An investigation of the mathematical education of pupils at secondary school with particular reference to potential craft apprentices, and evaluation of some relevant teaching material

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AN INVESTIGATION OF THE MATHEMATICAL EDUCATION OF PUPILS AT SECONDARY SCHOOL WITH PARTICULAR REFERENCE TO POTENTIAL CRAFT APPRENTICES; AND EVALUATION OF SOME RELEVANT TEACHING MATERIAL

by

JAMES GATENBY, C.Eng.M.I.Mech.E.

A Master's Thesis

Submitted in fulfilment of the requirements for the award of Master of Philosophy of the Loughborough University of Technology

January 1982

Supervisor: PROFESSOR A. C. BAJPAI
CAMBT

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Abstract

An investigation of the mathematical education of pupils at secondary level with particular reference to potential craft apprentices; and evaluation of some relevant teaching material

J Gatenby

This work investigates the industrial environment entered by craft apprentices in the Derby area and records a two-year dialogue with 4th and 5th Year pupils from one school. Companies were visited and examples of the mathematics required were collected. The views of training officers were noted and these are presented with the corresponding opinions from educationalists.

The destinations of the leaving population were analysed and the examination results extracted for those entering craft apprenticeships.

Pupils were tested on basic arithmetic and gave their own ideas for improving mathematics in school in answer to questionnaire and by taped interview.

Attempts by the school to overcome problems caused by a partially "inner city" catchment area are described with the implications for attainment in mathematics.

Teaching material based on engineering mathematics was evaluated with pupils of all abilities and lunch-time clinics held for intending apprentices to correct their weaknesses.

Assessments of the teaching material were obtained from industry, training officers and mathematics teachers in schools.

Biographical details of intending craft apprentices were collected and compared with the school population in general.

Samples of work produced by pupils of all abilities and specifically those successful in obtaining craft apprenticeships are presented as separate appendices.

Attempts were made to relate data gathered locally to statistics published on a national level. Supplementary material was available from recent substantial D.E.S. reports on school mathematics and from the many projects on school/industry co-operation which/co-ordinated by the Bath Project.
ACKNOWLEDGEMENTS

I would like to thank Professor A.C. Bajpai of the Centre for Advancement of Mathematical Education in Technology for his encouragement, help and direction in this work and for giving me the opportunity to evaluate the text, "Apprentice Maths" by Bajpai and Bond.

The joint author of the text, Mr. R.M. Bond, M.Sc., has also been very helpful in generously sharing his own earlier work in this field; also the publisher of "Apprentice Maths," Mr. Michael Packard, of Packard Publishing Ltd., who supported the work by providing copies of the text for evaluation.

I received substantial help from the training officers of several large organisations and am especially grateful to those who went to great lengths to provide samples of the mathematics used in their establishments.

I am indebted to various institutions for the use of their resources, particularly the University of Technology, Loughborough, and also the other universities and institutions which have provided papers in this field.

Much information was obtained during discussion with fellow teachers and in particular I am grateful to those who submitted written reviews of "Apprentice Maths" and evaluated the material with their pupils.

My headmaster has given continual support and has allowed me considerable freedom to use the resources of the School, especially the pupils to whom I am greatly indebted for their willingness and enthusiasm in undertaking extra work in their own time.

Finally, I wish to express my sincere gratitude to my wife for her forbearance throughout this project and for undertaking the onerous task of typing the thesis in addition to many other very heavy commitments.
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Chapter 1

INTRODUCTION

During the 1970's, numerous bodies criticised the standard in mathematics of school leavers entering employment, particularly vociferous being the engineering employers.

C.B.I. Wales, 1977 (30), gave an example of lathe turning which required the use of tangent. "Only about three apprentices in an entry of ten boys will be able to undertake this calculation unaided. The Craft Instructor then has to teach mathematics instead of concentrating on the fundamental skills of his trade."

In November, 1976, The Royal Society Working Party on School Mathematics in Relation to Craft and Technician Apprenticeships in the Engineering Industry (2) recommended, inter alia, greater liaison between schools and industry, and specially prepared material illustrating the use of mathematics in industry.

Simultaneously, the Prime Minister at that time, Mr. Callaghan, initiated the Great Debate on Education in response to the mounting publicity given to claims of falling standards in schools.

The Royal Society Report (2) gave typical views from school and industry including the following:-

Teachers

"Industry doesn't realise the problems we have in schools. We don't pay the pupils, and we haven't got the threat of dismissal to back up our authority. It is very difficult to get them doing any work."
Industry

"We are appalled at some of the mistakes we see. After 11 years at school they come to us without the most basic arithmetical skills, so there must be something very wrong with the schools."

Following this report, work began under Professor Bajpai at Loughborough on two projects closely following the recommendations of the Royal Society; Graham (1) investigated the GSE syllabuses in relation to the needs of employers and proposed a new syllabus designed to meet the needs of engineering employers while also considering other requirements.

Bond (3) investigated the requirements of craft apprentices in industry and, amongst other things, produced, with Professor Bajpai, a text-book "Apprentice Maths" (4) intended to motivate pupils at school to understand the mathematics required by industry.

A substantial part of this thesis is the evaluation of "Apprentice Maths" in school to examine the extent to which the material achieves the objective of motivation.

