as "English Language". At the same time a sixth form group following a City and Guilds 365 Vocational Preparation (General) course would also attempt the work, their course being based upon interrelated assignments. From a mathematician's viewpoint the programme would contain many aspects of mathematics which would be dealt with in context as and when they arose.

This Chapter continues with a description of the work carried out by these students.

5.2 An Initial Trial: A Hay Fever Survey

When discussing with representatives from the pharmaceutical industry proposals for a school based project involving measurement and their industry, many possibilities for creating investigative student tasks emerged.

One such task emanated from discussions with Mr. G. Willimont, Personnel Officer, and Mr. I. Mason, Market Research Manager, at Fisons PLC, Pharmaceutical Division, Loughborough. This was to illustrate to students how the market research function
operates in a large company by means of carrying out a survey into the occurrence of hay fever amongst the student population of a college. The survey and analysis of results would be carried out by a small number of students. Their findings would then be compared with those produced by the professional market research team within the company.

It was hoped that the liaison between students, teachers and industrialists would lead to a refreshing, appealing interchange of ideas with a useful outcome in terms of both the experience and the knowledge gained.

Aims Of The Exercise

Title

To carry out a survey to investigate the incidence of hay fever amongst students in the age range 14 - 18 years.

Aims

1. To produce a teaching programme which showed how market research is conducted in modern industry/commerce as a pattern for future exercises.

2. To foster links between teachers and students in schools and workers in industry/commerce as a means whereby tasks were both meaningful and relevant to life.

3. To investigate a topic which may adversely affect the performance of students in schools and colleges, and hence to bring about an awareness of the problem and its magnitude to both students and staff who were fortunate enough not to experience it.

4. To illustrate the interrelated manner of the many disciplines needed to carry out such an exercise, i.e.
communications, mathematics, modern technology, science, etc.

5. For the students to realise that the results of their work may be noted and investigated further by people within industry, i.e. the initial results may have indicated to the pharmaceutical world that there was a need for a proper medically controlled survey to take place.

Implementation Of Ideas

The exercise was carried out by two classes. One was a large fourth year English Language class who, it was planned, would spend two periods (70 minutes) per week for approximately eight weeks directed by their teacher, Mr. Richard Shepherd. The other was a smaller group of sixth form students following a City and Guilds 365 Vocational Preparation (General) course. They would spend a longer period of time per week on the project (approximately ten x 35 minute periods) but for a fewer number of weeks. They were directed by Mr. Harry Gordon, a mathematics specialist, and Mr. Peter Morell, a humanities specialist.

The teachers involved collaborated to produce an imaginative programme of study which encompassed many aspects of the curriculum as shown on the next page.

Conclusions

1. The exercise was successful in the fact that a realistic, useful task was completed which involved students and staff at Burleigh College working closely with representatives from industry.

2. The support given and interest shown by personnel from Fisons PLC was considerable and demonstrated the
HAY FEVER SURVEY

interchange of ideas between teachers

modern applications of computers

botany - causes

biology

use of library

design of questionnaire

collection and analysis of data

representation of data

visits to industry

visitors from industry

technology - measurement of the pollen count

communication
  - report writing
  - recommendations

INTERRELATIONSHIPS IN A HAY FEVER SURVEY
willingness of workers in industry to help in worthwhile school-based projects.

3. The fourth year English group maintained interest and completed the task well.

The sixth form group worked intently on the project but eventually lost interest. With a project of this type, which required considerable effort to plan, carry out and analyse over a lengthy period of time, the method of working employed by the fourth year group is to be recommended.

4. The exercise highlighted how the barriers between subject areas can be broken down to present students with a "complete" project. This work had elements of science, mathematics, communications, design, etc.

5. Students did not follow up all the suggested ideas; for example "how is the pollen count measured?" and "the use of video to present information" were omitted because of the time factors involved.

6. The information accumulated was presented in a variety of ways by students who had been given the task of writing a report suitable for the "average person". This led to considerable ingenuity on the part of some students.

7. Collection and representation of data, percentages and work involving the use of the computer emerged as necessary parts of the exercise. The mathematics was accepted by students as a useful tool of communication.

Feedback From Staff

The English specialist involved, Richard Shepherd, wrote the
following comment relating to the exercise.

"I enjoyed working with Rod Bond. The students benefited in several ways and I gained personally and professionally.

The students worked in groups, learning to co-operate to achieve a common goal. They discussed and developed ideas. They had to frame questions for a known audience, which raised issues of precision of vocabulary, ambiguity, syntax and register. They had to write clear instructions, and present questionnaires to an audience. They had to evaluate replies, again by discussion, and present a report on their work, on why and how they had done it, and the conclusions they had reached, in a way which would arouse the attention of a general public - an audience not familiar with the material. This involved selection, organization and discussion on layout and appropriate illustration, as well as matters of vocabulary, clarity and tone. These are all skills which I believe should concern me as an English teacher. The conversations I had with managers and employers during my Sabbatical in the Autumn of 1983 confirm me in that belief.

The students gained from the experience of working towards a goal over a sustained period of several weeks. The work was contained within a double lesson each week and homework as required; other work was done during the remaining lessons, so there was variety. There was also variety in that more than one teacher was involved - four "teachers" altogether, Rod, myself, Mr. Ian Mason from Fisons and one of his staff, Ms. Sue Buckle; not all of us all the time, but the varying personalities, styles and expertise added interest and perhaps sustained motivation.

I enjoyed the broadening of my work which the project involved. It was interesting and motivating for me to work with other adults, to see and help the work develop, to have the chance to work with students in their groups. In other
years I would have fabricated a piece of 'research' as an exercise; this research arose from a real need to know by Fisons and was thus higher in esteem, in everyone's eyes perhaps, than 'another exercise'. The visit which some students and I made to Fisons, to help feed results of the questionnaire into a computer, also connected the classroom with the world of work.

I have since worked with Rod on a shorter but similar project with another class, and hope to do so again. The subject barriers dissolve; the 'teachers' act as starting-points and consultants; 'the walls of the classroom crumble'.

5.3 A More Detailed Exercise: Packaging For Coffee

In the remainder of the Chapter a report is presented of a project attempted by two groups of fourth year students at Burleigh College, Loughborough, during time designated as English lessons. The project was planned bearing in mind the experiences gained from the hay fever survey outlined previously.

5.3.1 Aims And Objectives

These were debated and agreed by the author and the English specialist involved.

Aims

1. To provide a project for students which would be suitable for inclusion in their English Language course work folder.

2. To create a pleasant, friendly, industrious atmosphere in the classroom with good relationships between students and between students and teacher.

3. To show how skills acquired during English lessons interrelate with aspects of mathematics, science, design,
technology and the humanities when students attempt projects such as the one chosen. In doing this the barriers between subjects would be broken down resulting, hopefully, in increased interest and motivation being shown by students.

4. To introduce students to skilled and knowledgeable people outside the College as a means whereby a project would take on a more realistic approach to everyday life.

Objectives

By the end of the exercise it was hoped that students would have:

1. devised questions for other people in an appropriate register;

2. carried out a survey;

3. interpreted, understood and evaluated data from a survey;

4. worked with teachers from other disciplines within the school curriculum (via project consultant(s)) and with representatives from outside agencies (business or commerce):

5. designed and manufactured a package in line with the findings from their survey;

6. presented, in a register appropriate for a given audience, a report, having considered and discussed the importance of handwriting, layout, design, etc.;

7. contributed orally at some stage;

8. produced a piece of work suitable for inclusion in their English Language course work folder;
9. worked in a variety of ways, i.e. individually, and in pairs or groups;

10. developed an appreciation that in English skills of listening, speaking, reading and writing are a powerful means of communication and, as such, form a part of all aspects of mathematics, science, design, technology and the humanities.

11. performed a variety of mathematical tasks in context with the project as a whole.

5.3.2 Planning The Exercise

Ideally for a project of this type input from teachers representing English, mathematics, science, design, technology and humanities curriculum areas would be required. In practice the project was planned by Richard Shepherd (English teacher) and Rod Bond (mathematics teacher). Between them they had a broad range of interests and a good knowledge of activities carried out in other curriculum areas within the College. With hindsight a design expert on the planning team would have greatly enriched the project. It was planned that the exercise would be attempted by two fourth year classes of average ability during November and December 1984.

The normal weekly time allocation for English within the College is five x 35 minute periods comprising one single and two double periods. It was decided that the groups would each spend one double period per week on the project with the other three periods being used for "normal" English work. A student brief giving information and project plan was prepared along with teachers' notes. Throughout the exercise a team teaching approach was to be used.

The module organisers made every effort to produce a professional-looking students' module as a means whereby it would show the participants that teachers were taking the project very
seriously. The importance of good presentation of material and investigative type assignments was confirmed in the HMI document "Curriculum 11 - 16. Towards a statement of entitlement: curricular reappraisal in action." (99). This report described the findings of a working partnership between some secondary schools in five LEAs and a group of HMI. Their main aim was to establish a working relationship which would help the schools involved to examine, rethink and improve their curricula and classroom practice. The Report, published in 1983, included a section written by teachers and HMI from Nottinghamshire which stated (p 66):

"It became increasingly clear that it was how material was presented to pupils and what sort of opportunities they were given to work on it which enabled them to develop as genuine learners. Schools which did not foster critical and reflective thinking, which did not involve pupils in making meanings for themselves, which did not include opportunities for pupils to fail, redraft and reshape information, were preventing children from developing as real learners ... . Classrooms should be places where pupils can think personally, feel personally and develop a strong self-identity, and where the formulation and solution of problems is not inhibited."

A Description Of The Groups Used To Evaluate The Project

Teaching groups for English at Burleigh College are described, for administrative purposes, in terms of year and house. The two groups involved in evaluation are described in this report as 4th Year Britons and 4th Year Saxons.

4th Year Saxons

This class contained 30 students, some following "O" level and some CSE courses. Ability and motivational levels varied; some of those less motivated were not less able than the others, as the project revealed. Many students had lively minds but
were unaware of or careless of some of the conventions and disciplines of punctuation and spelling.

4th Year Britons

This class contained 25 students. The class was target CSE and some students had difficulty in concentration on a sustained task, especially one involving a piece of continuous writing.

5.3.3 Project Brief

Students' Booklet

During the early planning stage it was decided to present students with a project booklet. This would outline the tasks to be undertaken as well as giving background information which may prove to be useful. The project booklet would be presented in an attractive, professional manner with the intention of showing the students that the planning team was putting much thought, time and effort into the project. It was hoped that this would indicate to them that we were really taking the whole thing very seriously and, in turn, would expect a similar attitude from them.

In order to try to maintain momentum, a "project plan" was included which outlined weekly tasks to be performed. This gave students an overall picture of the project and an idea of the pace at which they should be working.

The students' booklet is shown in Appendix 5.1.

Teachers' Notes

It was intended to make these as concise as possible. It was considered to be important to think about and write down the
project objectives not forgetting, however, that the work had to be assessed as part of the students' English Language course work. The objectives, therefore, were biased towards the exploitation of English skills. Teachers' Notes are shown with the students' booklet in Appendix 5.1.

Amendments Made To The Project Plan During The Project

The planning team were ambitious in setting a fairly rigid timetable for the completion of tasks. Task 5 was removed (although some students completed this and were rewarded accordingly). Originally it had been intended that task 6 would require students to answer questions orally. In place of this students listened to a talk about bar codes and then were asked to write "An Idiot's Guide To Bar Codes".

5.3.4 A Record Of Progress

A Visiting Speaker

Mr. Waddington, Assistant Manager at Safeway Foodstores Limited, Loughborough, gave an excellent introduction to the various types of coffee and the way in which they are packaged. He gave a most informative talk followed by informal discussions with students, and time was available for close examination of the various types of coffee packaging.

Basic Design Techniques

Students and teachers discussed ideas relating to packaging in terms of shapes, sizes, function and design of covers and labels.

Graphic design of packages was considered to be important especially in relation to sales appeal. Information printed on to the packages was discussed along with the use of bar codes.
The students were reminded of the various types of materials used for packaging.

The different ways of opening and closing containers were discussed and instruction given in drawing nets of solids for cardboard packaging.

Making Packages

Students made prototype boxes from cardboard which was supplied free of charge by a local box manufacturer.

Generally they worked on the packages with interest and concentration.
5.3.5 Students' Questionnaires

Students worked in groups with two main tasks:

(a) to devise questions which would give them the information they required;

(b) to write the questions in a form which could be easily understood by the respondents and thereafter could be easily analysed.

For both of the classes involved, certain students volunteered to type the questionnaires in their own time.

280 questionnaires were duplicated for each class. The fourth year Saxons class returned 230 completed forms. The fourth year Britons class returned 123 completed forms. Actual questionnaires and results are shown in Appendix 5.2.

5.3.6 Students' Work

Samples From Written Reports

Students were asked to make their reports appealing and easy to read.
Simple, attractive statistical representation of data was required when reporting on the findings of the survey.

Misuse of line graphs was common in students' reports.
Nets of solids was an important mathematical topic which was tackled successfully by students.

Samples Of Packages Produced

A design intended to stand out on the supermarket shelves.

Packages needed to be functional, informative and attractive.
This student's design incorporated a device for dispensing a given amount of coffee. (At the end of the project he still had not explained how it would work!)

Hexagonal based prisms were a popular choice.
Debate was directed towards how the consumer would obtain a measured amount of coffee from this container.

The girl who made this package eventually abandoned the design in favour of a cuboid. She had intended to produce "something different". In the end, and after much discussion, she decided that her design was impractical.
5.3.7 Feedback From Students

The importance of feedback is described by Hadley (100):

"Every teacher needs some indication from his students as to the effect of his teaching. Without a response, a sense that our energy and interest are reciprocated, the effort seems wasted - it feels like thrusting into nothingness. Without confirmation (which included disagreement) our understanding is undermined and our expression of that understanding seems eccentric."

De Bono (101) also adds weight to the argument for good feedback by saying:

"We can learn a lot from children and especially from watching children think."

In order to gauge the reactions towards the project, the students involved were given two tasks to complete:

(a) A feedback sheet asking "Did you enjoy the project?"
In addition they were requested to place the various activities in order of popularity, giving explanations why they had chosen their most and least popular choices.
PACKAGING FOR COFFEE

YOUR VIEWS ARE IMPORTANT!

NAME ........................................ TUTOR GROUP .................................

1. Did you enjoy the project? [ ] No [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 YES

Please tick only one box. A tick in box 1 means definitely No
A tick in box 5 means definitely YES

2. Listed below are the various parts of the project.

- talks/participation by visitors [ ]
- devising a questionnaire [ ]
- analysing the questionnaire [ ]
- writing a report [ ]
- making the package [ ]
- designing the label/cover [ ]
- taking notes and producing "An Idiot's Guide to Bar Codes" [ ]

Please number the boxes 1 - 7. Put number 1 into the box against the activity which you liked the MOST and carry on until you put number 7 into the box against the activity which you liked the LEAST.
3. Your Box 1
Explain why you enjoyed this activity.

4. Your Box 7
Explain why you did not enjoy this activity.
(b) A more formal written English assignment asking for their feelings about working on a project of this type as part of their English course work.

**PROJECTS AND ME**

The project "Packaging for Coffee" tried to show you how certain skills which are acquired during your English lessons have an important part to play in the making and selling of a product.

Your knowledge of English and of aspects of mathematics, science, technology and design helped you to produce a package which could have the sales appeal necessary for a company to break into the market, sell a product and make a profit.

(a) Write down your feelings about doing a project like this as part of your English course work. You should try to be constructive in your comments.

(b) If you were to tackle another project in the future relating to a manufactured product:

1. Describe what task you would choose to undertake (remember the work must be suitable for inclusion as English course work);

2. Give a plan of events/activities which would enable your project to be carried out;

3. State which other subject areas in the College you should approach for advice;

4. From what sorts of companies or jobs would you invite visitors to your lessons to help with the project?

5. State some of the places you feel that the class should visit in order to create interest, and describe how you would organise the visits.

From the two classes involved feedback sheets were completed by a total of 49 students (31 girls and 18 boys).
Enjoyment

When asked "Did you enjoy the project?" the reactions were as follows.

Girls (31)

| NO | 1 | 2 | 3 | 4 | 5 |
| YES | 2 | 7 | 8 | 11 | 3 |

Boys (18)

| NO | 1 | 2 | 3 | 4 | 5 |
| YES | 2 | 4 | 7 | 4 | 1 |

Girls and Boys (49)

| NO | 1 | 2 | 3 | 4 | 5 |
| YES | 4 | 11 | 15 | 15 | 4 |

The figures endorse observations made throughout the project. The vast majority of students maintained interest during lessons. Behaviour and attitudes were good. Generally, the students who indicated that they had enjoyed the project were the ones who were prepared to carry on with tasks and complete them in their own time or as part of designated homeworks. Even though a reasonable time was allowed for various assignments to be completed, the English teacher had difficulty with some students in obtaining finished designs, reports, etc.

The questionnaire indicated that the rank order of the activities, in terms of enjoyment, was as follows on the next page.
<table>
<thead>
<tr>
<th>GIRLS AND BOYS TOGETHER</th>
<th>GIRLS</th>
<th>BOYS</th>
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</thead>
<tbody>
<tr>
<td>1. Designing a label/cover</td>
<td>1. Making the package</td>
<td>1. Making the package</td>
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<tr>
<td>2. Making the package</td>
<td>2. Designing the label/cover</td>
<td>2. Designing the label/cover</td>
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<tr>
<td>3. Analysing the questionnaire</td>
<td>3. Talks/participation by visitors</td>
<td>3. Talks/participation by visitors</td>
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<td>4. Devising the questionnaire</td>
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<td>5. Talks/participation by visitors</td>
<td>5. Analysing the questionnaire</td>
<td>5. Analysing the questionnaire</td>
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</tbody>
</table>

Detailed Comments About The Various Sections Of The Project

Students were asked to place activities in rank order according to comparative levels of enjoyment. The findings are given on the following pages.

(N.B. Quotations from students' work have not been corrected for spelling or punctuation errors.)
Activity 1 - Talks/Participation By Visitors

This referred to visits by Mr. Waddington, Assistant Manager at Safeway Foodstores Limited, Loughborough, who gave an illustrated talk about the various types of coffee and its related packaging.

Student Rating

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<tr>
<th>Students</th>
<th>Rank Position</th>
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</table>

Student Comments

(a) From students who ranked this activity as Number 1.

"I enjoyed this because I learnt alot of different things about coffee that I didn't know about before. The talk that the visitor said was interesting and enjoyable to listen to."

Rosalyn
(b) From students who ranked this activity as Number 7.

"When the man from Safeway came in he didn't really tell us anything that we didn't know or couldn't found out easily anyway. While he was in we could of been getting on with the questionnairre or something like that."

Jane

General Comment

Mr. Waddington gave a comprehensive talk about coffee and its packaging. He included details about design, the technology needed for manufacture of the packaging and to maintain freshness, the human attitudes of the consumer in their purchasing activities, etc. At the end of the talk students were involved in looking at packages, testing the various odours of coffee, etc.

From a teacher's observation point at the back of the classroom, the sessions went very well with Mr. Waddington maintaining a high degree of student interest. The talk helped to launch the project and also brought into the classroom expertise from the world outside school.

Activity 2 - Devising A Questionnaire

The aim of this activity was twofold:

(a) to think about the questions which needed to be asked:

(b) how to ask the questions in a simple, clear manner which would be easily understood by the respondent.
### Student Rating

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### Student Comments

(a) From students who ranked this activity as Number 1.

"I enjoyed doing this, because it got us into groups, and having to decide on things as a group or in pairs. It made us think about other people's thoughts instead of just our own. It turned out to be an enjoyable time, instead of having to do just writing all the time."

Jane

(b) From students who ranked this activity as Number 7.

"I found it difficult to think what the general public would like in coffee packaging and what choices to give them."

Stephen
"This was quite boring because we hardly did anything everyone was doing it and I didn't get a look-in, and I didn't like putting it all together."

Caroline

General Comment

This involved each class working in small teams. A questionnaire for each class was compiled from the various suggestions made. In this activity leaders emerged who displayed qualities of organisation. Students generally responded well to orderly, yet lively, group sessions.

Activity 3 - Analysing The Questionnaire

Students were asked to work in groups, each group analysing the answers to two specific questions. The task involved a great amount of teamwork.

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</table>
Student Comments

(a) From students who ranked this activity as Number 1.

No student ranked this as Number 1.

(b) From students who ranked this activity as Number 7.

"Analysing was boring because it was nothing to do with the answers."

Karl

"I didn't enjoy analysing the questionnaire because it was tedious and took along time at looking at 230 different sheets of paper. Through it taking so long mistakes appeared and so the results were a bit out. All of this could have been saved (time) by feeding the sheets of answers into the school computer."

Stuart

General Comment

Although this activity may have been thought of as being monotonous by some students, it did create excellent teamwork in the classes as well as being fun for the students. It is interesting to read the comment by Stuart about "feeding the sheets of answers into the computer". It perhaps illustrates the popular misconception amongst students about today's modern technology being able to work wonders.

Activity 4 - Writing A Report

The English teacher asked the students to concentrate on four headings:
1. What Did We Do?

2. Why Did We Do It?

3. What Did We Find Out?

4. Recommendations For Action.

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Student Comments

(a) From students who ranked this activity as Number 1.

"Most of all I enjoyed writing the report because you could write it exactly as you wanted which included pie charts, drawings, graphs and anything I wanted. I'm glad that I could write my own points of view, without making it hard for 'Jo Public' to read."

Lisa
"I enjoyed writing the report best out of the activities. The report seemed interesting and there was lots of choice in what to write or draw. I enjoyed designing the cover of my report as I like drawing. I didn't want to do the report at first but then after I got started on it I quite enjoyed it."

Rona

(b) From students who ranked this activity as Number 7.

"I didn't enjoy writing the report after as we had to do alot of bar-charts and pie charts and I thought this involved alot of maths and thought that this had nothing to do with english."

Tina

"Although this activity was enjoyable I found it was complecated."

Chris

Activity 5 - Making The Package

Students were asked to design a package in line with their findings from the questionnaires.

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Student Comments

(a) From students who ranked this activity as Number 1.

"I enjoyed the activity of making a package because we were designing a new kind of jar for coffee and I really enjoy making things and drawing. I like to design things of my own that is why I chose it as the most enjoyable one."

Alison

"I enjoyed making my package because it was something constructive to do, rather than just drawing pictures of my model. It also gave the knowledge of what it would be like to be a package designer. Doing this piece of work made the project more interesting rather than the normal non-stop writing."

Kerrie

(b) From students who ranked this activity as Number 7.

"Basically it was boring. It was hard and labourous and mine didn't work. It was difficult and frustrating to do so I gave up on mine."

Sean

"I didn't like making the package. I found that we made virtually the same things but I wanted something different. I made a weird shape design but found it very hard and annoying trying to put it together."

Iris

General Comment

This proved to be one of the most enjoyable activities for students. There were exceptions, however, with 8 students out of the 49 giving it bottom ranking. The students who were most unhappy appeared to be those who didn't succeed with an end result and who became frustrated with their attempts at the practical work.
Activity 6 - Designing The Label/Cover

Students were asked to design a label which contained a barcode, a "best-before" date; ingredients; and a brand name.

In addition the label should be attractive, colourful and not crowded with information.

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Student Comments

(a) From students who ranked this activity as Number 1.

"I enjoyed designing the label cover mainly because I like art. It was also a challenge producing a finished piece of work that had all the relevant information on it, but still trying to keep it eyecatching and simple."

Jackie
"I enjoyed doing the label because it was a break from writing. It would be interesting if the teacher made a package and label."

Stuart

"I liked designing a label for the coffee jar as I liked the designing and the drawing of the label, using all the bright colours, and different types of writing. It made us think we were designers for a company."

Tina

(b) From students who ranked this activity as Number 7.

No student ranked this activity as Number 7.

General Comment

Most students rated this activity highly. Many of the finished packages produced were colourful, appealing and informative. Students needed to be aware of the necessity for bar codes, information about ingredients, etc. and also were expected to display ingenuity and creativity.

Activity 7 - Taking Notes And Producing "An Idiot's Guide To Bar Codes"

In this activity a mathematics teacher took on the role of a supermarket manager and gave the students a talk about bar codes. Students, who assumed the roles of shop assistants, were asked to take notes during the talk and then write a simple appealing description for the use of the general public telling them all about bar codes.
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Student Comments

(a) From students who ranked this activity as Number 1.

"I thought it that it was interesting and I like writing. It's nice doing different things, writing about what you'd never wrote before."

Caroline

(b) From students who ranked this activity as Number 7.

"I did not like writing an idiot's guide because I found it tedious and very monotinuse. Though the bar code was quite interesting the writing was simply boring. Trying to keep it simple and easy to understand was pretty difficult."

Jackie
"I didn't enjoy this part because I find that I lack concentration when taking notes. It was a part of the project when you have to concentrate continuously otherwise it is difficult to write down the notes you have been given and interpret them into your own words."

Helen

General Comment

This was a simulation exercise the likes of which many of the students involved may meet in later life, i.e. the giving of information orally and then the necessity to write down what was said.

The activity was given a low ranking and was considered by many to be just "plain hard work".

Student Feelings

Students were asked to write down their feelings about doing a project such as this as part of the English course work. Examples of comments written are as follows.

"I felt that this project in English was not write. I found it good because it was very interesting and full and very unusual things to do, e.g. designing a package for coffee. I thought it should have been a subject say for design. I felt that we were not using our English skills but more of our design skills."

Iris

"I think that doing this type of project as your English course work is a good idea because it gives you a chance of showing how you can use the skills from all of your lessons and bring them together in one project. It also shows how good you are at planning and organising your time and the resources that you use."

Stuart
"You could do a project like this in maths, English, design as each subject has an equal part in the project."

Alan

"At first I though doing this type of work in a English lesson seemed a bit stupid and though this should be done in a design lesson but it was quite interesting on the whole. I always though a English lesson was all nouns, essays and spelling. In a way I still don't see why we did this in a English lesson because it's the sort of thing you do at infants school. I now think that doing this has made me see English in a different light, its obviously very different to what I expected."

Debbie

"I didn't think the project on the whole had very much to do with English because English is all about reading and writing. So I think that the project on the whole was a good piece of work because we spent more time drawing and making things rather than reading and writing."

Chris

"I think that the idea of doing a project similar to that of packaging for coffee is a good way of putting over facts and figures. I think that it gives you a wide choice of all subjects but is still based strongly on English and gives you more experience on the subject. We do use English in other subjects and so I think that it is good to bring other subjects into our English project."

Helen

"This project "Packaging for Coffee" was a fairly interesting project. A subject everybody could do and like or dislike. I think this project shouldn't be classed as English but in something more general like Study Skills or SPE (Social and Personal Education). That would include all different subjects and not call it one subject. I, myself, quite
enjoyed most of the project, and the way it was set out was interesting. The information and thought behind it was a major task, I would have imagined it was hard work. Seeing that the project was classed as English makes it seem to be an essay report, but in truth it was a little bit of this and that and a mixture of both. All in all, I think the project was fun, interesting, easy in some places, harder in others and a major part of the half-term was put to good use."

James

"To start with I thought "What the devil are we doing this for?" but soon I realized that English has a lot to do with packaging. To begin with I couldn't see the connection so I didn't take a lot of interest but then I had a lot of work to do and took it seriously. I found it hard work, getting the survey together, the right questions to ask and how to plan the final report. What made me laugh was on the questionnaires when people would say, and I quote:

'The material used - tin'
'The colour of box - clear'

I have never seen clear tin before! On the whole I enjoyed doing the project because it opened a new area into packaging and marketing products."

Kerrie

"I wouldn't mind doing another one of these projects but I wouldn't like it if we did something like packaging coffee because I thought of it as being a bit boring. I wouldn't mind if we did something like the manufacture of a bike and designing bikes, manufacturing bikes, selling bikes, etc. I think the project should have a little more practical work."

Laxman
"I enjoyed doing the project "Packaging for Coffee" as part of my English lesson because I thought it was interesting and a break from the usual work. It also taught me a lot about how designs on packages and tins start off and what exactly to put onto the front of the package/tin to make it look attractive and appealing. I thought doing this project was a good idea because everybody did a lot of thinking over it and enjoyed making the package."

Pam

"Doing a project about coffee in an english lesson I thought that it was a bit stupid because you would usually do it in a design lesson. Then after a while I thought that it was quite interesting because we found out quite a few things, like all different types of coffee and all different types of packages which it came in. So doing this in an english lesson is not what I really expected but I thought that it was good anyway."

Alison

Student Suggestions For Future Projects Of This Type

Students suggested a wide variety of themes for future topic work, which are detailed on the next three pages.
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<th>SUGGESTED TASK</th>
<th>OTHER SUBJECT AREAS TO BE APPROACHED FOR ADVICE</th>
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<tbody>
<tr>
<td>Rosalyn Wayment</td>
<td>4B5</td>
<td>An investigation into the appeal and taste of cakes</td>
<td>Home economics, library, science (information on calories)</td>
<td>A sales assistant from a cake shop and a baker from a cake factory</td>
<td>A bakery which made cakes</td>
</tr>
<tr>
<td>Tracey Tovey</td>
<td>4B7</td>
<td>An investigation into the design of packaging for chocolates</td>
<td>Home economics, art department</td>
<td>Representative from a chocolate company</td>
<td>A chocolate factory (a three day trip)</td>
</tr>
<tr>
<td>Stuart Bond</td>
<td>4S5</td>
<td>An investigation into the design and appeal of motor cars</td>
<td>Maths dept. (questionnaire), science dept. (science of a car), design dept. (detailed drawings)</td>
<td>A man from Rolls Royce, Mountsorrel and a car salesman</td>
<td>Rolls Royce, Mountsorrel, because they build engines (*Note - they build AIRCRAFT ENGINES)</td>
</tr>
<tr>
<td>Wayne Richardson</td>
<td>4S1</td>
<td>An investigation into the design and appeal of clothes (Several students chose this topic)</td>
<td>Humanities (history of fashion), design, maths (details concerning measurements), library (looking at brochures, magazines)</td>
<td>-</td>
<td>Hosiery factory (morning visit)</td>
</tr>
<tr>
<td>TUTOR GROUP</td>
<td>NAME</td>
<td>SUGGESTED TASK</td>
<td>SUGGESTED VISITS</td>
<td>OTHER SUBJECT AREAS TO BE APPROACHED FOR ADVICE</td>
<td></td>
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</tr>
<tr>
<td>457</td>
<td>Wade Brown</td>
<td>An investigation into the rise in popularity of home computers and electronic gadgets</td>
<td>Sinclair Research or Centre of Information Technology, London</td>
<td>Library, maths dept. (how to display information), science dept., technology and science (materials)</td>
<td></td>
</tr>
<tr>
<td>455</td>
<td>Alan Brownlow</td>
<td>An investigation into packaging for bread</td>
<td>A sales representative dealing with home computers</td>
<td>Design department</td>
<td></td>
</tr>
<tr>
<td>451</td>
<td>Iris Guida</td>
<td>An investigation into the design and appeal of dresses</td>
<td>A manager from a supermarket</td>
<td>Fabric and Fashion department</td>
<td></td>
</tr>
<tr>
<td>451</td>
<td>Chris Demison</td>
<td>An investigation into the popularity of gassy drinks</td>
<td>A manager from a supermarket or off-licence</td>
<td>Design dept. (appeal of container), maths dept. (help with survey)</td>
<td></td>
</tr>
<tr>
<td>455</td>
<td>Helen Castledine</td>
<td>An investigation into the design of houses</td>
<td>A builder (possibly a plumber and electrician also)</td>
<td>Design, technology and science (materials)</td>
<td></td>
</tr>
<tr>
<td>452</td>
<td>Karl Bursnell</td>
<td>An investigation into cameras and films</td>
<td>A representative from a company manufacturing cameras</td>
<td>Photography</td>
<td></td>
</tr>
<tr>
<td>NAME</td>
<td>TUTOR GROUP</td>
<td>SUGGESTED TASK</td>
<td>OTHER SUBJECT AREAS TO BE APPROACHED FOR ADVICE</td>
<td>SUGGESTED VISITORS</td>
<td>SUGGESTED VISITS</td>
</tr>
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</tr>
<tr>
<td>Jackie Harrison</td>
<td>4S3</td>
<td>An investigation into the popularity of magazines</td>
<td>English dept. (investigate level of language in magazines)</td>
<td>A reporter or editor from a magazine</td>
<td>Visit to a publisher/printer who produces magazines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Visit to a newsagent (display sales technique)</td>
</tr>
<tr>
<td>Jeannette Bird</td>
<td>4S3</td>
<td>An investigation into the popularity of various types of music</td>
<td>Music dept., library</td>
<td>A music teacher or a record producer or the manager of a pop group or the manager of a record shop</td>
<td>Visit to a recording studio and possibly to a factory where records are manufactured</td>
</tr>
<tr>
<td>James Davidson</td>
<td>4S7</td>
<td>An investigation into the design of book covers</td>
<td>Maths (price calculations), design, history (if it was a history book)</td>
<td>A writer or a person from a book company or a person from a place that sells books, e.g. W. H. Smith</td>
<td>Visit to a bookshop</td>
</tr>
<tr>
<td>June Seddon</td>
<td>4B3</td>
<td>An investigation into hair styles</td>
<td>Chemistry, maths.</td>
<td>A hairdresser</td>
<td>Visit to a hairdressers</td>
</tr>
<tr>
<td>Pam Wood</td>
<td>4B2</td>
<td>An investigation into the design of shoes</td>
<td>Design, maths.</td>
<td>A shoe designer</td>
<td>Visit to a shoe factory</td>
</tr>
</tbody>
</table>
5.3.8 Comments By Teachers

Comments By The English Teacher

"My reactions as an English teacher are that I feel the classwork and homework time spent on the project was worthwhile. A range of tasks and skills was covered, given coherence and bound together by their contribution to an overall piece of work - for instance, devising and administering a questionnaire, analysing its results, working in groups, listening to speakers, writing notes, and writing a report and other exercises for a target audience. The interest of I think practically every student was engaged by at least some of the work. There was often what an experienced teacher might define as "a good working atmosphere" in the classrooms, and some students clearly put a lot of effort, both in class and at home, into their work. Some, however, have still not completed the tasks. Perhaps the tasks were beyond them, or motivation could not be sustained at home.

From my point of view the time spent making the packages gave me cause for concern. I wondered how I could justify this to myself as "English". On reflection, however, the problem-solving involved, the motivation, excitement and pleasure, the sense that it gave the students something further to refer to, with interest, in their written work, the "goodwill" engendered, all do justify it.

We packed more variety of work into this "Coffee" Project than we did into "Hay Fever", and so those students who have completed the tasks have more, in course work terms, to show for it. I think, however, that the Students' Booklet which we issued was too lengthy and complicated for most of the students, and I suggest simplification in future.

Once again, I feel I have benefited personally and professionally
from working with Rod, and from bringing other disciplines into the classroom. The students, too, reveal in their remarks that their perceptions of "school work" have been widened."

Richard Shepherd
February 1985

Comments By The Mathematics Teacher (Project Consultant)

One of the aims of the project was:

"To show how the skills acquired during English lessons interrelate with aspects of mathematics, science, design, technology and the humanities when students attempt projects such as the one chosen. In doing this the barriers between subjects are broken down resulting, hopefully, in increased interest and motivation being shown by students."

This aim was fulfilled. English skills formed a prominent part of the task but also included were many aspects associated with other curriculum areas within the College."
English/Communication

Students were asked to perform many tasks associated with communication, for example:

asking questions;

producing an appealing report;

taking notes and producing "An Idiot's Guide To Bar Codes";

writing frankly about their feelings;

presenting facts in a clear, easily understood manner on a label.

As a non-English specialist it was interesting to observe certain aspects of student attitudes to these tasks.

(a) Many students had problems with spelling and yet they appeared reluctant to use a dictionary. Words such as "alot" and "lable" appeared frequently.

(b) In some cases sentences did not make sense. Students had not bothered to read and check what they had written.

(c) When given both written and verbal instructions about assignments a minority of students were unable to follow them.

(d) Most students took pride in their work and attempted to present written assignments in a neat manner.

(e) Level of language in written instructions needs careful thought before presenting them to students, e.g. one student could not understand the instruction (from "Projects And Me"), "Describe what task you would choose to undertake".
Perhaps teachers in other curriculum areas can learn from the approach of the English teacher, Richard Shepherd, in setting students tasks. For example, for the project report he gave students four main headings to work on:

1. What We Did.
2. Why We Did It.
3. What We Found Out.
4. Recommendations For Action.

These were simple, straightforward instructions which were noted and understood by students.

He used a similar strategy in setting the task of writing "An Idiot's Guide To Bar Codes". General headings were:

1. What Are Bar Codes?
2. Why Do We Use Them?
3. Are They Only Used In This Country?
4. How Is A Bar Code Read?
5. What Do The Numbers In A Bar Code Stand For?
6. How Does A Bar Code Help The Customer?
7. How Does A Bar Code Help The Shop Keeper?

Simplicity and directness appear to be key factors in communicating effectively with students.
Mathematics

Many basic aspects of mathematics emerged, for example:

- masses
- measurement of lengths
- nets of solids
- two and three dimensional shapes
- the need for accuracy
- tessellations
- geometrical constructions (e.g. hexagon)
- costs and discounts
- analysis of data
- statistical representation of data
- percentages
- use of mathematical equipment, e.g. compasses, protractor, rule, etc.

I did not receive any complaints from students about "having to do maths". The mathematical tasks were an integral part of the overall programme.

Generally students coped well with the nets of solids section. Having to bend the shape and actually make the box brought many students to think carefully about accuracy of measurements. Some students' first attempts at making boxes were disastrous due to their disregard for accuracy.

It was pleasing to see attractive pie charts, bar charts and pictograms in the written reports. Many students, however, used line graphs incorrectly in representing data. Some students gave information in terms of percentages, demonstrating a good understanding of the concepts involved.

The exercise made students relate mass to volume. They could physically see the volume required, for example, for 200g of coffee.
Making the package made students think about geometrical construction, for example how to draw a hexagon (for a hexagonally based prism); how to find the circumference of a circle (for a cylinder); how to construct a triangle accurately (for a pyramid).

Design

Design of the package and its label proved to be the most popular and enjoyable part of the project for many students. Making things was fun. Students took pride in the design of labels for their containers and also with the front sheet of their reports.

It was noticeable, however, that in their feedback sheets, a small number of students gave low ranking to the task of making the package. Their attitude undoubtedly stemmed mainly from failures in producing a finished article.

In retrospect input and advice from a design specialist would have greatly enhanced the project.

Technology

Discussions about bar codes introduced students to the use of the computer in modern retail outlets. In their reports they freely mention light pen scanners and laser gun scanners. This section highlighted how modern technology can be a tremendous aid to both the shop owner and shopper. Shops and the use of computers also brought about discussions concerning the social implications associated with the introduction of modern technology especially in relation to reductions in employees.

Mr. Waddington from Safeway Foodstores talked about the technology associated with coffee packaging, for example the process of freeze drying coffee, decaffeinated coffee,
how to keep freshness and flavour in the product, vacuum packing, recycling materials for packaging, etc.

Incidental information such as that quoted above was well received by students.

Science

It was pleasing to note that a few students investigated where and how coffee is grown and the processes used to convert the coffee beans into the coffee that we buy on the supermarket shelves.

Discussions took place concerning the types, properties and relevant costs of materials suitable for use in packaging coffee.

Humanities

Details about the geographical location of coffee plantations and the history of coffee could have been easily incorporated into the project (time permitting). In practice only a few students dealt with geographical data, obtaining their information from the library.

Business Skills

As a result of Mr. Waddington's visit students became aware of the business skills required to sell coffee. Terms like advertising and marketing were discussed. Students were told that the public could be "brainwashed" by continuous TV advertising. Shelf display and position of goods in the store had a bearing upon which products sold most successfully. Special offers were mentioned as a means whereby the public were tempted to buy (and hopefully continue to buy) a particular kind of coffee.

Transportation of packaging, subsequent damage, breakage and waste were factors which had to be considered by management in the retail trade.
Teaching Staff Development

As a teacher, the author gained much from working with the English specialist. It provided an insight into how another curriculum area operates as well as an opportunity to observe the style and methods employed by a fellow teacher.

Assessment

Assessment was challenging as the final pieces of work involved a diverse range of interdisciplinary tasks. The English specialist had the ultimate responsibility for awarding marks for the work set. He requested, however, that the author should allocate marks specifically relating to the mathematical/design content. This arrangement worked well, enabling both teachers to learn about each other's thoughts regarding assessment.

5.3.9 Conclusions

1. Student opinions revealed some confusion concerning why this exercise had been attempted as part of English Language course work. As one student commented "To me this topic isn't English". Many students, however, appeared to understand the rationale behind the task set. One student astutely wrote "We do use English in other subjects and so I think that it is good to bring other subjects into our English project." The teachers involved had attempted to produce a topic for study which would show students language in use. This approach was commended by HMI in their report "Aspects of Secondary Education in England. A Survey by HM Inspectors of Schools" in which they reported (102):

"In discussions with teachers and with heads, it was clear that at the centre of many difficulties and differences of view there lies a confusion between two functions of
language – the first as a communication of what has been learned and the second as a part of the activity of learning itself. Concentration on the first of these at the expense of the second, which is often more important, may obscure the stages of misunderstanding, approximation and correction through which the learner often needs to pass and also may reduce the pupils' engagement with learning. For those who find the art of abstraction difficult (and even for some who do not), the use of language to explore an experience often reveals what can be discovered in no other way.

A change of emphasis from language as evidence of learning achieved to language used in the process of learning is needed. This is a matter of creating opportunities for pupils to find and use whatever language they need for their learning. Practical subjects, in which the centre of attention is less likely to be language than some other activity of which language is a by-product, frequently offer good examples. In those subjects which are largely word-centred, it is more difficult to find such immediate sources of experience."

2. Student "feelings" highlighted their conceptions of the purpose and format of English lessons. Some comments were:

"I always thought a English lesson was all nouns, essays and spelling."

"English is all about reading and writing."

"In English you normally do things like comprehension and essays."
When developing this project the organisers' intention was to produce course work which would require students to apply English skills to a situation associated with the world outside school.

3. Most students appeared to enjoy the project. As James said:

"All in all, I think the project was fun, interesting, easy in some places, harder in others and a major part of the half-term was put to good use."

Other students had different ideas. Jeannette points out:

"I don't see the reason why we should do a project in English. I think it's a waste of time, although I liked doing some of it."

4. The project had much variety in terms of student activities. There was something to interest everyone even if some students disliked the project as a whole.

5. The student booklet tended to have too much information, for some students obviously did not read it. For others the instructions and project plan were easily followed and instructions fully complied with. The teachers were aware of the importance of using appropriate language in dealing with the topic, again a point supported by HMI in their survey (63, pp 99-110):

"On the whole, there was a gap between the language of the teacher and that of the pupil, and this is not a new phenomenon. Most of the language of classroom talk and of textbooks was in standard English, and it was a part of the concern of teachers to help pupils to acquire this form of English through talking as well as through the related activities of reading and writing. The best
teachers were sensitive to differences in language and led their pupils discreetly and by a variety of means towards a wider range of language use and a surer command of language itself."

Perhaps a smaller, simpler booklet would have been better. Our policy of producing an attractive, well presented booklet, however, was effective. As James pointed out:

"I, myself, quite enjoyed most of the project and the way it was set out was interesting. The information and thought behind it was a major task, I would have imagined it was hard work."

6. The project itself did not motivate all students to hand in packages and written assignments on time. Only approximately 50% of students met the generous deadlines which were set.

7. It was noticeable that, with a few exceptions, the girls in the groups tended to produce more carefully written and better presented reports than the boys.

8. The "feedback" assignments illustrated that students have many good, innovative ideas which could be considered when planning future projects.

9. The policy of using a double period (70 minutes) per week for a number of weeks proved to be a good decision. (The alternative was to allow students to spend all five English periods on the project for a shorter period of time.) We maintained both momentum and interest. Possibly the pace was too fast for some students but if slowed down, then certainly others would have claimed to be "bored".
10. The two teachers principally involved agreed that team planning and team teaching was mutually beneficial, as it resulted in interaction and interchange of ideas and subsequently fostered a stimulating learning environment for the students.

11. It was encouraging for the English teacher to see one particular student motivated to work by the project. Before its commencement Alison had shown little interest in her English work. In her "feelings" about the project, however, she wrote:

"Doing a project about coffee in an English lesson I thought that it was a bit stupid because you would usually do it in a design lesson. Then after a while I thought that it was quite interesting because we found out quite a few things, like all different types of coffee and all different types of packages which it came in. So doing this in an English lesson is not what I really expected but I thought that it was good anyway."

She then produced a carefully written and well presented report in a plastic wallet. This example shows that, given the right motivation, some students in schools can happily discard lethargic, disinterested attitudes and achieve results compatible with their ability.

12. The overall reaction of many students can be summed up by the comments of Wade:

"I enjoyed the activity because it was like nothing I had ever done before, in English or otherwise. There was a good balance of writing and making things which came together very well. It was also good to get a proper finished result to the work we had done. It was also quite interesting and informative and I learned quite alot about how shops operate."
13. The project was conducted in an English classroom. Part finished boxes, however, had to be taken by the English teacher and stored in another part of the College as space was not available in the classroom's store cupboard.

At times students were frustrated by having to wait for their packages to arrive. The teachers had to provide felt tip pens, scissors, glue, compasses, rules, card, coloured paper, etc. which had to be obtained from various places. The project would have run more smoothly if the resources and materials had been available and easily accessible within the classroom at the beginning of each session.

14. At times concern was expressed by the English teacher regarding the quantity and quality of the English content of the project, bearing in mind the criteria laid down for English Language course work assessment. On completion of the project he was satisfied that his fears had been unfounded.

15. Both teachers involved reacted subconsciously to other English teachers coming into the classroom (to obtain books from the store cupboard) and seeing an English class cutting cardboard, colouring labels, gluing and sticking with Sellotape, etc. The feeling was "I wonder what my departmental colleagues think?". (N.B. The activities in the classroom were being carried out industriously and with interest by both students and staff.)

In the future it is hoped that the teachers involved with the project will discuss the principles with staff from the English curriculum area as a means whereby experiences and ideas can be shared.
16. Throughout the comments made by students, mathematics was hardly mentioned and yet all students had used a range of mathematical skills as part of their work. During the project mathematics was enjoyed by the majority of students much to the delight of the teachers involved.

5.3.10 **Recommendations For Future Projects**

1. The planning team should be enlarged to include representatives from science, design/technology and humanities curriculum areas.

2. Planning and management of the resources required must be given a high priority.

3. One student suggested "I think it would be a good idea if the topic or topics were chosen by the class." The suggestions written describing future projects were thoughtful and sensible. Perhaps students should be consulted about the choice of topic and actually be involved in planning the exercise. Taking on responsibility is part of growing up and a most important part of student development. The degree of student involvement would obviously depend upon the type of class involved.

4. The project was enriched by information given by the visitor. A visit to a relevant company by the class would be a useful addition to provide motivation to the students.

5. During the exercise the teachers did not exploit audio/visual aids or modern educational technology. In future they should try to include relevant videos, tape/slide programmes, computer work, etc. as a means of stimulating interest.
6. One student remarked "It would be interesting if the teacher made a package and label.". That is quite a good suggestion and one to be recommended for the future.

7. This type of project would be suitable for all levels of ability. The restraints on using this approach appear to be syllabus content and methods of assessment relating to English Language course work. These aspects should be fully debated.

8. Alan wrote:

"You could do a project like this in maths, English, design, as each subject has an equal part in the project."

On this occasion English lessons were used as a base. As the student said the ideas could have been evaluated in other curriculum areas.

5.3.11 Further Module Development

A copy of the "Packaging for Coffee" module was requested by Ms. Ceri Davies, a teacher working in the Learning Support Faculty at King Edward VII Community College, Coalville, Leicestershire.

A selection of modules was sent to Ms. Davies, who found them "very useful". She wrote: "I have used the modules selectively" and said: "I am less constrained by the need to get through certain mathematical concepts and so I have been able to develop your topics in various directions. For example, with the "Packaging for Coffee" module I have looked at implications of coffee production for the 'Third World'."

"Packaging for Coffee" created sufficient interest to motivate Ms. Davies to use the ideas from the module to produce schemes of work for her pupils to suit their abilities and needs.
6.1 A Brief Overview Of Recent Developments In 14-18 Vocationally Biased Courses

Over the past few years the number of pre-vocational courses such as TVEI and CPVE have increased. New courses which are developed with seemingly excessive amounts of paperwork, proposals and counter proposals have created confusion and anxiety amongst teachers, students and employers. Questions such as the following need clear, well-defined answers:

(a) Will the new courses be accepted by colleges, universities and employers?

(b) Will the new courses link up efficiently with existing ones rather than duplicate them?

Already, statements of disquiet regarding the compatibility of GCSE and CPVE courses have been made. Henry Macintosh, Secretary to the Southern Regional Examinations Board, says (103):

"In view of the differences between the GCSE and the CPVE, it is not easy to see how connexions between them can be developed, particularly when more and more students are staying on longer in full-time education after the age of 16 and where much more flexible and less age-related patterns of education, training and employment (and unemployment) will become the norm for increasing numbers."

Before youth unemployment became a major social source of concern, academic progression for the less able student was not a problem. In recent years the clientele remaining in education voluntarily at the age of 16 has increased in number and the general ability range of students staying on is wider than ever before. It has become increasingly difficult for
schools to make effective provision for all sixth form students (104). Educationalists are becoming much more aware of the need to improve the structure of education and training for young people at the schools/industry interface.

Kirkman (86) indicates that a degree of animosity exists between various examination bodies by saying:

"Tension between bodies like the Secondary Examinations Council (SEC) which oversees the traditional, single subject exams, and the vocational exam boards strains consultation over the school curriculum. The final GCSE subject criteria are not yet known, but it will obviously be difficult to make interdisciplinary core skills such as communication conform to the criteria for single subject courses such as English. Comparison between TVEI courses and SEC criteria will suffer from similar problems. How can you measure a vocationally orientated electronics course against criteria for a traditional physics exam?"

In the confusing array of vocationally biased courses available to young people, the following are prominent.

**TVEI - The Technical And Vocational Education Initiative**

This was launched in 1982 to stimulate the provision of technical and vocational education for 14 to 18 year olds from a wide range of abilities. The initiative is administered by the Manpower Services Commission who liaise closely with the Department of Education and Science. The criteria for each programme offered as part of TVEI are listed in Chapter 4.

**Royal Society of Arts Pre-Vocational Certificates and Profiles**

These are popular with further education students but are available for students in the 14 to 18 age range. There are four main vocational preparation courses, aimed at active learning through real assignments. They were first offered nationally in 1977. They are:
(a) Vocational preparation (distribution)

(b) Vocational preparation (clerical)

(c) Vocational preparation (basic clerical procedures)

(d) Vocational preparation (basic receptionist/telephonist skills)

They all share a common core: communication skills, numeracy, and career and personal development. The core skills are applied to a variety of work experience. The schemes might also include study of a particular vocational skill, for instance, bookkeeping, which might lead to RSA 1 Bookkeeping.

The City and Guilds of London Institute Pre-Vocational Courses And Certificates

(a) Foundation Courses

There are nine foundation schemes designed by CGLI which can be used as guides for schools and colleges to design their own courses. Eight of them were developed between 1976 and 1978. They are: construction, engineering, science industries, food industries, community care, agricultural industries, commercial studies and distribution. A ninth, information technology, was introduced in 1983. Schools and colleges can devise a course relevant to local needs while providing a recognized basis for national examinations and certification. Some schools and colleges have offered locally modified courses in other vocational areas such as garment manufacture, printing and nursing.

These courses are designed for young people of average (CSE Grade 3/4) academic ability in their final year of full-time general education. Basically each course consists of six main elements:
(i) Industrial, social and environmental studies involving the industry or occupational group chosen;

(ii) Skills and practices introducing practical activities associated with the vocational direction chosen;

(iii) Technology, theory and science connected with the vocation chosen;

(iv) Communication studies including written and oral communication and numeracy;

(v) Optional activities - at least two activities from a wide range such as pottery, music, local history, sports and hobbies;

(vi) Guidance education - individual and group counselling on careers and the students' aptitudes.

(b) City And Guilds Of London Institute Vocational Preparation (General) 365 Course

This is the forerunner of CPVE and is designed to give students from the age of 14 upwards a chance to sample a wide range of vocational activities.

Schools and colleges are free to design their own courses which must meet 365's aims and follow its curriculum structure.

The Certificate Of Pre-Vocational Education (CPVE)

This is a one year full-time course designed for students in schools and colleges drawn from a wide range of abilities who, at the age of 16, wish to stay on at school or take a full-time college course but do not want to take A levels or a purely vocational course. The three main parts to the course are core studies, vocational studies and additional studies. Further mention of CPVE is made later in this Chapter.
BTEC General Award In Business Studies

This is aimed at 16 or 17 year olds attending college part-time and has become increasingly popular with schools and YTS trainees. Unlike CGLI's 365 course, it is not available to pupils under 16.

The aim of the course is to provide a broad general education for young people with few academic qualifications who are interested in a clerical or sales career in industry, commerce, distribution and the public sector.

All courses are made up of three core modules:

- people and communication;
- business calculations;
- the world of work, for students interested in office work, or elements of distribution, for those with an interest in the distributive trades.

In addition students must also choose option modules to study.

The Certificate Of Extended Education

This scheme is aimed at students with good CSE grades who wish to stay on for an extra year at school. The CEE syllabuses include a range of subjects related to the world of work. The CEE is quite popular with schools but was felt to be too inflexible by government bodies and hence it ceased to be offered after summer 1985.
6.2 An Interrelated Approach With Sixth Form Students – Identifying A Suitable Course

The nature of the City and Guilds 365 Vocational Preparation (General) course is such that emphasis is directed towards the "integration or wholeness of educational experiences". The course was an ideal vehicle in which work of an interrelated nature could be prepared, tested and evaluated.

The course offers much scope for communication between many parties, for example between trainers in industry and teachers, between teachers themselves, between teachers and students, etc., and in so doing sets the scene whereby the course content and method is determined by people with a diverse range of skills and interests. Interchange of ideas and the sharing of experiences is to be welcomed and helps to give the modules used by students a very broad outlook.

The documents outlining the City and Guilds 365 Vocational Preparation (General) Course (105) issued by the Institute are specific in stipulating the aims of the course. These are:

To provide students with opportunities to develop their:

ability to communicate;

practical numeracy;

manipulative and other physical skills;

social skills;

self-confidence and adaptability;

capacity to tackle problems;

knowledge of the world of work and the roles of young people in it;
appreciation of the economic, political and environmental factors which influence their lives;

readiness to seek employment or further education and training;

capacity to cope with the adult world.

6.3 A Theme For Study - The Pharmaceutical Industry

The pharmaceutical industry has a profound effect on most of the population of the world. Within the immediate vicinity of Loughborough there are three major pharmaceutical companies, namely Boots PLC, 3M Health Care Limited and Fisons Pharmaceuticals PLC. It seemed appropriate to use the pharmaceutical industry as a theme for work with City and Guilds students.

The aims and objectives of the exercise complied with those set out by the City and Guilds of London Institute. It was intended that the pharmaceutical industry module should be taught in an interrelated way thus following the general philosophy in the City and Guilds 365 guidelines.

6.4 Module Planning

6.4.1 Module Planning By Teachers

The module was planned by a team of teachers at Burleigh Community College. Curriculum areas within the College were asked to provide representatives who would contribute towards the City and Guilds courses, both in the planning and teaching stages. The planning team for the pharmaceutical industry module consisted of volunteers drawn from these curriculum area representatives. The team members were:
Planning and discussions regarding the module took place regularly during one period (35 minutes long) per week. Enthusiastic team members gave up one "free" period to attend these meetings.

The pharmaceutical industry module was planned so that students would spend seven weeks on the activity. Each week would consist of fifteen timetabled periods plus homework time. The work produced could not possibly cover the entire pharmaceutical industry in seven weeks and so specific parts were chosen for inclusion. The team agreed to divide the module into three parts.

Part 1 - A General Introduction (duration 1 week)

Part 2 - Packaging (duration 3 weeks)
This involved aspects of design, mathematics (areas, volume, nets of solids, bar codes, etc.) and communication.

Part 3 - The Working Environment (duration 3 weeks)
This was basically science orientated with a predominance of biology and physics. In addition a case study dealing with safety at work was included.

One of the basic aims was to cover the course content by teaching in an interrelated way.
After producing a skeleton outline of the various sections of the course, planning team members were allocated various parts to prepare. Teachers then produced draft copies of work which were discussed by the team and modified if necessary. The project co-ordinator was responsible for tidying up the content, adding graphics if appropriate, typing, duplication and collation. This worked well as team members could concentrate on writing creatively with the burden of final production removed from them.

The team were conscious of the need to enrich the course by using links with local industry. Two local pharmaceutical companies, 3M Health Care Limited and Fisons Pharmaceuticals PLC, were approached for advice.

Members of the planning team visited 3M Health Care and discussed the project with Mrs. Karen Deakin, Training Officer, and her colleagues.

Planning team members also visited Fisons PLC, Pharmaceuticals Division, and obtained many ideas from Mr. Gordon Willimont, Personnel Officer, and his colleagues.

Contributions by both companies were most welcome and their constructive suggestions brought a sense of reality to the project.

The value of teachers and local industrialists meeting in this way is warmly supported by HMI (63, p 16):

"A greater knowledge of local conditions can provide teachers of most subjects with immediate and appropriate source material from which to illustrate general ideas, while discussion with employers can help schools to appreciate more clearly the skills required from their leavers."
The meetings produced many ideas and offers of help in terms of visits and visiting speakers. It was possible thereafter to produce a weekly work diary for students showing them the time allocation for the various tasks as well as indicating where input from the local companies would occur.

The planning team considered that students should be given variety in what they were asked to study. They would also be given freedom to choose how they worked, i.e. individually or as a member of a small group. The prepared work would allow them to progress at their own pace but, however, the structure was such that they were able to meet collectively as a group for visits and visiting speakers.

6.4.2 Project Diary For Students

This is shown in Appendix 6.1. It was helpful to both students and staff in pacing the course correctly. Students were given generous deadlines for handing in work. The diary also gave students and staff a small amount of background information about visitors and organisational arrangements.

The diary was planned on the basis that two distinct groups of students would be involved. After discussion it was decided to amalgamate the groups and use a common timetable. The actual timetable, therefore, deviated slightly from the one used on the project diary sheets.

6.4.3 A Description Of The Group Of Students Using The Module

The students were all members of the first year sixth form, being aged either 16 or 17. It was anticipated that approximately 20 students would be studying the module. In practice, however, 16 completed it with some students leaving the course having found employment. There were equal numbers of boys and girls.
The students involved had mostly achieved CSE grades 3, 4, 5 or U in the subjects which they had studied in the fourth and fifth years at College.

There was a good mix of personalities within the group with some extrovert characters who were vociferous at times and others who worked quietly alone or in a small group. Generally the students were pleasant and friendly to each other and to members of staff.

6.5 The Module

This involved industrial visits, contributions by visiting speakers and written/practical assignments. Sample assignments are shown in Appendix 6.2. The complete set of assignments may be inspected at CAMET.

6.5.1 An Industrial Visit

A visit to 3M Health Care Limited gave students an insight into the work of a pharmaceutical company. Mrs. Karen Deakin devised an interesting programme which was much appreciated by teaching staff and students. The visit consisted of a conducted tour of two sites in the morning followed by an afternoon session where students worked in the training centre on syndicate exercises based upon information gleaned from the tours.

The timetable for the day's activities is shown on the next page.
Timetable for Friday 11 January 1985

9.30 am  :  Students arrive and are welcomed at Derby Road.  
            :  Tour of Derby Road site including:
            :    - Outside of Chemical Production.
            :    - Stores
            :    - Aerosols
            :    - Solid Dose
            :    - Analytical Laboratories
            :  Karen Deskin
            :  Brian Cuthbert +3

10.30 am :  Transport to Wharncliffe Road.  
            :  Mick Bailey

10.45 am  :  Coffee and Biscuits at Wharncliffe Road
            :  Conference Room
            :  (25 people)
            :  Beryl Cooper

11.00 am :  Tour of Wharncliffe Road site including:
            :    - Packaging
            :    - Valve Assembly
            :    - Stores
            :    - Warehouse
            :  Brian Cuthbert +3

12.15 pm :  Lunch at Wharncliffe Road Cafeteria
            :  Beryl Cooper

1.30 pm   :  Students meet in Training Room 1 at Morley Street.
            :  Syndicate Exercises based on tours of
            :  morning session.
            :  Karen Deskin

3.00 pm   :  Finish
The afternoon session involved students working in groups on the task shown below. This focused their thoughts on what had been observed in the morning tours.

THE DEVELOPMENT AND PRODUCTION OF A TABLET

Below is a list of the different processes involved in making a tablet. In your group, try to identify each part of the process and draw a flow chart showing how a tablet is made.

Your group will be asked to present your chart to the other groups. Every person should be involved in the presentation.

To help you with the exercise, a file is provided giving information about the development and production of a tablet.

GRANULATION
WAREHOUSE
RESEARCH IN AMERICA
COATING
STORES
QUALITY
DISPENSARY
PACKAGING
COMPRESSION
DISTRIBUTION
DEVELOPMENT LABORATORIES

You have 30 minutes to complete this exercise.
General Comments

It was a most successful day. The students arrived in the morning on time and, with one or two exceptions, behaved maturely and showed much interest.

6.5.2 Visiting Speakers

The inclusion of visiting speakers was intended to ensure that the students would receive accurate information at first hand from skilled, knowledgeable people. This would help to prepare them for the world of work.

As expected, the visitors were well organised, well prepared and they imparted a great variety of information to the students.

Mr. Alan Fryer - Quality Compliance Manager, 3M Health Care Ltd.

Mr. Fryer showed a film about "Good Manufacturing Practice", which illustrated how mistakes could be made in a pharmaceutical company and the possible consequences.

Students showed great interest in both his talk and the film. The end of the film created debate amongst students when a child was seen to be about to take a tablet which had ten times the dose prescribed. The session illustrated to students the stringent safety and inspection procedures in a company which are taken to ensure that a product is correctly manufactured.

Mr. Gordon Willimont - Personnel Officer, Fisons PLC, Pharmaceuticals Division

Mr. Willimont showed a video describing the development of Fisons PLC and brought along a whole range of products for students to look at. He also advised students about the types of jobs associated with various aspects of his industry.
The opportunity to meet a person involved with recruitment was welcomed by students. In addition, teaching staff present remarked how beneficial the session had been to them in relation to improving their knowledge of local industry.

Students responded well to the three main activities of the session:

(a) the video;

(b) a talk supported by items brought from the Company;

(c) follow-up written exercises relating to the pharmaceutical industry.

A varied programme such as this appears to have merit.

Mr. Dixie Dean - International Technical Services Manager, Fisons PLC

Mr. Dean gave an informative, humorous talk on the history of packaging. He described his boyhood experiences of 50 years ago when he worked with his father in a grocery shop. He displayed a deep knowledge of the historical development of packaging and illustrated his comments by using a selection of packages which varied in age.

His presentation gave students and staff a personal insight into ways of life over the past 50 years. Mr. Dean also described how the 1939-45 war had accelerated the need to develop packaging technology.

Dr. Kevan Chippendale - Packaging Technologist, Fisons PLC

Dr. Chippendale gave a lively, humorous talk about packaging in the pharmaceutical industry. He mentioned the functions of packaging:
Dr. Chippendale talked about primary and secondary packaging, presentation, abuse and misuse, information, non-tamper packs, etc. and dealt with the vast range of materials used in packaging. He brought along a large selection of samples which students had the opportunity to examine. He concluded his talk by looking to the future and suggested that computer designed bottles would soon be with us.

Mr. Arthur Fish, Safety Officer, and Sister Jean Walker, Occupational Health Specialist, 3M Health Care Limited

Sister Walker used her wide experience to describe to students how she ensures that employees at 3M Health Care Limited are checked for medical fitness. She has to check, for example, for colour blindness in employees doing certain jobs. She is actively involved in first aid instruction and counselling within the company. She talked about how injuries occur and showed students evidence to suggest that hearing can be impaired by attending discos. She emphasised the need for proper training in the company concerning lifting procedures. Back problems were a major cause for concern in industry.

Mr. Fish brought along a large amount of equipment which he uses in monitoring and measuring such things as dust, static electricity, chemical composition, noise, fumes, etc.
6.5.3 **Written/Practical Assignments**

When producing written and practical assignments in the module, the planning team considered the following points to be important:

(a) have a variety of work, both written and practical;

(b) use equipment wherever possible;

(c) produce attractive, easy to read worksheets/instruction sheets;

(d) consider carefully line spacing, levels of language and graphic design of worksheets;

(e) ensure that pictures and diagrams are used as much as possible;

(f) use available commercial publicity material wherever appropriate;

(g) ask students to present answers in a variety of ways, i.e. writing answers on worksheets, filling in missing spaces, writing answers on file paper.
PACKAGING PROJECT

STUDENT BRIEF

1 Design packaging for "Children's Vitamins" or another home pharmaceutical product that is to be sold in local chemist shops and supermarkets. This container must:

- have sales appeal - be attractive and eye-catching;
- have clear labelling - brand name, contents, instructions and legal requirements;
- be easy to display, stack and store and transport.

2 Make a prototype of your package.

3 Write a short report describing the steps you took in designing and making your package. Include sketches and any calculations which were carried out.

4 If your package was to be made by a company in very large quantities, write down details for the company regarding actual materials, types of top or closure, etc. to be used.

5 Go back to the section dealing with design considerations. Answer the same questions but this time about your own product.

OPTIONAL

6 Carry out a market research exercise using a questionnaire to obtain views about the design of your package.

Good Luck!

Practical work such as making a package was accompanied by relevant written work.
WORKSHEET 2

MEDICINES AND THEIR HISTORY

NAME ..................................................

TUTOR GROUP .................................

Complete the following.

1. The microscope was invented by scientists from the country ............. around the year ............. .

2. Two American scientists discovered vaccines to protect against Poliomyelitis. The scientists were called .................................................. and ............................ .

3. The experts in plant lore in the Middle Ages in England were ...................... . They treated the sick in ...................... .

4. An alchemist is ..............................................................

5. The first and most renowned of the alchemists was .............................. who was born in the year ............. .

6. Some diseases still to be overcome are ........................................

7. The pharmacist has the job of ........................................

8. Modern medicines come in many forms. Describe three of these forms,

(1) ........................................................................

(2) ........................................................................

(3) ........................................................................

For this exercise students had to read an illustrated leaflet on "The History of Medicine" and then find the answers to the questions.
Attractive pictures were included wherever possible. Here students were requested to look at the picture and write down the health hazards.
6.6 Students' Work

6.6.1 Written And Practical Assignments

In addition to the visit to 3M Health Care Limited and a number of visiting speakers, students were given a mixture of written and practical work to attempt.

These two students are seen working on a sheet which requires them to describe jobs associated with various aspects of the pharmaceutical industry.
Students tended to concentrate on cuboids for their packages rather than being adventurous and designing revolutionary shapes.

Students enjoyed this activity. Their product needed to have sales appeal as well as containing relevant information for the consumer.
The case study on work safety required students to design an eye-catching poster.

The growth of microbes on agar plates proved to be a popular activity which will leave a lasting impression in the minds of students.
6.7 Assessment

Assessment Procedures For The City and Guilds 365 Course

This is by the use of a personal profile together with written examinations in, for example, Numeracy Levels 1 and 2 and Communication Skills Levels 1 and 2.

Entry for the various examination components depends upon the progress made by the student throughout the course. The City and Guilds 365 information pack gives their views about the value of profiling.

"A profile is an attempt to record, with full pupil participation, the realities of achievement. The emphasis in profiling within 365 rests on general abilities such as those expected in adult life rather than a specific subject knowledge. It is an attempt to capture, in the round, the light and shade of student achievement so that the student can see himself/ herself realistically with a view to desiring to effect adjustments where necessary."

The profile for each student is a comprehensive document which requires careful thought by teachers and students at the completion stage.

Assessment Of The Pharmaceutical Industry Module

In order to be consistent with marking, teaching staff accepted responsibility for marking various sections of the work. They agreed that science biased sections should be marked by a specialist from science, mathematics biased sections should be marked by a mathematician, etc. Teachers were given freedom to organise marking schemes themselves. When marking for each section was complete, scripts were sent to the City and Guilds co-ordinator in the College, who was responsible for accumulating information on the progress of each student before completing their student profiles.
6.8 Feedback From Students

Feedback was considered to be most important as a means whereby the information could be used and considered when planning future modules.

Student feelings were monitored in three ways:

(a) by using a brief weekly feedback sheet;

(b) by asking students for written comments to given questions at the end of the work;

(c) by interviewing students and recording their responses, again towards the end of the course.

6.8.1 Written Comments

Student Comments Received On A Weekly Basis

After the deadline for each week's work had passed, students were asked to complete a feedback sheet. This consisted of an assessment grid asking them to grade each activity, e.g.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>DID NOT DO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In addition students were asked to respond to two further questions.

Qu. 2 What were the really good points about Week ...?

Qu. 3 What did you not enjoy about Week ...?

Student responses are shown in Appendix 6.3. The number of completed forms varies from week to week and is dependent upon various factors, for example some students were not present owing to heavy snow falls, work experience, etc.

Students' Comments After Completion Of The Topic

At the end of the module students were given a feedback sheet to complete. The heading and instructions are shown below.

<table>
<thead>
<tr>
<th>CITY AND GUILDS 365 COURSE</th>
<th>TOPIC: THE PHARMACEUTICAL INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>YOUR OPINIONS ARE IMPORTANT!</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>NAME ............... TUTOR GROUP ..................................</td>
<td></td>
</tr>
</tbody>
</table>

It is essential that we obtain your views and opinions about how successful the course was. Your feelings will help us tremendously with our planning for next year's work. Please would you answer the following questions. You must write sentences and try to be constructive with your answers, e.g. give reasons for what you have said. This exercise will be assessed and submitted as part of your course work.

12 students completed and handed in their work. Questions and a summary of comments written are summarised as follows. (Please note that students' comments are copied as written - spelling and punctuation errors have not been corrected.)
Question 1  Was The Topic On The Pharmaceutical Industry Worth Doing?

All students responded "yes" to this question. Two students said "no in places". The overall feeling is epitomised by the response given by Mandy.

"The topic was worth doing because it gave us a chance to see what goes on in such a big industry and also the chance to see what sort of jobs are available. It was very interesting and it opened our eyes to see what really goes on around us. With the great amount I have learnt I have to say "yes" it was well worth doing."

Question 2  Did You Enjoy The Topic?

Everyone said "yes" to this question. Most people stated a few sections which they particularly did not enjoy. Examples of comments are:

"Yes I did enjoy the course but some parts were hard and very difficult in parts to understand."

Mark S.

"I did enjoy the topic. It was realistic and very interesting. It was the best topic we have done so far."

Mandy

Question 3  What Have You Learned From The Topic?

Responses varied. Everyone, it seems, learned something from the topic. Comments included:

"Well I have learnt from the topics a great deal knowing about the human body. most of the exercises where interesting."

Brinderjit
"I have learnt that there is an awful lot of work behind some of these factories, i.e. packaging, making, buying, storing, etc. I have also learnt things about the eye and ear, the parts that I didn't know."

Michelle

"I have learned how complicated things are i.e. how a drug is made. Also how the eye and ear works, this has taught me alot about sences of the body."

Mark W.

Question 4 Did You Enjoy The Way In Which We Studied Maths, Science, Design, Humanities, etc. As And When They Occurred In The Topic Rather Than Studying Them Separately (e.g. 2 periods Maths, 2 periods Design, 2 periods Humanities, etc.)?

Seven students said "yes" and four students "no". Comments included:

"The way we do it now is alright but the way we did it in the forth and fifth year was better because it was less confusing."

Anish

"Yes, this was much better as it is a more real life situation. You use all methods of learning when at work, not just one, every now and then. It prepares you better for after school life."

M. Anthony T.

"It was more interesting doing a bit of everything than splitting it up. It would have been boring."

Helen

"I would personally like them all mixed up because you don't know what you're doing next so it keeps the interest up."

Paddy
Question 5  What Are Your Opinions About The Visit To 3M Health Care?

Everyone enjoyed the visit and were most complimentary about the whole day. Comments included:

"The visit was very interesting and very helpful. The people that worked there were very kind and helpful to. I enjoyed it very much."

Mandy

"The visit was very enjoyable and interesting for the day."

Yogini

"I really enjoyed 3M Health Care, I never realised how big it was, and clean, some of the people take the job to seriously. I especially enjoyed talking to Mr. Fryer. It is a shame that we didn't visit Fisons."

Michelle

"This was great. It showed you how real people work in a real environment. It shows you what to expect, and how to prepare for it. Also it made us realize how much effort goes into making a product - pharmaceutical or not."

M. Anthony T.

Question 6  What Are Your Opinions Generally About The Visitors Who Came To Talk To You?

The feelings of the students varied. They all appreciated the effort that the visitors had made in contributing to the course, for example:

"Over all the visiting speakers were very nice people and tried to be helpful."

Mandy
"The visitors who came to talk to us give us more information about the subject so we know what kind of work is involved."

Shivraj

The main problems which arose were:

(a) possibly 1 hour sessions were too long to maintain the concentration of students of this ability level;

(b) some students who were trying to take notes were left in confusion by the pace of the talks;

(c) the visitors tried very hard to make their presentations simple, humorous and interesting; at times, however, students could not understand words that they were using. Some speakers' level of language was not low enough to match the ability of the students, for example

"I enjoyed a change from the teachers talking to us and have some who know more about their job it was interesting sometime but some of the visitors really rushed it not enough time perhaps."

Brinderjit

"I thought that the visitors were good but a little above us, they used to many technical words that some people couldn't understand."

Paddy

Question 7 What Are Your Opinions About How The Work To Be Done Was Presented To You, e.g. Worksheets, Booklets, etc.?

With two exceptions there was general approval of the way the work was presented. Comments included:
"How the work was presented is good because it does not confuse you and you don't have to write an essay about a question."

Anish

"I think this was a good idea and also the information was good and detailed well."

Michelle

"The worksheets etc. in general were fairly interesting, especially the one on Areas on Volumes."

M. Anthony T.

Comments from people who didn't like the way the work was presented were similar to the following example:

"I didn't like the way the work was presented because I don't like working from booklets. I would much rather work from the blackboard as I take more into my mind this way."

Mark W.

Question 8 Were The Worksheets/Booklets Easy To Read And Easy To Understand?

Students agreed that the answer to this question was "yes". Some comments were:

"Yes, they were very easy and plain to read. This is very good because some people get in a muddle or are dislexic."

M. Anthony T.

"The worksheets were easy and interesting to read and understand. Easy to read because they were well planned and set out. The information was put in simple language so that it was easy to understand."

Mandy
Question 9  What Are Your Comments About The Amount Of Work That You Were Expected To Do? Was It Fair, Too Little Or Too Much?

Comments were mixed. Some students felt that the amount was fair, others thought there was too much. Some students appeared to believe that all the work should be covered in classwork time. They did not seem to accept that homework was inbuilt into the assignments. Comments included:

"At first the work looked to much but once you got onto it it was okay, I always seemed to finish early."

Mandy

"I think it is just right, just enough to keep people busy without tiring them out."

M. Anthony T.

"I thought the amount of work to do was too much because most of the time I had to do maybe half of the work at home."