As part of the evaluation it was also decided to visit engineering training establishments to examine their requirements and to obtain their assessment of the teaching material.

While this work was proceeding, the author became aware of the earlier project by Linda Dickson (24) involving ten London Transport craft apprentices. In this work, the trainees were interviewed about their experience in mathematics at school and issues of "ineffective class control" and "low motivation through lack of practical application of mathematics" were raised.
The qualitative approach used by Dickson, in investigating "their low level of attainment on the arithmetic test given at selection and the seemingly marked improvement shown ........ at the end of the first year of training ..." suggested to the author that a similar strategy might be of value with potential craft apprentices while they were still in the school situation.

Later chapters therefore attempt to diagnose reasons for poor attainment in mathematics by interviewing the pupils and also by considering biographical and social factors.

The remainder of this chapter attempts to describe the environment into which the craft apprentices are recruited and the mathematics needed.
Report on a Visit to a Government Skill Centre

Discussions with the Manager and Education Officers responsible for the teaching of mathematics.

Although this centre is mainly concerned with mature students (from 19 onwards), it was thought worth visiting because of the large range of craft subjects taught and hence mathematical skills needed.

Many of the students are learning a trade as an alternative to unemployment; others are retraining after voluntarily ending their previous employment. The trades covered include painting and decorating, bricklaying, welding and fabrication, machining, instrument making and electronics.

Mathematics lessons are given to all trainees; an initial test is given overleaf with scores as low as 4%. It has been noticed that older candidates (45 years plus) are often much better at basic maths than those who left school more recently.

The students are given one hour of maths a day for twenty days and retested; generally the marks on the second test are double those of the initial test.

The actual lessons varied with the trade; the painters and decorators are concerned with areas and lengths of wallpaper. The builders need help with metric units, particularly with plans showing dimensions in mm. and concrete being ordered in $\text{m}^3$.

The machinists need revision of all the basic skills in
maths, i.e. the four operations with decimals and fractions (drill sizes being quoted widely in fractions.)

The sheet metal workers need particular help with geometry, and special emphasis on the parts of a circle, radius, diameter, chords, arcs and sectors etc. (Many trainees do not know the difference between radius and diameter).

The instructors did not like the idea of electronic calculators; they thought logarithms involved valuable arithmetic skills and that calculators damage ability to estimate. Logarithms were considered cheaper and more reliable.

Many of the trainees state that they cope with subjects which they could not understand at school; possible factors include:

- smaller class sizes (about 20)
- motivation to end unemployment
- more mature attitude
- closer linking of mathematics to trade

Poor understanding of English was regarded by the instructors as a constituent of the learning problem; questions written in words prove much more difficult than those using only mathematical symbols.

The text book 'Apprentice Maths' was received favourably by the Education Officers, who thought it suitable for their work; particularly liked were the applications such as machine tools and problems involving costs of batch production.
1. (1) Multiply 29 by 9
(2) How many eights in 496
(3) What number can be divided by 6 exactly 47 times
(4) Take away 5 times 9 from 12 times 9

2. Fill in the missing numbers:
(1) 3, 6, 9, 12, ( ), 18, 21, ( ), 27
(2) 2, 4, 8, 16, ( ), 64, ( ), 256
(3) \( \frac{1 \times 3 + 7}{10} \times 10 = ( ) \frac{11}{10} \times ( ) \frac{15}{10} \)

3. (1) Multiply 56 by 10000
(2) Multiply 17.162 by 100
(3) Divide 14379 by 1000
(4) Divide 1200 by 25
(5) Divide 4500 by 50

4. (1) How many pounds in \( \frac{1}{2} \) ton
(2) How many yards in 1 mile
(3) How many inches in \( \frac{1}{2} \) yard
(4) How many ounces in \( \frac{3}{4} \) lbs

5. (1) How many sixteenths of an inch in \( 2\frac{1}{2} \) inches
(2) How many 32nds of an inch in \( \frac{3}{8} \) of an inch
(3) How many half inches in \( 2\frac{1}{16} \)ths of an inch
(4) Take away \( \frac{7}{16} \) of an inch from \( 2\frac{3}{4} \) inches
(5) Which is longer and by how much: \( \frac{15}{32} \) or \( \frac{1}{2} \) inch

6. (1) Change 0.125 to a vulgar fraction
(2) Change 0.0013 to a vulgar fraction
(3) Change \( \frac{8}{9} \) to a decimal
(4) Change \( \frac{5}{16} \) to a decimal

7. Calculate the following:
(1) 0.2 + 0.125
(2) 1 inch - 0.016
(3) 0.8 x 0.03
(4) 0.0044 \div 0.12

8. (1) Find area of a rectangle 24 metres long by \( 1\frac{1}{2} \) metres wide
(2) Find volume of a block 7 inches long, 1 foot 4 inches wide, by 5 inches deep
(3) That is the value of 15 squared
(4) That is the square root of 64
(5) Find the area of a right angle triangle with a base of 18 inches and vertical height of 3 inches
(6) That is the circumference of a circle of diameter \( 7" \) (\( \pi = 3\frac{1}{7} \))
(7) That is the area of a circle with radius of \( 1\frac{1}{2} \) inches (\( \pi = 3\frac{1}{7} \))
(8) Quote the formula for finding the volume of a cylinder
(9) That is the value of the remaining angle of a right angle triangle given second angle is 40°
8. (10) Find angle \( X \)