Paddy

Maybe the comments indicate the need to have two components for each section of work. One component could be compulsory and the other optional.

Question 10  Were The Deadlines For Handing In Work Fair? Generally Did You Hand In Work On Time?

The teachers working with the students felt that the deadlines were generous (i.e. allowing a week to complete after the finishing date). Student reactions were mixed. Comments included:

"I thought the deadlines were fair, but a complete waste of time because some people were handing in work 2 or more weeks after the deadline."

Paddy
"deadlines were to quick - because all the work I did I had to rush."

Anish

Question 11 Did You Enjoy The Practical Work, e.g. Making The Package, The Agar Plates, Measuring Light, etc.?

This proved to be a popular component of the assignments. Samples of comments were:

"I enjoyed doing the practicle work it broke up the work sheets so that we got a brake. I think more practicle things were needed."

Mandy

"I enjoyed making the Agar plates because it was a nice change from writing all the time, which is what we need every so often. The making of a package was fun , and it showed your flair and imagination in a creative sence."

M. Anthony T.

Question 12 (a) Were The Attitudes Of Students Working On Topics Good? and (b) Was There A Good Working Atmosphere, Generally, In The Classroom?

Students indicated that after initial teething problems the answers to both parts of the question was "yes". One problem arose from the situation where the two distinct groups working on the C & G 365 course were amalgamated into one at the start of the pharmaceutical industry module. Initially the two groups did not work harmoniously, on occasions, but this problem diminished quite quickly with time. Comments included:
"Most of the students didn't argue at all with the work, and had good attitudes, but one or two would take part in experiments. At first, when the two groups merged, it was caos, and rivalry, but now we work well together, and the only problem is the noise."

M. Anthony T.

**Question 13** Were You Satisfied With The Help Given By Your Teachers And The Way In Which The Group Was Treated By Staff?

There was an overall feeling of satisfaction with the help given by staff. Comments included:

"Yes, the teachers helped alot they would always explain clearly."

Brinderjit

"The teachers helped us where they could and we also had a chance to show that we could help ourselves get on. The staff were very nice to us."

Mandy

"The teachers are always there if you need them, but most of the time the work is self-explanitary, and you can just get straight on with it. I get on well with all the staff and can talk to any of them really."

M. Anthony T.

**Question 14** Having Learned About The Pharmaceutical Industry, Has This Made You Want To Seek Employment In This Industry?

The balance was seven students who did not want to seek employment in the industry against five students who would like to work in the industry. One job which did not appeal to them was sitting at a machine watching pills and bottles. Comments were:
"Yes I would like to work in a pharmaceutical industry. It's so interesting."

Brinderjit

"Yes I have already started to apply."

Anish

"Yes and no, yes because it is nice to work there and the people are kind to. No because you need O level and A level to work there and we aren't doing any here."

Shivraj

**Question 15** How Does The Work On The Pharmaceutical Industry Compare With The Topics Which You Have Worked On Previously In The City And Guilds Course?

Comments included:

"It's completely different."

Kathy

"There has been a lot more work on the pharmaceutical work than the other pieces of work. It has been a little boring at times but I have enjoyed it a little. Some of the other work has been more interesting though."

Mark W.

"The pharmaceutical does not compare at all with the rest of the work we done because the pharmaceutical lasted for ages and there was so many task to do."

Anish

"The topic is the most interesting out of all the other topics we have done. It was also the longest with the most work."

Mandy
Question 16 Have You Any Other Comments To Make About The Pharmaceutical Industry Topic?

Comments included:

"Yes some of the work could be made a little shorter. Also a few more trips to factories would have been a lot better for us."

Mark W.

"I enjoy the topic because it's interesting and worthwhile, specially the visit to the 3M health care."

Yogini

"I think that this should be arranged so that pupils can actually have a chance to work some of the machines at the plant at some time."

Paddy

"Yes the work was great but the teachers could have given us a little more time."

Brinderjit

6.8.2 Taped Interviews

At the end of the course students were invited to be interviewed with the intention of obtaining their opinions about various aspects of the work covered.

It was interesting to note that, in some cases, the oral comments of students differed from written answers to similar questions. At times students contradicted themselves as the interview progressed. All students were interviewed individually and appeared to respond in a sensible, constructive manner.

A transcript of a typical taped interview is as follows.
Student - Mark T.

Mark is a quiet, pleasant student with a mature, sensible attitude. On the few occasions that he has been late to lessons he has always apologised sincerely. Compared with the other students in the group he appears to possess a flair for expressing himself both in written work and orally, and is probably one of the most able. He usually works conscientiously alone or in a group.

On his written work he writes his name as M. Anthony T. Perhaps he feels that this will help to identify his work to teachers bearing in mind that two other members of the group are called Mark.

R.B. Hello, what's your name please?

M.T. Mark.

R.B. And how old are you, Mark?

M.T. Seventeen.

R.B. What's your favourite subject at College, Mark?

M.T. Um ... English.

R.B. What do you like about English?

M.T. I don't know ... I just like writing.

R.B. Fine. Have you enjoyed the work on the pharmaceutical industry?

M.T. I enjoyed bits of it ... like when we went visiting factories and things like that but ... other bits I didn't like much.
R.B. You enjoyed the visit the most did you?

M.T. Yes.

R.B. What haven't you liked or enjoyed about the pharmaceutical industry module?

M.T. Um ... We did so much on it, I can't remember half the stuff we've done. Um ... probably all the sort of reports and things that we had to write.

R.B. But I thought you liked English ... I thought that you liked writing words?

M.T. Not necessarily reports and things like that. I like writing stories.

R.B. What about the way we've been working? We've mixed up maths and science and design and technology ... history, in one project. Is this a better way to learn than how you did it last year when you had all your subjects individually?

M.T. Yes I think I preferred that.

R.B. Why?

M.T. Um ... I think you've not got so much emphasis on just one thing ... it all comes in together ... one thing you need, then another thing.

R.B. Do you not feel that this is how things operate when you go to do a job?

M.T. Yes, that's it ... exactly how it is.
R.B. Fine. What about the assignment sheets that you were given? Were they set out well and easy to follow?

M.T. Yes ... they were easy to follow.

R.B. Did you like the way we asked you to give us written work? For example some work had to be done on file paper, other work involved writing answers on typed sheets. Do you think it's good to have a mixture of the two or would you have preferred to have written all your answers, say, on file paper?

M.T. I suppose it's a good idea to get a bit of both.

R.B. Fine. Did you like the practical work like the experiments, measuring the values, making the package?

M.T. Yes ... that was good because it showed you used your initiative.

R.B. You've already said you liked the visit. Why did you like the visit?

M.T. Well it got you out of the school environment ... it showed you what it was really like in a place of work.

R.B. What did you enjoy particularly about actually going round there? What things did you see that you really enjoyed and valued?

M.T. I saw how other people worked and what it would be like if I went to work ... I've found out now that I wouldn't like to work in a factory like that ... not in the sort of packaging part.

R.B. Have you enjoyed having visitors in?

M.T. Some of them. I found some of them a bit boring though.
R.B. Why were they boring?

M.T. I don't know ... I just didn't enjoy some of them.

R.B. Did they use too big words?

M.T. Well, no, but a lot of them just kept repeating themselves or telling us things that were uninteresting that we didn't really want to know.

R.B. You've had six teachers working with the group at various times in the week. Do you think that this is a good idea or would you prefer to have just one or possibly two teachers?

M.T. Um ... I think it's a good idea. You get to see lots of different teachers. It's hard to describe ... I think it's better, I don't know why, but I think it's better.

R.B. Fine. Looking back, is the City and Guilds course what you thought it would be?

M.T. No ... no really. Um ... I didn't know there were so many different topics. I thought it was going to be one big long topic ... like on construction or something to do with that. The name City and Guilds you associate with all different sorts of working environments. I didn't think that it was going to be so much written work.

R.B. So has it been better or worse than what you expected it to be?

M.T. Um ... well I've enjoyed it as much as I thought I would ... but I wouldn't say it was worse or better. It was like what I expected really but not the same sort of thing.

R.B. Would you recommend the course to a younger friend who was coming up into the sixth form?
M.T. I would say it was a good course if you wanted to do the sort of thing that they do in the course.

R.B. O.K. that's fine. For students in the future studying on a course like this, could you suggest any topics that you feel would be interesting to them?

M.T. Well you could always get the teachers to ask you when you start the course if there is anything that you would like to do a topic on and see what they say.

R.B. Do you feel then that it is important that the teachers do ask the students what they think?

M.T. Yes ... because you need to get a good relationship between the teachers and students because if a kid don't like the teacher then he won't work so well or he'll just start messing around when the teacher's out. You've got to talk to the teacher and get to know them like people, not so much as the teachers.

R.B. Fine. Well ... thanks very much indeed Mark for your help.

6.9 Feedback From Teaching Staff

6.9.1 The Planning Stage

The project co-ordinator worked with a small team of teachers. These were:

Rowena Dawson - Design Department

Melody Elliott - Biology Department

Harry Gordon - Mathematics Department
After the module had been planned, written and produced, they were each asked for feedback by writing answers to three questions:

1. What were the good things about how the planning team worked?

2. Were there any aspects that we didn't tackle or tackled badly?

3. If you were to be involved in working with a planning team for another topic, could you suggest any improvements which would make the planning stage better?

In response to the questions, the general consensus of opinions was as follows:

(a) Team members gained much in terms of information and personal development by working as an interdisciplinary team. The words stimulating and interesting were used by one teacher.

(b) To improve matters, members of the planning team must participate in the teaching process.

(c) We tried to use an interrelated approach yet team members worked separately on given tasks. Perhaps a topic of study should be chosen, e.g. the eye, and the science and design teacher work together on producing the work.

(d) We must write down objectives and take greater note of the assessment procedure.

(e) To prepare a module of this type team members must be allocated at least two periods (70 minutes) per week, this to be timetabled. For the pharmaceutical module the planning team gave up "free" periods to have meetings.
(f) Some aspects of the work should be optional.

(g) The planning team needed more balance. Perhaps a teacher from the humanities curriculum area would have provided extra ideas.

(h) Team members who wrote parts of the module submitted rough drafts to the project co-ordinator. He then organised typing, graphics, duplication, collation and stapling hence taking work away from the busy team members. This practice worked well and is recommended for future projects.

6.9.2 The Teaching Stage

Teachers who worked with students on the pharmaceutical industry module were asked to complete a feedback sheet. Each teacher worked with the group at various times during the week. No teacher had continuous contact for all the designated lessons.

It was interesting to note the variety of opinions as expressed by a group of teachers with a diverse range of disciplines. The comments made by a Religious Education teacher who was a member of the teaching team are given in full. Some of his remarks highlighted the extra dimension which a humanities teacher would have contributed at the planning stage.

Teacher - Gerry Gardiner

Gerry is a very experienced teacher who specialises in Religious Education and is also a member of the humanities team. He is responsible for supervising probationary and student teachers. He is a man with strong and sincere opinions on moral issues.
Question 1  Did You Enjoy Working With Students On The Topic?

"Yes - or perhaps I was actually enjoying the insight into another profession/industry quite apart from the students. Listening to experts explaining a job they enjoy is always enriching."

Question 2  In Your Opinion, Did The Students Enjoy The Topic?

"Enjoy is a difficult term to deal with in isolation from other responses. Through conversation my impression is yes, but ... (as to be expected):

(a) they didn't appreciate the depth of 'know how' displayed by visiting lecturers

(b) they found the language and references to specialist terms hard to follow at times - especially on 3M visit."

Question 3  Generally, Was The Working Atmosphere In The Classroom Good?

"Yes, better I considered than for the other assignments. It was rooted in real factory process not an imagined one."

Question 4  What Are Your Views About The Work Content?

"Looked about right. I valued the art/colour/design element re: packaging and the practical assignment linked with it. They seemed generally busy - towards being stretched without asking for the impossible."

Question 5  What Are Your Views About The Way In Which The Work Was Presented To Students, e.g. Worksheets/Booklets, etc?

"I didn't encounter any problems of understanding - seemed clear - examples as models obvious to follow for non-specialist staff."
Question 6 Did The Students Understand The Worksheets? Did We Get The Level Of Language And Use Of Diagrams Right?

"By reactions and responses during my 5 lessons a week - yes - but of course problems could have surfaced on other occasions."

Question 7 Were You Happy About How Answers Were To Be Written, i.e. Some On The Worksheets And Some On File Paper? Is This A Good Idea Or Have You Any Other Suggestions?

"Seemed right. Different kinds of answer require appropriate format."

Question 8 Did We Expect Students To Do Too Little Or Too Much Work Or Was The Target Amount Usually Fair?

"Yes - fair - but I found it difficult to assess quality when some tasks which perhaps I felt were important were considered optional."

Question 9 Were The Deadlines For Completion Of Work Fair? How Did The Students Respond To The Deadlines?

"Assorted response. I marked the Packaging work. 2 students still haven't produced anything. Some confusion as to which pieces of work went to which staff. Some went astray."

Question 10 Was The Standard Of Work Produced Pleasing To You?

"If I bear in mind their CSE 4/5 background - yes - (though one at least has a grade 1 and a 2)."
Question 11 Was The Organisation Of Resources/Worksheets etc. Satisfactory? Have You Any Suggestions For Improvements?

"Perhaps for the lectures/demonstrations we need guideline headings – in advance – for students to gather information under. They couldn't make intelligent notes on their own."

Question 12 Looking Back, Are There Any Aspects Which We Could Have Included Which Would Have Made The Topic Better Or More Interesting? Are There Any Sections Which You Felt Were Out Of Place And Inappropriate?

"I think it would have benefited from a slightly longer introductory section which attempts to place the pharmaceutical industry in some kind of context both nationally and internationally – volume of trade, size of profits, number of employees, patterns of trade, etc. Also – some content on the more controversial aspects of the pharmaceutical industry – advertising, research methods, Third World activities, marketing of unsafe products, etc."

Question 13 In Your View What Were The Successes Of The Topic?

"The successes seemed to be simply the variety of skills involved in the different sections of the topic, and the standard of work produced by some of the students."

Question 14 In Your View What Were The Failures Of The Topic?

"Some of the speakers. Some of the topics lacked work which gave scope for initiative and individual work, and there was some borrowing of worksheets and copying out each others' answers."
Question 15  Have You Any Comments About The Visit To 3M Health Care?

"Yes! - I wished I could have gone in the morning. I joined them pm - impressed at their serious approach - well resourced - real style - good experience for our lot. I gather the morning guides assumed too much (somewhat naturally) and lost our people in technicalities."

Question 16  Have You Any Comments About Contributions Made By Visiting Speakers?

"Very commendable. The equipment/examples I found very interesting. But - 365 youngsters couldn't really benefit from hour talk/demo - after 15/20 minutes I think their attention wandered. Overall though I thought the speakers made a real effort to acknowledge the students and to meet them at their level - but some changes required here."

Question 17  Have You Any Comments About How The Practical Work Was Received By Students, i.e. Making The Package, Measuring Light Levels, The Agar Plates, etc.?

"I was not involved in measurement of light levels and making the agar plates. Making the package - access to the required materials not always easy but actual work tackled with considerable enthusiasm."

Question 18  How Did The Pharmaceuticals Topic Compare With Topics Previously Attempted By Students, e.g. Did It Create More/Less Interest And Why?

"I think it created more interest; see Question 3. It used a wide variety of skills - hand, eye, maths, design, commercial considerations and the visit linked theory to production."
Question 19 Have You Any Other Comments Or Suggestions?

"1. Thanks for your preparation! I can now talk about OTC and ethical drugs!

2. The aspect of the **morality** of the drug industry - a tricky area I concede but it did need looking at in some way. Some exercises could be thought out - game simulation type perhaps allowing different **values** to emerge and be considered.

3. I was 'hazy' over how to assess the work."

6.10 Organisation Of Resources

Students working on the module were based in a mobile classroom and did the majority of the written work in this base. On a few occasions they worked in the science laboratories, for example when working with the agar plates.

Written worksheets and booklets for each of the three major sections were placed in clearly labelled folders which were then stored in cardboard boxes. The boxes were stored in a lock-up cupboard in the classroom.

Other resources such as paints, brushes and paper were provided by the design department. These were also kept in the cupboard and then returned after the appropriate pieces of work had been completed. Specimens, student packages and large sheets of card also had to be stored in the cupboard. Storage was unsatisfactory for two reasons:

(a) only one cupboard key was available which was kept by a particular member of staff with six teachers needing access;
(b) lack of organisation and care by students meant that the cupboard was usually in a state of disarray.

Storage was organised with no capital outlay. It would have been much better if pigeon holes and stackable cardboard storage boxes were provided.

6.11 Conclusions

1. The module was generally successful. Students worked hard on a variety of tasks and maintained interest even though the whole project lasted for seven weeks.

2. Undoubtedly the highlight of the whole module was the day's visit to 3M Health Care. Students spoke glowingly about the value of the visit and the lasting impressions that they had, not only about the factory tours but also about the warmth and friendliness of the personnel.

3. The planning team worked hard at producing resource material. They were correct in:

(a) varying the tasks set;

(b) trying to produce professional looking worksheets;

(c) using, wherever possible, diagrams and illustrations in the worksheets;

(d) including speakers in the programme;

(e) including a visit in the programme;

(f) including a number of practical assignments;

(g) setting target deadlines for the handing in of written work.
The module could be improved by:

(a) including more practical assignments;

(b) providing an element of choice - some sections could have a compulsory section followed by optional elements;

(c) breaking down the course structure and providing student tasks which would give scope for student initiative;

(d) reconsidering how deadlines should be stated and adhered to. At the planning stage the deadlines set were felt to be generous. In practice some students found the schedule tight and confusing. Other students who had handed work in on time complained when teachers extended deadlines when requested.

(e) the inclusion of more aspects relating to humanities, e.g. the morality of the drug industry, testing of drugs, animal rights, etc.

4. The visitors who took part were pleasant, friendly, well prepared and very supportive. Their presentations, as expected, were informative, interesting and put over in a most professional manner. They were not as successful as they should have been mainly due to problems of communication. The course organisers should consider:

(a) How best they can explain the level of ability of students to visitors. Generally speakers tried very hard to simplify the terminology used in their presentations. This is, of course, very difficult when we are privileged to have technical experts
from a science based industry. The use of specimen containers, films and videos to support the oral presentation was, however, quite successful.

(b) One hour was too long for students at this level to maintain concentration and interest during talks by visiting speakers.

5. In order to give staff encouragement in planning work for the module, members of the planning team should also be members of the teaching team. Disappointment was expressed by those planning the exercise who did not teach on the course. As one teacher remarked "I would like to reap the benefits of hours of hard work."

6. We tried to plan the module so that it was taught in an interrelated way. In practice experts from various curriculum areas contributed various pieces of work. To some extent we need to have staff working in, say, pairs on specific topics to make the exercise truly cross-curricular.

7. Staff planning the work were under pressure to produce ideas. Not enough time was available/allocated to staff for the writing of resource material. Under the circumstances teachers who contributed to the preparation of course materials should be congratulated on their interest, dedication and professional approach.

8. The logistics of classroom organisation could be improved. The hut used for a base was poorly equipped. For example:

(a) The only storage capacity available was in a lock-up cupboard for which only one key existed. This caused frustration to both students and staff.
(b) Storage facilities for worksheets were inadequate and resulted in a certain amount of disarray.

(c) Water was needed for the painting exercise. No water supply was available in the hut.

Confusion arose amongst students and staff regarding which members of staff were marking the various pieces of work. A notice giving information should have been displayed in the classroom.

9. Staff should have discussed assessment procedures more fully and agreed upon a common system.

10. The preparation and operation of the module can be commended in terms of staff development. Teachers implied that they had enjoyed working with colleagues from other curriculum areas. Generally their outlook had been broadened and the whole process carried out in a pleasant, friendly manner.

11. The module had also given some staff experience of visiting companies and meeting/working with experts from industry. This had proved to be a rewarding experience for the teachers involved. As one teacher remarked "I learnt a great deal".

12. For some students and teachers the course was too structured. They felt that it left little scope for self-expression, initiative and individual ideas. These are fair and valid comments which need to be remedied for future work.

13. Throughout the work there was no real attempt to encourage group discussion and debate. This may be another weakness which needs to be remedied in the future.
14. The induction programme for students prior to commencement of the course appeared to be inadequate. Aims and objectives must be outlined in simple terms as well as giving students details and the thinking behind the structural organisation of the course.

15. It was most encouraging to find that the approach used has the support of HMI (88, p 11-16):

"Active learning, and a sense of purpose and success, enhance pupils' enjoyment, interest, confidence and sense of personal worth; passive learning and inappropriate teaching styles can lead to frustration and failure. In particular, it is necessary to ensure that the pupils are given sufficient first-hand experience, accompanied by discussion, upon which to base abstract ideas and generalisations. Teaching and learning might, for example, extend to using the local environment, undertaking community service and establishing contact with commerce and industry."

HMI goes on to say:

"The curriculum of all schools should involve pupils in each of the following areas of learning and experience:

- aesthetic and creative;
- human and social;
- linguistic and literary;
- mathematical;
- moral;
- physical;
- scientific;
- spiritual;
- technological."
The pharmaceutical industry module contained aspects of all of these areas of learning and experience, obviously some more fully than others. In addition HMI (88, pp 39-40) lists the important skills which need to be developed in schools:

"communication; observation; study; problem solving; physical and practical; creative and imaginative; numerical; personal and social."

Again the pharmaceutical module can claim to have included all of these aspects in its entirety.

16. Many mathematical topics were included within the module. They were attempted by most students with both interest and enthusiasm. "Mathematics in context" appeared to be a success.

The benefits of an interrelated approach using the medium of the pharmaceutical industry are supported by the work of Turner (31). He carried out extensive investigations into the mathematical needs of workers employed by E. R. Squibb Ltd., a large pharmaceutical company in the North West. He concluded that the mathematics required was basic and could not be isolated from science and technology when applied to a particular production line task. Thus he supported the "mathematics in context" approach to learning.

17. Using the pharmaceutical industry as a motivator to learning yielded a vast, diverse range of possible activities. Ideas not used with the sixth form groups
were successfully tested within fourth and fifth year engineering science and control technology classes.

Example: Design and manufacture of a simple device to count 100 tablets by weighing (engineering science classes).
6.12 Recommendations For Future Modules

If other modules are to be prepared similar to the one dealing with "The Pharmaceutical Industry" then the following are recommended.

1. Work provided for students should be based upon a diverse range of industries/jobs.

2. A properly resourced and equipped work base is needed. This will require financial input.

3. Time must be allocated to staff for them to write, produce and organise assignments - both written and practical.

4. Every effort should be made to involve representatives from industry in the planning of modules and to seek their help and support in the provision of visits, speakers, films, videos, etc.

5. The policy of using multi-disciplinary planning and teaching teams should continue.

6. It is necessary to discuss and carefully debate styles of teaching to be used. Feedback from students suggests that a few "chalk and talk" lessons would be well received. Feedback from staff highlights the need for more open-ended types of assignments.

7. Modern educational technology must be used much more frequently, for example by exploiting the computer and videos/films.

8. The structure of the modules should be less rigid, compared with the pharmaceutical industry work.

9. Practical work of a varied nature is appealing and should be encouraged.
10. Concerted efforts should be made to explain the new courses to local employers in an attempt to apprise them of the teachers' objectives.

11. Students who are embarking on a course using modules of this nature should have an induction period where the overall philosophy of the course and methods of working could be outlined.

6.13 Implications For Future CPVE Courses

As stated earlier in the Chapter, the City and Guilds Vocational Preparation (General) Course is the forerunner of CPVE. As such it will decrease in popularity for sixth form and further education students with the development of CPVE.

The evaluation, however, of the exercise based upon the pharmaceutical industry will be of great value to staff in their planning and execution of vocationally biased CPVE assignments.

The CPVE Joint Board Unit, in their published framework (106) list the three major components of CPVE as the core, vocational studies and additional studies.

The core, they say, should consist of a range of experiences and competences (which includes skills, knowledge and attitudes) which are essential to the students' chances of making a success in adult life including work. Core competences are broadly based. They are meant to be covered by students using a variety of situations. Basically core competences are listed under ten main headings:

Personal and Career Development
Industrial, Social and Environmental Studies
Communication
Numeracy
Science and Technology
Information Technology
Creative Development
Practical Skills
Problem Solving

These headings are defined in great detail in "The Certificate of Pre-Vocational Education Part B" (107).

The framework strongly points out that these areas of the core should not be taught as separate subjects but need to be fully integrated with each other and with other parts of the programme if they are to be successfully completed.

The Vocational Studies section of CPVE again is flexible in its stated guidelines giving students the opportunity to break down subject barriers and deal with topics as a whole. The CPVE Joint Board Unit (106, p5) lists the purposes of Vocational Studies as:

"(a) to encourage student motivation through studies related to their interests;

(b) to enable students to explore their talents and interests;

(c) to provide the focus for the development of the common core competences;

(d) to develop broad vocational skills applicable to a variety of adult roles found both inside and outside of employment;

(e) to enhance opportunities for progression into continuing further education, training and/or employment;

(f) to provide opportunities for students to meet either pre-entry requirements for specific vocational courses and/or to gain credit/exemption from some parts of vocational courses."
The last of the three major components of the CPVE, additional studies, is defined by the Joint Board Unit (106) as:

"Schools and colleges must make provision for Additional Studies for up to a maximum of 25% of the course time in order to:

(a) provide time for community activities, leisure, recreation and for reflection;

(b) allow for particular educational needs.

N.B. It is not a requirement for individual students to include additional studies in their programmes if their needs are better covered by further work in core and vocational studies."

Already, feedback from schools and colleges working on pilot schemes for the CPVE indicates that an interrelated approach to teaching is proving to be beneficial to both students and teachers, for example one course co-ordinator wrote (108):

"We felt initially that translating CPVE's curriculum framework into practice was a challenge that required a distinctive and imaginative response. Through our weekly meetings we have come to express our anxieties and needs. Experienced staff have supported less experienced colleagues and we have all built upon each others' expertise. We have a CPVE staff newsletter to exchange information and (hopefully) to record examples of good practice. Enthusiasm is growing! From September 1984 there will be four official CPVE pilot courses in the college, each serving 15 students. Each course will be the responsibility of a team of six to eight staff. One school team will link with one college team. Colleagues from different Departments will work as multi-skilled teachers. (One 'engineer' will be making bread!) The curriculum will be integrated through activities
that are as 'real' as possible, including a small 'business'.
To facilitate negotiation and integration, courses and staff
will be timetabled, on the whole, for three-hour blocks
rather than for 'subject slots'."

Another says (108):
"We opted for a highly integrated approach, focussed through
major projects. Staff from different backgrounds will teach
in pairs, learning from each other and the situations; for
example, an engineer and a psychologist will build a kit-car
with the students, and a biologist and an engineer will create
an allotment. The timetable will be divided into four-hour
blocks. The four teaching hours will be shared by a pair of
staff, whose enthusiasms, social skills and hobbies will be
as relevant as their academic training."

Already the enthusiastic response to an interrelated approach
to teaching on the CPVE course has resulted in many suggestions
for integrated assignments, as shown on the next page (109).

These comments and ideas re-affirm the views expressed by
staff working on the pharmaceutical industry module. The way
is clear for an interrelated approach to be adopted and
accepted as a valuable teaching strategy within sixth form
classes via the new CPVE courses.
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<tr>
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To be continued
CHAPTER 7

IN-SERVICE TRAINING FOR SCHOOL TEACHERS

7.1 In-Service Education

Morant(110) defines the purpose of in-service education by saying:

"... in-service education aims to widen and deepen teachers' knowledge, understanding and expertise (including skills, techniques and powers of judgement in respect of their professional work, by means of activities designed primarily to attain this purpose)."

To complement this statement, one of the best set of objectives relating to in-service education, in the opinion of the author, is provided by the Advisory Committee on the Supply and Training of Teachers (111), namely to enable teachers:

"(a) to develop their professional competence, confidence and relevant knowledge;

(b) to evaluate their own work and attitudes in conjunction with their professional colleagues in other parts of the education service;

(c) to develop criteria which would help them assess their own teaching roles in relation to a changing society for which the schools must equip their pupils;

(d) to advance their careers."

In 1981/82 educationalists came together from the 24 member nations of the Council of the Organisation for Economic Co-operation and Development to produce a detailed report on in-service education and training of teachers. A six year
investigatory project conducted by the OECD concluded, amongst other things (112):

"There was a recurring plea for INSET to be rooted in practice, to be relevant, to be context specific and for theory to be based upon an analysis of practice."

"Each member of the school personnel must be provided with an opportunity for consistent, integrated, personal and professional development throughout his/her career, enabling both his/her own training needs and those of the changing educational system to be met as closely as possible."

More recently teachers' professional associations have been urging the Government to make more and better provision available for in-service training especially in relation to the vast number of curriculum innovations currently being mooted.

The National Association of Schoolmasters/Union of Women Teachers (113) calls on the Government and LEAs to:

"develop a more coherent and rational policy for in-service training, particularly since it is recognised by all those involved in education that a high quality teaching force is crucial to the future development of the Education Service in this country."

Contained in the conclusions of this policy statement is a key paragraph (113, p13) which echoes the thoughts of most teachers who are aware of the necessity to keep abreast of changes in education required to remain in step with the needs of modern society:

"In the second half of the Eighties the education service will face a prolonged period of change and mounting problems as a result of: falling rolls and contraction; the effect on teaching methods of the widespread application throughout
schools of the new technologies; the increasing demands made
on teachers and schools by Government, LEAs, employers and
society as a whole, whose expectations of what schools can
achieve will be greater than ever before; and above all, as
a consequence of the Government's failure over many years to
recognise the resource implications of the educational
objectives which it has pursued throughout this period."

The importance of involving practising teachers in in-service
training programmes was noted by Cockcroft (22, p217) when he
recommended that:

"Any improvement in the standards of mathematics in schools
must come largely as a result of the efforts of those teachers
who are already in post; they must, therefore, receive all
possible support to enable them to improve the effectiveness
of their teaching."

Joyce and Showers(114) distinguish between two purposes of
teacher education: the "fine tuning" of existing skills and
the learning of new skills. Each brings different problems but,
they argue, "fine tuning" is generally easier to achieve. They
also distinguish between four levels of impact training and
five components of training. This enables them to formulate
the question:

"In the body of research on training, how much does each kind
of training component appear to contribute to each level of
impact?"

The four levels of impact are: awareness, the acquisition of
concepts and organised knowledge, the learning of principles
and skills and, finally, their application to problem-solving
in the classroom. Joyce and Showers argue that it is only when
the fourth level is reached that it is reasonable to look for
impact on pupil learning.
Their five components of training are:

"1. Presentation of theory or description of skill or strategy;
2. Modelling or demonstration of skills or models of teaching;
3. Practice in simulated and classroom settings;
4. Structured and open-ended feedback (provision of information about performance);
5. Coaching for application (hands-on, in-classroom assistance with the transfer of skills and strategies to the classroom)."

In her work with 6 and 7 year old children, Matthews (115) concluded that:

"Pre-service and in-service trainers (lecturers and course organisers) should ensure that courses are aimed at helping teachers (particularly the non-mathematicians) first to identify children's levels of ability and then to develop ideas for helping them forward."

One of the aims of in-service training courses should be to disseminate ideas emerging from research programmes. The Secretary of State for Education (116) has said:

"The effect of educational research on classroom teaching is patchy and often fails to reach 'hard-pressed' teachers in schools."

Researchers have problems, however, in passing on information. As Bechar (117) points out:

"The difficulty is not that the teacher wilfully refuses to listen to the researcher, but that however carefully he listens the researcher has little of interest to tell him."
The latter quotation can have two interpretations. Firstly, that the researcher uses a means of communication which either (i) the teacher does not understand, that is the fruits of research are only interpretable to fellow researchers or (ii) engages in tactless language. Perhaps the aims of in-service courses should be written with the actual process in mind. As Spooner (118) says: "A good course depends substantially on contributions from its members, which usually consist of a sharing of experience."

Galloway (119) cites several features common to courses perceived to be successful:

"(a) Participants attend the course voluntarily;

(b) Participants are involved in planning the course;

(c) The provider has some idea of teachers' 'needs and wants';

(d) Participants have time for informal talk and discussions;

(e) Congenial surroundings;

(f) The programme is flexible enough to adapt to the participants' needs;

(g) The participants are actively involved throughout the course."

The in-service training courses organised by the author and described at a later stage in this chapter have, wherever possible, encouraged active participation by the teachers involved. Programmes were intended to be flexible in nature, informal and were conducted in congenial surroundings.

Not all teachers value the importance of in-service training courses. Spooner (118), a head of a Leeds comprehensive
school, claims that many in-service courses are both disruptive and useless.

"I would abandon the whole range of in-service training as it exists at the moment in return for an investment within actual classrooms of an equivalent amount of teacher time and physical resource."

He challenges the value of many courses and implies that some may be detrimental to teaching. "Course directors feel compelled to introduce radical innovation and thus undermine the value of accepted practices."

Spooner obtains support for his views from Lynch and Burns (120) who report on the findings of a small-scale survey of 273 teachers in several areas of northern England, carried out in 1982. 65% of the teachers questioned had not been on a course in the past five years and of these two thirds had never applied for one. Referring to the 177 people who had not been on a course, 90% of these thought that INSET was unnecessary and 99% thought that the courses were of little use (the author wonders, however, how teachers could offer constructive answers to the questions posed without attending some courses).

In the author's opinion the worst type of in-service training session is one where participants go away thinking "what a waste of time". In all the in-service work covered during the course of the research project the author obtained either written or oral feedback from participants. This, of course, is a tremendous aid to the planning of future courses.

7.2 In-Service Training Courses For Teachers Organised For The Leicestershire Education Authority

These consisted of one day courses conducted in conjunction with the County Mathematics Advisers, each course having a distinct link with industry and/or commerce. Examples of
programmes and course reports can be found in Appendix 7.1.

7.2.1 A Course For Teachers In Their Probationary Year

An HMI survey (121) produced results which indicated that, for new, inexperienced teachers in schools, one teacher in ten felt insecurity in the subject he/she was teaching. Lack of subject knowledge led to teaching approaches which maintained an often slavish adherence to the textbook, reliance on narrow questions often requiring monosyllabic answers, an inability to follow up and extend pupils' answers and an over-prescriptive method whereby the teacher was able to remain within a constricted, safe pattern of work.

The course organised for probationary teachers introduced young teachers to the idea of an interrelated approach and also illustrated how local employers, in this case a building company, could provide many positive ideas for developing exciting, interesting modules of study.

7.2.2 Courses For Established And Potential Heads Of Mathematics Departments

The County Mathematics Advisers were supportive in wanting two main aspects of work relating to the author's research project in their INSET programmes for heads of mathematics departments. These were:

(a) to introduce the philosophy of an interrelated approach and to illustrate how it can be successfully applied within lessons designated as mathematics;

(b) to introduce teachers to personnel from industry and commerce in order to demonstrate how they can be effectively used as a resource in terms of ideas, materials, visits and oral presentations. It was considered essential that another objective would be to create an atmosphere in which both parties could begin to learn more about each others' roles.
7.3 School Based In-Service Training

7.3.1 Introduction

When the barriers between subject areas are to be broken down so that topics can be taught in an interrelated way, many aspects need to be considered, for example curriculum organisation, co-ordination among teachers, design of work areas, obtaining suitable equipment, etc.

One of the most fundamental tasks is to encourage discussion and interchange of ideas between teachers so that ideas can be cross-fertilised and developed fully using a wide range of opinions and experiences. This can only help to broaden the knowledge of teachers and subsequently enrich the material offered to students.

With this in mind the author proposed that some time be allocated within the 1983 Burleigh College Staff Conference for interdisciplinary teams to discuss and plan topics suitable for use within the curriculum based upon an interrelated approach to teaching.

Proposals and ideas for topics were outlined as follows.

1983 Burleigh College Staff Conference
Proposal For Consideration
Theme: Skills For Adult Life

Courses such as the City and Guilds 365 and TVEI demand close liaison between curriculum areas. At present the educational diet given to our students is fragmented. They learn their mathematics, science, design, humanities, etc. in isolation with little discussion/interchange of ideas between teachers within the various curriculum areas.
There is a need for staff to understand and value the work done by colleagues in the various areas. We must make our subject content meaningful and relevant to our students' existing and future experiences.

The conference will give staff the opportunity to work in interdisciplinary teams. Topics will be suggested and teams will be invited to devise a teaching programme for a topic whereby it will be taught in an interrelated way.

Teams will be asked to discuss how materials will be presented, thus creating the opportunity to update our knowledge of modern educational technology, in addition to discussing teaching methods and assessment procedures.

Training officers from industry/commerce, parents and students will be present to work within teams.

It is hoped that ideas emerging from the conference will be developed, tested and evaluated within the College in the future.

Suggested topics for discussion by interdisciplinary groups were:

- the motor car
- the pharmaceutical industry
- the Concorde
- the oil rig
- movement
- the building site
- map reading
- the departmental store
- dams
- submarines
- mountains
- the guitar
- the library
- the piano
- clocks
- trains
- discos
- an athletics meeting
- the hospital
- the theatre
- the furniture industry
- pottery
- the bicycle
- the electricity generating station
- the environment
- the zoo
- a school
- a river
- the farm
BURLEIGH COMMUNITY COLLEGE

STAFF CONFERENCE 1983

CURRICULUM REVIEW: SKILLS FOR ADULT LIFE

Objectives

By the end of the Conference delegates will have had the opportunity to:

- Experience at first hand a participative learning exercise and explore the range of skills/attitudes which it enabled to be developed.

- Design, in interdisciplinary groups, a series of sessions based upon a given theme.

- Identify the College's main curricular aims and explore the importance of teacher/pupil relationships in such areas as development of pupil potential and the assessment of achievement.

Venue

All plenary sessions Library
Lunch on Friday Youth Wing
Coffee on Friday and Saturday Sixth Form

Social Area

Group rooms are indicated next to the group lists.

FRIDAY 30 SEPTEMBER

09.00 Assemble in Library
Welcome and Introduction to the Conference
Plenary Session
"The School Curriculum - what should it provide and how may it do so?" - Ruby Chambers

10.20 Coffee

10.50 Group Session 1 - Interdisciplinary Groups
"Identifying the potential for learning"

11.50 Plenary Session - Ken Longman

12.30 Bar and Lunch

14.00 Group Session 2 - Interdisciplinary Groups
"Developing a topic for learning"

15.45 Cup of tea
Depart

SATURDAY 1 OCTOBER

09.00 Assemble
Introduction - Ken Longman

09.15 Group Session 3 - Curricular groups
Applying yesterday's learning to the work of curriculum areas.

10.30 Coffee

10.50 Plenary Session
"Giving feedback: the importance of attitudes and relationships in the development of young people" - Ruby Chambers

11.50 Closing remarks - Joan Gregory

12.00 Bar
Depart

PROGRAMME FOR THE STAFF CONFERENCE 1983
7.3.2 The Programme

The programme for the Conference is shown on the previous page.

Over 100 staff, parents, representatives from other education establishments and industrial/commercial concerns participated in the 1½ day Conference.

The idea of interdisciplinary groups working on topics was accepted and incorporated into the Staff Conference programme.

The Conference organising committee asked College staff for their suggestions regarding topics for development by interdisciplinary groups. Ideas came from a diverse range of curriculum areas. Actual topics allocated to groups included:

- feeding the world
- the future
- the curriculum
- coping with unemployment
- education
- mountains
- music
- adolescence
- crime
- clocks

Interdisciplinary groups were asked to submit brief reports containing ideas/suggestions/feelings etc. about their topics, i.e. possible content, teaching approaches, resources, etc.

7.3.3 Developing A Topic For Learning

Teachers working in interdisciplinary teams produced many exciting skeleton outlines which showed possibilities for creating stimulating teaching situations using an interrelated approach. One example of ideas produced is detailed below.

Topic - Clocks

The results of the initial session (an excellent opportunity for interchange and cross-fertilisation of ideas) are shown on the next page. The Brainstorming session proved to be interesting and enthralling to the staff involved.
INTERRELATED STUDIES - BRAINSTORMING SESSION ON CLOCKS
Lesson Plans (time unspecified)

Plan A

Introduction

- baby's heart beat
- use of metronome/pendulum
- measure of time in number of pendulum swings - a silly measure - we need some standard units
- development of standardisation

units of time - Earth, Sun, Moon, tides, seasons (use models, films, videos)

Group Projects

- investigate the history of and the use of library
- types of clocks
  - visits to Greenwich, London, etc. (much preparation needed)

Design Projects

- concerned with simple devices (design/science based to include control technology)

- write up and evaluate projects

Language

- include diagrams and sketches

Music
  - dance

Fantasy
  - poetry

Exercise
  - design
  - painting
  - essay
Plan B

TRAVEL

- movement - types of transport
- 24 hour clock
- time ZONES
  - language
  - multi-cultural information
  - geographical/religious aspects
- folk dances
- fantasy exercise
- poetry, etc.
- international times
- timetables
- speed, distance, time

Plan C

Introduction - pulse rate

- exercise
- recovery time
- running

- measurement,
- recording time,
- graphs

- physical extremes of man and machines
- records/history
- Guinness Book Of Records

- reasons for improved performances
The group of teachers working on the clocks topic felt that points to consider when operating an interdisciplinary approach were:

(a) resources

(b) group sizes

(c) teaching space

(d) time for staff preparation/discussions/evaluation

(e) evaluation and certification of content

(f) syllabuses (existing)

Suggestions made for facilitating a trial of an interrelated approach included:

(a) Could a team of teachers work with a group of students on a topic such as clocks on a day designated as ACTIVITIES DAY? – more than one day would be needed, however, as trips would be included in the programme.

(b) Could an approach like this be suitable for consideration under the proposed 16+ DESIGN COURSE syllabus?

Conclusions

The group worked harmoniously and with enthusiasm during this session. If time was made available, informal interdisciplinary sessions of this type in the future would prove to be both enlightening and stimulating to the participants.
7.3.4 Final Conclusions

1. Reactions to the task appeared to be mixed. Some groups generated much enthusiasm, others did not. It was refreshing to hear comments like:

"If we lacked anything in the minutes of detail we compensated in energy, and discussion took place in a spirit of enthusiasm for effective change."

"Schemes of work devised by interdisciplinary groups facilitate the transference of skills as well as real team work and co-operation."

"A central idea of 'change' and 'adapting to change' was suggested and accepted."

"We would all like to try though we're not sure how."

No group advocated a total move towards an interdisciplinary approach but there was support for interchange and cross-fertilisation of ideas between curriculum areas.

2. There were many comments regarding the practical measures necessary to enable topics to be taught in an interrelated way.

(a) Resources

A common suggestion was the need for good resources. One group felt that the central feature of a system working on an interrelated approach should be a well equipped resource centre which would include a computer containing a guide to all resources. An example was given that "a well organised primary classroom is a joyful experience".
(b) **Co-ordination Amongst Teachers**

Some groups expressed the view that it would be advantageous to work in interdisciplinary teams. Initial discussion may centre upon:

What are we doing at the moment?

What would we like to do?

How would we like to do it?

What are the feelings of students about what we do and how we are doing it?

Have they any suggestions regarding content and style of teaching programmes?

This would be followed up by discussing courses, syllabuses, assessment, certification, etc.

(c) **Syllabuses/Teaching Styles**

There appeared to be support for Mode 3 syllabuses as a means whereby teachers could develop ideas. The importance of preparatory learning was mentioned in addition to the need for developing individualised learning programmes.

(d) **Organisation Of The Teaching Day**

There was some support for a flexible teaching day. This obviously requires much debate.

(e) **Constraints**

If teaching is to be carried out in an interrelated way then certain constraints need to be overcome. Conference participants mentioned the following:
(i) lack of time - to develop courses
to discuss resources
to develop teaching approaches

(ii) money - essential to thoroughly resource
and staff, especially in relation
to reprographics, texts and
adequate work spaces

(iii) motivation - if an interrelated approach is the
way forward then both teachers,
students and parents must be
consulted and briefed to obtain
their support if success is to be
achieved.

(f) In-Service Training

The Conference enabled groups of teachers from all
disciplines to talk together - to exchange ideas - to
explain to each other how they think, what they do, how
they do it, etc. Perhaps teachers, in the course of their
duties, are in danger of becoming "blinkered". They, in
their busy day, are engrossed in their particular
discipline and, in many cases, have little idea of what
other courses consist of.

By sharing ideas, approaches, problems, etc. teachers can
benefit personally and the knowledge gained must have a
very good spin-off when advising students about their
current and future work, thus enhancing their role as
tutors.

Participants expressed the opinion that an in-service
training programme for teachers is a priority if an
interdisciplinary approach is to be operated successfully.
3. **Possible Starting Points**

Perhaps some of the ideas raised at the Conference could be tried out by:

(a) adapting topics for use in the C and G 365 courses;
(b) adapting topics for use in the TVEI programmes;
(c) looking closely at the Design 16+ syllabus;
(d) considering the use of activities day(s).

7.4 **An In-Service Training Course For Experienced Indian Teachers And Teacher Trainers Working On The All India Mathematics Education At CAMET (AIMEC) Project**

7.4.1 **Introduction**

A two day workshop was organised in order that the AIMEC members could have the opportunity to discuss and debate educational ideas relating to the author's research programme.

Many of the ideas put forward can be summarised by a quotation from a paper recently written by Professor Bajpai.

"The structure of most courses of study in the school/college curriculum is such that a set of individual subjects are often taught in isolation. It is believed that rigid boundaries created by this teaching in isolation should be crossed in a smooth and effective way. The teaching of these subjects should be relevant to the world of work and should take account of technological developments currently taking place. Wherever possible students should be shown examples of how subjects depend on each other and then be given practical assignments so that these features are highlighted. It is believed that such an interrelated approach for teaching school subjects would generate interest amongst students who will be better motivated to learn."
The workshop gave participants the opportunity to receive information and then to generate ideas and opinions about an interrelated approach to teaching.

7.4.2 The Programme

The programme, which follows, gave researchers and participants an ideal opportunity to interchange ideas and opinions about the value of an interrelated approach.

Programme
Sunday 24th February 1985

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.30 - 10.00</td>
<td>Introduction - Professor A. C. Bajpai</td>
</tr>
<tr>
<td>10.00 - 11.00</td>
<td>&quot;What is an Interrelated Approach?&quot;</td>
</tr>
<tr>
<td></td>
<td>- Stan Turner*</td>
</tr>
<tr>
<td></td>
<td>- Rod Bond†</td>
</tr>
<tr>
<td>11.00 - 11.20</td>
<td>Coffee</td>
</tr>
<tr>
<td>11.20 - 12.30</td>
<td>Small group work - &quot;Designing a Course of Study&quot;</td>
</tr>
<tr>
<td>12.30 - 2.00</td>
<td>Lunch</td>
</tr>
<tr>
<td>2.00 - 3.40</td>
<td>&quot;Designing a Course of Study&quot; (continued)</td>
</tr>
<tr>
<td>3.40 - 4.00</td>
<td>Tea</td>
</tr>
<tr>
<td>4.00 - 5.40</td>
<td>Plenary session - &quot;Feedback from Working Groups&quot;</td>
</tr>
<tr>
<td>5.40 - 6.00</td>
<td>Review of the day - Professor Bajpai</td>
</tr>
</tbody>
</table>

* Stan Turner is Senior Lecturer in the Department of Science and Mathematics at the Wirral Metropolitan College, Birkenhead
† Rod Bond is a mathematics teacher at Burleigh Community College, Loughborough, presently on sabbatical leave for pursuing research at CUMET
Programme

Monday 25th February 1985

9.00 - 10.30 Small group work - "Examination of Existing Course Modules"

10.30 - 11.00 Plenary session - "Feedback from Working Groups"

11.00 - 11.20 Coffee

11.20 - 12.30 "Early Experiences in Schools" - Rod Bond

12.30 - 2.00 Lunch

2.00 - 3.15 "Early Experiences in Colleges of Further Education" - Stan Turner

3.15 - 4.15 Small group work - "Procedures for Starting an Interrelated Approach and the Problems to be Overcome"

4.15 - 4.30 Tea

4.30 - 5.30 Plenary session - "Feedback from Working Groups"

5.30 - 6.00 Review of the day - Professor Bajpai
The task set for the working groups is shown below.

AIMEC PROJECT
WORKSHOP
Sunday 24th February 11·20–3·40

Designing a Course of Study

Produce a skeleton outline incorporating:

(a) an interrelated approach;
(b) real life applications;

for the teaching of a topic of your choice.

Your submission should be specific regarding:

(i) the level for which the module is designed;
(ii) the possible uses for more than one level;
(iii) the involvement of more than one member of staff;
(iv) the use of resources, e.g., models, overhead projector, computer, etc.;
(v) documentation and assessment.

Each group will be asked to describe their ideas orally in the plenary session (4.00 – 5.40). A more detailed written version is also requested (to be completed at a later date).

Many imaginative ideas emerged from the five working groups. For example, one group of teachers chose the topic "Housing".
In their presentation during the plenary session they demonstrated the potential of such a topic using schematic diagrams.

A House

- Design
- Income
- Ventilation

- Materials
  - Building
  - Electricity
  - Sanitation

- Construction
  - Labour
  - Supervision
  - Co-ordination

- Furnishings
  - Drinking Water
  - Heating
  - Safety & Equipment
  - Lighting
  - Furniture & Curtains
Areas of the curriculum relating to the various sections of the "House" module were outlined as:

<table>
<thead>
<tr>
<th>Type</th>
<th>Sociology</th>
<th>Economics</th>
<th>Ecology</th>
<th>Art and Design</th>
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<tbody>
<tr>
<td>Location</td>
<td>Geography</td>
<td>Graphs</td>
<td>History</td>
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<td>Materials</td>
<td>General Science</td>
<td>Physics</td>
<td>Chemistry</td>
<td>Biology</td>
</tr>
<tr>
<td>Construction</td>
<td>Work and Wages</td>
<td>Commerce</td>
<td>Economics</td>
<td>Work Study</td>
</tr>
<tr>
<td>Furnishing</td>
<td>Chemistry of Water, Distribution</td>
<td>Physics (Heating)</td>
<td>Safety - First Aid</td>
<td>Lighting - Physics</td>
</tr>
<tr>
<td>Furniture</td>
<td>Designs - Measurement</td>
<td>Home Management</td>
<td>Craft</td>
<td></td>
</tr>
</tbody>
</table>
Procedures For Implementing An Interrelated Approach

The task set for working groups is shown below.

AIMEC PROJECT
WORKSHOP
Monday 25th February 3.15 - 4.15

Procedures for Starting an Interrelated Approach
and the Problems to be Overcome

It is suggested that topics may be taught in an interrelated way using either:

(a) a single subject area as a base and enriching the content covered with material, ideas and methods from other curriculum areas;

or

(b) devoting an amount of time to a specific topic with inputs from a variety of curriculum areas.

For either of these situations you are asked to produce brief outlines of general procedures for starting the approach within an educational establishment. You must clearly state:

(i) the age range and ability of students that you have in mind;

(ii) the problems that you envisage and how they might be overcome.

Each group will be asked to give a brief oral summary of their findings in the plenary session (4.30 - 5.30). A more detailed written version is also requested (to be completed at a later date).
Oral reports from the working groups are summarised as follows.

**Group 1**

The members of the group felt that the approach should be introduced very gently. They recommended that the schools' annual sports day would be a good occasion to use for testing an interrelated approach.

**Group 2**

They expressed the view that an interrelated approach is already to be found in certain schools in a small way. Teachers take a single subject area as a base and then introduce applications which involve other subject areas. The group members felt that current syllabuses, assessment procedures and examinations did not lend themselves to an approach of this type. School management may not support this new approach and both managers and parents needed to be convinced of the benefits. The group highlighted the need for more laboratory facilities and general equipment as well as an investigation into and revamp of assessment procedures. Workshops, they said, could be organised in the school holidays and would be required to launch the new approach.

**Group 3**

This group questioned if it was feasible to introduce an interrelated approach. It would require drastic changes in syllabus with more provision to be made for project work. Possibly a pilot project could be evaluated using time allocated to SUPW (socially useful productive work). They felt that this approach may not be suitable for the more academic pupil who required deep knowledge of various subjects, but thought that it would be suitable for the lesser able pupil. Owing to the present educational system in India, some resentment to change may be forthcoming from the heads of educational institutions.
Group 4

Members emphasised the need to communicate new ideas to parents and educational authorities and convince them of the advantages. Outline modules could be prepared using conferences or workshops. Money would be needed, however, to finance modules, teaching aids and other resources. This may prove to be a problem and local authorities and parents may have to be approached for support. The group members were emphatic in their wish to ensure that any new teaching programme adopted must be shown to be better than existing programmes. Workshops and in-service training courses should be organised for teachers to promote discussion and generate ideas relating to the new approach.

Group 5

The members of this group suggested that topics should be written after consultation with both teachers and representatives from industry. They gave much importance to incorporating field trips, slides, photographs, films, etc. into teaching programmes. They recommended that, initially, pilot projects should be evaluated before making a major initiative in schools.

7.4.5 Final Review

Professor Bajpai said that perhaps the use of the word "problems" in the initial task description was rather negative. We should have asked the question "How can an interrelated approach work?" He felt that pilot studies were vital as a means whereby people would be convinced of the merits of the new approach.

The suggestion regarding the use of SUPW time for work on modules was queried. Professor Bajpai expressed the opinion that SUPW was looked at, by some people, with contempt. It
was not treated seriously. If an interrelated approach is to be accepted it must be treated as a serious activity, otherwise teachers should not try it.

It was important, he said, for us to realise the aim of this new approach - "To show how subjects have a purpose without the subjects losing their purpose." We are aiming to set up "sliding partitions between subjects".

Professor Bajpai concluded by thanking everyone who had participated for their hard work, enthusiasm and constructive attitudes in what had proved to be a successful workshop.

7.5 An In-Service Training Course For Experienced Teachers On Secondment At The University Of Leicester

7.5.1 Introduction

This course was designed to show teachers working on the Education and Industry Diploma Course how an interrelated approach can be successfully implemented in a classroom situation. Participants learned about the work carried out involving the pharmaceutical industry module (reference Chapter 6) and they also had the opportunity to work in small groups in order to devise a skeleton outline for a module of study.

7.5.2 The Programme

The programme for the session is given on the following page.
Date: Wednesday, 8th May 1985
Time: 9.30 a.m. - 12.30 p.m.
Venue: CAMET, Loughborough University of Technology

Programme

9.30 - 10.45 "Links between schools and industry in relation to the preparation of teaching materials"
Mrs. Karen Deakin - Training Officer, M.E. Health Care Ltd., Loughborough
Mr. Gordon Willimont - Personnel Officer, Fisons p.l.c., Pharmaceuticals Division, Loughborough
Rod Bond - Mathematics Curriculum Area, Burleigh Community College, Loughborough - currently on secondment at CAMET

10.45 Coffee
11.00 - 11.45 Working groups - "Devising a module of study"
11.45 - 12.20 Plenary session - feedback from the working groups
12.20 Summary
12.30 Depart

7.5.3 Dialogue Between Teachers And Industrial Training Officers

During the first session much discussion took place between training officers and the teachers, who represented a diverse range of subject areas. Points made are summarised as follows:
1. Teachers present were all on secondment for a one year period to the "Education and Industry Course". If finance was available it would be pleasing to invite training officers/industrial personnel to spend a similar period of time on an "Industry and Education Course".

2. There appears to be misunderstanding on the part of many teachers and training officers regarding the "jargon" currently in use in education today. Efforts must be made by teachers to explain to people outside school the type of courses and educational objectives in today's schools and colleges.

3. Mr. Willimont outlined several areas within a company such as his which could be catalysts for school based projects. These were:

   sales/commerce department - translations for language students
   computer department
   accounting - for example, a project based upon the establishment and running of a sports and social club
   engineering/production - work study projects - wages/deductions, etc.

4. Mrs. Deakin felt that working in liaison with teachers had helped her to learn more about the various levels of ability of students. She was involved with several liaison groups between schools and industry. She felt that teachers might be able to help with her training programmes by assisting with:
the development of distance learning methods (especially for 3M Health Care's countrywide network of representatives);

calendar programmes;

good manufacturing practices.

5. Much discussion was centred upon "what should all post 16 students know about industry?". It was stated that in some cases teachers were persuading their students not to enter industry. Teachers, it was felt, in the school pupil - university student - school teacher loop lacked industrial awareness. Also parents were not as well informed as they might be.

6. Alan Sutton, lecturer at the University of Leicester, suggested the following as a means whereby the situation would be improved:

(i) brief all parties about the aims, objectives and content of CPVE and TVEI;

(ii) encourage and support the release of training officers to spend periods of up to two days in school, possibly following a student to his/her classes;

(iii) encourage training officers and teachers to work together on specific projects;

(iv) ensure that industrial awareness has some significance within the school curriculum;

(v) determine what specific support local and national firms can offer to schools and what support they would like from schools;
(vi) encourage schools to appoint teachers with responsibilities for industrial liaison - the person should have a half teaching timetable at the most and should be actively involved in organising cross-curricular groups to work on links with industry and commerce. Perhaps a "head of pre-vocational education" was an apt description.

7.5.4 Developing A Topic For Learning

Participants formed three groups, each group having members drawn from varying subject areas. They were then asked to choose a student age range and to choose a subject area and then comply with the following brief.

**Brief**

Produce a skeleton outline incorporating an interrelated approach and real life applications for the teaching of a topic inspired by the object given to you.

The main objective here was to prove to the participants that it was possible to produce a module of study, based upon an interrelated approach, for any curriculum area using simple everyday objects.

Participants were then given AN EMPTY COFFEE JAR.

**Results**

The ideas produced by participants in a short space of time were interesting and varied. It was hoped that the activity showed that useful, worthwhile projects can be evolved for any subject base using mundane, everyday objects to inspire ideas. All the presentations submitted contained a possibility of some degree of involvement by local shops, industries and commerce. This would help to bring a sense of reality and
relevance to the outside world to the schemes of work.

Participants worked industriously and with enthusiasm at the task set. Hopefully, working in interdisciplinary groups gave cross-fertilisation of ideas and, in the process, gave teachers insights into each others' subject areas, hence providing an excellent vehicle for their personal development.

An idea of the enthusiasm which emerged can be gained from studying the proposals submitted by one group which chose GEOGRAPHY for their base subject area. Their brief skeleton outline was aimed at work for fourth or fifth year CSE students following a Mode 3 syllabus.

At first they held a brainstorming session on the object before them, namely the empty coffee jar, and produced possible areas of interest.

![Diagram of JAR with associated ideas]

- communication
- printing glass
- design paper
- plastics
- source
- contents
- types of storage
- volume and measurement
- distribution
- market
- design

JAR
Having formulated a broad range of ideas, they decided it would be necessary to concentrate on one aspect, otherwise the course content would be too lengthy. They chose "storage".

They planned that a module of this type would take 7/8 weeks to complete. A programme for implementation of their teaching programme was submitted.

**Weeks 1 and 2**

(a) discuss the overall task and presentation;

(b) negotiate methods of learning with students, i.e. group work, individual work, programmed learning, etc.;

(c) discuss where the work will be done, for example in the home/school/supermarket.

**Weeks 3 to 6**

Each group of students will look at various aspects of glass storage, namely:

(a) local examples;

(b) collection of varieties;
(c) recycling and waste disposal;
(d) design;
(e) alternatives;
(f) sealing;
(g) making and raw materials;
(h) health and safety;
(i) other uses of glass;
(j) making models.

Week 7

Final details, collection and sorting of information.

Week 8

Producing a final piece of coursework in a well presented form.

Other course participants questioned the group regarding the geography content of their proposals. The group replied that dealing with the topic locally would involve surveys and mapping in addition to aspects of environmental studies, e.g. recycling, litter, raw materials, etc. Students would be encouraged to write letters to obtain information and local visits would be arranged.

7.5.5 Final Plenary Session

At the end of the morning's activities, teachers were asked about their feelings regarding the session, for example, was it worthwhile? Comments which emerged were:
1. they had enjoyed the session;

2. perhaps the teachers had, in parts, been rather negative in their attitudes (this was contrary to observations made by the organiser);

3. we should be concerned about the image of teachers in the eyes of representatives from industry - training officers were smart and had arrived punctually; some teachers were late, some did not come (two were attending hospital); perhaps the male teachers should have worn suits and ties (some did);

4. it was good for the teachers to hear the views of training officers and vice versa;

5. teachers felt that they should have been properly briefed about the session before the actual day of the seminar - they felt that just being given the bare programme with no discussion was unsatisfactory;

6. it would be useful in the future for teachers to hear the views of representatives from smaller companies; it was suggested that they might have different thoughts in relation to schools/industry links.

7.6 Conclusions

The ideas put forward centred upon an interrelated approach to teaching were generally well received by participants who attended the range of in-service courses organised. Teachers acknowledged the value of the approach but, on many occasions, drew attention to the problems to be overcome in order to implement the ideas put forward.

Turner (31) achieved similar success in obtaining acceptance of ideas by teachers in further education. He found that
introducing the approach via a tape/slide programme generated a great deal of discussion from which teachers eventually perceived the overall philosophy. In further debate with teachers he advocated a policy of inter-departmental communication whereby specialists from various disciplines would enrich their teaching by cross-fertilisation of ideas, for example basic mathematics and typewriting, biology and hairdressing, etc.

Acceptance of an interrelated approach has also been observed by Professor Bajpai during his discussions with educationalists and teachers on his worldwide travels. He noted a general acceptance of the philosophy of the approach but also was made aware of anxieties regarding feasibility of implementation bearing in mind constraints due to facilities, finance, examinations syllabuses, etc.
INITIAL AND IN-SERVICE TRAINING:
THE CASE FOR THE PROVISION OF A PROFESSIONAL CENTRE
FOR MATHEMATICAL EDUCATION IN SCHOOLS AND COLLEGES
IN LEICESTERSHIRE

8.1 Introduction

Throughout the course of the author's research programme it has become evident that the current rate of change in terms of curriculum development in school mathematics is so considerable that many experienced, conscientious teachers feel overwhelmed by the seemingly impossible demands which are being made upon them. They are faced with such daunting tasks as trying to implement the many excellent suggestions in the Cockcroft Report (22, p4). Prominent amongst these are the tasks of:

(a) enabling each pupil to develop, within his capabilities, the mathematical skills and understanding required for adult life, for employment and for further study and training, while remaining aware of the difficulties which some pupils will experience in trying to gain such an appropriate understanding;

(b) providing each pupil with such mathematics as may be needed for his study of other subjects;

(c) of helping each pupil to develop, so far as is possible, his appreciation and enjoyment of mathematics itself and his realisation of the role which it has played and will continue to play both in the development of science and technology and of our civilisation;

(d) above all, of making each pupil aware that mathematics provides him with a powerful means of communication.
Key words occur such as skills, adult life, employment, other subjects, enjoyment, science, technology, our civilisation, communication. All these key words feature continuously in ideas propogated and strategies formulated in the modules produced for teaching in an interrelated way. The research programme is very much in tune with the aims and objectives outlined in the Cockcroft Report.

Modules written in an interrelated way have been well received by teachers in a number of schools. In meeting other teachers it is apparent that many good ideas and practices are currently in use throughout Leicestershire. The main problems appear to be in:

(a) formulating ideas;

(b) discussing various approaches and teaching methods;

(c) producing finalised, professional packages and schemes of work which are appealing to both students and teachers;

(d) creating a system whereby these ideas can be disseminated in many schools and colleges.

There is an urgent need to provide secondary schools with some positive guidelines, suggestions and materials dealing with, for example:

investigational work
practical work
mathematics applied to everyday problems
mathematics applied to science and technology
special needs, i.e. work for both the least and most able
the effective use of the computer
the effective use of audio/visual aids
assessment.

} reference GCSE
16+ criteria
There are some schools of thought which place much value on processes rather than actual teaching content. The "OCEA Piloting Pack" (122), for example, gives in some depth details about important mathematical processes and relevant criteria for assessment. Assessment procedures recommended appear to demand a large amount of teachers' time. If this is to be a viable proposition then classroom management and teaching resources must be well organised to allow teachers time to talk with students and encourage their "student learning", as well as allowances being made for the inevitable increase in paperwork.

Solutions to these problems and others can be proposed after looking at training provisions for both student teachers and experienced teachers.

8.2 Initial Teacher Training

The demands on teacher trainers appear to be increasing with time. Current teacher training programmes are comprehensive and forward thinking. For example:

(a) The Postgraduate Certificate in Education Course Booklet from Loughborough University of Technology (123) gives details of mathematics course content for both main and subsidiary levels. These include:

"The Mathematics Curriculum

The contents of the curriculum and the factors affecting this content. Current syllabuses and examinations; the demands of employers and of higher education; the use of mathematics in other school subjects and in adult life. The impact of calculators and microcomputers on the mathematics curriculum."

and
"Teaching Methods In Mathematics

The development of effective approaches to teaching mathematics, preparation of schemes of work and of individual lesson plans. The use of a variety of resources, including text books, work card schemes, television and video films and computer programmes."

(b) The Advanced In-Service Studies for Teachers course booklet from the University of Nottingham School of Education (124) openly states:

"Great benefit is obtained from the school's close links with local educational authorities and practising teachers."

"Their well-stocked video classroom is used to foster confidence in this important modern medium."

(c) The School of Education at the University of Leicester in their course booklets (125) give an insight into what the teacher training programmes are about.

"At Leicester we think that it is our primary task to help students to work effectively in the classroom in their own individual styles. Throughout the course strong emphasis is placed upon school-based experience and upon the development of practical skills and insights."

"The responsibilities of teachers and the context within which they work are continually developing. It follows that a course preparing people for the profession must itself be constantly evolving. The Leicester course is kept always under revision in order that it may remain relevant to the needs of teachers and schools today and tomorrow."
Under the heading of Mathematics (126) they say:

"Students will be encouraged to develop a personal response to a range of issues and problems that currently face teachers of mathematics."

"By the end of the course it is hoped that students will join the teaching force feeling better able both to play an effective role in the classroom and to take an active part in promoting innovation."

The schools of education appear to be well resourced with up-to-date information and equipment. For example, the School of Education at the University of Leicester describes, in one of its course booklets (126), its Resource Centre:

"A Resource Centre was opened in August 1976 under the direct control of the School of Education Librarian and is housed in a room above the main Reading Room. The Resource Centre is available to all students and staff at the School of Education. Most of the 21,000 items housed there are specifically for teaching practice use, i.e. tapes, slides, filmstrips and film-loops, video tapes, teaching packs, charts and posters and similar audio-visual aids. Equipment for looking at, or listening to, the resources is available in the Resource Centre, or the nearby Audio-Visual Block."

8.2.1 Feedback From Student Teachers

Schools of education have, however, been put under pressure over the past few years to make changes to their courses. The Cockcroft Report (22, pp 204-205) describes some findings from a survey commissioned by the DES and organised by the NFER which consisted of a questionnaire sent to a sample of teachers of mathematics in their first three years of training. The survey, which included questions about the adequacy of their
teacher training courses, was carried out in October 1980 and replies were received from 198 teachers of whom 48 were in their first year of teaching.

The subsequent replies yielded a body of opinion concerned about the balance between different elements of their courses. There was a general wish for a greater emphasis on the more practical elements of their courses, such as methods of teaching and classroom management, practical teaching and observation in classrooms. Of those teachers who had asked themselves how time was to be found for a greater emphasis on these elements, almost all suggested that the time given to education theory should be reduced. Many teachers felt that the relevance of education theory had not become apparent by the end of their initial training course.

8.2.2 Comments By Teacher Trainers

Lecturers involved with teacher training courses have themselves been frequently criticised by their peers. Collins (127) points out that:

"Most of those involved in teacher training sell a strong line on theory. What they want from their students, and expect to get, is informed practice; practice built on clearly thought out understanding of the nature of the subject area and the principles that govern it.

Without classroom understanding, they would argue, classroom performance is a poor blind thing. Their strongest scorn is reserved for the helpful-hints approach - the lecture or book that offers 10 or 101 ways to freshen up your teaching approaches.

In striking contrast, most teachers are impatient of theory and fret at overmuch talk of underpinning principles, and have a huge appetite for things that may be used in the classrooms."

"Philosophy is derived from practice, not practice from philosophy."
Pollard (128) calls for radical changes in working patterns for lecturers in schools of education:

"Three fifths of new teachers feel that they have not received sufficient instruction in teaching methods and the complaint was made that 'all too often lecturers in professional studies fail to get down to classroom practicalities'. It is precisely here that educationalists need to look more closely at their performance."

"For the continuity and health of a department of education there must be some permanent staff, but I think a number of radical changes are needed. There should be far more joint appointments. Far more practising teachers should be involved in the regular work of organisations concerned with teacher-training. Balancing this, some full-time teacher trainers should be on limited tenure contracts, with much more transfer to and fro between schools on the one hand and university departments and colleges on the other. Moreover members of such departments and colleges ought to be committed by their contracts to regular teaching in schools. With several of these ideas there may be administrative difficulties, but if the will is there, a way can be found."

8.2.3 Comments By Learned Bodies

As long ago as 1972 strong recommendations for reform in teacher training procedures were made in a report "The Training of Graduates for Secondary Education" (129). Amongst the findings were:

"So far as is possible there should be movement of college lecturers into the schools and vice versa."

"Co-operation between the colleges of education and the teaching profession in the training process must be regarded as basic to all the recommendations of this Report."
"The maximum possible use should be made of discussion groups and seminars where school and college staffs may meet for mutual support."

The need for future teachers to be introduced to elements of industry and commerce were forcefully put forward in "Teacher Training and Preparation for Working Life" (130). Amongst many recommendations made were:

"Industrial visits, though not necessarily an ingredient of initial training, can contribute very much to future teachers' understanding of society and the way in which that society maintains its living standards."

"No student preparing for secondary school teaching should complete a course of initial training without a clear idea of how to help pupils prepare for their adult working life."

"Initial training institutions often lag behind schools in developing industry-related activities for the curriculum. More effort should be devoted to placing students in schools where the 'applied curriculum' can be seen working. More and better use could be made of the experience of practising teachers, by bringing them into the initial course, and allowing them to demonstrate to students the material and approaches which they have found to work in practice."

"Many of the institutions seen were not well placed in terms of staff background and expertise to introduce the preparation for working life component into initial teacher training. While many tutors had involved themselves so closely with the activities they arranged for their students that the quality of their teaching was very good, there were also many who had had no personal experience of working life outside the field of education; and in some cases it was clear that this inexperience inhibited them from commenting clearly on students' work, or even from critical appraisal of the activities they
had initiated. The quality of work in one institution, where all the tutors involved had had substantial work attachments themselves was noticeably good, and the confidence of tutors deservedly high. HMI felt a realistic goal for any institution would be a group of tutors with first hand experience of industry to co-ordinate the overall activities, and preferably at least one tutor in each subject department with this experience and interest."

HMI were instrumental in endorsing many of the above views in their discussion paper "Teacher Training and the Secondary School" (131). They expressed views such as:

"Polarisation is sometimes a source of mistrust between the staffs of teacher training institutions and schools, the one being characterised as out of touch with practice and the other as uninformed in the educational disciplines on which their profession rests."

"Certainly there is room for more instances of teachers working in college with students, for example in subject method courses, and of lecturers regarding a regular school teaching assignment as an essential part of their work."

"An important dimension of the pattern of co-operation should be the relationship of initial and in-service training within the same school. When colleges are involved with schools in a variety of activities of which teaching practice is only one there is potential benefit for students, teachers and college staffs alike."

8.2.4 Summary

Within initial teacher training establishments there is much expertise and a general acceptance that their courses should be continually evolving in line with modern educational practices. Schools of education appear to have good facilities
in terms of accommodation and resources. They are, however, under mounting pressure to involve practising teachers within schools in their teacher training programmes as well as encouraging lecturers to gain more experience working with pupils in the classroom.

Legislation to implement such ideas appears to be imminent from information supplied in the DES Circular "Initial Teacher Training: Approval of Courses" (132). Criteria for the approval of courses include many points previously mentioned relating to links between training institutions and schools.

Schools of education are also under pressure to include many other aspects in their programmes, one of which is the need to introduce some element of industrial/commercial understanding in relation to how teachers should prepare pupils for their adult working life.

A need exists for teacher trainers, teachers and other professions such as industrialists to be able to meet more regularly and exchange ideas and experiences.

8.3 In-Service Training For Teachers

The NAS/UWT recent policy statement on "In-Service Training of Teachers" (114) echoes the general views of teachers about the importance of INSET. Amongst their main recommendations are:

"The increasing demands on teachers call for a massive programme of support for teachers in which opportunities for professional renewal must be a key element."

"Diminished opportunities for movement from school to school among teachers makes it essential that INSET should be available to long serving teachers."
They also cite "the difficulties which teachers face in attempting to cope with changes in the nature of their job" as a cause of increased stress which could be reduced by effective INSET.

The Cockcroft Report (22, pp 217-231) calls for the need to place importance upon INSET.

"However good their initial training and induction may have been, all those who teach mathematics need continuing support throughout their careers in order to be able to develop their professional skills and so maintain and enhance the quality of their work."

The Report commends the value of teachers' centres set up as part of the Nuffield Mathematics Projects in the latter part of the 1960s. It goes on to say:

"It is necessary for those who teach mathematics to have the opportunity to meet other teachers. Local teachers' centres can play an important part in providing facilities for teachers to meet each other."

The Government have already outlined the need for in-service training of mathematics teachers in their DES Circular "The In-Service Teacher Training Grants Scheme" (133) by suggesting priority areas such as:

(a) training of mathematics co-ordinators for primary schools;

(b) training for heads of mathematics departments in secondary schools;

(c) training for teachers of low attainers in mathematics in secondary schools;

(d) training for teachers of mathematics in secondary schools who are inadequately qualified in the subject.
In addition the development of schemes such as the TVEI and courses like CPVE have created the need for discussion and curriculum development in which aspects of mathematics features prominently.

The need exists, therefore, for support services to be available to schools to assist with, promote and organise INSET.

8.4 The Establishment Of A Professional Centre

It would appear that the universities have good facilities and resources with a need existing to improve links with practising teachers.

In addition a need exists for INSET within schools but this is hampered by lack of facilities and resources.

The author proposes that teachers and teacher trainers could benefit from the establishment of a professional centre, based at a school of education in one of our universities. It is hoped that the centre would attract both parties, as well as student teachers.

The concept of a professional centre is not new. Cripps (134), writing about the Liverpool Pilot Scheme for Induction of New Teachers attempts to define the role of such a centre.

"The basic concept of a Professional Centre is that it is a place where,

(a) students are trained as teachers

(b) probationary teachers can be assisted and supported

(c) experienced teachers can be refreshed by In-Service Training."
The Professional Centre is an attempt to say that although the emphases are different, teachers who have not yet started to teach, teachers who are in their Probationary Year and teachers who have been teaching for several or many years, should all rub shoulders in the same institution.

The Professional Centre is part of an integrated strategy proposed by the James Committee to deal with a group of exposed weaknesses/problems in the system of teacher training. These were:

(a) The gulf that seemed to exist between the schools where the teaching is done and the colleges where the teachers are trained. On the one hand, it was alleged, college staffs cannot possibly know in detail what is happening in the schools and, on the other hand it is certain that schools are woefully ignorant of what is happening in the colleges.

(b) The difficulty new teachers face in translating college learned theory into actual classroom teaching situations.

(c) The problem of supervision of both probationers and students on school practice.

(d) The inadequacy of In-Service Training.