9. (1) How many m/m in 1 metre 
   (2) How many metres in 3 kilometres.
   (3) How many kilogrammes in \( \frac{1}{2} \) ton.
   (4) How many m/m in 1 inch
   (5) How many pint in 1 litre (approx)

10. (1) \( 3\frac{1}{2} \times \frac{11}{16} \div \frac{3}{4} \)
    (2) \( \frac{1}{4} + \frac{1}{3} - \frac{2}{3} \)
    (3) \( \frac{1}{2} \times 2\frac{2}{5} \)
    (4) \( \frac{7}{12} \div 5\frac{1}{4} \)
Mr. Gordon, the manager of the Centre, made the point that whereas at one time an engineering craft apprenticeship was attractive to 'able' boys, they are now aware of the fact that skilled craftsmen often earn less than unskilled workers. The availability of weekend work and self-employment were also given as reasons for some capable boys entering employment other than engineering craft apprenticeships. The manager was favourably impressed with 'Apprentice Maths'; he felt the level was more suitable for craft apprentices than other available texts and particularly liked the diagrams and practical examples.

Summary of points made by Staff at the Skill Centre

1. Linking of maths to trades improves motivation to learn compared with school.
2. Low verbal ability is a major factor in maths learning difficulties.
3. The status of the engineering craftsmen has declined and able boys are attracted to other occupations.
4. 'Apprentice Maths' considered to be at relevant level for craft trainees, and contain useful work.
BRITISH RAIL ENGINEERING LTD.
LOCOMOTIVE WORKS TRAINING SCHOOL
DISCUSSION WITH MR. POULTNEY, TRAINING OFFICER

General Description of School

The school recruits about 130 apprentices annually from 35 schools within a 15 mile radius of Derby, including Nottingham and Burton-on-Trent, representing a wide range of schools.

Candidates are initially selected by the Otis-Lennon Mental Ability Test and the Bennett Mechanical Comprehension Test; those achieving the required marks are invited for interview and subject to a satisfactory school report, are offered apprenticeships.

The students spend an initial period of 24 weeks on a variety of trades i.e. fitting, machining, fabrication and electrical work, after which they specialise for a further 24 weeks in their first choice trade. This is followed by works training until the apprenticeship is completed at 20 years of age.

During the initial training year apprentices spend two weeks out of every three on basic practical training and the third week on release to the College of Further Education.

The Craft course is taken by those who are expected to achieve Grades 3, 4 or 5 in Maths, English Language and Science,
although places are offered before results are known. (Experience at a Derby school suggests large number of future apprentices subsequently fail CSE or are not entered for the examination, but are still accepted by the firm).

British Rail operate a programme of one-week courses for local school teachers; personnel from their training department have spent periods in local schools. The apprentices receive a Technical Drawing lesson for one afternoon per week and considerable difficulty has been experienced by the apprentices because of their weaknesses in the following areas:

1. Use of Imperial Units (inches, fractions, etc.)
2. Reading of drawings.
4. Simple multiplication and division of decimals.

As a result of these weaknesses it has been necessary to devise exercises in simple measuring with both decimals and fractions.

The necessity for local schools to teach Imperial Units will exist for many years because of the continued use at British Rail of expensive machinery graduated in Imperial Units.

The College of Further Education has had problems with basic skills with British Rail craft trainees and the training officer claims that many of the weaker students have a Modern Maths background.
**BRITISH RAIL ENGINEERING LTD.**

**FIRST YEAR CRAFT TRAINING**

**MEASURING EXERCISE**

<table>
<thead>
<tr>
<th>USE OF RULE</th>
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<tr>
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<td>TRAINEE</td>
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<td>BLOCK 2 - METRIC</td>
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<th>D</th>
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<td>Actual Dimension</td>
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<tr>
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<td>Specified Dimension</td>
<td>Actual Dimension</td>
</tr>
<tr>
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<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BC</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CD</td>
<td>5 1/2 + 1/64</td>
<td>—</td>
</tr>
<tr>
<td>EF</td>
<td>7 + 1/64</td>
<td>—</td>
</tr>
<tr>
<td>FG</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>AG</td>
<td>6 1/6 + 1/64</td>
<td>—</td>
</tr>
<tr>
<td>AE</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BF</td>
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<td>—</td>
</tr>
<tr>
<td>CE</td>
<td>—</td>
<td>—</td>
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</table>

**COMMENTS**
Visit to E.I.T.B. Craft Training School 13.8.79

Mr. Cawthorne, Engineering Drawing Instructor and Lecturer at College of Further Education

This school provides craft training for firms throughout South Yorkshire; Apprentices spend 46 weeks in the school with one day a week at the college of further education.

Mr. Cawthorne is concerned with Engineering Drawing at the school and also lectures at the College of Further Education, Sheffield.

Poor ability in basic maths has so hindered craft training that remedial lessons given in mathematics with every new intake (one apprentice using a lathe could not divide a decimal by 2.)