(e) The cynicism, if not actual antipathy, on the part of the schools towards 'theory'.

The Professional Centre's role, so far as the induction of new teachers was concerned, was four-fold:

(a) To provide a meeting place where new teachers could 'rub shoulders', if not with students and with experienced teachers, at least with other new teachers from other schools.

(b) To provide supplementary courses of instruction where needed.
(c) To offer facilities as a Resource Centre.

(d) To offer a consultancy service to new teachers seeking information, advice or guidance on the teaching of their subject."

It is interesting to note that the weaknesses/problems in the system mentioned in this article, written in 1977, are still prevalent.

Gough (135), in an article entitled "The Colleges of Education and Support for Curriculum Planning. Towards a Significant In-Service Role", endorsed the above views by saying:

"The needs of teachers in terms of curriculum planning will vary in nature and scope, and a college could be involved in various kinds of provision helping to meet those needs. They might include:

(a) part-time courses

(b) school-focused activities

(c) consultancy

(d) resource provision."

One important and fundamental aim of a professional centre is made by Weindling and Reid (136) who say that "it should be responsive to the needs of local teachers".

There are many other avenues which could be explored when considering the initiation of a professional centre. For example it could be organised using the format employed by centres of mathematical education such as the Shell Centre at the University of Nottingham. Bell (137) describes centres of this type as:
"Typically they have a small permanent staff, who also have teaching duties on initial or in-service courses or on undergraduate work, and a variable number of other people on secondments, research projects or on study leave from overseas, working on individual or collective projects."

A professional centre might be resourced more on the lines of teachers' centres currently found in this country. The first were established in England in the early 1960s, and they proved so successful that they are now numbered in hundreds - many in the centres of large towns, but some also in rural areas. Most are "general centres", available to support all areas of the curriculum (including, of course, mathematics); some LEAs, however, have set up specialist mathematics centres. Shuard and Quadling (138) describe a typical teachers' centre as a building with a complex of rooms such as:

- a large room for lectures and workshop activities;
- a sitting room for informal discussions;
- a library;
- a room for storage and display of equipment;
- a kitchen;
- a printing room, etc.

"It will be under the control of a 'warden' (who will be an experienced teacher) with his assistant and secretarial staff, and on most days of the week it may be open from 9am to about 8pm (and even later when there is some special activity or meeting). It is the place to which teachers naturally come for advice, to look at equipment, to attend courses and meetings."

A possible layout for such a centre is shown on page 328.
With a well-supported and financially secure centre of the type outlined previously, the opportunities to assist teachers in schools and colleges develop meaningful and relevant materials appear to be diverse in nature. For example the following may be considered for inclusion in the work of a professional centre.

(a) The Provision Of A "Travelling Roadshow"

Invariably schools and colleges will find difficulty in releasing members of staff. Cynics amongst the teaching profession may be disinclined even to visit the centre. It would be very useful and beneficial, especially in the early developmental stages of the centre, to have the facility to mount small exhibitions and provide talks/demonstrations for whole departments (by invitation). Provided that the presentations offered are practically helpful and not theoretically biased, teachers will be able to assess and subsequently appreciate the value of such a centre.

(b) Schools, Colleges And Industry

Many training officers claim that working for a time within industry brings teachers "down to earth". This statement has been proved to be correct from comments made to the author by teachers who have spent time in industry. A professional centre could encourage, support, maintain and expand links with industry and commerce especially bearing in mind the Cockcroft Report(22) and the 16+ Criteria. Specific suggestions for inclusion could be:

(i) to organise short visits for teachers to a variety of industrial/commercial concerns;

(ii) to organise courses for mathematics teachers (and teachers from other curriculum areas) which would enable them to spend longer periods of time in industry/commerce (for example a minimum of a week on "the shop floor");
(iii) to encourage industrial/commercial training officers to actively participate in both attending and organising courses at the centre;

(iv) to organise schemes whereby industrialists could gain experience working with teachers in the classroom;

(v) to make provision for talks/demonstrations to be made outlining current and projected common practices within schools to groups of employers, employees, training officers, etc. within their companies or through various employers' bodies, such as:

- The Education Sub-Committee of the Leicester Chamber of Commerce and Trade
- The Training Boards
- The Professional Institutions, for example The Institution of Mechanical Engineers

(vi) to actively help, wherever possible, in the mathematical components of remedial and new training programmes within industry/commerce and also in the development of selection tests.

These measures would have tremendous benefits to schools and colleges in terms of forging links with industry/commerce and encouraging companies to help with school/college resources, works visits and visiting speakers (this appears to be a growth area in education). In addition industry should benefit by the offers of help from teachers to industrial training officers where appropriate.

(c) Greater Links Between Schools And Further Education

In the author's opinion, link courses between schools and colleges of further education and "cluster" arrangements are
to be welcomed. There is little evidence that significant liaison/interchange of ideas is taking place between mathematics departments. A professional centre could attempt to bring together mathematics teachers within schools and further education in attempts to share ideas and rationalise approaches, where possible, in the interests of the students. Within this framework the possibilities of interchange of teachers between the two types of establishment could be explored.

Links Between Schools And Higher Education Establishments

In addition to bridging gaps between teacher trainers and practising teachers, a professional centre might be a good base for experienced teachers researching for higher degrees into school based topics. The centre could also be responsible for providing long courses of in-service training, for example 6 weeks, 1 term or 1 year courses or part-time courses where students meet on a regular basis. If a university housed the centre then the possibility of certification for such courses could be investigated (for example courses such as the Diploma in Education and Industry course at the University of Leicester are proving to be very popular with experienced teachers on secondment).

A professional centre could, even on a small scale, be most useful to teachers and teacher trainers. For example directories of:

(a) computer software;

(b) video programmes and films;

(c) schemes of work;

(d) written resource materials for various levels of ability and age ranges;
(e) investigational work;

(f) practical work;

(g) cross-curricular topic work;

would be a valuable asset. Perhaps with a wide, comprehensive range of materials backed up by teacher support, the problems outlined by, for example Brown (139), in her article "Rules Without Reasons" may be overcome.

Feasibility Of The Proposal

If the idea of a professional centre in Leicestershire is to be seriously considered then, in the author's opinion, the following steps are necessary.

(a) Gather information about existing professional centres, teachers' centres, centres of mathematical education, by reading and visits.

(b) Have informal talks with:

(i) County Mathematics Advisers

(ii) representatives from local universities

(iii) representatives from local colleges of further education

(iv) representatives from local schools

(v) supportive training officers from industry and commerce.

This would give feedback regarding the degree of support for a proposed scheme.
(c) If, during the course of informal discussions, the ideas were received with enthusiasm and interest, set up a small working party consisting of representatives from higher education, further education, schools, County advisory staff and industry to discuss:

(i) aims and objectives of such a centre

(ii) proposed management structure

(iii) room allocation needed

(iv) staffing

(v) financial aspects including the possibility of grants from various sources (including industrial sponsorship).

(d) Present the findings of the working party in a formal report to the appropriate people.

8.5 Summary

Shuard and Quadling (138, pp 138-139) consider the priorities in the professional life of teachers of mathematics. They suggest that the first priority is not expensive. It is a recognition that the professional life of a mathematics teacher needs to be seen as a lifetime of growth and development. Mathematics itself does not stand still over the forty years of a teacher's professional life. The point was vigorously made by HMI (140) in the Mathematics Supplement of the HMI secondary survey, but it applies equally to teachers in primary schools.

"In industry and in higher education mathematicians require continually to update and improve their knowledge, and people who previously needed little mathematics not infrequently have to learn to apply branches of knowledge which involve mathematical skills. There are comparable needs in school
teaching. The knowledge of teachers needs to be refurbished and refreshed, and if this knowledge is to be put to the most effective use teachers need to participate in regular professional discussion of the aims which they are working to achieve."

The establishment of a professional centre for mathematical education in schools within Leicestershire would be beneficial to teachers in schools and lecturers in further and higher education, and also student teachers. It should also be available for use by training departments within industry and commerce. It would be a vehicle for developing and disseminating ideas to the benefit of all.
LECTURER'S OFFICES
ASSOCIATED WITH THE CENTRE

WORK AREA
- RESOURCE DIRECTORIES FOR MATERIALS
- COMPUTER SOFTWARE VIDEOS/FILMS
- SCHEMES OF WORK SYLLABUSES
- TEXTS/JOURNALS PRACTICAL ASSIGNMENTS

PHOTOCOPIER, VIDEO M/c, COMPUTER, LETTERING M/c, GRAPHIC EQUIPMENT, etc.

RECEPTIONIST/ SECRETARY

AREA FOR STATIC DISPLAY OF GOOD PRACTICE IN SCHOOLS AND COLLEGES (TO BE FREQUENTLY CHANGED)

LARGE ROOM FOR LECTURES/SEMINARS, etc.

LOUNGE AREA FOR QUIET READING

A POSSIBLE MODEL FOR ACCOMMODATION
CHAPTER 9

SUMMARY, RECOMMENDATIONS AND
SUGGESTIONS FOR FURTHER RESEARCH

9.1 Summary

Although the thesis is entitled "An Interrelated Approach To Teaching Mathematics In Secondary Schools", it was inevitable that many non-mathematical aspects of education would emerge during the integration of various subject disciplines.

The interrelationships between subjects was used as a vehicle to promote curiosity and interest in pupils, the research being centred upon topics containing mathematical concepts. It was felt that this would provide the means whereby the curriculum would begin to assume a more attractive, appealing look which might overcome pupil disenchantment as outlined in Chapter 1.

The importance of interchange of ideas between teachers is highlighted in Chapter 2 where proposed objectives and strategies for the implementation of an interrelated approach to teaching are presented. Brainstorming sessions and the enthusiasm and commitment of industrial/commercial training officers were important factors when preparing modules for testing within schools. The industrial case study in Chapter 2 helped to show that measurement is universal. Consequently measurement formed the nucleus from which a number of teaching modules evolved.

Throughout the course of this research project the author has learned much about basic design techniques associated with preparation of teaching modules. The ideas and suggestions made in Chapter 3 apply to materials produced
for subjects across the curriculum. These ideas positively influenced the quality of written resources produced for pupils.

When considering the whole spectrum of learning situations encountered in a person's life, an interrelated approach to learning can be found in pre-school and junior school life and also in employment. In general, secondary school education tends to compartmentalise subjects although the research revealed many current innovations aimed at bringing subject areas together.

The main evaluation of the proposed approach is outlined in Chapters 4, 5 and 6 where comments made by pupils and teachers vividly showed a good degree of enthusiasm and support for an interrelated approach to learning. The most enjoyable aspects of work carried out by students was, undoubtedly, practical tasks, whether it was making boxes or designing labels or posters. Practical work within mathematics (and other) lessons has much appeal to pupils.

The evaluations reveal that to be successful the teacher needs to carefully consider many factors other than teaching content. Seating arrangements, organisation of resources, variety of student tasks, different methods of student responses are just a few aspects which needed to be considered when planning mathematics (and other) modules.

The varied in-service training programmes organised as part of the research revealed the value of using groups of teachers to generate exciting ideas. Examples given in Chapter 7 illustrate the potential imaginative schemes of work which could emerge as a result of interdisciplinary teams of teachers working together.

It became apparent during the course of the research that discussion, debate and dissemination of information were
important ingredients in the development of a new approach to teaching and learning. It was a natural progression to recommend that a professional centre for mathematical education as described in Chapter 8 would be a most useful addition to initial and in-service training programmes within Leicestershire.

9.2 A Joint Research Project

The author found that working as a member of a research team in conjunction with Stanley Turner and Professor Bajpai enriched the project, especially in relation to brainstorming sessions and cross-fertilisation of ideas. The two researchers worked in tandem with regular meetings and dialogues taking place.

It was found that experiments within schools were easier to organise than in colleges of further education. Turner had a limited number of colleges to approach and found that many lecturers were resistant to change and were especially aware of the time constraints due to tight teaching schedules. The author found teachers in schools to be receptive to new ideas and willing to evaluate relevant materials presented in an attractive manner.

One basic difference between the work of the two researchers was the medium used for module presentation. The author's work centred upon preparation and evaluation of written materials whereas Turner used the microprocessor as a powerful tool of communication as well as exploiting the use of the overhead projector and tape-slide programmes.

Both researchers used representatives from industry as advisers and providers of ideas and resources to good effect. They both acknowledge the value of such links when developing a "relevant" curriculum.
9.3 Module Design

Modules tested within the classroom were enhanced by the thought given to content, style and presentation. The research made the author and his teaching colleagues aware of the interest generated in pupils by the use of well presented, attractive materials. Feedback from pupils and teachers also revealed a wealth of ideas for future modules. Ideas generated by pupils were particularly attractive and their use and development can only help to break down barriers and overcome the misunderstandings detailed in Chapter 1.

9.4 Relevance of Tasks

One of the successes of the materials produced was the "hidden" mathematics which pupils performed as part of an integrated task. Mathematics occurring naturally, as compared with rote learning situations, promoted understanding of basic concepts and played a significant part in problem solving exercises. For example pupils making a pill counting device (reference page 263) used a number of mathematical skills throughout their design projects.

On occasions, however, students unused to an interrelated approach questioned the objectives of some tasks given to them and voiced concern that deviations were being made from the "norm" within a particular subject. Some of these fears were removed as can be seen in Chapter 5 when enjoyment and interest in the given task overcame any inhibitions.

9.5 Recommendations

1. Mathematical concepts can be effectively included in the work of all curriculum areas as illustrated in Chapters 5 and 6. The concept of "mathematics across the curriculum" should have an important place in school planning procedures.
2. Topics presented in an interrelated way during this research project helped to make the curriculum more relevant to the world in which we live. The author is not suggesting that subject areas should dissolve completely but that the value of well thought out interrelated modules/projects should be recognised by teachers who should be given the opportunity to participate in planning and preparation of pupil tasks.

3. If pupil interest and curiosity is to be aroused in mathematics by using an interrelated approach then support and finance must be found to promote further curriculum development and in-service training for teachers. This does affect the success/failure of any new initiative, as mentioned in Chapter 1 where, as an example, the TVEI has been generously funded and subsequently has been shown to be successful.

4. Responses from teachers attending in-service training sessions organised by the author (reference Chapter 7) have been encouraging. Ideas and materials generated by groups of teachers should be disseminated amongst colleagues. The provision of a professional centre as proposed in Chapter 8 appears to have a vital role in this respect.

5. Within single subject areas there is much scope for developing ideas in sympathy with an interrelated approach. The author has shown that lessons labelled mathematics and English (Chapters 4 and 5) are excellent vehicles in which to bring many disciplines together to form "complete" projects. Subjects such as design, control technology, engineering science, physics, etc. have a natural inclination towards interrelating many aspects of the curriculum. Single subject specialists such as mathematicians do have a role to play in discussing and developing aspects of
their subject which occur in curriculum areas such as the ones mentioned previously.

6. Every effort should be made to promote the ideas put forward in this thesis when planning new courses within schools. There is considerable scope for this approach as mentioned in Chapter 6 where the CPVE structure openly encourages the use of integrated assignments.

7. The introduction of GCSE which will eventually include course work for all students gives much opportunity for development of ideas. Some mathematics syllabuses, for example, include suggested course work topics such as packaging, surveying, etc. These could include, at all levels, topics developed for mathematics classes as part of this research which are described in Chapter 4.

8. Pupils' comments and opinions help to bridge the generation gap between themselves and teachers. Wherever possible, pupil suggestions regarding topic work should be carefully considered and, if suitable, developed in co-operation with pupils to give them a sense of responsibility and a feeling of being valued.

9.6 Suggestions For Further Research

1. Modules of study involving an interrelated approach should be devised, tested and evaluated for students of high academic ability.

2. An investigation into course work for GCSE mathematics courses would yield helpful and constructive ideas and curriculum materials currently being demanded by teachers.
3. An investigation into the use and application of modern educational technology for modules such as those described in the thesis would enhance the work already carried out. Special areas for consideration would be:

(a) the computer
(b) video programmes
(c) tape-slide programmes
(d) films

This would lead into the possible development of distance learning programmes.

4. Interrelationships are common within the workplace as shown by the case study in Chapter 2. An investigation into tried and tested methods of training within industry and commerce could provide successful approaches and strategies applicable to school teaching programmes.

5. If the approach put forward in this thesis is to gain acceptance then ideas and suggestions must be carefully put forward to trainee and qualified teachers. An investigation into how the approach could be incorporated into existing initial and in-service courses for teachers would appear to merit consideration.

6. The possibility of further courses in universities which promote mutual exchange of ideas between teachers and industrialists could be investigated. For example, the University of Leicester organise a most successful "Education and Industry" Diploma course which offers teachers an insight into industry during a year's secondment. The author strongly believes that a need exists for a reciprocal course "Industry and Education" where industrialists would be seconded for periods of time to learn more about current educational thinking especially in relation to the aims and objectives of new courses, methods, assessment and the related jargon.
7. Further research is suggested into how the skills and expertise of teachers within schools could be used to assist industrial/commercial training officers with their training programmes. This is especially relevant to sharing ideas regarding mathematical processes and their peripherals.

8. Practical work in mathematics and other subjects proved to be enjoyable to pupils. An investigation and subsequent report detailing practical interrelated tasks for mathematics classes would be welcomed by teachers in schools.
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APPENDIX 2.1

Report of visits made to Riker Laboratories (now 3M Health Care)

To:       Professor A. C. Bajpai, Director - CAMET, Loughborough University

C.C.      Mr. Tony Fletcher - Riker Laboratories
           Mr. Alan Fryer - " "
           Mr. Colin Dickens - " "
           Mr. Stan Turner - Research Student, CAMET

From:     Rod Bond              Date:  31st July, 1983

_________________________________________________________________________

MODULE ON "MEASUREMENT AND THE PHARMACEUTICAL INDUSTRY"

Report on the visit made to Riker Laboratories, Loughborough on
Tuesday, 26th July (a.m. and p.m.) and Thursday, 28th July (p.m.)

A copy of the first draft of the module was given to Tony Fletcher, Training Manager. He made the following constructive comments.

Notes on Measurement and the Pharmaceutical Industry

(1) First page - there are some additions which could be suggested.

Environment - temperature
               - humidity
               - dust count
               - sterility
               - noise

Quality Control - hardness
               - friability

Production Control - forecasting sales
               - bills of material
               - shopfloor loading
               - work in progress
               - shortages
               - yield comparisons
               - stock location
               - batch control

Manufacturing - waste
               - rejects
               - operator performance
               - machine performance
               - energy performance
Research and Development - many statistical techniques
- performance characteristics, e.g. flow rates, dissolution, particle size

Market Research - competitor performance

These are off the top of my head - if we consulted individual experts it could be made more comprehensive. Other areas might be

Finance - costing
- budgeting
- forecasting
- auditing
- payroll

Personnel - salary planning
- absence monitoring
- recruitment testing
- manpower planning

Sales - target setting
- performance monitoring
- call reporting

(2) A talk to some of our specialists (limited to say ¾ hour each) could probably be arranged. This would help to expand the range of examples in particular fields.

(3) We do not possess a great deal of literature apart from product promotion. There are a number of photographs and slides which might be of some value.

(4) We have made a number of films for use by the medical profession, parts of which may be of value. These are available in video format.

(5) The use of computers and sophisticated technology is becoming a major feature in employment. Emphasis on this within the teaching would be valuable. We may be able to help with loan of equipment if necessary.
Visits to the works were conducted by Alan Fryer and Colin Dickens from the Quality Assurance Department. From the two sessions spent at Riker the following points/suggestions were noted:-

1. Tony Fletcher has kindly agreed to look through his file of existing photographs/films/video films to see if any relevant material exists.

2. It may be possible to take photographs/slides of selected measurement activities within the Company either by involving a photographer from the University or by using the Company's photographer (at a small fee).

3. A section on measurement of the environment appears to be essential, especially noise ) I met Mr. Fish, vapours/gases ) the safety officer, lighting ) who showed me a dust ) variety of humidity ) measuring devices moisture ) used by him sterility ) within the Company.
temperature )

Perhaps fire prevention, safety glasses, boots, clothing etc. could also be included here.

4. Alan Fryer indicated that there were some problems experienced by employees and that there was a need for some in-service training. In this respect teachers in school may be able to use their experiences to assist with development of this training. He will be contacting me in the future to discuss problems and how the resources and expertise of teachers could help to remedy problems. Perhaps exercises/practical problems involved in this work could also be used in our teaching programmes within schools. Specific areas causing concern include:

spelling
units
magnitude of size
substitution into formulae
accuracy, s.f. and decimal places.
5. One observation was the use of the term weight throughout the Company. We in schools have been debating the terminology of weight or mass. We are tending to emphasise mass as being the correct term to use, possibly causing some confusion. We need to standardise terminology for schools/industry/the community.

6. Hardness testing and abrasion testing (friability) were evident.

7. Dial test indicators and vernier caliper gauges were used to check dimensions of tablets.

8. Throughout production tolerances are given - an important concept often omitted in school teaching programmes.

9. Economic batch sizes need to be determined.

10. Tablet coatings were built up progressively and determined by weight.

11. For hygiene purposes agar plates were in common use to sample microbiological specimens - it seems a good exercise for use in schools. Alan Fryer has a set of slides dealing with the use of these plates and has agreed to let me see them.

12. Counting of tablets is carried out by weighing, differential scales and conventional scales both being used. Other methods observed included the use of a triangular shaped tray.
13. Melting points, specific gravity and weight/ml. were frequently used.

14. Colour testing took place with tolerances given and testing equipment in use, e.g. colours on packaging boxes were to a given standard.

15. Tubes were lacquered internally to protect contents. The coating of lacquer needed to be tested (ref. BS 2006:1966).

16. Bottles were examined and tested for screw threads on the neck and also for being vertical (important when in use on automated machinery lines).

17. The manufacturing record card was very thorough. Details of quantities of raw materials for products were stated and others had to be calculated (and checked). Proportion was needed in this exercise. Also weighing details had to be recorded throughout the production process. Perhaps a similar record card and associated problems could be incorporated into a teaching programme.

18. Viscosity and pH values were measured.

19. Bottle sizes were standardised at 100ml, 250ml, 500ml and 1l.

20. In some processes numbers of items, i.e. bottles/packages were counted using a photocell.
21. Bottle cap tightness was checked using a torque testing device:

![Torque Testing Device Diagram]

This seems to be a most important aspect relevant to many commodities. Too often the weak person has great difficulty in opening bottles, etc.

22. The Quality Assurance department use sampling procedures in accordance with BS 6001:1972 and BS 6002:1979. Sampling procedures could be included in a teaching programme.

23. Production processes and automated machinery operated by hydraulic, pneumatic and electronic control for positioning, filling, capping etc. School teaching programmes could include sections on simple control devices leading to solving basic design problems.

24. When giving doses from aerosol containers, a valve assembly is required. This consists of a number of small parts assembled together (automatically). A good exercise would be to provide students with an assembly (not particularly the valve) and to let them examine jig and fixtures, and layout of workplace, which would help to assemble the parts in the most efficient manner. Timing assembly could be included here.

25. For items used in the aerosol spray manufacture many standard items of engineering inspection are employed, e.g. plug gauges, dial test indicators, shadowgraph.
Simple design problems could be set involving design of shakers, machines to test friability, etc.

Measurement of temperature is important.

Reading charts plotted by machinery occurs frequently.

Mean value occurs in sampling procedures.

The use of + and - is common on measuring devices.

The microscope together with its associated scientific principles could be included in a teaching programme.

Within the laboratories much glass equipment is used. Exercises on how it is made and calibrated may be relevant.

Possibly 6th form students/University students could write programmes aimed at school children for use on the microprocessor which simulate problems found within industry. The programmes could possibly help in in-service programmes within industry.

I was very impressed by the most helpful way in which the staff at Riker Laboratories were prepared to assist in the project. The operatives in the works took the time to describe their tasks in a constructive, enthusiastic manner and there was clearly a most pleasant atmosphere pervading. Perhaps one aspect of any work designed for use in schools should be to encourage students to be responsible, to effectively communicate and to work with others harmoniously as a team - a hidden aspect highlighted by the interesting and worthwhile visit to Riker Laboratories.
APPENDIX 2.2

Specimen Slides And Dialogue From Tape-Slide Programme

Extracts from the tape-slide programme of 48 slides based on "Measurement" to illustrate an interrelated approach are shown as follows.

Slide 10*

Commentary for Slides 10 and 11

The wing is clamped so gently that the butterfly flies away, leaving a record of its wing thickness. Technology has been involved: the biologist and the butterfly are pleased.

* Slide 11 not shown
Every industry requires teamwork to produce the finished product. If they wish to achieve harmonious, efficient production then the parts of any industry must come together as naturally as nature brings together the segments of an orange.

Within schools throughout the world, to teach mathematics, science and technology in separated isolation may prove to be a worthless, meaningless exercise for many. If we can prove to our students that what we are asking of them is
relevant to their existing and future experiences then we may generate both enthusiasm and interest. By relating our work in schools to actual everyday things we cannot treat subjects in total isolation. The products of today's society requires a marriage of science, mathematics and technology. For many students within schools and interrelated approach may be the way forward – the way in which their curriculum takes on a new exciting look. If, using this approach we can arouse curiosity and generate interest then we will have achieved a great success in communicating through INTERRELATED STUDIES.
One of the aims of teachers should be to make the content of their teaching material, where appropriate, relevant to their students' current and future experiences in order to show that many of the concepts taught in schools may have uses in life outside the classroom.

Car parks are abundant in all forms of industrial, commercial and domestic premises (including all pharmaceutical companies). The car park is something that is taken for granted and yet its design has to be carefully planned to ensure maximum utilization of space and ease of use for employees/customers.

It seemed appropriate to use the car park as a means whereby measurement could be discussed in a low ability mathematics group of 14/15 year old students. Even with this age range, the concept of "how long is a metre?" is one which causes difficulty.
A factory has a space in the shape of a rectangle 74m x 54m suitable for use as a car park. You are asked to design a plan for white lines marking car spaces in the car park to get as many cars in as possible.

1. What is the size of space needed for each car?
2. What should be the widths of roads within the car park?
3. What should be the size of the access gate(s) and where should they be situated?
4. Using an A3 sheet of plain paper, draw a plan showing car parking spaces, roads, entrance/exit gates (suggested scale 1cm represents 2m).
5. How many cars can you get into the car park?

Some employees ride motor bikes. You are asked what additional space would be needed to accommodate 75 motor cycles.

6. How much space would a motor bike need?
7. What shape and markings would you suggest for the motor bike park? Draw a plan.
PROPOSED STRATEGY

1. Discuss car parks; where they occur; why they are needed.

2. Study the task and make appropriate measurements. Discuss degrees of accuracy regarding measurement. Discuss human considerations regarding parking space size and size of roads, e.g. the need to allow adequate room between cars, especially, for example, in the event that disabled drivers may be employees.

3. Discuss strategies and debate the possibilities. Careful consideration should be given to the position of entrances/ exits.

4. Design the car park.

TRYING THE EXERCISE

The attempts of one particular group of 15 year old students at Burleigh College, Loughborough, were monitored. The students in this group were in their last year of compulsory education. They were in a low ability C.S.L. Mathematics group.
TEXT BOUND INTO THE SPINE
1. Cars and, especially, motor cycles interest many students. Measurements involving them helped to create motivation.

2. The exercise not only involved measurement of length but also how to draw to scale.

3. Much discussion took place regarding width of access roads within the car park. Some students measured the classroom to obtain a better idea of how wide a 5m, 6m, 7m etc. road would be.

4. Entrances and exits caused problems. Some students did not think carefully and initially made their exits directly into the factory. Putting entrances/exits near to a junction was debated especially relating to safety factors. The number of entrances/exits was discussed with the emphasis upon human frustrations when leaving if large queues were to form.

5. How to maximise parking space available was thought provoking especially in relation to a directed route around the car park, e.g. some students' designs involved the following feature.

|lore cars would need to either (a) make a three point turn or (b) reverse a long way if all the spaces were occupied.|
6. Some students fantasized and provided space for
   
   luggage
   toilets
   cycles
   motor bikes (not asked for in the car park)
   executive cars quite a good idea
   visitors' cars

7. Some students considered that a box for an attendant was required
   together with swing arm barriers to allow cars to pass.

8. The design of the motor bike park proved to be trivial compared with
   that of the car park. No solutions have been included in this report.

9. Other aspects which occurred during discussions were:

   (a) pollution from motor vehicles and how it is measured

   (b) aspects of driving a car, e.g. reversing procedure, three point
       turns, etc.

   (c) should spaces in car parks be numbered and allotted to
       particular personnel?

   (d) the various types and sizes of motor cars and motor bikes
       which included measurements regarding

       engine size (what is a c.c.?)
       number of cylinders
       tyres and their pressures, etc.
CONCLUSIONS

1. The investigations aroused interest and enthusiasm amongst most of the students who attempted it.

2. It involved the application of measurement to a real-life problem of which students already have an understanding.

3. The exercise involved both individual and group orientated tasks. Aspects involving design, detail drawing, scale drawing, mathematics, measurement, the environment, human behaviour, etc. emerged and were discussed before final plans could be made.

4. An improvement to the task would be for the teacher to approach a local company to enquire if a copy of the plans of their car park could be obtained. Students could then be given a real problem relating to a local company and, at the end of the investigation, their solutions could be compared with the actual layout used by the company.

Rod Bond
February 1984
APPENDIX 3.1

STUDENT MODULE

Measurement Of The Dental Condition Of The Human Population In Your Area

You will need to obtain books which contain information about teeth from your library or science department.

Part A

1. Take a piece of well-cooked yam or similar. Bite firmly on to the yam. You will now have an impression of your teeth and gums. Fill in the impressions (top and bottom) with some Plaster of Paris and let them set. Separate the yam to obtain a plaster cast of your teeth.

2. Draw a diagram showing the arrangements and types of teeth that human beings have. Name and label the four types of tooth.

3. Describe the jobs that these teeth perform when eating occurs.

4. What is the normal number of teeth to be found in a human adult?

5. Draw a diagram showing the various parts of a tooth clearly labelled.

7. Write down guidelines which would advise people how to keep their teeth healthy.

8. What measures can be taken nationally to help prevent tooth decay?

9. When decay occurs, how can the dentist remedy the problem? What does he need to do? What equipment and materials will be used?

10. Invite a dentist to visit your school to talk about dentistry and dental hygiene.

11. Design an attractive, appealing poster which illustrates how dental decay can be prevented.

Part B

1. You are asked to carry out an exercise to measure dental condition amongst the population in your area.

   Design a questionnaire to help you determine:

   (a) How often children and adults are seen by a dentist.
(b) The number of teeth present in humans compared with age.

(c) The numbers of cavities and fillings present in adults and children of various ages and where they occur.

(d) If diet affects the condition of teeth. Compare the state of teeth of people who:

(i) eat a lot of refined carbohydrates (i.e. cakes, bread, sugar, sweets)

(ii) eat refined carbohydrates only occasionally

(iii) eat few refined carbohydrates

2. Carry out the survey on people of all ages.

3. Write a report which illustrates your findings. Your report should be simply written, attractive and appealing to the average person. You should try to present data in a variety of ways, e.g. using line graphs, bar charts, pie charts, pictograms, etc.
TEACHER'S NOTES

Measurement Of The Dental Condition Of The Human Population In Your Area

This module is aimed at 14-16 year old students. The topic itself is considered to be important to young people as a means whereby knowledge regarding dental hygiene can be gained. Within an existing school organisational structure, part or all of this exercise could be carried out by:

(a) an English Language class working on communication

(b) a Mathematics class working on collection, representation and interpretation of data

(c) a Biology or Chemistry class working on teeth and diet

(d) a Design class working on the design of publicity material relating to the process of imparting information in a clear concise manner.

Ideally the topic would be conducted by a team of staff from the various disciplines, each member inputting specialist information. (The teacher may refer to the types of teeth and their functions for some species from the animal kingdom.)

When the module has been completed, students should have experience of:-

(a) using a library

(b) biological and chemical aspects of teeth and tooth decay

(c) the effects of diet on the condition of teeth

(d) how tooth decay can be prevented

(e) communication via written work and diagrams
(f) communication with people via verbal contact, e.g. when carrying out a survey

(g) inviting and welcoming a visitor

(h) modern technological techniques associated with dentistry

(i) the design of a questionnaire

(j) analysis of information and how to represent data in a number of ways

(k) design of publicity material.
APPENDIX 4.1

Results Of Feedback From Students Regarding Phase 1 Mathematics Modules

C.S.E. MATHEMATICS COURSE WORK

YOUR OPINIONS ARE IMPORTANT!

NAME .................................. MATHEMATICS TEACHER .................

<table>
<thead>
<tr>
<th>TOPIC</th>
</tr>
</thead>
</table>

1. There is a list below of all the sections in this topic. For each section that you attempted, please put a ✓ in one of the boxes to tell us if you thought the work was interesting and worthwhile or not.

There are 5 columns which you could tick, numbered 1 to 5.

A tick in the column marked 1 means "not very interesting".
A tick in the column marked 5 means "very interesting and worthwhile".

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</tr>
</tbody>
</table>

In addition space was provided to answer:

2. What were the good things about the topic?

3. What were the bad things about the topic?
RESULTS

(1) Topic - "The Kitchen"

Number of completed feedback sheets - 47.

(a) Responses to Question 1

Numbers in the table are percentages relative to the number of respondents.

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>No tick i.e. not attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Position And Size Of The Kitchen</td>
<td>9</td>
<td>13</td>
<td>51</td>
<td>19</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2. Kitchen Layout</td>
<td>13</td>
<td>8</td>
<td>26</td>
<td>11</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>3. The Shape Of Wall Tiles And How They Are Fixed</td>
<td>15</td>
<td>6</td>
<td>36</td>
<td>9</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>4. Wall Tile Decoration</td>
<td>11</td>
<td>11</td>
<td>25</td>
<td>2</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td>5. Painting The Kitchen</td>
<td>13</td>
<td>15</td>
<td>6</td>
<td>6</td>
<td>11</td>
<td>49</td>
</tr>
<tr>
<td>6. Paint And Its History</td>
<td>11</td>
<td>11</td>
<td>6</td>
<td>11</td>
<td>8</td>
<td>53</td>
</tr>
<tr>
<td>7. Food And The Kitchen</td>
<td>4</td>
<td>9</td>
<td>21</td>
<td>17</td>
<td>26</td>
<td>23</td>
</tr>
</tbody>
</table>

In this module students were asked to answer at least sections 1, 3 and 7. Other sections were optional.

(b) Responses to Question 2 - What Were The Good Things About The Topic?

Comments written included:

"Nothing."

"It taught us things that we would need to know when we get our own home and have to plan our kitchen."

"The food."

"Planning out the kitchen." (a frequent comment)

"How we were shown the costs of cupboards and things in the kitchen."

"Home and Garden (spot 10 differences) made the topic a lot more interesting. This broke up the topic a bit from just normal topic work."
"I enjoyed it."
"Doing the wall tiles, I liked drawing the tiles."
(a frequent comment)
"The cheese and wine evening that Craig and Andrea held was very interesting."
"The good things about this topic was, I suppose, when we were finding out about how much the different things cost."

(c) Responses to Question 3 - What Were The Bad Things About The Topic?

Comments written included:

"I never finished the topic completely."
"It dragged on."
"None."
"Doing the written work."
"What's the use of learning this if you want to be a police officer or are joining the army?"
"I didn't like the drawing."
"It was boring all the time."
"Not having enough time to finish it."

(2) Topic - "Electricity In The Home"

Number of completed feedback sheets - 43.

(a) Responses to Question 1

Numbers in the table are percentages relative to the number of respondents.
In this module students were asked to answer Section 1 together with at least two of the sections 2, 4 and 6. Other sections were optional.

(b) Responses to Question 2 - What Were The Good Things About The Topic?

Comments written included:

"It helped me to be able to wire a plug plus my uncle who is an electrician helped me to do some of the work."

"To learn about electricity and to keep safe."

"I found that the good things about the topic were the 'Do We Depend Upon It' and 'Units of Electricity' because I could understand most of the exercises I was given."

"It taught you uses of electricity. It also taught you how to wire a plug which is essential." (a frequent response)

"It was practical."

"Nothing."

"I enjoyed it. It was interesting."

"It makes you look at different books."

"Working out electricity bills was interesting." (a frequent comment)

"Plugs, fuses and current."

"We did a lot of writing which I like."

"The good things about the topic was that we could work at our own pace."

"I don't think there are any good things about the topic." (N.B. This student's response to question 3 was: "There weren't any bad things in the topic.")
(c) Responses to Question 3 - What Were The Bad Things About The Topic?

Comments written included:

"The writing."
"Not enough practical work in it."
"It was boring."
"Not enough time to complete all the topic."
"All the working out of the maths part."
"Nothing."
"Too much writing, not enough of hard good maths."
"It took too long and wasn't all that interesting."
"None - I enjoyed the topic."
"The only bad thing about it was units of electricity where I had to do a lot of work."
"Nothing, it was worthwhile to do."

(3) Topic - "Our Water Supply"

Number of completed feedback sheets - 56

(a) Responses to Question 1

Numbers in the table are percentages relative to the number of respondents.

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>No tick i.e., not attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Water Cycle</td>
<td>9</td>
<td>29</td>
<td>23</td>
<td>20</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>2. Water Treatment And Sewage</td>
<td>23</td>
<td>14</td>
<td>29</td>
<td>9</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>3. Did You Know ...?</td>
<td>13</td>
<td>16</td>
<td>30</td>
<td>21</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>4. Pollution</td>
<td>9</td>
<td>11</td>
<td>20</td>
<td>11</td>
<td>12</td>
<td>37</td>
</tr>
<tr>
<td>5. Recreational Activities</td>
<td>16</td>
<td>7</td>
<td>14</td>
<td>20</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>6. The Cost Of Water</td>
<td>7</td>
<td>11</td>
<td>9</td>
<td>13</td>
<td>14</td>
<td>46</td>
</tr>
</tbody>
</table>

In this module students were asked to answer at least two sections from 1, 3 and 5. Other sections were optional.
(b) Responses to Question 2 - What Were The Good Things About The Topic?

Comments written included:

"Finding out about water."
"The drawing."
"It was enjoyable, especially recreational activities."
"Learning about something we take for granted."
"There was a lot of work but it was not too hard to do."
"'Did You Know' was the best because it was pretty easy to understand and because it was good fun to do."
"I really found out how water gets to us."
"I learnt the way water is treated and how much pollution there is in rivers and canals and ways in which we can solve this problem."
"Nothing."
"Not many people think about or know what happens to our water supply before it reaches our taps and home. We just turn on a tap and out it comes, but it was interesting to find out what happens. It was also interesting to find out, and know all about, pollution and the interesting sports involved with water."
"It taught you about 'our water supply' as well as teaching you plain, boring maths on its own. Also it wasn't just '+, -, ÷, x' etc."
"It was interesting."
"I enjoyed the topic because it was different and interesting."
"Nothing really except it wasn't all that boring."
"It was quite easy."
"Everything."

(c) Responses to Question 3 - What Were The Bad Things About The Topic?

Comments written included:

"The bad things were looking up things in the books."
"All the writing when you should just answer questions."
"Some things were a little boring."
"There wasn't anything bad really."
"Some parts were not worth doing."
"Everything. They were boring."
"There were no bad things about the topic. It was all very interesting."
"Some parts were too easy and some were quite difficult. It should be more even."
"It took too long and I didn't learn anything."
"Nothing."
"The bad things about the topic was I didn't see that any of the exercises were relevant to us learning about mathematics. I didn't see how learning about the life of water would help us with money matters in later life."
"Reading all the worksheets."

4.2.1 GENERAL CONCLUSIONS

1. Student comments and ratings were made at the end of the trials with, in some cases, work on topics having been completed up to 4 months previously. Assessment should have been requested immediately after each topic had been completed when facts and feelings were fresh in the minds of students. Some comments and ratings therefore may not be valid.

2. The modules were not an overwhelming success but there were encouraging comments made by many students. The comments were pleasing as the approach used was different to that which students had experienced in their mathematics classes on previous occasions. Ratings may reflect a comparison of their expectations in mathematics classes (good or bad) compared with the diet given to them e.g. several people felt that "pages of fractions and decimals" would be more appropriate.

3. It was pleasing to hear from staff that, when attempting the modules, levels of behaviour were good which may result from students' interest in the work and the fact that they were doing something different from their experiences in the past.
APPENDIX 4.2

Results Of A Survey Of Teachers' Opinions Regarding Phase I Topic Work

RESULTS

1. Topic - "The Kitchen"

Number of completed feedback sheets - 8

(a) Responses To Question 1

Values in the table indicate the numbers of teachers ticking particular boxes.

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>very few attempts</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Position And Size Of The Kitchen</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kitchen Layout</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>The Shape Of Wall Tiles And How They Are Fixed</td>
<td></td>
<td></td>
<td>4</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Wall Tile Decoration</td>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Painting The Kitchen</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Paint And Its History</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Food And The Kitchen</td>
<td></td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

(b) Responses To Question 2 - What Were The Good And Successful Points About The Topic?

Written comments were:

"The students were happy about 'Position And Size Of The Kitchen' but a few questions suggesting what they could..."
look for might help to provide better responses. "Food And The Kitchen" was well received but definitely too long."

"The 'Position And Size Of The Kitchen' section was generally well thought out by students - it helped make them aware of the importance of planning. It was also short which was a great advantage. The students enjoyed parts of the 'Wall Tile Decoration' section, mainly the shapes, tessellations and the spot the difference page. 'Food And The Kitchen' was warmly received at the start but went on too long to maintain the students' interest."

"'Food And The Kitchen' seemed to appeal. They liked using the glossy Marks and Spencer booklet. However, very few students attempted the 'making jam' section. They seemed to have become disinterested by this stage. The 'Position And Size Of The Kitchen' was well done by all - very short and simple."

"The practical parts. In the first section it was not clear that they needed to write a comment. It did, however, require a lot of thought. The second section on 'Kitchen Layout' was excellent and generated a lot of interest."

"The work shows the relevance of maths to real life situations. There was a good variety of work for students."

"Planning and drawing to scale (though many students found it rather difficult and needed help frequently."

"Presentation of the modules is good and there are plenty of exercises set out for the students."

"'Food And The Kitchen' was the most popular section in this topic as it was all set out for them. The party which they had to plan themselves caught their imagination and many of them had some interesting ideas."
(c) Responses To Question 3 - What Were The Bad and Unsuccessful Points About The Topic?

Written comments were:

"Students found those areas of the topic which involved writing an explanation very difficult."

"Students didn't seem to like the wall tile decorations and really didn't get to grips with it."

"It was too long. 'Food And The Kitchen' should be in two sections. Provision was lacking for students to take work home."

"In general I felt the topic was too long with some parts needing a good bit of teacher explanation (viz 'Position And Layout Of The Kitchen'). An order form for 'Food And The Kitchen' would be helpful - a lot of students had problems with the layout here."

"The 'Position And Size Of The Kitchen' needed answers to 3 significant figures which students were unfamiliar with. Question 4 on page K15 was difficult. I suspect students were put off by the layout of wall tile drawings. A possible improvement might be to direct the student to draw a 1 metre square shape on the classroom floor using chalk and to cut out a tile 100mm x 100mm, then use this as a pattern to draw round on the floor hence answering the questions set."

"The most unfortunate point about the topic was that the set pieces of work were so long that, once the students completed these, they wanted to/needed to move on to the next module. The kitchen layout could have been an interesting section, however, the explanation took too long putting many of the students off. Also the order form was rather difficult for the standard of student involved. 'Find the profit for the plum jam ...' was too obscure. The students needed more guidance (this was also true of the end part of the work on the party)."
"The amount of time required for various parts. Many sections were not attempted."

"Too much work, especially in the last section."

(d) **Responses To Question 4 - Have You Any Suggestions For Improvement?**

Written comments were:

"Reorganise how much has to be done!"

"Smaller units with a target time of a double lesson (70 minutes) thus giving students the satisfaction of short-term goals and more or less instant achievement."

"This could be a very interesting and enjoyable topic for the students, however, much of the work needs to be split up into smaller modules e.g. 'Food And The Kitchen' should be divided into at least two smaller sections and the same for the 'Kitchen Layout' and 'Shape Of Wall Tiles' etc. Some modules could build on the previous one, e.g. for 'Kitchen Layout', module 1 could be 'Planning The Kitchen' with module 2 being 'Cost Of The Kitchen' based upon module 1."

"We need to link requirements in the topic work with core work coverage. The 'Kitchen Layout' should be split, e.g. (1) design and layout, (2) cost of a new kitchen. Students need to be taught accurate drawing techniques to enable them to make a good attempt at 'Shape of Wall Tiles And How They Are Fixed'. 'Food And The Kitchen' should be split, e.g. (1) party and its cost, (2) recipes and cost, etc. With regard to the party and its cost:

(i) I suggest that students find the total + £45 then divide only once to obtain cost/person;

(ii) in part (h) too many words were included, resulting in students needing a lot of help."
With regard to recipes:

(i) we could ask students to provide their own recipe and work out the cost;

(ii) we need to separate the strawberry from the plum jam or simply have only one plus their own recipe."

"A scale model of the kitchen would be useful - made to a different scale to that required. I feel the students would relate better to a 3D model and understand the process of drawing a plan in a more natural way. An order form for 'Food And The Kitchen' would be very useful. Models of tessellations would help students greatly."

"The answer booklet should have more clearly defined marking schemes in places especially relating to questions requiring written answers."

"'Food And The Kitchen' could be shorter - perhaps made into two separate sections. I think the painting and kitchen sections could be made simpler by, perhaps, giving students all the measurements they need."

2. Topic - "Electricity In The Home"

Number of completed feedback sheets - 8

(a) Responses to Question 1

Values in the table indicate the numbers of teachers ticking particular boxes.

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>very few attempts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do We Depend Upon It?</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units Of Electricity</td>
<td></td>
<td></td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Plugs, Fuses And Current</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Safety In The Home</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Working Out Your Electricity Bill</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Insulation</td>
<td></td>
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<td></td>
<td></td>
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<td>7</td>
</tr>
</tbody>
</table>
(b) Responses To Question 2 - What Were The Good And Successful Points About The Topic?

Written comments were:

"Students enjoyed thinking about 'Do We Depend Upon It?'. Making the list was well received although the order was somewhat suspect. 'Plugs, Fuses And Current' - Questions 1, 2, 3 and 4 were popular although 4(b) proved difficult for all."

"'Do We Depend Upon It?' was interesting for the students as it made them think about where/how electricity is used. Students thoroughly enjoyed the start of the section on 'Plugs, Fuses And Current' and generally this section was well received. 'Safety In The Home' was thought of as important and students did this section rather than any of the other voluntary parts."

"The practical exercises. I found, too, that it was very useful to work out concrete examples with students, e.g. What did it cost to leave their bedroom lights on (by mistake) for a night or a 1/2/3 bar electric fire. So - what time do you go to sleep? What time do you wake? What is the wattage of the bulb/fire? Then find out the costs, etc.."

"'Plugs, Fuses And Currents' allowed practical work to be done in the class. The 'Safety In The Home' poster allowed students to have a break from 'normal' maths."

"'Do We Depend Upon It?' proved to be a nice easy introduction. 'Units Of Electricity' was well received by my group as they regarded it as 'real' maths. 'Plugs, Fuses And Current' included an easy to read leaflet with not too many pages. Students found the practical task of wiring the plug not as easy as they thought they would which resulted in much amusement."
"Most students enjoyed wiring the plug, the only real practical task in the topic. Students got on well with working out units of electricity once the calculation was explained although they still found it difficult."

"This was a very good topic and generally people enjoyed it very much."

(c) Responses To Question 3 - What Were The Bad And Unsuccessful Points About The Topic?

"Working out electricity bills was very tedious with four pages of notes to read before students could get started."

"I think that the main problem with this topic was the use of the little pamphlets. Possibly the language used was complicated and consequently the students found it difficult to glean the necessary information from them (although, in principle, this is something which they ought to be able to do')."

"Those areas of the topic which required a lot of reading and then a written explanation of what the students had read were not very successful."

"Some of the aspects covered were too artificial. Some things were calculated by routine methods with no student understanding."

"Working out the electricity bills was not clear and too long.

"Lighting' involved the reading of material which is somewhat difficult for limited grade students who are at similar stages of development in English lessons. Writing needs greater structure and more careful marking schemes, i.e. more guidance for students if it is to be as successful as 'maths'."
"The section 'Do We Depend Upon It?' needs to be better worded - Questions 1 and 2 sound too similar. Students showed interest in the section 'Working Out Your Electricity Bill'. However, the text was too wordy and the exercise was too abstract. The students needed careful guidance through the various steps. Again working out the 'units used' in the section 'Units Of Electricity' needed a lot of guidance and maybe could have been better laid out."

"'Do We Depend Upon It?' - students were confused. They were not able to distinguish the difference between Questions 1 and 2. 'Lighting' - those students who attempted this were not very successful."

(d) Responses To Question 4 - Have You Any Suggestions For Improvement?

"Maybe a section on fuses blowing or not (colour of fuses, etc.)."

"I think more practical work could be useful, e.g. experiments with circuits and resistors, although this is not perhaps as relevant to their experience as some of the other things."

"It was suggested to me by one of the students that the use of video films would help. For example, 'Safety In The Home' would have had more impact if tackled in this way."

"A more structured approach to answers would have been better in some parts, e.g. for the section dealing with working out electricity bills. Example sheets could show bills worked out in full followed by other sheets with boxes saying:

<table>
<thead>
<tr>
<th>units used</th>
<th>price/unit (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>day</td>
<td>x 5.04</td>
</tr>
<tr>
<td>night</td>
<td>x 1.94</td>
</tr>
<tr>
<td>standing charge</td>
<td></td>
</tr>
<tr>
<td>Total cost</td>
<td></td>
</tr>
</tbody>
</table>
"As with 'The Kitchen' maybe some of the sections could be split into two (although this isn't such a problem as for 'The Kitchen'). Most of the compulsory sections really need to have more guided questions, therefore giving students more confidence to try the work."

"Do We Depend Upon It?" - I suggest that ten rectangular pieces of card are cut. On each card is stated one particular use. Students would be asked to place the cards in order and then copy the information into their books.

'Units Of Electricity' - Students could be directed to find appliances in catalogues and extract information on watts/kilowatts. Examples could be set out in the form 'copy and complete'. If needed work on conversion of minutes to hours and watts to kilowatts could be included.

'Fuses' - Students could be directed to use catalogues to obtain ratings and hence fuse size. Should the section on current be missed out? How relevant is it really?

'Working Out Your Electricity Bill' - This should be appealing but it is very confusing, e.g. 5.09p used for each unit except during night) They all cost for non-night period ) mean the cost for normal daily use ) same thing"

3. Topic - "Our Water Supply"

Number of completed feedback sheets - 8

(a) Responses To Question 1

Values in the table indicate the numbers of teachers ticking particular boxes.

<table>
<thead>
<tr>
<th>Section</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>very few attempts</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Water Cycle</td>
<td>1</td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Water Treatment And Sewage</td>
<td></td>
<td></td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Did You know ... ?</td>
<td></td>
<td></td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Pollution</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Recreational Activities</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>The Cost Of Water</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>
(b) Responses To Question 2 - What Were The Good And Successful Points About The Topic?

Written comments were:

"General levels of interest and application were good throughout the topic though many difficulties were experienced."

"Generally there were fewer really interesting sections in this topic compared with others. Students enjoyed the beginning of 'Recreational Activities' but rapidly became disinterested as the section became too difficult. The sections on 'The Water Cycle' and 'Did You Know ... ?' were reasonably well received but students never appeared to fully enjoy any part of the topic."

"'The Water Cycle' was the most successful section which most students tackled. 'Did You Know ... ?' was alright except students often couldn't handle the pie chart section. We need to closely link core and topic work."

"There was a surprising range of mathematical techniques used in this topic, i.e. pie charts, graphs, percentages, etc. These were presented and used in a natural way as in 'real life'."

"Percentages."

"'Water Treatment And Sewage' was well attempted as was 'Did You Know ... ?' (students thought that this was more like 'proper maths'!). Students who attempted the 'Pollution' section showed a good deal of interest."

"I enjoyed this topic very much. It lends itself to a great deal of further work."

"'The Water Cycle' went very well. Students enjoyed drawing the flowchart and the graph. 'Did You Know ... ?' had all the information on two sides with easily found tables. The work also followed through quite nicely."
(c) **Responses To Question 3 – What Were The Bad And Unsuccessful Points About The Topic?**

"Time! Blocks of material need breaking down into smaller units. Maps for 'Recreational Activities' need to be clearer and more useable."

"It was a very mundane topic with nothing really interesting and appealing in it. In the section 'Recreational Activities' the estimation of distances was extremely difficult as the resorts that students chose were hard to locate on the A.A. map, i.e. the measurement of distances on this map was not easy. 'Water Treatment' and 'Pollution' sections were too much like an English assignment."

"In 'The Water Cycle', some confusion occurred between information on the graph and the more accurate value 1 gallon = 4.55 l. Generally there was too much writing required. Can we think of a way of making it more practically based? Can we link with the biology department in any way?"

"'Recreational Activities' was too difficult."

"The 'Water Cycle' diagram wasn't very well done. Students found it very complicated and tended just to copy the picture in the pamphlet. They had problems with 'Recreational Activities', the sketch maps and calculation of distances proving to be very difficult."

"In 'Recreational Activities' the maps are very large and cumbersome. In general too many leaflets were required - a problem of resources."

"Again faced with a large amount of reading my students were put off, e.g. 'Water Treatment And Sewage'. 'Recreational Activities' was initially well attempted. The problems came with trying to find distances travelled using the A.A. book."
(c) Responses To Question 4 - Have You Any Suggestions For Improvement?

"A structured marking scheme is required for 'Water Treatment And Sewage' and 'Pollution'."

"More practical work is desirable - or rather some kind of practical work somewhere in the topic."

"Generally I found this to be the least successful of the topics. There was too much reading in it. In 'The Water Cycle' there is a need to make it clear to students that a flow diagram is required - students tended to draw pictures. The marking scheme must show what detail is expected under 'Water Treatment And Sewage'. 'Recreational Activities' is too long and needs to be reduced in size although access to better maps might help. (N.B. I suspect the students who tried this topic for me were generally weak and a better response might have occurred with different students.)."

"Some kinds of visual aids to estimate volumes would be very useful."

"A trip to a reservoir, water treatment centre or something similar would be interesting. Perhaps some insight into what would happen if water was cut off for a day might be useful. We could look at countries where there is no water supply like ours."

"I suggest that 'Recreational Activities' should be taken out of the assessed piece section. Could anything mathematical be brought into the 'Pollution' session, e.g. pollution rates, parts per million, etc. (graphical work?)?"

"Rather than having to write a paragraph on a pamphlet they have read, perhaps students could have a passage with missing words which they must complete. 'Recreational Activities' would have been a lot better if the map with all the activities had included a scale."
An attempt has been made to design an attractive common front sheet for all topic work.

On the back of the above sheet boxes are provided for an assessment of the students' work in line with EMREB's requirements.

By completing this in the presence of the student, each person is kept fully informed of his/her performance and progress.

**ASSESSMENT RECORD**

<table>
<thead>
<tr>
<th>Correctness of work</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development and content of topic</td>
<td>15</td>
</tr>
<tr>
<td>Completion of topic</td>
<td>5</td>
</tr>
<tr>
<td>Independence of work</td>
<td>5</td>
</tr>
<tr>
<td>Presentation and logical progression</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>
**TOPIC ASSESSMENT**

For each section attempted a mark out of 10 is placed in the empty box.

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PLEASE LEAVE BLANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE WATER CYCLE</td>
<td>10</td>
</tr>
<tr>
<td>WATER TREATMENT AND SEWAGE</td>
<td>6</td>
</tr>
<tr>
<td>DID YOU KNOW ... ?</td>
<td>5</td>
</tr>
<tr>
<td>POLLUTION</td>
<td>7</td>
</tr>
<tr>
<td>RECREATIONAL ACTIVITIES</td>
<td></td>
</tr>
<tr>
<td>THE COST OF WATER</td>
<td></td>
</tr>
</tbody>
</table>

For each topic students are given an assessment sheet which indicates the sections which they have covered and the marks obtained.
APPENDIX 4.4

Hints And Suggestions For Module Production

1. Watch the level of language very carefully.

2. I suggest that you type the script with double line spacing.

3. Watch the amount of writing on each page.

4. Use pictures wherever you can.

5. Should you back the sheets or not? Typing on one side only means more paper but students complete more sheets thus giving them a sense of pace and progress.

6. Exploit the type faces on your electric typewriter to obtain effects - especially with headings. (I suggest a maximum of three type faces on a page.) Can you use Letraset or equivalent in places?

7. A "Jumbo" typewriter is useful, if you have one, to provide large, clear lettering.

8. Incorporate a system of extra questions/answers sheets on which students can write answers in addition to other sections where answers are written on file paper.

9. Practical work of any kind generates interest.

10. Can you incorporate any work involving the computer?

11. Should you include an open-ended project/investigation type section in each module?
12. Should you include sections for class discussion?

13. Can students be involved with "off the premises" activities, e.g. obtaining information, surveys, etc.?

14. Have you organised input from outside speakers?

15. Videos/films/tape-slide programmes create interest.

16. What about the life of your modules? Can you have hard covers, laminated and spiral bound?

17. Have you planned enough supplementary sheets outside the bound module to allow students who wish to do work at home to do so (without taking the modules away)?

18. A clear answer/marking scheme - simple yet fairly comprehensive - is required for use by students and staff.

19. An assessment sheet to show progress and sections attempted needs to be designed for each module.

20. You need to provide clear instructions for students (and staff) regarding how to use the module.

21. If you are planning practical work you need to design/provide storage facilities for equipment - easy to check for missing pieces and security.

22. You need to provide pigeon holes/boxes, clearly labelled, for modules and supplementary sheets.

23. You need to provide a master record sheet for the teacher to give him/her an overall picture of class/individual progress.

Good Luck!
Layout Of Sheets

1. I suggest that a drawing board, tee square and set squares are useful.

2. For sticking pictures I suggest you use SCOTCH 3M SPRAY MOUNT ADHESIVE rather than Cow Gum. (The Scotch spray costs approximately £3.50 per can but it is economical to use.) Also a set of tweezers is useful for positioning pictures.

3. For paste up guidelines use a LIGHT BLUE PENCIL. This will not show on photocopies.

4. When pasting pictures you will see a line around the edge when photocopied.

You will need to photocopy once, Tippex out the perimeter line and then photocopy again to get a perfect copy which can be used to produce large quantities of sheets for the pupils.
APPENDIX 4.5

Results From A Questionnaire Completed By Pupils At The Grove School, Market Drayton

Number of boy respondents = 10
Number of girl respondents = 9

Age range 14/15 years

Figures given for each question indicate numbers of respondents.

1. Did you enjoy working on the Electricity topic?

   YES 6
   SOME PARTS ONLY 13
   NO 0

2. What were the really good things about it?

   Comments included:
   
   the video
   going round the school counting the lights
   the visitor
   the posters
   wiring the plugs

   All these appeared on most of the students' responses.

3. What were the parts which you didn't enjoy?

   Comments included:

   "The part when Nyree Green nearly blow the school up when she wired a plug up wrong."
"All the writing." (a popular comment)

"The watts and Kw. I found it difficult to learn."

4. Is doing a topic like this in maths different to what you have done before in your maths lessons?

YES 19
NO 0

5. Is it better or worse?

BETTER 11
ABOUT THE SAME 4
WORSE 4

6. Please explain your answer to question 5.

Comments by pupils indicating "better" included:

"In the last class we just worked out of books and it got a bit boring."

"Most of the other classes didn't let you go out of the classroom."

"It is better because you can work at your own speed and it is a lot more interesting than boring maths."

"It is better because more programs."

"It is better because you have more choice."

"Because I am not very good at maths."

"It is better because more television programmes and more exciting."
"Because last year in Mrs. M. maths lesson all we did was write, write every lesson. It is better now well at least we have a break from writing, even though we have 4 lessons a week."

"In the last class we just worked out of books and it was boaring."

Comments by pupils indicating "about the same" included:

"I like to do sums and mathematic as well as topics."

Comments by pupils indicating "worse" included:

"Because it was not like other people doing work. It was remedial."

"It was boring in places."

"It doesn't learn me about fractions, adding quicker, it's boring."

7. What did you think about the way the work was given to you? For example it was put in a booklet form rather than loose worksheets - was this good or not?

GOOD 16
NOT GOOD 3

8. Were the questions easy to read and understand?

MOSTLY YES 16
MOSTLY NO 3

9. Explain your answer to question 8.

Comments from pupils indicating "mostly yes" included:

"they were set out well and explained what to do."
"The questions were easy to understand because they had examples."

"They were easy because they were well explained."

"They were set out properly."

Comments from pupils indicating "mostly no" included:

"Some of it was confusing; you just needed to look closely."

10. Did you feel that the pictures made the booklets more appealing?

YES  13
NO   5
NO RESPONSE  1

11. Did you enjoy the practical work, for example the plug, the poster, the survey, etc.?

YES  13
SOME PARTS  4
NO   1
NO RESPONSE  1

12. Explain your answer to question 11.

Comments from pupils indicating "yes" included:

"the work made the work interesting"

"yes because the poster was O.K. and Vicki Cartwright won the poster competition"

"I liked the plug the best"
"I enjoyed it because it was not like normal maths work, e.g. sums."

"Yes it was enjoyable and it gives you a break from writing."

"because I like to do drawing and mend things"

"it was a lot better and it wasn't boring"

"the practical work made the folder more interesting"

"I like walking round the school counting the lights."

"It was different from normal maths work."

Comments from pupils indicating "some parts" included:

"It was to hard, I did not do the poster."

The comment from the pupil indicating "no" was:

"It was remedial".

13. Did you enjoy the visitor?

YES 17
NO 1
NO RESPONSE 1

14. Please explain your answer to question 13.

Comments from pupils indicating "yes" included:

"She was very helpful."

"Her talk was very interesting."

"She was very nice."
"Because she told us things we didn't know and helped us to find out where electricity comes from."

"It was very interesting and I hope she comes again."

"She explained more clearly about electric and she told us where our power station was."

The comment from the pupil indicating "no" was:

"It was boring."

15. If you were allowed to choose a topic like this to study in your maths lessons (remember that it must contain maths work), could you suggest any titles or themes that would be interesting for you and your friends; for example motor bikes or fashion?

Suggestions included:

letters, fashion, pop groups, cars, lorries, holidays, gas, make-up, hair care, cooking, computers, maths at work, television.

16. Did you enjoy working in small groups?

YES 15
NO 3
NO RESPONSE 1

17. Please tick one of the boxes to show how you would prefer to work.

ON MY OWN 4
IN A SMALL GROUP 14
AS A CLASS 0
NO RESPONSE 1
18. The topic included some work on science and design. Do you think that this made your maths lessons more interesting?

YES 10
NO 8
NO RESPONSE 1

19. Please explain your answer to question 18.

Comments by students indicating "yes" included:

"It made it interesting because it was not the usual maths."

"because it is a mixture of everything not just boring maths I think the topics are a good idea and I hope we do another one."

"because you can put more into a lesson than doing maths"

"because you get a bit of everything"

"It was very good. I think it was brilliant because it teaches a lot about electricity that I never new before."

Comments from pupils indicating "no" included:

"I want to do harder work. Be moved up."

"It did not make it interesting."

"Because I like to do proper maths, example sums, fractions, etc."
Mathematics

Panel 1: Mathematics 5-7
Mathematics happens very early in a child's school life. Recognition of the numerals in both real and abstract situations is vital to understanding and for progression later. Representing information from the class forms the basis for work on graphs. It is important that the child can identify easily with the beginnings of symbolism.

Panel 2: Mathematics 5-7
Counting needs to be taught and arises from the rich experience of handling everyday objects in the classroom. The progression towards a more formal way of recording can be clearly seen.

Panel 3: Mathematics 7-11
Problem solving is at the heart of mathematics and here several problems have been successfully solved. Aspects of pure mathematics can be seen and one child has been encouraged to make up appropriate problems to use his newly gained mathematical skills. It is very important that children both learn skills and learn how to apply these skills in everyday situations.

Panel 4: Mathematics 11-14
An interesting exercise is shown where young secondary children were asked how they could teach fractions to 7 year olds. Notice how they started with real situations and progressed towards abstract problems - a sure way to see if children really understand what they are doing in mathematics lessons.

Panel 5: Mathematics 14-16
This numeracy profile grew out of the need to develop a basic skills package that was recognised by education and employer in the county. A typical profile is shown giving an overview of performance on specific numerical tests. It also shows how the earlier recording has now been formalised into the language of mathematics.

Panel 6: Mathematics 14-16
Older children are encouraged to see the application of mathematics in a variety of situations and the co-operation with industry and commerce is much valued.

Work Displayed For Elected Representatives On The Leicestershire County Council
English

Panel 1 : English 5-7
In the early years at school children write about their own experiences and observations. Part of the pleasure of describing an experience is to illustrate it themselves.

Panel 2 : English 7-11
Here you can see children writing for different purposes. Jane has written a story and Georgina and Aimee have produced a book of information about Dinosaurs. They devised the list of questions themselves, then wrote the title of the book they thought would help, and made a summary of their research.

Panel 3 : English 11-14
In the early years of the secondary school, children enjoy experimenting with form and style, and can enter imaginatively into a wider field of experience.

English

Panel 4 : English 11-14
Anthony's poem was written on a residential week at the Arvon Foundation's centre in Devon. The Arvon Foundation was set up by the poet laureate, Ted Hughes, to encourage writers. Anthony has written several drafts before arriving at his final version.

Panels 5 & 6 : English 14-16
At this stage young people show themselves to be skilled and effective writers in a variety of forms. You can see for example the difference in tone between 'The Letter' and the closely argued description of 'Utopia'.

These two boards illustrate the kind of writing which would form part of folders compiled for CSE and GCE examinations.

English
The Mathematics display

The English display
"Our Water Supply" illustrated how an interrelated approach can effectively be used within mathematics lessons.
APPENDIX 5.1

Module With Teachers' Notes
Called "Packaging For Coffee"

<table>
<thead>
<tr>
<th>Name</th>
<th>Tutor Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>English Teacher</td>
<td></td>
</tr>
<tr>
<td>Project Consultant</td>
<td></td>
</tr>
</tbody>
</table>
TIME ALLOCATION

This project is designed to be completed within 8 weeks. Students should spend approximately 70 mins. per week plus homeworks as required on the work.

OBJECTIVES

By the end of the exercise it is hoped that students should have:

1. devised questions for other people in an appropriate register;

2. carried out a survey;

3. interpreted, understood and evaluated data from a survey;

4. worked with teachers from other disciplines within the school curriculum (via project consultant(s)) and with representatives from outside agencies (business or commerce);

5. presented, in a register appropriate for a given audience, a report, having considered and discussed the importance of handwriting, layout, design, etc.;

6. contributed orally at some stage;

7. produced a piece of work suitable for inclusion in their English Language course work folder;
8. worked in a variety of ways, i.e. individually, and in pairs or groups;

9. developed an appreciation that in English skills of listening, speaking, reading and writing are a powerful means of communication and, as such, form a part of all aspects of science, technology and mathematics.

INTERDISCIPLINARY PLANNING

It is recommended that colleagues from other curriculum areas, e.g. science, technology, mathematics, design etc., are consulted before the project takes place so that their expertise may be tapped. Teachers from other areas of the curriculum will provide a vast range of ideas and suggestions. Ideally the project will be conducted with the help of a teacher from another department (the project consultant). Together the English teacher and the consultant should provide a refreshing approach, different from that either of them might achieve alone.

STUDENT MATERIAL

Students will be provided with a student brief and a project plan, including:

(a) an introduction to packaging;

(b) a section on vocabulary and hints;

(c) pages upon which they can make notes.

In addition information on coffee and bar codes will be made available by the teachers for use in the classroom.

USEFUL SOURCES OF INFORMATION

International Coffee Organisation,
22 Berners Street,
London W1.

British Soluble Coffee Manufacturers' Association,
6 Catherine Street,
London WC2B 5JJ
Coffee Trade Federation,  
69 Cannon Street,  
London EC4N 5AB

The Nestlé Company Limited,  
St. George's House,  
Croydon,  
Surrey.  
CR9 1NR

The Institute of Packaging,  
Sysonby Lodge,  
Nottingham Road,  
Melton Mowbray,  
Leicestershire.  
LE13 0NU

Article Number Association (bar codes)  
6 Catherine Street,  
London WC2 5JJ
Student Brief

A British food company which sells to many well known supermarkets is introducing a new brand of coffee. The company asks you to design and make a container for the coffee which will have:

- sales appeal, i.e. be attractive to look at;
- clear information about the contents;
- a system of sealing the contents in order to keep them fresh.

The work to be done by you before sending your design to the company must include a market research exercise in the form of a survey to give you information about the public's view concerning:

(a) the quantity of coffee which customers prefer to buy in one package;

(b) the shape of the container;

(c) how the container should be opened/closed;

(d) the material to be used in making the container;

(e) the colours of the container and its label;

(f) the type of information that the customer looks at when buying the product;

(g) who buys the coffee in the family;

(h) a suitable name for the product.

* This is explained in the section called "Vocabulary and Hints" which follows later.
The company would like the following from you.

1. A detailed report about the findings of the survey. You should try to make your report easy to read. It should contain diagrams wherever possible to represent the findings, e.g. bar charts*, pie charts*, graphs*, pictograms*, etc.. You may also use a computer*, if you wish, to sort the information. The report must be well presented with an attractive cover. The cover must contain:

   the title - "Packaging for Coffee";

   your name;

   your tutor group.

2. A sketch showing the shape and dimensions of your design. You must give details of any calculations carried out. Work out and write down the area of material used to make your container.

3. A mock-up* of your container made out of card. This should include lettering, illustrations, choice of colours, etc..

4. A statement saying why you think your design is good.

Remember - You may decide to design a completely different style of container from the ones currently found in the shops if you think that it will appeal to the customers more.

Extra Tasks

5. To make a good job of your design you will need to know where coffee is grown and how the coffee in the package is produced. This may also help the company when it starts its advertising campaign. Information about this can be found on the wall display and the resource file provided by your teacher.

Write a report on what you find out for your own reference and for the company.

* This is explained in the section called "Vocabulary and Hints".
Space must be given to a bar code on your package. Look at the classroom resource file and find out about bar codes.

Be prepared to answer questions orally about bar codes.

SUCCESS OR FAILURE

The results of investigations in industry, similar to the one that you are carrying out, can have a big effect upon the success or failure of a company. Good market research can lead to success.

Poor market research can lead to problems.
This project is designed to be completed within 8 weeks. Students will spend 2 x 35 minute periods per week plus homeworks as required on the work. The project, after being written up, will be added to students' English Language course work folders.

N.B. Comments in boxes — these tasks will be carried out in the week between the timetabled sessions.

WEEK 1 Discuss the aims of the project and obtain ideas. Discuss how to organise a questionnaire*, how to ask questions, what to ask, etc.

WEEK 2 Continue with the questionnaire. A final version to be written and typed by one of the group.

QUESTIONNAIRES TO BE DUPLICATED

WEEK 3 VISITOR — Welcome and receive a visitor connected with a coffee company or supermarket who will work with the class and discuss such things as marketing*, sales appeal, packaging, etc.

SURVEY

WEEK 4 Questionnaires returned. The class will discuss how to analyse the information.

A SHEET GIVING A SUMMARY OF ALL THE FINDINGS FROM THE QUESTIONNAIRES WILL BE PRODUCED FOR EACH STUDENT

WEEK 5 Students will receive a sheet giving a summary of all the findings. Students will start writing their reports on the findings from the survey. The reports must be finished for homework.
WEEK 6  Designing the shapes and labels for the package, and making the package.
        Homework - Answer questions 2 and 3 from the student brief.

WEEK 7  Continue with the work from week 6.
        Homework - Answer question 5 from the student brief.

WEEK 8  Provide a front sheet for your work. Sort out your sheets and prepare them, in a folder, ready for marking by your teacher. Small groups will be asked questions orally about bar codes (reference question 6 from the student brief).
There are many definitions of packaging. Three of these are given below.

1. Packaging is the art, science and technology of preparing goods for transport and sale.

2. Packaging is the means of ensuring the safe delivery of a product to the consumer in sound condition at the minimum overall cost.

3. Packaging must protect what it sells, and sell what it protects.

In a manufacturing company, packaging needs to be discussed by many people before it is produced. This, in itself, calls for a lot of communication, both written and verbal.

There are five basic things that people consider when producing a package [1]. These are listed below.

1. Appearance - it must appeal to the buyer.

2. Protection - usually it must protect the contents.

3. Function - it must do specific jobs.

4. Cost - always an important factor.

5. Disposability - how the package can be disposed of when the contents have been used.

With various products each of the five points has a different level of importance. For example:

(a) with make-up, appearance is likely to be very important;

(b) with an aerosol spray, the most important thing is that it works, i.e. function;

(c) with drugs and tablets protection is important;

(d) for a yoghurt tub, appearance, cost and disposability are important.
market research - it is the gathering, recording and analysis of information about the appeal of something to the public.

questionnaire - this is a prepared set of questions which are given to a number of people in order to obtain an overall opinion about a particular thing.

marketing - this is a plan by a company which helps to sell its products to the public. Marketing usually includes advertising in the newspapers, on television, etc.

prototype - this is the first or original full size version of something from which others are copied.

mock-up - this has a similar meaning to prototype.

computer - if you have a computer at home you could try to write a simple programme to sort out the information in the survey. If you do this please put a copy of your programme in your report.

bar charts - these are diagrams which have bars. The heights of the bars tell us certain pieces of information, e.g. how students travel to school.

You must remember to clearly label your diagram.
pie charts - these are diagrams where figures are represented as slices of a pie, e.g. how students travel to school.

You must remember to clearly label your diagrams.

line graphs - Graph showing the times when people go to bed.

Here a line joining up plotted points represents information.

pictograms - these are diagrams in the form of pictures used to present information, e.g. a pictogram to represent the number of bicycles produced each year by a company between 1976 and 1980 might be:

<table>
<thead>
<tr>
<th>Year</th>
<th>Pictograms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td><img src="image1.png" alt="Bicycles" /></td>
</tr>
<tr>
<td>1977</td>
<td><img src="image2.png" alt="Bicycles" /></td>
</tr>
<tr>
<td>1978</td>
<td><img src="image3.png" alt="Bicycles" /></td>
</tr>
<tr>
<td>1979</td>
<td><img src="image4.png" alt="Bicycles" /></td>
</tr>
<tr>
<td>1980</td>
<td><img src="image5.png" alt="Bicycles" /></td>
</tr>
</tbody>
</table>

 représente 1000 bicycles
nets of solids - when making boxes from card you will need to draw the net of the shape, cut this out and then bend to make the shape. Remember to leave suitable flaps for glueing.

e.g. shape net (without fixing flaps)
nets of solids (continued)

shape

net (without fixing flaps)

This shape would also form a pyramid.
MATHEMATICAL (continued)

areas of shapes - common shapes are:

- square
  \[ \text{area} = b \times b = b^2 \]

- rectangle
  \[ \text{area} = b \times h \]

- triangle
  \[ \text{area} = \frac{1}{2} b \times h \]

- circle
  \[ \text{area} = \pi r^2 \]

volumes of shapes - many packages are prisms, i.e. they have parallel sides, e.g.