It has been necessary for Mr. Cawthorne to produce his own course in Mathematics (see overleaf) covering the following topics which have limited progress in craft training:-

1. BODMAS (Order of mathematical operations.)
2. Addition and Subtraction of decimals.
3. Place value relative to decimal point.
4. Calculating dimensions from drawings.
5. Multiplication and division of decimals.
6. Imperial as well as metric units.
7. Areas and volumes.
8. Conversion of decimals to fractions and vice versa.
9. Indices e.g. $5^2 \times 5^3, 4^3 \times 4^2$.
10. Fractions, mixed numbers, improper fractions, etc.
Mr. Cawthorne felt that Imperial Units and fractions would be needed for the foreseeable future; he also believes that logarithms are useful on the shop floor and should be taught in schools.

The mathematics teaching notes produced by Mr. Cawthorne are very similar to material in 'Apprentice Mathematics' and he decided to obtain the book for use with his students.
COMPLETE THE FOLLOWING QUESTIONS

1. ADD TOGETHER THE FOLLOWING VULGAR FRACTIONS
   \[ \frac{3}{32} + \frac{5}{8} + \frac{1}{16} \]

2. SUBTRACT \( \frac{5}{32} \) FROM \( \frac{27}{64} \)

3. ADD TOGETHER THE FOLLOWING DECIMAL FRACTIONS
   \[ 1.099 + 0.036 + 0.701 \]

4. SUBTRACT \( 1.987 \) FROM \( 11.084 \)

5. MULTIPLY \( \frac{8}{39} \) BY \( 3\frac{1}{4} \)

6. DIVIDE \( \frac{39}{128} \) BY \( \frac{1}{8} \)

7. MULTIPLY \( 4.032 \) BY \( 0.75 \)

8. DIVIDE \( 2.075 \) BY \( 0.2 \)

METRIC SYSTEM

9. SHOW THE ABBREVIATIONS FOR THE FOLLOWING:
   
   METRE = KILOGRAMME = SECOND OF ANGLE =

   SQUARE METRE = BRINELL HARDNESS NUMBER =

10. HOW MANY MILLIMETRES IN ONE METRE

11. HOW MANY GRAMS IN ONE KILOGRAM

12. CONVERT ONE KILOGRAM INTO LBS.

13. IF YOU DRINK EIGHT LITRES OF BEER HOW MANY PINTS WOULD YOU CONSUME

14. USE YOUR RULE TO MEASURE THIS QUESTION PAPER

15. HOW MANY METRES IN ONE KILOMETRE

16. IF A PIECE OF LAND WAS FOUR SQUARE KILOMETRES, WHAT WOULD ITS SIZE BE IN SQUARE MILES

17. IF THE SPEED OF A CAR WAS 60 M.P.H. WHAT WOULD ITS SPEED BE IN K.P.H.

18. GIVE YOUR APPROXIMATE HEIGHT AND WEIGHT IN METRIC UNITS.
   
   HEIGHT = WEIGHT =

PUT YOUR QUALIFICATIONS BELOW.

<table>
<thead>
<tr>
<th>G.C.E. SUBJECT</th>
<th>GRADE</th>
<th>C.S.E. SUBJECT</th>
<th>GRADE</th>
<th>OTHERS</th>
</tr>
</thead>
</table>
Determine lettered dimensions

A =
B =
C =
D =
E =
F =
G =
H =
I =
J =
K =

A =
B =

X =
Y =
Z =

2.312
0.812
0.745
1.555
4.904

2.742
0.615

22
DETERMINE LETTER DIMENSIONS.

DETERMINE LETTERED DIMENSIONS.
BODMAS shows the order by which any mathematical problem should be solved.

e.g. \(3(2+3)-2 \cdot 3 =\)

In this example the bracket should be solved first. i.e. \((2+3) = (5)\)

Now the multiplication

i.e. \(3(5) = 15\)

Then the addition; as will be seen we have \(+15 \& +3\). i.e \(15 + 3 = 18\)

Now doing the subtraction part of the problem we get \(18 - 2 = 16\)

\[
\therefore 3(2+3)-2 \cdot 3 = \\
3(5) - 2 \cdot 3 = \\
15 - 2 \cdot 3 = \\
18 - 2 = 16
\]

We must remember that the order by which we do maths is of the utmost importance in order to arrive at the correct result.

---

Notes prepared by the instructor for the remedial teaching of school mathematics to apprentices.
### ADDITION + (PLUS)

The addition sign (+) shows that the number behind it is to be added to the number in front of it. Thus $4 + 5$ means that 5 is to be added to 4; i.e., $4 + 5 = 9$ or $\frac{4 + 5}{9}$.

#### ADD $9.0971 + 9.756 + 0.435 + 1111.037$

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<th>0.4350</th>
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**Note:** A unit in each vertical column, reading from the right-hand side, is $10 \times$ greater than a unit in the previous column.

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**Decimal System.**
SOLVE THE FOLLOWING

1/ \(7 + 5 + 10 = \)

2/ \(1.25 + 0.625 = \)

3/ \(13 + 1.750 = \)

4/ \(1.156 + 1.81 + 2.633 + 0.813 = \)

5/ \(131.121 + 2.867 + 0.00102 + 63.2059 = \)

6/ \(10.250 + 1.375 + 2.1875 = \)

7/ \(1.0835 = \)

8/ \(1.1875 \times \)

9/ \(0.3125 + 0.375 + 0.250 = \)

10/ \(1.375 + 0.625 = \)
Visit to a Large Engineering Company
26th October 1979

Personnel seen: Works Training Superintendent,
Tool-Room Manager,
Training Instructors.