Volume = base area x height

Other useful volumes are:

Volume of a pyramid = \( \frac{1}{3} \) base area x height = \( \frac{1}{3} \)abh

Volume of a cone = \( \frac{1}{3} \) base area x height = \( \frac{1}{3} \pi r^2 h \)
We are carrying out a survey into the views of the public regarding packaging for coffee. It would help us very much if you could answer the following questions. In each question please could you only tick ONE box.

1. Who buys the coffee in your house?
   - MUM
   - DAD
   - GRANDMOTHER
   - GRANDFATHER
   - CHILDREN up to the age of 16
   - (OTHER)

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUM</td>
<td>174</td>
</tr>
<tr>
<td>DAD</td>
<td>28</td>
</tr>
<tr>
<td>GRANDMOTHER</td>
<td>7</td>
</tr>
<tr>
<td>GRANDFATHER</td>
<td>3</td>
</tr>
<tr>
<td>CHILDREN up to</td>
<td>12</td>
</tr>
<tr>
<td>the age of 16</td>
<td></td>
</tr>
<tr>
<td>(OTHER)</td>
<td></td>
</tr>
</tbody>
</table>

2. What amount of coffee in one container does your family like to buy?
   - SMALL CONTAINER (e.g., 100g)
   - MEDIUM CONTAINER (e.g., 200g)
   - LARGE CONTAINER (larger than 500g)

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL CONTAINER</td>
<td>47</td>
</tr>
<tr>
<td>MEDIUM CONTAINER</td>
<td>136</td>
</tr>
<tr>
<td>LARGE CONTAINER</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDIUM CONTAINER</td>
<td>136</td>
</tr>
<tr>
<td>LARGE CONTAINER</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGE CONTAINER</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>(NO ANSWER)</td>
<td></td>
</tr>
</tbody>
</table>
1. Which shape of container do you find the most attractive?

2. How do you prefer to open/close the container?

- Hinged Top: 23
- Slide-on Top: 14
- Screw Cap: 115
- Push-on Lid: 49
- Cork: 25
- Other: 1

If other, please would you explain: (No answers)
5. What material do you prefer the package for coffee to be made from?

<table>
<thead>
<tr>
<th>Material</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>122</td>
</tr>
<tr>
<td>Cardboard</td>
<td>20</td>
</tr>
<tr>
<td>Plastic</td>
<td>33</td>
</tr>
<tr>
<td>Tintlated</td>
<td>46</td>
</tr>
<tr>
<td>Wood</td>
<td>7</td>
</tr>
<tr>
<td>(No answer)</td>
<td></td>
</tr>
</tbody>
</table>

6. Which colour of container do you find the most attractive for coffee?

<table>
<thead>
<tr>
<th>Colour</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>60</td>
</tr>
<tr>
<td>Red</td>
<td>32</td>
</tr>
<tr>
<td>Green</td>
<td>14</td>
</tr>
<tr>
<td>Brown</td>
<td>26</td>
</tr>
<tr>
<td>Orange</td>
<td>10</td>
</tr>
<tr>
<td>Pink</td>
<td>10</td>
</tr>
<tr>
<td>Clear</td>
<td>71</td>
</tr>
<tr>
<td>White</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>(No answer)</td>
<td></td>
</tr>
</tbody>
</table>

   if other, please state__________________________

7. What is the most important information in a coffee label that you look for?

<table>
<thead>
<tr>
<th>Information</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingredients</td>
<td>25</td>
</tr>
<tr>
<td>Where it is made</td>
<td>4</td>
</tr>
<tr>
<td>Weight</td>
<td>20</td>
</tr>
<tr>
<td>Brand name</td>
<td>127</td>
</tr>
<tr>
<td>Slogan</td>
<td>5</td>
</tr>
<tr>
<td>Best before date</td>
<td>37</td>
</tr>
</tbody>
</table>
The following names have been suggested for a new blend of coffee:

- Which one do you like the most?

<table>
<thead>
<tr>
<th>Name</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Pot Coffee</td>
<td>24</td>
</tr>
<tr>
<td>Night Coffee</td>
<td>26</td>
</tr>
<tr>
<td>Le Cafe Coffee</td>
<td>34</td>
</tr>
<tr>
<td>Coffee Blend</td>
<td>26</td>
</tr>
<tr>
<td>Sun Blend Coffee</td>
<td>40</td>
</tr>
<tr>
<td>High Rise Coffee</td>
<td>14</td>
</tr>
<tr>
<td>Nice Coffee</td>
<td>16</td>
</tr>
<tr>
<td>Brazilian Best Coffee</td>
<td>50</td>
</tr>
</tbody>
</table>

Thank you very much for your help.
(b) Fourth Year Britons Class

**Caffeine We Choose**

For each question below please tick ONE box.

1. Are you male or female?  
   - MALE 31  (Spilled 2)  
   - FEMALE 40

2. How old are you?  
   - 10-20 53  
   - 21-30 22  
   - 31-40 16  
   - 41-50 20  
   - 51-60 7  
   - 61-70 5  
   - Over 70 -

3. Does your family buy coffee in small (100) 27  (Spilled 6)  
   - Median (200g) 62  (No answer 5)  
   - Large (500g over) 21

4. What shape container appeals to you most?
   - 7  
   - 8  
   - 39  
   - 1  
   - 39  
   - 29
5. How would you prefer to open and use the package holding coffee?
   - Screw top [82]
   - Snap down lid [32] (NO ANSWER)
   - Other [4]
   IF OTHER EXPLAIN

6. In what material do you like coffee to be packaged? Glass [33]
   - Plastic [15]
   - Tin plate [14]
   - Cardboard [5]
   - Other [2]
   IF OTHER EXPLAIN (NO ANSWER)

7. What colour coffee would you most want? Red [23]
   - Blue [6]
   - Green [7]
   - Brown [29]
   - Yellow [5]
   - White [32]
   - Clear [82]
   - Fluorescent pink [11]
   - Other [5]
   IF OTHER EXPLAIN (NO ANSWER)

8. What is the most important information on the label?
   - Ingredients [44]
   - Brand name [54]
   - Directions for use [7]
   - Quantity [7]
   - Other [3]
   IF OTHER EXPLAIN (NO ANSWER) (Spilled)

9. Who usually buys coffee in your family? Mum [103]
   - Dad [10]
   - Children [7]
   - Grandmother [0]
   - Grandfather [1]
   (NO ANSWER)
10. The following names have been suggested which do you prefer?

<table>
<thead>
<tr>
<th>Name</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnival Coffee</td>
<td>14</td>
</tr>
<tr>
<td>Soothing</td>
<td></td>
</tr>
<tr>
<td>to celebrate</td>
<td></td>
</tr>
<tr>
<td>Carno Coffee - Coffee</td>
<td>1</td>
</tr>
<tr>
<td>Fluorescent wondere</td>
<td>4</td>
</tr>
<tr>
<td>Coffee</td>
<td></td>
</tr>
<tr>
<td>Sunbeam Coffee</td>
<td>21</td>
</tr>
<tr>
<td>Coffee Time</td>
<td>10</td>
</tr>
<tr>
<td>Make quick Coffee</td>
<td>4</td>
</tr>
<tr>
<td>Great grain Coffee</td>
<td>5</td>
</tr>
<tr>
<td>Sunshine Coffee</td>
<td>12</td>
</tr>
<tr>
<td>Wannam Coffee</td>
<td>15</td>
</tr>
<tr>
<td>Pine Coffee</td>
<td>1</td>
</tr>
<tr>
<td>Neat Coffee</td>
<td>5</td>
</tr>
<tr>
<td><strong>(SUNBSH)</strong> (NO ANSWER)</td>
<td></td>
</tr>
</tbody>
</table>

Thank you very much for your time in completing this questionnaire.
APPENDIX 6.1

Project Diary
## WEEK 1 COMMENCING JANUARY 7th 1985

### THE PHARMACEUTICAL INDUSTRY - PART 1 - "A GENERAL INTRODUCTION"

<table>
<thead>
<tr>
<th>DAY</th>
<th>JAN 7th</th>
<th>JAN 8th</th>
<th>JAN 11th</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MONDAY</td>
<td>TUESDAY</td>
<td>FRIDAY</td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td></td>
<td>GROUP SESSIONS</td>
</tr>
<tr>
<td>1/2</td>
<td>ASSIGNMENTS</td>
<td>ASSIGNMENTS</td>
<td>VISIT - 3M HEALTH CARE</td>
</tr>
<tr>
<td>3/4</td>
<td>VISIT - ME A FRESH QUALITY CONTROL MANAGER, 3M HEALTH CARE - FIRST TALK ON &quot;GOOD MANUFACTURING PRACTICE&quot;</td>
<td>ASSIGNMENTS</td>
<td>HEALTH CARE</td>
</tr>
<tr>
<td>5/6</td>
<td></td>
<td>VISIT TO 3M, HEALTH CARE OFFICE, SMEAR MICROSCOPY, VISION TEST, PHARMACEUTICAL INDUSTRY</td>
<td>ASSIGNMENTS</td>
</tr>
<tr>
<td>7/8</td>
<td></td>
<td></td>
<td>TECHNICAL COLLEGE</td>
</tr>
</tbody>
</table>

### NOTES

1. Assignments - please see instruction sheet - worksheets 1 and 2 and written assignment on "how a drug is discovered and developed"

2. Visitors - Mr. Fryer will arrive at reception at 11.15 a.m. on Monday Jan. 7th
   - Mr. Willimont will arrive at reception at 9.30 a.m. on Tuesday Jan. 8th

3. Visit (Friday) - You are asked to meet at 3M Health Care, Derby Road site at 9.30 a.m. You may buy your lunch at 3M canteen (excellent quality!). In the afternoon (1.30 - 3.00 p.m.), Mrs. K. Deakin, Training Officer, will work with you in 3M Health Care Training Centre.

### DEADLINES

Assignments to be handed in by FRIDAY 18th JANUARY

*** PLEASE BRING IN EXAMPLES OF PHARMACEUTICAL PACKAGING AND OTHER PACKAGING READY FOR MONDAY 14th JANUARY ***
### Notes

1. **Visitor** - Mr. Dean is an expert on packaging. He lectures in many parts of the world. He will arrive at the foyer (reception) at 9.30 a.m..

2. **Assignments** - Try as much as you can; we don't expect that you will finish everything.
   - On the bar codes section, you should finish the section on ISBN numbers for homework.

3. **"Use of colour"** - Mrs. Dawson has kindly volunteered to organise paints/brushes and paper. Any problems - please could you see her.

### Deadlines

Written work on this section to be handed in by **Friday 25th January**.
<table>
<thead>
<tr>
<th>DAY</th>
<th>JAN 21st</th>
<th>JAN 22nd</th>
<th>JAN 25th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>1/2</td>
<td>3/4</td>
<td>5/6</td>
</tr>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areas and Volumes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areas and Volumes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visitor - Dr. Chippendale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Packaging in the Pharmaceutical Industry&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical College</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style and Methods of Lettering - Adrian Wood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nets of Solids</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**

1. Visitors - Dr. Chippendale is an expert on packaging. He will arrive at reception at 9.30 a.m. - Adrian Wood is a talented designer/artist currently working with Mr. Elliott. You will have seen some of his work around College in the form of posters.

2. Assignments - Try as much as you can.

**DEADLINES**  Written work on this section to be handed in by FRIDAY 1st FEBRUARY
1. Obtain a copy of the project brief.

2. DEADLINE - you must have your design complete by FRIDAY 1st FEBRUARY (PERIOD 7)
   DEADLINE - you must have "written up" your project by FRIDAY 8th FEBRUARY

3. * VISITORS - FRIDAY 1st FEBRUARY - Mr. N. EDWARDS 1/c Marketing at Fisons
   Mr. G. WILLIMONT
   + possibly Mr. DEAN
   They will be arriving at reception at 1.45 p.m. - they will discuss with students their projects, etc..

* This visit did not take place owing to students having problems with deadlines for completion of packages.
### THE PHARMACEUTICAL INDUSTRY - PART 3 - "THE WORKING ENVIRONMENT"

#### WEEK 5  COMMENCING FEBRUARY 4th 1985

<table>
<thead>
<tr>
<th>DAY</th>
<th>MONDAY</th>
<th>TUESDAY</th>
<th>WE/D</th>
<th>FRIDAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERIOD</td>
<td>1/2</td>
<td>3/4</td>
<td>5/6</td>
<td>7/8</td>
</tr>
<tr>
<td>GROUP1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Light And The Eye

- **Visitors** - Mr. Fish and Sister Walker are involved in making sure that workers have a clean, safe place in which to work. They will be arriving at reception at 9.30 a.m.

- **Equipment** - Mrs. Elliott - Biology Dept. - has kindly volunteered to organise equipment for practical work - any problems please contact Mrs. Elliott. Look carefully at the tasks set - you may have to borrow equipment at the start of the section to give you time for everyone to have a go.

#### Technical College

- Health, Disease and Hygiene

### NOTES

1. Visitors - Mr. Fish and Sister Walker are involved in making sure that workers have a clean, safe place in which to work. They will be arriving at reception at 9.30 a.m.

2. Equipment - Mrs. Elliott - Biology Dept. - has kindly volunteered to organise equipment for practical work - any problems please contact Mrs. Elliott. Look carefully at the tasks set - you may have to borrow equipment at the start of the section to give you time for everyone to have a go.

### DEADLINES

Written work on these sections to be handed in by **FRIDAY 15th FEBRUARY**
### NOTES

1. **Visitor** - We are hoping to secure a visit by a factory inspector - negotiations are still taking place. He/she should arrive at reception at 9.30 a.m.

2. **Equipment** - Some will be needed for the "ear" section. Mrs. Elliott has kindly volunteered to organise this - any problems please see Mrs. Elliott.

### DEADLINES

- Work from the "Sound, Noise and The Ear" section to be handed in by **MONDAY 25th FEBRUARY**
- Work from the case study will be continued next week - completed work to be handed in by **MONDAY 25th FEBRUARY**

*This visit did not take place owing to limitations of resources ref. H.M. Factory Inspectorate.*
MONDAY & TUESDAY, FEB 18th & 19th - CONTINUE WITH ASSIGNMENT "A CASE STUDY ON WORK SAFETY"

Remember - Friday is a holiday! - enjoy yourselves

- the deadline for your written work on the case study is MONDAY 25th FEBRUARY

You have 8 periods to attempt the topic "TEMPERATURE". This will then complete the work on the pharmaceutical industry.

The deadline for written work on "TEMPERATURE" is MONDAY 4th MARCH
APPENDIX 6.2

Sample Assignments From A Module Based Upon "The Pharmaceutical Industry"
THE "COLOUR WHEEL"

Equipment needed:— (1) paints — red, yellow, blue, black, white
(2) brushes
(3) A3 white paper

The object of this exercise is to introduce you to the skills required in order to mix colour pigments by drawing and painting colour wheels (two versions possible — a simple one and also a more complicated one).

All colours used will be made by mixing three primary colours — red, blue and yellow — to make secondary colours — orange, purple and green. Black and white will be used to make light and dark shades/tones.

PLEASE TRY THE COMPLICATED VERSION IF YOU CAN

Simple Colour Wheel

(1) On an A3 sheet of white paper draw the "wheel" as big as possible (please see sheet 4)

(2) Begin by painting the three "primary" colours in the centre ring as shown on the diagram (sheet 4)

(3) Mix "secondary" colours using the two adjacent primaries, e.g.
   BLUE + YELLOW = GREEN
   RED + YELLOw = ORANGE
   RED + BLUE = PURPLE
(4) Make pale tones of each colour by adding WHITE - paint these in the centre segments of the wheel.

(5) Starting Again With Pure Colours add BLACK to each colour to make dark tones and paint in outer areas of the wheel.

* NOTE It is important to start again with new colour mixes - if black is added to the pale tones, a greyish colour will result.

Complicated Colour Wheel

The method for this "wheel" is similar to that of the simple one except that step (3) needs to be extended (please see sheet 5), e.g.

\[
\begin{align*}
\text{BLUE} + \text{BLUE} + \text{YELLOW} &= \text{BLUEY GREEN} \\
\text{BLUE} + \text{YELLOW} &= \text{GREEN} \\
\text{BLUE} + \text{YELLOW} + \text{YELLOW} &= \text{GREENY YELLOW}
\end{align*}
\]

Further Tasks

(1) Using the colour wheel colours you have made mix and paint blocks of the following colours:

(a) warm, dark blue 
  cool, light blue
(b) warm, dark green 
  cool, light green
(c) warm, light orange 
  cool, dark orange
(d) warm, light red 
  cool, dark red

(2) Cut blocks (or patches) of colour from pictures in old magazines and make two collage/patchwork designs exploring the effects of colours.

(a) Use "complimentary" (opposite) colours to create a dazzling effect, e.g. blue with orange or red with green

(b) Use "related" colours to create a harmonious effect, e.g. a cool, calm atmosphere or a warm, cosy atmosphere.
(3) Can you relate colours to pharmaceutical product packaging? Try to arrange groups of colours – either painted or collage – to represent two of the following:

(a) cool and clinical  
(b) clean and hygienic  
(c) hot and spicy  
(d) sharp and fresh  
(e) natural and earthy  
(f) soft and gentle

Each group must consist of at least three colours.
You are going to investigate the hearing ranges of the people in your group. You will be using a signal generator. This produces a buzzing sound which can be changed from a low hum to a high pitched whistle. This is caused by a change in the frequency of the sound.

Individual people have differences in sensitivity to frequency, or we can say they have differences in their range of hearing.

By turning the dial we can raise the frequency.

When the dial is set for a low frequency you may not hear any sound. This is because the frequency is out of your range of hearing.

Turn the dial until you can hear a low hum (write down the frequency). Continue turning the dial and resetting the frequency using the switches until you can no longer hear the high pitched whistle (write down the frequency).
(1) Fill in the table to show different people's range of hearing.

<table>
<thead>
<tr>
<th>Person</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low frequency</td>
</tr>
<tr>
<td></td>
<td>high frequency</td>
</tr>
</tbody>
</table>

Our ears usually detect frequencies between 20 and 20,000.

(2) How do your subjects compare to this?

The sensitivity of the ear varies from person to person and also changes with age. Usually young children can detect higher frequencies than adults.

(3) Do your results support this statement?
Very high frequency sound can damage your ears.

(4) What may produce this type of sound?

(5) Are there any jobs which may be affected by high frequencies?
APPENDIX 6.3

Student Feedback

This was written on a weekly basis in line with the student diary.

Week 1  Number of responses - 15

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>DID NOT DO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitor - Mr. Fryer, 3M Health Care (film about good manufacturing practice and talk)</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Visitor - Mr. Willimont, Fisons (video about Fisons and samples of bottles, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning Visit (3M Health Care)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Session p.m. - (3M Health Care)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Worksheet On The Pharmaceutical Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;How A Drug Is Discovered&quot;</td>
<td></td>
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</tr>
<tr>
<td>&quot;Medicines And Their History&quot;</td>
<td></td>
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</tr>
</tbody>
</table>

Questions 2 and 3
The obvious highlight of the week was the visit to 3M Health Care. As one student remarked "It was very interesting and informative." Various students didn't enjoy the worksheets but, however, there was no obvious major dislike for any part of the week's work.
Week 2  Number of responses - 14

Question 1

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td>Analysis of Existing Packaging</td>
<td>4</td>
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<td>9</td>
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<tr>
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<td>2</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Use of Colour (Colour Wheel, etc.)</td>
<td>1</td>
<td>4</td>
<td>1</td>
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<tr>
<td>Article Numbers and Bar Codes</td>
<td></td>
<td></td>
<td>1</td>
<td>4</td>
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</tbody>
</table>

Questions 2 and 3
Many students enjoyed the exercise on the colour wheel.
Surprisingly article numbers and bar codes was the most popular activity. Mr. Dean had much support when he provided a most interesting talk. For some students his talk, which took approximately 50 minutes, was too long and they lost concentration.

Week 2  Number of responses - 13

Question 1

<table>
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<tr>
<th>ACTIVITY</th>
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<td>2</td>
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<td>Nets of Solids</td>
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</tbody>
</table>

Questions 2 and 3
One student sums up Week 3 by saying "I found everything quite good". Another says "Dr. Chippendale was very good". Many students commented that they had "enjoyed the maths" in both 'area and volumes' and 'nets of solids'. Overall comments indicate that the assignments set for students were quite well received.
Week 4 Number of responses - 11 (some students had difficulty in getting to school owing to a heavy snowfall)

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>1</th>
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<tbody>
<tr>
<td>Actual Design Of Box, i.e. Net Of Solid</td>
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<td>Making The Shape</td>
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<td>Designing Cover and Label</td>
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<td>4</td>
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<td>Short Report</td>
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<td>2</td>
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<tr>
<td>Details, For Company, Of Materials, Top, etc.</td>
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<td>2</td>
<td>4</td>
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<td>Market Research Exercise</td>
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</tbody>
</table>

Questions 2 and 3
Comments supported ticks on the grid. Students had obviously enjoyed designing and making the box and label. The written part of the project didn’t rate as highly as the practical aspects.

Week 5 Number of responses - 10 (some students were attending work experience sessions at the time of the feedback session.)

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>1</th>
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<tr>
<td>The Eye</td>
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<td>Sect. 1 - The parts of the eye</td>
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<td>Sect. 3 - How do we see? - practical work with lenses</td>
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<td>Sect. 4 - Lenses</td>
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<tr>
<td>Sect. 5 - Defects of the eye - long sight, short sight</td>
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<tr>
<td>Sect. 6 - Lighting in the various rooms of a house</td>
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<td>Sect. 7 - Measuring light levels around the College</td>
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continue
Week 5 - Question 1 continued

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<td>Sect. 1 - Working conditions</td>
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<td>Sect. 3 - Cleanliness - The Agar Plates</td>
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<td>Sect. 4 - Protection - destroying bacteria</td>
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<td>Visitors - Mr. Fish, Safety Officer</td>
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<td>3</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Sister Walker, Nurse</td>
<td></td>
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</tbody>
</table>

Questions 2 and 3

Most students commented upon how much they had enjoyed attempting the work on the eye. The visitors, Mr. Fish and Sister Walker, had provided "a very interesting talk" according to one student. Several students commented that there had been "too much work" and/or "too many worksheets".

Week 6  Number of responses - 11

Question 1

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>1</th>
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<th>3</th>
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<tbody>
<tr>
<td>Sound, Noise and The Ear</td>
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<tr>
<td>Sect. 1 - Sound, types of sound</td>
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<tr>
<td>Sect. 2 - What is sound? Units of sound, etc.</td>
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<tr>
<td>Sect. 3 - Detecting sound, label diagram of the ear</td>
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<td>6</td>
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</tr>
<tr>
<td>Sect. 4 - How does the ear work? How do we hear?</td>
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<td>4</td>
<td>2</td>
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<tr>
<td>Sect. 5 - Measuring your range of hearing</td>
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<td>Sect. 6 - Measuring sound - using a sound meter</td>
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<tr>
<td>Sect. 7 - Levels of sound - graphs, tables, bar charts</td>
<td>1</td>
<td>2</td>
<td>4</td>
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</tbody>
</table>
Questions 2 and 3
Comments were very diverse in nature. Overall, students enjoyed many sections of work on both the ear and the case study. Several students commented that "there were too many worksheets".

Week 7
No feedback as all students were on work experience placements.

General Comment
Student responses to Question 1 indicate that the vast majority of the work provided for them had been quite well received. The feedback sheets revealed that most students had attempted nearly all of the sections. Others had several omissions in any one week.

Responses to questions 2 and 3 were not well thought out and were mainly a written summary of what was indicated on the grid. They were content to write very short answers. The word boring or "boaring" occurred frequently in Question 3. This is the easy way for students to describe some of the activities. (Perhaps research is needed into what students perceive the word to mean!)
APPENDIX 7.1

Examples Of In-Service Training Courses For School Teachers Organised In Conjunction With The Leicestershire County Mathematics Advisers
REPORT

"THE ENRICHMENT OF OUR CURRICULUM BY MEANS OF PRACTICAL PROBLEM SOLVING"

WILLIAM DAVIS BUILDING SITE AND BEAUMANOR HALL, WOODHOUSE EAVES

FRIDAY, 22ND JUNE 1984
May we thank all the course participants for their contributions to the day. We are especially grateful to Ernie Moore for his enthusiasm and support in promoting the day's activities, to Maurice Edwards and Stewart Friis for their help and encouragement and, lastly, to Roger Bradley for taking slides at the building site.
9.15 - 9.30
Assemble at Beaumanor Hall

9.50
Arrive at William Davis building site, Shepshed

10.00 - 10.15
Introduction by Mr. Ernie Moore,
Personnel and Training Manager,
William Davis Limited, Loughborough

10.15 - 12.30
Observation of the many activities and tasks performed on the building site. Opportunities will arise for teachers to have brief discussions with both craftsmen and trainees.

1.00 - 2.00
Lunch - Beaumanor Hall

2.00 - 2.15
Introduction to the afternoon's activities by Mr. Ernie Moore

2.15 - 2.45
Identification of the skills used by personnel on the building site. This session will enable teachers to work in small groups and is aimed at analysing the observations made during the morning visit.

2.45 - 3.15
Plenary Session - an opportunity to pool ideas and have open discussion.

3.15 - 3.30
Tea

3.30 - 4.00
Production of ideas on how practical aspects observed in the morning could be incorporated into our teaching programmes within schools. Small groups will be asked to list skeleton ideas on paper and hand them in at the end of the session.

4.00 - 4.30
Ideas by teachers currently working on topics associated with practical real-life situations in schools -

Eddie Gosling - Woodbrook Vale High School, Loughborough

Rod Bond - Burleigh Community College, Loughborough
SESSION REPORTS

10.00 - 12.30 Visit to William Davis Limited Building Site -  
"Foxwood", Leicester Road, Shepshed

Introduction

Mr. Moore gave a brief introduction. William Davis Ltd. employ approximately 650 people and have an annual turnover of £25 000 000. They are involved in both new house building programmes and house modernisation as well as industrial and commercial projects.

"Training officers in industry need to continually up-date themselves with important trends in education" said Mr. Moore. He felt that teaching was an insular profession. He welcomed and encouraged visits by teachers as a means whereby they can become acquainted with what really happens in industry and subsequently appreciate the type of trainees required.

For the building industry, some academic success was required of applicants wishing for formal training by the Company but many other qualities were valued, e.g.

(1) candidates should have an enquiring mind;

(2) they should be "busy" people and be taking an interest in a variety of activities, e.g. have a paper round, have a range of hobbies, etc.;

(3) they should be able to communicate effectively both by written word and verbally;

(4) they should have certain social skills, i.e. to be able to work happily with others and especially to work as a member of a team;

(5) they should possess self-discipline especially in relation to safety matters on site - Mr. Moore felt that discipline in schools generally leaves much to be desired.

The idea of a profile for each student is warmly welcomed by industrialists as a means whereby the qualities listed above (and others) could be assessed when appointments of trainees are made.
The relevance of mathematical topics taught in schools to real-life situations was important as a means whereby students could be motivated to work hard and not be "switched-off" as appears to be the case with many students in their last years at school.

**Site Visit**

Points noted which may be of some use to the mathematics teacher included:

1. A piece work system is in use;
2. Templates are used for cutting arcs;
3. Bending allowances are needed for pipes;
4. Allocation of space is made for gardens;
5. Room allocation in buildings is varied, e.g. "batchelor pad";
6. Vertical and horizontal measures are important;
7. Surveying is used for marking out sites;
8. Every dimension was metricated - all drawings are in metric and nearly all materials are supplied in metric sizes - Mr. Moore felt that continued use of imperial units confused craftsmen and trainees and held back the full introduction of the metric system;
9. Local authorities have great power with regard to planning new building complexes;
10. Market research is used by the building company to ascertain types of buildings that will sell;
11. The sequence of jobs on a building site is important - use of flow diagrams and bar charts;
12. Kitchen layouts involve art, design and technical drawing - these are subject to certain regulations;
(13) craftsmen have to work from drawings which automatically involve tolerances; 

(14) checking for squareness involves basic mathematical concepts; 

(15) the height of lintels, doors, etc. are set using a storey rod; 

(16) bricklayers need to be able to calculate/estimate the number of bricks required for a particular job — at times they meet geometrical constructions, e.g. curved brickwork and arches, using wooden templates made on site; 

(17) volumes of material to be removed from foundations have to be estimated — this, for example, helps to decide how many lorries are required; the amount of concrete has to be calculated; 

(18) the carpenter on site needs a good understanding of certain geometrical properties, e.g. cutting wooden roof structures; 

(19) craftsmen need to be able to read and interpret geometrical drawings, e.g. plan, front and end elevations; 

(20) plumbers need to be able to calculate — heat losses 
   - size of pipes 
   - boiler sizes 
   - number of radiators; 

(21) electricians meet formulae involving current, voltage and resistance.

Deputy Site Foreman 

The Deputy Site Foreman gave his view regarding the main mathematical skills encountered on site:—

approximation/estimation — very important 
money — relating to costs of materials and wages 
percentages — percentage increases and decreases 
areas 
volumes
Paul - a trainee in his last year of training

Paul said, with conviction, that school for him had been boring. "All we did in our maths lessons was use books - there was no practical work at all. I'm not surprised that so many kids are turned off maths."

In spite of the importance given to the use of calculators in schools, Paul pointed out that it was impractical to have calculators on site. The men worked very well without them.

THE PROGRAMME FOR THE AFTERNOON SESSION WAS REARRANGED SLIGHTLY.

2.00 - 3.00 Identification of Skills Used by Personnel on the Building Site

(1) Estimation was important. "Back of envelope" calculations were carried out without the use of a calculator due to practical considerations. Employees gained in confidence with practice.

(2) Teamwork was very important on the building site. In schools children are taught to work on their own for a large proportion of the time. Mr. Moore felt that more opportunities for teamwork should be made available.

(3) An understanding of tolerances and accuracy appropriate to the task was essential. An understanding of cumulative tolerance was important.

(4) Craftsmen needed an understanding of basic geometry, e.g. a carpenter for roofing joints, a bricklayer for making curved arches and checking squareness.

(5) Craftsmen had to have a knowledge of strength of materials.
SUGGESTED PROJECTS SUITABLE FOR USE IN SCHOOLS (AS A RESULT OF THE DISCUSSIONS)

1. The design of a house, both exterior and interior, dealing with both aesthetic and functional appeal. This could involve:

   (a) scale drawings;
   (b) pictorial/3 dimensional views;
   (c) making models;
   (d) a market research exercise involving collection, analysis and representation of data.

   Designs of kitchens and bathrooms may well be an interesting project.

2. The design of roads, drives and gardens associated with a new building site. This could include much incidental information such as types and cost of plants, shrubs and trees, etc.

3. Estimation - the number of bricks/amount of mortar for a building plus the relevant costs.

4. The use of concrete - ingredients, their properties and costs together with related problems based upon ratio.

5. The design of devices for checking that surfaces are level and/or vertical.

6. The basic surveying of a site.
7. An investigation into the cost of buildings and how companies make a profit.

8. The materials used and layouts required when connecting basic services, e.g. gas, electricity, water and drains, to a property.

3.00 - 3.30 An Opportunity For Mr. Moore To Comment Upon What He Would Like To See In Schools

Comments made include:-

(1) The need for a broad curriculum was accepted and whole-heartedly supported.

(2) There is a need to develop social skills amongst students. Communication, both written and verbal, is of the utmost importance. Trainees in industry need to work harmoniously with others as a team. They need to be able to discuss problems/approaches in a sensible, logical manner.

(3) Schools should make every effort to produce individual student profiles to assist training officers in selection procedures.

(4) Discipline is important - in some schools this leaves much to be desired.

(5) The "basics" are important.

(6) Mathematics should be made more relevant to students' current and projected experiences as a means whereby they are motivated to work hard.

(7) Mental arithmetic is important as well as a sound knowledge of tables which is always needed.

(8) Problems of a practical nature are useful.

(9) Reading of engineering drawings/use of scales are very important.
Eddie Gosling outlined how the staff at Woodbrook Vale High School use an interrelated approach to their teaching. A "centre of interest" is chosen and all the specialist teachers work together to form links across the curriculum. Their philosophy is to adopt a skills based curriculum.

In the first and second years students spend 50% of their school time with a "base" teacher. During this time students study Mathematics, English, Science and Humanities. In the other half of their time students go to specialist lessons such as Design, French, Expressive Arts, Games, etc. Double and triple rooms with teams of teachers are used which means that specialists are available in base time to give guidance, thus making their approach very flexible. Mr. Gosling described some of the activities which had been introduced at Woodbrook Vale, e.g.

(a) an exercise involving entrepreneurial skills - each class in a particular year were given £5 to spend and were asked to devise methods for making a profit; they became involved in various activities which resulted in every class making a profit, the lowest net profit being 230%;

(b) an investigation into the aesthetic appeal and functional design of packaging; he illustrated this with samples of his students' work and a basic Easter egg box.

He emphasised that with a skills based approach to teaching, dialogue and interchange of ideas between teachers with differing interests and backgrounds brought about refreshing ideas which were proving to be both stimulating and exciting to the vast majority of students.
Feedback From The Participants

Alison Walker - She had enjoyed the day and would welcome the opportunity to visit other industries. She felt that the exercise would also have been very useful for more established teachers.

Christine Darke - She had enjoyed the day. She would like to try a project in schools based upon the design of a kitchen.

Tony Chanter - He had enjoyed the day. It had given him an insight into the construction industry. He was very interested to learn more about Woodbrook Vale's approach.

Harish Raithatha - He had learned a lot about the building trade. He was impressed by the approach adopted by Woodbrook Vale and would welcome the opportunity to visit the school.

Maurice Edwards - He was excited to get into the world of work and to see, at first hand, how parts of the school curriculum could be applied.

Ernie Moore - He emphasised the importance of closer liaison between industry and schools. He hoped that teachers are becoming more aware of the importance of social skills and would make a special effort to encourage group activities in the classroom. "We want children who have confidence and the ability to think for themselves and adapt where necessary." He was excited about the approach currently being adopted by Woodbrook Vale.

Final Comment

The day encouraged dialogue between teachers and teachers, and between teachers and an industrial training manager. Interchange of ideas and sharing views must be of benefit to all concerned and ultimately result in a more realistic approach to curriculum development. The course was poorly supported and yet those who attended thought it to be worthwhile as well as being enjoyable.
REPORT

"SCHOOL MATHEMATICS AND PARENTS, THE COMMUNITY AND INDUSTRY/COMMERCE"

BEAUMNOR HALL, WOODHOUSE EAVES - WEDNESDAY 15TH JUNE 1983
May I thank all the course participants for their contribution to the day, the visitors for their willingness to take part, Roger Bradley for taking photographs, Peter Morley, Dave Bushell and their staff for the most informative visit, Maurice Edwards and Stuart Friis for their help, encouragement and support in organising the day's events.

Rod Bond
**PROGRAMME**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>9.00</td>
<td>Introduction</td>
</tr>
<tr>
<td>9.15 - 10.45</td>
<td>Schools/Industry/Commerce Liaison</td>
</tr>
<tr>
<td>10.45 - 11.00</td>
<td>Coffee</td>
</tr>
<tr>
<td>11.00 - 12.15</td>
<td>Parents'/Community Needs</td>
</tr>
<tr>
<td>12.15 - 1.00</td>
<td>Lunch - Beaumanor</td>
</tr>
<tr>
<td>1.30 - 4.30</td>
<td>Mathematics and Modern Technology in the Workshop - Training Centre, Brush Electrical Machines - Peter Morley and Dave Bushell, Training Department</td>
</tr>
</tbody>
</table>

**SESSION REPORTS**

**9.00 Introduction**

Rod Bond gave a brief introduction. He highlighted the following points:

1. Education is a continuous process throughout life.
2. There is a real need to share and standardise approaches especially in the interests of trainees.
3. The accountability of schools and schoolteachers - to whom are they accountable?
4. Are schools/teachers unrealistic in what they request of training officers within industry/commerce?

**9.15 - 10.45 Schools/Industry/Commerce Liaison**

We were pleased to welcome representatives from:

- Brush Electrical Machines Limited - Dave Bushell, Training Department
- Marks and Spencer PLC - June Bottomley, Staff Management Team
- Walkers Crisps Limited - Roger Hawes, Training Manager

who were present to discuss schools/industry/commerce liaison. They had been asked to consider the following specific questions.
Qu. 1
Are there any initiatives which industry/commerce are taking or could take to assist mathematics teachers within schools to make their subject more interesting, meaningful and relevant to life?

Qu. 2
Are there any initiatives which mathematics departments within schools could take in order to improve liaison between schools and industry/commerce? In conjunction with this, are there any ways in which the skills of schoolteachers could assist industrial training officers in training programmes within their companies?

Qu. 3
Is there a need for more formal discussions between mathematics teachers and employers with reference to course contents, teaching methods, assessment, etc. at both school and industrial training level, especially in the light of the many new innovations currently being suggested for the 14 - 19 year old?

Course participants formed three small groups, each led by a visiting representative. They discussed a designated question and then reported back to the whole group in a plenary session where an interchange of ideas took place. The following points were noted:

(1) One initiative which has proved successful is the organisation of a short "Mathematics for Craft Apprentices" course organised by teachers and industrialists for prospective apprentices, offered after their C.S.E. examinations had been taken and prior to their commencement of work in industry.

(2) Industry values the opportunity to speak to students and parents in both high and upper schools regarding careers and their contents.

(3) Industry values both short and long visits from schoolteachers and sees them as a means whereby mutual understanding can be achieved. Certain companies have had schoolteachers working on their premises for up to 9 weeks. There is also a need for industrialists to visit schools.

(4) Schools could possibly assist training departments in industry/commerce with:
(a) selection testing procedures
and
(b) training programmes required to help retrain employees to cope
with new technology.

(5) It was generally agreed that there was a need for more formal discussions
between mathematics teachers and employers.

Other points which emerged from the discussion session were:-

(i) It would be beneficial for teachers to work for periods on the "shop
floor" and both teach in context and learn in context.