This company recruits annually a total of 120 craft
apprentices out of the total of 650 for the City of Derby.
The catchment area includes schools within a 10 mile radius
of Derby; mathematics is seen as the most important
subject.

Entry Requirements
The company is setting a minimum of Grade 3 CSE mathematics
for all trainees following the E.I.T.B. Modular Course.
(A small batch of Grade 4 CSE trainees follow a simplified
apprenticeship for work in a department where the work is
less exacting. Many applicants are rejected because of
their poor mathematical ability.

The tables overleaf show how the company has tightened
its mathematical entry requirements since 1975, when there
was considerable concern about numeracy. There is now
greater satisfaction with the standard of apprentices
within the Company.

The Works Training Superintendent thought the poor numeracy
experienced at the Company in the early 1970's could be
partly explained by the low esteem in which engineering was
held at that time, with local concern over security of
employment. The superintendent forecast that the falling
school-leaving population would, in the 1980's, again
make it difficult for engineering to attract the most-able
pupils.
RECRUITMENT OF APPRENTICES TO A LARGE ENGINEERING COMPANY - (CRAFT APPRENTICES ONLY)

<table>
<thead>
<tr>
<th>CSE GRADE 3</th>
<th>MATHEMATICS</th>
<th>BECAME MINIMUM ACCEPTABLE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>CSE GCE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C</td>
<td></td>
<td>D</td>
<td></td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
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<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1975

NUMBER OF PRENTICES CRUITED

<table>
<thead>
<tr>
<th>MATHEMATICS GRADE OBTAINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
</tr>
<tr>
<td>1976</td>
</tr>
<tr>
<td>1977</td>
</tr>
<tr>
<td>1978</td>
</tr>
</tbody>
</table>

CSE GCE | 1 | 2 | 3 | 4 | 5 | 0 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td></td>
<td>C</td>
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<td></td>
</tr>
<tr>
<td>D</td>
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</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VISIT TO A LARGE SCHOOL, DERBY, BY REPRESENTATIVES FROM A PRECISION ENGINEERING COMPANY — 22nd January 1980

Introduction

This was a sequel to the visit to the firm made earlier, when the apprentice training facilities were seen and a discussion was held with the works training superintendent, Mr. John Smith. Mr. Smith was responsible for recruiting craft apprentices, the management of the large workshop training school and the subsequent training programmes at College and in the factory.

Also on the visit was Mr. D. Gaunt, from the toolroom, a skilled craftsman who was involved with apprentice training. The toolroom is used by the Training Department for part of the training programme because of the wide variety of skills required. It therefore enables the apprentices to satisfy many of the compulsory skill requirements for their E.I.T.B. modules.

As the toolroom was engaged in one-off jobs such as machining jigs, fixtures and press dies, there was a need for continual calculating work in setting up new operations; ability in arithmetic was essential.

Standard of Apprentices

Mr. Gaunt thought there had been a decline in arithmetical skills in the last 12 years. He stated that if only boys were competent in the four operations with decimals, he would teach them the trigonometry etc. required later on. (Mr. Smith cited a recent apprentice who claimed to have done no trigonometry.)

Mr. Gaunt said that many boys were ashamed of their low standard in arithmetic and were embarrassed to ask for help. Often the pressure of urgent jobs for customers caused difficult
Metric vs. Imperial Units

The training centre uses a mixture of metric and Imperial Units (approx 40% Imperial, 60% Metric). The instructors considered it simpler to familiarize an Imperial-educated student with metric than vice versa.

The Imperial Units were mainly used for drill sizes, bar stock, and collets for lathes.

Interview with the Tool-Room Manager

This area of the Company is involved in non-repetitive work involving considerable skill on the part of the craftsmen; there is a high degree of numerical accuracy required in the initial setting-up of one-off jobs and mistakes can easily cost £10,000. Against this background, the manager had been particularly vociferous about falling standards in mathematics; apprentices unable to do simple calculations failed to gain the confidence of their foremen and their progress was hampered.

The manager of the tool-room had himself been to primary schools and urged the learning of multiplication tables. The tool-room had listed its own basic mathematical requirements (overleaf) and 80 apprentices were tested. The results are shown in the tables where it can be seen that multiplication and division of decimals had not been mastered by roughly half of the sample.
Female Craft Trainees

The Training Superintendent described one of the small number of female apprentices employed by the Company; initially she had found difficulty with the manual skills but having very good mathematical ability, relative to the boys, increased in confidence and became one of the Company's outstanding apprentices.

This suggests a large and virtually untapped source of able students which perhaps Industry should make more efforts to attract.

General Standards of Apprentices

The superintendent, while expressing some continuing concern over numeracy, pointed out that the present day apprentices seem much more mature than, say, 20 years ago, showing considerable initiative, pride, and wider interests. Each apprentice must now complete a log book and the standard of written presentation of the examples shown was very high.

Calculators

The Superintendent was not happy that calculators should be used exclusively; instructors on the factory floor found difficulty in persuading some apprentices to buy calculators and questioned the reliability of them. The instructors said it was imperative that apprentices be able to multiply and do long division with decimals and were frustrated at having to spend time teaching these operations.
A Large Engineering Company

Internal Arithmetic Tests on 80 Apprentices

Name ...................... Check No. ..... Date .......

Start ......................

Finish ......................

All problems on this paper are expressed in ins.

Number of Wrong answers

1. 3.478 + .005 = ...
   Wrong answers = 5

2. 2.311 + 5.293 + .866 = ...
   Wrong answers = 9

3. .732 - .391 = ...
   Wrong answers = 7

4. 2.385 - .1354 = ...
   Wrong answers = 14

5. 2.078 x .128 = ...
   Wrong answers = 42

6. .037 x 4.290 = ...
   Wrong answers = 39

7. .670 x .030 = ...
   Wrong answers = 34

8. .276 + 6 = ...
   Wrong answers = 39

9. 1.120 + .030 = ...
   Wrong answers = 48

10. Express 2/5 as a decimal = ...
    Wrong answers = 15

11. Express 5/8 as a decimal = ...
    Wrong answers = 26
METRIC TEST

A Large Engineering Company

Internal Arithmetic Tests on 80 Apprentices

Name ................................ Check No. ...... Date ..........

Start ................................

Finish ..............................

All problems on this paper are expressed in m/ms.

Number of Wrong Answers

1. \(44,501 + 0,127\) = 1
2. \(58,69 + 134,44 + 21,99\) = 11
3. \(18,5928 - 9,931\) = 17
4. \(60,58 - 3,429\) = 16
5. \(52,78 \times 3,25\) = 35
6. \(0,939 \times 108,96\) = 39
7. \(17,018 \times 0,762\) = 43
8. \(7,0104 + 9,00\) = 38
9. \(25,44 + 0,76\) = 55
10. \(610,047 + 6,00\) = 34
ANALYSIS OF RESULTS OF MATHS TEST USED IN TOOL ROOM

80 Apprentices were given the test in both imperial and metric.
15 achieved less than 50% correct on at least one paper (9 on both).
12 had studied at CSE before joining Company.

Their progress in 1st year training showed the normal distribution of ability ranging from below average (2) to very good (2).

11 Apprentices achieved 100% success in at least one paper (one in 5 minutes).

6 studied maths at CSE.

3 studied maths at GCE 'O' level before joining the Company.

Their progress in the 1st year training showed a tendency towards above average ranging from below average (1) to very good (1).

Superintendent -
Works Training
situations, with insufficient time for the older employees to help the apprentices.

**Metric and Imperial Units**

Mr. Gaunt said that both types of unit were used frequently and each apprentice was issued with a book of conversion tables, e.g.

<table>
<thead>
<tr>
<th>Inches</th>
<th>Decimal</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/64</td>
<td>0.015625</td>
<td>0.3969</td>
</tr>
<tr>
<td>1/32</td>
<td>0.03125</td>
<td>0.7938</td>
</tr>
</tbody>
</table>

etc. extending to 30 pages

**Calculators**

These were in use but Mr. Gaunt expected all apprentices to be capable of doing the work with logarithms.

**Place value (Decimal Point) and Estimation**

Mr. Gaunt spoke of the weakness in estimating the correct order of magnitude of an answer; a further problem was cited in dividing 40 ÷ 7, with few apprentices being able to handle the remaining \( \frac{5}{7} \) or convert to a decimal.

**Automation**

While the Company was making extensive use of numerically controlled machines for some work, there was a continuing need for numerate, skilled craftsmen. One problem was that the most able young men were transferring to drawing office and technical work and thereby reducing the potential standard of the work force.

cont'd ...
While toolroom work was amongst the most exacting of the skilled trades, the financial rewards did not help recruiting or retaining the best youngsters.

Schools/Industry Liaison

Mr. Gaunt pointed out that recent teachers on exchange visits to the Company had been offered a set of sample workshop calculations; only one of the party had accepted the offer.

Sample Calculations

A large quantity of engineering drawings were produced for use in school, which included the craftsman's own hand calculations needed to perform his machining operations. The engineering drawing does not contain all dimensions required by the craftsman, and he may be required to perform quite complex trigonometry, etc.

Some of the mathematics topics involved in the calculations were as follows:–

1. Calculate an angle from reduction in diameter in given length. Tangent.

2. Calculate a dimension by addition and subtraction.

3. Calculation of additional dimensions using sine, cosine and tangent

   e.g. \( y = 92 \times \sin 23^\circ 30' + (5,5 \times \cos 23^\circ 30') + 9,5 \)  
   (accuracy on some dimensions to 0.005 mm.)