(ii) With the introduction of new technology it has become apparent that
different skills are required, i.e. thinking skills, observation and
reaction techniques.

(iii) The rate of change in industry is very rapid.

(iv) Industry is moving to tests in contexts.

(v) Employees are interested in a "well rounded individual". They consider
examination results to be of importance but value social awareness,
personality, etc.

(vi) We all should realise that teaching does not stop at examinations.

At the beginning of the session a quote was given from a letter received from
a training officer.

"The modern educationalists' outlook does not pay due regard to
the facts of working life and the needs of industry. They
adopt the most unrealistic attitudes when attempts are made at
serious discussion between teachers and industry to try and
resolve the problems that beset us. I have taken part in a
number of these latter discussions and find that the only
factor, and divisive at that, to emerge is that opinions are
polarised."

It was very encouraging to note the way in which the participants were willing
to discuss and exchange views and ideas - no polarity on this occasion."
We were grateful to

Gloria Pace )
Geoff Simpson)

Parents of students at Burleigh College

Bob Dunne — Director, Charnwood Training Centre, Loughborough

for their willingness to take part in this session.

Questions suggested for discussion were:-

Qu. 1 Do parents want to know more about what and how mathematics is taught in schools? If so, how should we, in schools, inform parents about course content, teaching methods, assessment, etc. — by paperwork? meetings? open evenings?

Qu. 2 Are there any ways in which we could use the many skills of parents (and their goodwill) as a resource in schools, e.g. in the classroom? with help in the organisation of storage? repairing books? typing? or with their practical experience and industrial/commercial contacts?

Qu. 3 Should the mathematics department investigate what help, if any, they could offer in the form of daytime provision for the unemployed and adults who wish to improve their mathematics (at all levels)?

This session was introduced by reference to two abstracts from the Cockcroft Report.*

"We believe that there is widespread misunderstanding among the public at large as to the levels of attainment in mathematics which are to be expected among school leavers."

"Parents can exercise, even if unknowingly, a considerable influence on their children's attitudes towards mathematics. We believe that it is therefore important that schools should make active efforts to enlist the help of parents by explaining the approaches to mathematics which they are using and the purposes of mathematical activities which parents themselves may not have undertaken while at school."

Course participants divided into two groups, each led by a visitor. They discussed the questions and then reported back to the whole group in a plenary session. The following points were noted:

(1) Parents do want to be informed; the problem appears to be how to involve more of the reticent parents.

(2) Some parents are bewildered by what goes on in schools. They feel a sense of inferiority.

(3) The first contact between teachers and parents is very important.

(4) Should teachers make more home visits?

(5) Some ideas were suggested on how to "inform" parents.

   (a) Provide a brief outline of courses in a school prospectus or school video.

   (b) Have open evenings for new and existing parents (in June), not specifically in mathematics but to give parents an overall idea of what is done.

   (c) Organise meetings specifically for mathematics in an open forum. It was agreed that parents should be involved actively in the meetings and not take a passive role. A "show" of exhibited work may detract and mislead parents regarding the "real work" carried out in the mathematics department.

   (d) The goodwill and enthusiasm of a school's Parent/Staff Association should be harnessed in helping to organise meetings as in (c).

   (e) A mass of informative paperwork can be forbidding, and thus ineffective, to many parents.
(6) It was felt that schools should investigate what they can offer to the unemployed, not just in mathematics. Points arising were:

(a) What does unemployment mean? The unemployed are "reluctant" to seek education.

(b) A better knowledge of social "misfits" is needed.

(c) Do we really understand the stigma of unemployment?

(d) Meetings for the unemployed are not fruitful.

(e) Vast social problems occur in conjunction with the unemployed. We need stepping stones, i.e., set down particular steps and aim to solve problems at varying stages.

(f) We need to revalue the status of unemployment.

(g) Why do we create Youth Training Scheme centres? Why not use schools? Is there a misuse of resources?

(h) Youth Training Scheme tutors and school teachers could work together. Involvement by school teachers in programmes for the unemployed would necessitate extra staffing for schools.

(7) It was concluded that the goodwill of parents in schools was a valuable asset. We should not formalise the way we use parents but should work on an ad-hoc basis dependent upon the needs of the school and in the interest/skills of the parents.

1.30 - 4.30 Mathematics and Modern Technology in the Workshop

We would like to thank Peter Morley and Dave Bushell at Brush Electrical Machines for inviting us to visit their Training Centre.

The afternoon session illustrated how mathematics is applied in the engineering industry. It highlighted the practical mathematical problems encountered by young people during their training period. There were demonstrations showing how new technology is becoming an important part of training.
The type of apprenticeships offered by Brush Electrical Machines Ltd. were described together with a brief summary of the products of the Company.

The main part of the afternoon was designated as an opportunity for the teachers to spend some time "on the shop floor" in the training centre. They were openly invited to talk to first year trainees and were shown the new technology currently being used within the training area (and also in the main works).

A short session to discuss selection tests was held towards the end of the afternoon.

Observations

(1) This was an excellent occasion for teachers, training officers and trainees to discuss first year training tasks in the workshop.

(2) Teachers commented upon the mature, pleasant and responsible manner exhibited by trainees. Perhaps this demonstrates the need for personality and social awareness in a trainee in addition to academic ability and manual dexterity.

FEEDBACK FROM TEACHERS PARTICIPATING IN THE COURSE

A questionnaire was prepared in conjunction with the course. Teachers were asked to comment on the day's events. Questions and responses are shown below.

Question 1 Did you feel that the day was useful and worthwhile?

Response 9 replies indicated YES.

Please tick

Yes

Not Sure

No
Question 2
What were the good points?

Responses included:
- Talking to people who are not teachers
- Getting on to the "shop floor"
- Hearing the views of trainees, community workers and parents on education in general
- I've never had such contact before
- Reinforced my belief in what industry wants of pupils.

Question 3
What were the bad points?

Responses included:
- The "bulk" of the issues leave me feeling too ineffective
- We could have done with an extra session to identify one area on which to start.
- I do not think enough time was allowed to develop the discussions.
- I didn't see any actual training.*

*N.B. It was going on all the time during the visit.

Question 4
Did you like the format of the morning session, i.e. discussion groups then plenary sessions or would you prefer more formal "talk then question" type sessions.
Do you have any other suggestions?

Please tick

Prefer discussion groups and plenary ....
Prefer talk then question session ....
Others ....

Response
7 preferred discussion groups then plenary sessions.
1 person preferred a talk then discussion groups.
1 person preferred a mixture of both.
**Question 5**

Have you any general comments on the Schools/Industry/Commerce Liaison session?

**Responses included:**

We require more time to persuade industrialists. It doesn't happen often enough.

We really needed a whole day on this, but this has left me feeling more willing to approach industry.

The issue of maths, teachers being involved in the preparation of selection tests designed by companies ought to be followed up.

**Question 6**

Have you any general comments on the Parents/Community Needs session?

**Responses included:**

I will follow it up.

More parents should have been available for consultation.

Insufficient time given to this aspect.

The session turned out to be far too socio-political.

Interesting, but I didn't feel we were able to evolve any solutions to the problems which we could all identify.

I thought it very unlikely that High Schools could help the unemployed without major changes.

**Question 7**

Have you any general comments on the visit to the Brush Training Centre?

**Responses included:**

Very interesting.

Interesting and enlightening.

Talking to the apprentices was interesting and I would have liked to have spoken to some of the craft apprentices also.*

Enjoyable visit - both staff and trainees were polite and very helpful. I would have liked to have seen more of the work that the trainees actually do in their first year.

Perhaps we could have used the second half as a large group discussion with more trainees. They certainly had a lot to offer.

* N.B. Craft apprentices were working in the centre and were available for discussion.
Question 8
Would you like future in-service training programmes to include

(a) more sessions involving speakers from industry/commerce/community?

Response: 5 said YES
2 said NOT SURE
2 said NO

Response: 7 said YES
2 said NOT SURE

(b) more visits to a diverse range of industrial/commercial establishments?

Response: 7 said YES
2 said NOT SURE

Question 9
When you return to your school are there any recommendations that you will make as a result of the day's activities?

Responses included:
Liaison with other employers.
Simply to concentrate on the basics.
Recommend that reports and personal contact is more important than we think.
Support the push to turn the college into phase 3 to facilitate more involvement with the community.
Teachers ought to get out into industry/commerce to see for themselves.

With regard to mathematics, I think that what we are doing in schools is in the main what is required by industry although, perhaps, we need a more practical bias. I do feel, however, that schools ought to bring pressure to bear on all industry/commerce to allow maths teachers to be involved in re-writing the mathematics tests given to prospective trainees. The sad thing is that these tests at present don't even test what the employers want them to test or think they are testing. I am sure that open discussion on this matter could have widespread benefits - (cont').
Question 9
Responses (cont'd) for example we are teaching multiplication of fractions because we think employers are testing it — employers are testing it but only because they think it is something important that mathematics teachers want to teach. This ought to be discussed further and not allowed to drop just because we didn't have time for it.

The relevance of Imperial Units.

Question 10
Responses included: It seems that industrialists etc. are relying on maths, exams simply as a test of memory. They require thinkers but really are selecting on memory. I now realise I have to teach to pass exams for my pupils to get work, then teach pupils to be learners and thinkers in their own right so as to be successful in their jobs.

I found the day thought provoking in the wider aspects of education and the need to modify school courses drastically to suit today's needs emerged. As a help in the role of head of department, however, I do not think there was much to use. There is definitely a need for a day such as this — whether in the context of this course or not I am not sure.

OVERALL CONCLUSIONS

(1) It was most satisfying to see interchange of ideas between mathematics teachers, training personnel, parents and committed community workers.

(2) The day was ambitious and tried to do too much. The morning sessions were successful in the fact that earnest discussions took place, but too little time was available to debate and develop ideas in depth during the plenary sessions.

(3) Teachers found the visit to the Brush Training Centre of great value in respect of having the opportunity to talk to trainees and instructors in the working environment and seeing how mathematics is applied "on the shop floor".
RECOMMENDATIONS FOR FUTURE IN-SERVICE TRAINING

These are a few suggestions of mine which may be suitable as a follow-up to the course.

(1) Examine how a number of schools inform parents about contents and teaching methods of mathematics (and other) courses. Relate the findings to the discussions which took place in this day's session and provide recommendations and examples of good practice.

(2) Schools and Y.T.S. scheme organisers should liaise to see how resources can be used in an optimum manner.

(3) More visits to a diverse range of industrial/commercial concerns would be of benefit to teachers: suggest hosiery, food processing, pharmaceuticals, banking, building firm, wholesale or retail outlet.

(4) More efforts should be made to give teachers the experience of working on the shop floor with training instructors and also giving training instructors the experience of working in schools with teachers.

(5) Teachers could approach local firms with a view to discussing any help they can offer with training programmes. Suggest starting points:

(a) collaboration on form and style of selection tests

(b) retraining programmes for employees involving new technology.

(N.B. discussions regarding selection tests aroused much debate by course participants)

(6) The visit to the Brush Training Centre highlighted the interrelated approach to learning on the "shop floor", e.g.
This approach could make learning processes in schools more relevant and meaningful to students. Perhaps there is a need for discussion by interdisciplinary groups of teachers on teaching programmes and how subjects can be taught in an interrelated manner, not in isolation as often happens at present.

(7) An in-depth investigation into what qualities employers are looking for in prospective employees, e.g.

academic ability
personality
interests
reliability, etc.

resulting in a statement to schools and parents.

Rod Bond
Burleigh College
June 1983

* A research project on this aspect is currently in progress at the Centre for Advancement of Mathematical Education in Technology (C.A.M.E.T.), Loughborough University, under the direction of Professor A. C. Bajpai.
REPORT

"TEACHING TOPICS IN AN INTERRELATED WAY"

BEAUMANOR HALL, WOODHOUSE EAVES - TUESDAY, 19TH JUNE 1984
May we thank all the course participants for their contributions to the day, especially Maurice Edwards and Stewart Friis for their help, encouragement and support in organising the day's events.

Rod Bond
Jeff Lee
Chris Morley
9.15 - 9.30 Introduction - Stewart Friis

9.30 - 10.30 "Teaching Topics In An Interrelated Way"
Rod Bond, Mathematics Curriculum Area, Burleigh Community College, Loughborough, and part-time research student, CAMEL, Loughborough University of Technology.

10.30 - 11.00 Coffee

11.00 - 12.00 The Mathematics Department
Small group work to discuss
(a) how we operate at present in terms of organisation, teaching methods, content, etc. - the benefits, frustrations and problems;
(b) what we would like to do in our mathematics lessons in an ideal situation;
(c) the problems/difficulties to be overcome if an interrelated approach is to be of value, e.g. school organisation, resources, team teaching, assessment etc.

12.00 - 12.45 Plenary Session - to discuss and evaluate ideas from the previous session.

12.45 - 1.45 Lunch

1.45 - 2.00 Introduction - Rod Bond

2.00 - 3.15 Developing A Topic For Learning
Small groups will be asked to work together on a specific topic(s) and produce a skeleton outline incorporating, where possible, real life applications. Topics will be chosen to suit both 11-14 year old and 14-16 year old age ranges.

3.15 - 3.30 Tea

3.30 - 4.00 Plenary Session - feedback from the previous session to include ideas/suggestions for future developments if appropriate.

4.00 - 4.30 A Case Study
Jeff Lee and Chris Morley of Woodbrook Vale High School, Loughborough will illustrate how they have adopted an interrelated approach to teaching and will report on their experiences.

The organisers are very grateful to the students and staff at Woodbrook Vale High School for providing the display material.
SESSION REPORTS

9.30 - 10.30 Teaching Topics In An Interrelated Way

The contents of this session can be summarised by referring to the overhead transparencies used.

1. The tasks of the Mathematics teacher.

THE COCKCROFT REPORT STATES—"In our view the mathematics teacher has the task

● of enabling each pupil to develop within his capabilities, the mathematical skills and understanding required for adult life, for employment and for further study and training; 

● of providing each pupil with such mathematics as may be needed for his study of other subjects; 

● of helping each pupil to develop so far as is possible his appreciation and enjoyment of mathematics itself and his realisation of the role which it has played and will continue to play in both the development of science and technology and of our civilisation; 

● above all, of making each pupil aware that mathematics provides him with a powerful means of communication;"
2. Comments about current Mathematics teaching.

EXTRACT FROM "TOO MUCH MATH" BY MICHAEL CORNELIUS, SENIOR LECTURER,
SCHOOL OF EDUCATION, UNIVERSITY OF DURHAM (TIMES EDUCATIONAL SUPPLEMENT,
NOVEMBER 1983)

Her Majesty's Inspectorate has said '... at the extreme utilitarian end
of the range of reasons for teaching mathematics, each person needs to
know enough arithmetic to make simple purchases, count change, check
wages and understand a popular newspaper.'

The Cockcroft Report concluded: '... there is hardly any piece of mathematics
which everyone uses ... we would include among the mathematical needs of
adult life the ability to read numbers and to count, to tell the time,
to pay for purchases and to give change, to weigh and to measure, to
understand straightforward timetables and simple graphs and charts.'

Most children leave primary school at the age of 11 already knowing enough
mathematics to satisfy the needs of everyday life. It is sometimes sad to
see a pupil at the age of 16 who appears to know less mathematics than he/
she knew at 11 and who approaches the subject with increased trepidation.
By trying to teach too much mathematics our secondary schools are
shattering the mathematical confidence of a majority of children and
accentuating the adult fear of things mathematical.

While the actual abolition of secondary mathematics for some pupils might
by an extreme step to take, there does seem to be a strong case for a
severe diminution in the amount of time spent on the subject. Are there
not better things to do with pupils than spend hour after hour on work
which is meaningless, abstract and divorced from real life? Should not
the position of secondary mathematics as an automatic 'five period a week'
subject be challenged?

EXTRACT FROM THE COCKCROFT REPORT

462 We also wish to draw attention to an extract from one of the
submissions which has been made to us.

Mathematics lessons in secondary schools are very often not
about anything. You collect like terms, or learn the laws of
indices, with no perception of why anyone needs to do such
things. There is excessive preoccupation with a sequence of
skills and quite inadequate opportunity to see the skills
emerging from the solution of problems. As a consequence
of this approach, school mathematics contains very little
incidental information. A French lesson might well contain
incidental information about France è so on across the
curriculum; but in mathematics the incidental information
which one might expect (current exchange and interest rates;
general knowledge on climate, communications and geography;
the rules and scoring systems of games; social statistics)
is rarely there, because most teachers in no way see this as
part of their responsibility when teaching mathematics.

We believe that this points out in a very succinct way the need -
which is by no means confined only to courses for lower-attaining
pupils - to relate the content of the mathematics course to
pupils' experience of everyday life.
3. This session described some of the activities being carried out by a small team working on a research project at CAIET (Centre for Advancement of Mathematical Education in Technology), Loughborough University of Technology, under the direction of Professor A. C. Bajpai.

The team is investigating the value of an interrelated approach to teaching school subjects. We wish to break down barriers between subject areas so that topics are not taught in isolation. We wish to arouse curiosity and interest amongst students and make lesson content both relevant and meaningful to students' current and projected experiences. An interrelated approach can be introduced in several ways.

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2. A Content Based Approach
Mathematics incorporating scientific and technological examples and approaches to enrich the curriculum.

3. Mathematics In Other Curriculum Areas
Mathematicians giving teachers from other departments support and advice in order for them to incorporate mathematical concepts/skills into their teaching programmes where appropriate.
4. Some Objectives.

**AN INTERRELATED APPROACH**

Some Objectives

- To assemble a team of specialists from a teaching establishment who are sufficiently interested and motivated to co-operate in the use of interrelated curricula.
- To motivate students to learn.
- To ensure that teachers are sufficiently prepared to cope with an interrelated approach, by means of teacher/pupil modules and separate pupil modules.
- To draw on the experiences and particular interests of students.
- To ensure that the treatment of important phenomena is at a level of explanation suited to students.
- To consolidate learning processes by suitable student exercises.
- To produce modules which are sufficiently flexible for a variety of teaching methods to be employed.

5. The research team chose the topic of measurement to evaluate the approach. Training officers in the pharmaceutical industry were most helpful and constructive in devising tasks associated with their industry which could be used in schools.
6. Some ideas being evaluated at Burleigh Community College, Loughborough.

**MEASUREMENT & THE PHARMACEUTICAL INDUSTRY**

Ideas being evaluated include -

1. (a) Hay fever survey
   (b) Packaging

2. (a) Counting pills
   (b)Inserting cotton wool into bottles

3. (a) Counting pills
   (b) Torque testing / devices for opening screw cap bottles

4. (a) The car park
   (b) Various mathematical / design problems

5. Ideas for the Hay Fever Survey. Staff and students involved were very grateful for the support of Mr. Ian Mason, Market Research Manager, Fisons Pharmaceuticals p.l.c.
8. Packaging is a necessary process for most products and offers many challenges to students within schools.

**Packaging of Pharmaceutical Products**

- How are they packaged?
- Materials - relative properties & costs
- Colours - what? why? - how are they standardised?
- Sises - physical proportions - connections between height, width, thickness?
  - areas & volumes of similar figures
- Aesthetic appeal - design 6 shapes - carry out a market research exercise to evaluate appeal
- Manufacture - nets of solids, techniques, flow diagrams
- Inspection procedures
- Bar codes

9. Problems suitable for use in Mathematics classes could include:
   (a) the design of a car park clearly showing spaces for cars and motor bikes:

![Diagram of a car park with dimensions and labels](image-url)
(b) the design of a scoop.

Design & Manufacture of a Scoop to Hold 250g of a Given Powder

length, mass, volume
design — nets of solids, scale drawing
materials — types
  — percentage scrap
  — economic use of
manufacture — methods — producing many/a few
other methods of dispensing a given mass of powder?

10. There are many common objects which are appropriate for use in project work, e.g. the motor car.

THE MOTOR CAR ROUGH IDEAS

Engine
  — size, bores, volumes, cam

Electrical System
  — current, voltage, power, battery

Cooling System
  — temperature, humidity

Design
  — shape, weight, dimensions, materials

Fuel
  — consumption, volume, cost

Exhaust
  — noise, fumes

Gearbox
  — ratios

Types
  — pressure, depth of travel

Running costs
  — petrol, diesel, electric, solar powered

speed/distance/time — graphs
Could material used within science/design areas be appropriate for the Mathematics classroom? e.g. rotary motion

**The Transmission of Rotary Motion**

(Ref. Schools Council Control Tech. Programme)

The circle, gears, ratio, rotation leads on to lifting loads, velocity, force, lifting capability of electric motor, amps, volts, graphs

11. Other simple scientific work could be incorporated into Mathematics lessons.

**Measurement of Current & Voltage and the Application of Ohm's Law to Calculate Resistance**

Colour Coded Resistors

\[ \frac{1}{E} = \frac{1}{E_1} + \frac{1}{E_2} \Rightarrow E = \frac{E_1 E_2}{E_1 + E_2} \]

This could involve:
- formulae, substitution, solution of equations,
- fractions, measurement of current and voltage,
- Ohm's law, power, fuses, electricity charges/meters etc.
12. With an interrelated approach, many benefits to both teachers and students arise.

**Some Important Ingredients**

- Brainstorming sessions.
  - Teachers and students.
  - Teachers and parents.
- Communication between:
  - Teachers in different curriculum areas.
  - Teachers in different schools/colleges.
  - Teachers and training officers in industry/commerce.
- Dissemination of ideas.
- Sharing experiences and resources.

13. To be successful, good resources are essential.

**Proposed Guidelines For Preparation Of Teaching Modules**

- Assemble the teaching team
- Define the target student group
- Formulate general & specific objectives
- Outline a plan of action - flow diagram - set time schedules
- Allocate jobs to team members
- Assemble draft material
- Discuss draft material
- Formulate procedures for testing and evaluation in a 'Pilot Study'
- Test the draft version & revise where appropriate
- Make material available to other interested groups
The success of an interrelated approach will depend upon the enthusiasm and willingness of teachers and students to try out new ideas.

11.00 - 12.45 The Mathematics Department

This session encouraged dialogue between teachers and an exchange of ideas about current practices within their schools. Two groups were formed and they presented comments as shown below.

Group A

1. There was, as expected, a variety of experiences within the group. One frustration voiced was concerned with compulsory mixed ability teaching without adequate resources.

2. The group felt that a variety of approaches should be used when teaching Mathematics, e.g. classwork could include individual work, group work, investigational work and practical work. It is important, however, that this should take place within a structured course.
3. Initiating new innovations into a particular department may prove to be difficult in that agreement/concensus between members of the department is required in order to give new ideas any chance of being successful.

Group B

(a) Frustrations and Constraints

1. Large teaching groups.

2. Pressure on facilities, e.g. computers, special rooms.

3. Obvious demands by students and parents for an exam/qualification.

4. The inappropriateness of courses for the 16+ age range.

5. The views of employers about the 'O' Level/C.S.E. qualifications especially in respect of their levels of equivalence.

(b) Present Interrelated Courses

1. Foundation course at Gateway Sixth Form College: this is aimed at lower ability students entering College at 16+. It is examined internally with a profile provided for each student. It is covered in modular form with packages available dealing with cars, house-buying, etc.

2. Integrated Maths. scheme at Robert Smyth School: this has an individualised and thematic approach. Small groups of students, i.e. 12-16 in number, use material from the Kent Mathematics Project. Students are entered for a limited grade C.S.E. examination.

3. General Studies course for all students at Gateway Sixth Form College: this has elements of Mathematics, Statistics, Computing etc.

4. Foundation course at Wyggeston Collegiate: about 50 students are involved in this course. The numeracy element is related to projects, either "real" themes or puzzles/investigations. For some students, a City & Guilds qualification will be obtained.
(c) Comments About Interrelated Courses

1. There is a need for ENJOYMENT for both students and teachers in developing the approach.

2. It is important that teachers do not attempt too much in terms of innovation, i.e. channel your energy into one problem or project and make a good job of it whilst other ideas "tick over."

3. Commercial Mathematics 'O' Level as an integrated course has been found to be successful.

4. A start to improving communication with other departments might be to talk to colleagues in these departments about them making/providing materials for use in Mathematics projects, together with discussion about content of the projects.

5. Some Mathematical activities are perhaps better started in other departments, e.g. enlargement in Design, wages and money in Social Studies. Perhaps duplication by departments is not always useful reinforcement.

6. In an ideal situation we want to use equipment, e.g. laboratory and workshop facilities etc. - but in practice we talk about springs or wheels or other things without having these. A similar example is collecting data in Statistics, rather than using prepared examples.

1.45 - 2.00

This session involved course participants in attempting to solve a practical problem originating from ideas based upon practices in the pharmaceutical industry.
THE DESIGN AND MANUFACTURE OF A TABLET COUNTING DEVICE

You are asked to design and make a counting aid which will enable a person to quickly count 60, 80, 100 and 150 circular tablets.

Provided are (a) card;
   (b) scissors;
   (c) counters (as substitute for tablets);
   (d) rulers.

Print on your aid easy instructions telling how it should be used.

(A) Did you discuss tolerances when measuring the diameter or thickness of the counters?

(B) Did you consider a variety of shapes for your design?

(C) What materials would be used and how would it be made if
   (i) only two were required by a company?
   (ii) 1000 were required by a company?

This proved to be a challenging exercise which provided both enjoyment and competition amongst the teachers.
The session went on much longer than was anticipated.
Solutions included:

(a) MOVABLE FULCUM

(b) MEASURING STICK

(d) PULL TO RELEASE REQUIRED QUANTITY
This session did not take place owing to an extension of time on the previous session. Participants were to be offered a choice of tasks as follows.

**TYPE A**
(WORK FOR USE IN HIGH SCHOOLS)

**DEVELOPING A TOPIC FOR LEARNING**

Produce a skeleton outline incorporating:

a. an interrelated approach where possible;
b. real life applications.

Your submission should be geared to one year of an 11-14 High School (mixed ability).

The theme or Centre of Interest to be studied is:

ONE OF THE FOLLOWING TOPICS — (a) Food
(b) The Body
(c) Myself
(d) Movement

You should indicate the organisation required regarding:

Staff
Resources/Facilities
Procedures
Documentation
Assessment
DEVELOPING A TOPIC FOR LEARNING

Produce a skeleton outline incorporating

a. an interrelated approach where possible;

b. real life applications;

for the theme of:

ONE OF THE FOLLOWING TOPICS - (a) Surveying
(b) Travel
(c) Shelter
(d) Packaging

Included in your submission should be a brief statement regarding:

(i) the age group that the work is directed towards;
(ii) the intended level of study, e.g. 'O' Level/good C.S.E.,
C.S.E.
low ability C.S.E.,
non-examination;

(iii) the organisation required regarding staff...
resources/facilities
procedures
documentation
assessment.

TYPE C
(WORK FOR USE IN UPPER SCHOOLS - TOPIC BASED)

DEVELOPING A TOPIC FOR LEARNING

Produce a skeleton outline incorporating

a. an interrelated approach where possible;

b. real life applications;

for the topic of:

ONE OF THE FOLLOWING TOPICS - (a) Lengths, Areas and Volumes Associated with the Circle
(b) Speed, Distance, Time, Acceleration
(c) Proportion
(d) Algebra (any aspects of),

Included in your submission should be a brief statement regarding:

(i) the age group that the work is directed towards;
(ii) the intended level of study, e.g. 'C' Level/good C.S.E.,
C.S.E.
low ability C.S.E.,
non-examination;

(iii) the organisation required regarding staff...
resources/facilities
procedures
documentation
assessment.
3.30 - 4.15  A Case Study

Chris Morley and Jeff Lee outlined how the staff at their school use an interrelated approach to their teaching. A "centre of interest" is chosen and all the specialist teachers work together to form links across the curriculum. Their philosophy is to adopt a skills based curriculum.

In the first and second years students spend 50% of their school time with a "base" teacher. During this time students study Mathematics, English, Science and Humanities. In the other half of their time students go to specialist lessons such as Design, French, Expressive Arts, Games, etc. Double and triple rooms with teams of teachers are used which means that specialists are available in base time to give guidance, thus making their approach very flexible.

Mathematics staff at the school feel that teaching Science and other subjects enriches them as teachers and enables them to clearly see what Mathematics is required in other areas. The students easily relate Mathematics to other areas and most seem to enjoy their Mathematics.

The staff are conscious of the demands of their upper schools and ensure that the necessary content is covered in the centres of interest chosen.

With this interrelated approach, teamwork and co-operation between staff is essential. In-service training sessions are needed together with regular planning meetings. Resource materials and teachers' notes for each centre of interest are prepared and thoroughly discussed before a topic is attempted.

Details of the centres of interest currently being covered at Woodbrook Vale are shown as follows.

WOODBROOK VALE HIGH SCHOOL

A PROPOSED LIST OF MATHEMATICAL CONTENT AND SKILLS

FIRST YEAR

<table>
<thead>
<tr>
<th>Centre of Interest</th>
<th>Content</th>
<th>Process and Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>MYSELF</td>
<td>Relations</td>
<td>Measuring</td>
</tr>
<tr>
<td></td>
<td>Mappings</td>
<td>Estimating</td>
</tr>
<tr>
<td></td>
<td>Statistics</td>
<td>Checking</td>
</tr>
<tr>
<td></td>
<td>Types of average</td>
<td>Tabulating results</td>
</tr>
<tr>
<td></td>
<td>Types of chart</td>
<td>Collecting and interpreting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>data</td>
</tr>
<tr>
<td>Centre of Interest</td>
<td>Content</td>
<td>Process and skills</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>MOVEMENT</td>
<td>Graphing relations</td>
<td>Estimating</td>
</tr>
<tr>
<td></td>
<td>Speed</td>
<td>Using instruments accurately</td>
</tr>
<tr>
<td></td>
<td>Distance</td>
<td>Generating examples</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>Compiling a report</td>
</tr>
<tr>
<td></td>
<td>Reflection</td>
<td>Relating a table of values to a graph</td>
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<tr>
<td></td>
<td>Rotation</td>
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<td></td>
<td>Enlargement</td>
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<tr>
<td></td>
<td>Flow diagrams</td>
<td></td>
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<tr>
<td></td>
<td>Ratio</td>
<td></td>
</tr>
<tr>
<td>COMMUNICATION AND</td>
<td>Algebraic rules and expressions</td>
<td>Developing responsibility for work</td>
</tr>
<tr>
<td>THE MEDIA</td>
<td>Formulae</td>
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<tr>
<td></td>
<td>Directed number</td>
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</tr>
<tr>
<td></td>
<td>Interpreting and drawing graphs</td>
<td></td>
</tr>
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<td></td>
<td>24 hour clock</td>
<td></td>
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<tr>
<td></td>
<td>Using timetables</td>
<td></td>
</tr>
<tr>
<td>FOOD</td>
<td>Percentages</td>
<td>Using a calculator effectively</td>
</tr>
<tr>
<td></td>
<td>Fraction and decimals</td>
<td>Estimating</td>
</tr>
<tr>
<td></td>
<td>Ratio</td>
<td>Mental arithmetic</td>
</tr>
<tr>
<td></td>
<td>Surface Area</td>
<td>Accurate measurement</td>
</tr>
<tr>
<td></td>
<td>Volume</td>
<td></td>
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<tr>
<td></td>
<td>Metric Units</td>
<td></td>
</tr>
<tr>
<td>ENVIRONMENT</td>
<td>Networks</td>
<td>Interpreting data</td>
</tr>
<tr>
<td></td>
<td>Bearings</td>
<td>Making deductions</td>
</tr>
<tr>
<td></td>
<td>Statistics</td>
<td>Reaching conclusions</td>
</tr>
<tr>
<td></td>
<td>Area and Perimeter</td>
<td>Working accurately</td>
</tr>
<tr>
<td></td>
<td>Scale drawing</td>
<td>Using instruments correctly</td>
</tr>
<tr>
<td>HEROES AND VILLAINS</td>
<td>Pythagoras' Theorem</td>
<td>Abstracting principles from concrete materials</td>
</tr>
<tr>
<td></td>
<td>Pascal's Triangle</td>
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<tr>
<td></td>
<td>Fibonacci Sequence</td>
<td></td>
</tr>
<tr>
<td>OLYMPICS</td>
<td>Laces, distance, time</td>
<td>Accurate measurements</td>
</tr>
<tr>
<td></td>
<td>Statistics</td>
<td>Estimating</td>
</tr>
</tbody>
</table>
### THIRD YEAR

<table>
<thead>
<tr>
<th>Centre of Interest</th>
<th>Content</th>
<th>Process and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRUCTURES</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planes of symmetry</td>
<td>Measuring accurately</td>
</tr>
<tr>
<td></td>
<td>3D symmetry</td>
<td>Predicting</td>
</tr>
<tr>
<td></td>
<td>Application of Pythagoras’ Theorem</td>
<td>Using calculator effectively</td>
</tr>
<tr>
<td></td>
<td>Square roots</td>
<td>Estimating</td>
</tr>
<tr>
<td></td>
<td>Volumes of cuboids and prisms</td>
<td>Interpreting</td>
</tr>
<tr>
<td></td>
<td>Networks and matrices</td>
<td>Constructing</td>
</tr>
<tr>
<td></td>
<td>Polyhedra</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volume of similar objects</td>
<td></td>
</tr>
</tbody>
</table>

### THIRD YEAR POST OPTION

#### PROJECT BASED

##### Probability and statistics

##### Matrices
- Networks relations
- Transformations

##### Transformations
- Reflection
- Rotation
- Enlargement
- Translation
- Vectors

##### Graphs
- Use in statistics
- Relation to formulae
- Solution sets

#### TEXT BASED

##### Trigonometry
- Sine
- Cosine
- Tangent

##### Matrices and relations
- Solving equations
- Using formulae
- Graphing formulae
- Matrices and transformations
- Properties of a circle
- Probability
- Matrices and Relations
- Statistics
- Solution sets
- Matrices and networks

##### Surveying
- Using sine, cosine, tangent ratios
LEICESTERSHIRE COUNTY COUNCIL EDUCATION DEPARTMENT

IN-SERVICE TRAINING DAY FOR PROSPECTIVE HEADS OF MATHEMATICS DEPARTMENTS

Theme: Mathematics Teaching In Relation To The Needs Of Young Trainees In Industry And Commerce

Date: Wednesday 19th June 1985

Venue: Beaumanor Hall, Woodhouse Eaves (a.m.)
Corah PLC, Burleys Way, Leicester (p.m.)

Programme:

9.15 - 10.45 "Skills, skills ...... and more skills?"
A discussion about the skills needed and personal qualities required in young people during their early years of training. Also an opportunity to hear the opinions of a respected training officer on various aspects of the school curriculum.

Introduction - Rod Bond*, Mathematics Curriculum Area, Burleigh Community College, Loughborough.

Main Speaker - Peter Morley†, Senior Training Officer, Brush Electrical Machines Limited, Loughborough.

10.45 - 11.05 Coffee

11.05 - 12.30 "Teaching Mathematics In An Interrelated Way" - Rod Bond.
Course participants will be actively involved in generating ideas.

12.30 - 1.00 Lunch

1.35 Arrive at Corah PLC, Burleys Way, Leicester, for visit (please see the attached map).

1.45 - 2.00 Introduction by Mrs. Rachel Creamer‡, Training Executive.

2.00 - 2.45 Small group work with trainees, operatives, supervisors, technicians, etc.

2.45 - 3.15 Tea and syndicate discussion.

3.15 - 4.00 Small group work with trainees, operatives, supervisors, technicians, etc.

4.00 - 4.30 Plenary session with employers' panel dealing with questions.

4.30 Depart

A report on the day's discussions and conclusions will be sent to all those attending.
Rod Bond is a member of the Mathematics Curriculum Area at Burleigh Community College, Loughborough. He is currently on a one year secondment working on a research project at CAMET (Centre for the Advancement of Mathematical Education in Technology), Loughborough University of Technology, centred upon "Teaching In An Interrelated Way".

Peter Morley is Senior Training Officer at Brush Electrical Machines Limited, Loughborough. His training centre for young trainees is modern and very much in tune with current technological developments in the engineering industry. For many years he has shown great interest in developing links with schools believing that education is a continuing process, the employer taking over at the point where the school teacher finishes. He has been a great help to teachers in the past by both encouraging visits to his company and being prepared to speak about education in an open, constructive manner.

Rachel Creamer is Training Executive at Corah PLC. She is responsible for the training and development of all employees ranging from young trainees to experienced managers. She is enthusiastic and supportive in matters relating to schools–industry liaison and believes that all teachers would benefit greatly from some work experience.

Corah PLC was founded in 1815 and is today located in fifteen operational centres in England and one in Canada. It is a progressive company which supplies quality underwear, outerwear (leisurewear and dresses), knitwear and socks to Marks and Spencer and other leading chain stores in this country. Corah's products are also exported to Scandinavia and Europe.
POSSIBLE QUESTIONS WHICH COULD BE PUT TO TRAINING OFFICERS FROM INDUSTRY

BY TEACHERS

The questions below are only suggestions which might generate discussion and debate. The list is by no means exhaustive.

1. What are your views about young school leavers generally?

2. What are the skills/attitudes needed by young people in order to cope with training programmes?

3. What are your views and constructive comments about numeracy and the mathematical ability of school leavers?

4. What are your views about mathematics syllabus content and teaching methods?

5. Are selection tests involving mathematical skills fair? How are they devised? By whom?

6. If you had the opportunity to change method and content of mathematics courses in schools, what would you suggest?

7. How can training departments in industry/commerce help mathematics teachers in schools? How should teachers approach industry/commerce for help?

8. How can school teachers help training officers in industry and commerce? Should training officers make more initiatives in contacting schools with a view to sharing ideas, resources and expertise? (For example (a) Could the expertise of mathematics teachers assist training officers in devising selection tests or remedial programmes if appropriate? (b) Could teachers and students help to develop computer software for use in training programmes within a company? etc.)