4. Use of Pythagoras, Radius and Diameter to find distance of chord from circumference.
MACHINING A FLANGE
(CRAFTSMAN'S OWN CALCULATIONS)
CALCULATE X AND Y FROM DATUM POINT 0

\[ R = \sqrt{3.000^2 - 1.3125^2} = 1.6875 \]

\[ \varnothing \; 0.4444^\circ (0.016) \]
3 HOLE DRILL
\[ 0.2195 \]
\[ \varnothing 0.2165 \text{ TAP} \; 250-28 \text{ UNF} \]
\[ 0.2862 \]
c/ bore \[ \varnothing 0.2812 \times \]
\[ .250 \text{ DEEP AS SHOWN} \]
EQUI-SPACED

\[ \varnothing 71.12^\circ (2.800) \]

IT IS NECESSARY TO CALCULATE X AND Y BEFORE SETTING UP FOR MACHINING.

\[
\begin{align*}
\sin 30^\circ &= \frac{\text{OPP}}{1.6875} \\
\sin 30^\circ \times 1.6875 &= \text{OPP} \\
0.500 \times 1.6875 &= \text{OPP} \\
\text{OPP} &= 0.8437
\end{align*}
\]

\[
\begin{align*}
\cos 30^\circ &= \frac{\text{ADJ}}{1.6875} \\
\cos 30^\circ \times 1.6875 &= \text{ADJ} \\
0.866025 \times 1.6875 &= \text{ADJ} \\
\text{ADJ} &= 1.4614
\end{align*}
\]
USE OF PYTHAGORAS' THEOREM TO FIND AN ADDITIONAL DIMENSION \( x \)

ALL DIMENSIONS IN INCHES

\[ \theta = 25.00 \quad 4.000 \quad 2.000 \]

\[ \text{DIMENSION} \, y = \text{RADIUS} - \text{OP} \]
\[ \text{OP} = \sqrt{12.500^2 - 2.000^2} \]
\[ \therefore \text{OP} = \sqrt{152.250} \]
\[ \therefore \text{OP} = 12.339 \]
\[ \therefore \text{DIMENSION} \, y = 12.500 - 12.339 = 0.161 \]
\[ x = 3.000 + 0.161 \]
\[ x = 3.161 \, \text{INS} \]
Nomenclature

11,995 meant 11.995 mm  
and 8.67 ± 0.1

A diameter of 4 mm was written as Ø 4.

Also involved was the practice of quoting both inches and millimetres "40 m/m (1.5748)".

These examples are documented in greater detail in the section on industrial applications of mathematics.

Future Cooperation with the Company

Together with the Careers Master at the School the possibility of a talk to 5th form pupils by the Company apprentices was discussed.

The Training Superintendent also described the Company's special apprenticeship (not E.I.T.B. validated), during which less academic boys (CSE 4 and 5) could achieve a form of skilled status.

Also available was a scheme for 18 year-olds to train for semi-skilled work paying nearly as well as skilled occupations.

The Training Superintendent concluded by stating that some surprisingly good scores at interview tests had been obtained by pupils from the School and suggested that they were due to the work from 'Apprentice Maths'.
Some other Projects involving School/Industry Co-operation

Hunt (7) described a project in the Cambridge area, where 95 employers were questioned.

One conclusion was that, "In practice most employers were reasonably satisfied with the standard of their employees ..... Nevertheless many employees merely 'get by' and ideally could perform more competently in numerate skills, whilst employers sometimes avoid giving jobs with mathematical content to school leavers. The engineering industry appears to be more concerned than others with the level of its applicants, whilst commercial firms have few complaints.

In many cases the concern of the employer was over the abilities of those he had rejected ...."

Page 33 summarizes the results of the Cambridge investigation, showing frequency of use for the various mathematical topics. The frequent and regular use columns were topics used by more than 49% of employees in the first six months of employment.

As noted by Fitzgerald (8), frequency of use of a topic is not necessarily a measure of importance - stocktaking is important but not frequent. Fitzgerald also questioned the ability of the employer to give accurate answers to frequency of use without actually observing the employee over a period of time.
Costello (7), presented other findings from the 95 Cambridge area firms, including:

- "71% of all companies expect school leavers to use calculators and a further 12% were willing to allow them once employees had proved themselves to be numerate."

- "Almost all jobs involving measurement require metric units, but some \( \frac{2}{3} \) of these also require Imperial Units."

- "Substantial numbers of employers did not regard CSE 1 as equivalent to 'O' level - preferred 'O' grade D/E."

- "Few employers take notice of CSE grades 4/5 as indicators of mathematical ability .... "

Wells (10), commenting on industry in North Yorkshire noted the emphasis on:

- Clarity and presentation of calculations (for easy checking.

- Ability to decide what calculation is appropriate.

- Ability to read different graduated scales and tables accurately and quickly.

- Ability to decide whether an answer is sensible.

- Ability to estimate and also round off results.

- Knowledge and manipulation of certain fractions and their decimal equivalent.

- Understanding of tolerances."
<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Regular Use</th>
<th>Frequent Use</th>
<th>Casual Use</th>
<th>Little Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>Meet whole nos. to 1000</td>
<td>Meet whole nos. &gt; 1000</td>
<td>Long division</td>
<td>Arithmetic with negative numbers</td>
</tr>
<tr>
<td>Simple mental arithmetic</td>
<td>Tables to 10</td>
<td>Tables to 12</td>
<td>Short division</td>
<td>Use of powers, standard form,</td>
</tr>
<tr>
<td>Fractions</td>
<td>+/- up to 2 d.p.'s</td>
<td>+/- up to 3 d.p.'s</td>
<td>+/- up to 4 d.p.'s</td>
<td></td>
</tr>
<tr>
<td>Percentages</td>
<td>% of an amount</td>
<td>% increase/decrease</td>
<td>Simple and compound interest</td>
<td></td>
</tr>
<tr>
<td>Conversions</td>
<td>Decimal/fraction</td>
<td>Fraction/%</td>
<td>Inverse proportion</td>
<td></td>
</tr>
<tr>
<td>Measurement</td>
<td>Metric length</td>
<td>Length (except metric), area, capacity, weight, metric/imp. conversion, rate, revolution, time</td>
<td>Speed</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Perimeters &amp; areas of squares, rectangles, triangles, circles, simple compound shapes</td>
<td>Surface area and volume of solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angles</td>
<td>Substitution in algebraic formulae</td>
<td>Similar triangles, Pythagoras' theorem, sin, cos, tan Area = bcs sin A, sine and cosine rules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td>Co-ordinates in 2-D</td>
<td>Co-ordinates in 3-D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistics</td>
<td>Bar charts, histograms, St. line graphs</td>
<td>Pie charts and pictograms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td>+/-/x/+ with money</td>
<td>Making out bills, invoices and accounts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stanier (9) working in Berkhamstead, visited local industry and prepared worksheets peculiar to those firms. These emphasised:

- Basic arithmetic and percentages (15)
- Basic mensuration, including work on the circle (12)
- Trigonometry (6)

Stanier reported that the less-able 15 and 16 year-olds at her school showed increased motivation and interest, "when presented with practical applications of mathematics in 'the factory down the road'."

Stanier noted that "the use of trigonometry, particularly in the engineering industry, is far more widespread than most mathematics teachers realised." Also noted was the continued need for both metric and imperial units, into the next century in the case of aerospace industry supplying spare parts and servicing components."

The importance of estimation and working to sensible degrees of accuracy were also emphasised.

In conclusion, Stanier recommended a continuing liaison between mathematics and local industry and stressed that for maximum value the worksheets should be produced by individual teachers for their own lessons.

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Employers' Selection Tests

Harris (6) examined 18 industrial test papers embracing 1054 questions. The composition of the tests was as follows:

<table>
<thead>
<tr>
<th>Question type</th>
<th>No. in category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole numbers, four rules</td>
<td>14.4</td>
</tr>
<tr>
<td>Fractions, mixed numbers</td>
<td>12.5</td>
</tr>
<tr>
<td>Algebra</td>
<td>9.9</td>
</tr>
<tr>
<td>Decimals</td>
<td>9.8</td>
</tr>
<tr>
<td>Operations involving units</td>
<td>8.3</td>
</tr>
<tr>
<td>Areas and volumes</td>
<td>5.1</td>
</tr>
<tr>
<td>Indices (including fractional and negative)</td>
<td>4.4</td>
</tr>
<tr>
<td>Interpretation of diagrams</td>
<td>4.1</td>
</tr>
<tr>
<td>Geometry (incl. theorems and constructions)</td>
<td>3.9</td>
</tr>
<tr>
<td>Percentages</td>
<td>3.2</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>3.0</td>
</tr>
<tr>
<td>Hard problems (maths reasoning and multiple operations)</td>
<td>2.7</td>
</tr>
<tr>
<td>Logarithms</td>
<td>2.5</td>
</tr>
<tr>
<td>Circles (area, formulae, etc.)</td>
<td>2.3</td>
</tr>
<tr>
<td>Ratio and proportion</td>
<td>1.6</td>
</tr>
<tr>
<td>Progressions (A.P. and G.P.)</td>
<td>1.3</td>
</tr>
<tr>
<td>Place value, graphs, estimations, simple interest, probability, recognition of shapes, sets, number bases, scale drawing, calculus, factorials, equation of curves</td>
<td>Less than 1%</td>
</tr>
</tbody>
</table>

Harris commented on the "vast difference" between the emphasis in industrial tests and the school tests, and suggested collaboration to improve test design.
'Education and Employment'

Report by the Association of British Chambers of Commerce (11), September 1979; representing 50,000 manufacturing and service firms.

The recommendations of the report included:—

1. Government should set standards of numeracy to be achieved by all children.
2. Nationwide maths tests and schools with poor record to be inspected.
3. Primary teachers of mathematics to be qualified in the subject.
4. Emphasis on need for standards in maths in schools and training colleges.
5. Adequate numeracy to be a condition for 16+ qualifications.
6. Examinations to take account of industries needs; representatives of Industry and Chambers of Commerce to help determine 'O' and CSE syllabuses.

Consequences of failure to teach children essential skills:—
"Deprived of sufficient skills, British business will fail to defeat overseas competition and unemployment will continue to rise ....... high school leaver unemployment is already contributing to social tensions."

Pay Differentials

The erosion of differentials between skilled and unskilled work has, claims the report, removed the incentive for numerate school leavers to learn a 'trade.'
Higher Education

The expansion of this has led the more highly qualified school leaver away from industry into the government/service sector.

Employment Protection Act

The Association believes this has removed the incentive to learn a skill for increased security and reduced employers' willingness to take on school leavers and train them. "Firms have refined their recruitment screening to exclude those who do not achieve adequate mathematical ability."

The present government's (Sept. 1979) policy of shifting employment away from the public sector, the Association believes, will mean that school leavers will need to be more numerate (less porters, cleaners, etc.)

The report suggests that the rising unemployment is partly due to the less-able pupils achieving low standards of numeracy.

Calculators

The calculator is seen only as an aid, for an operator who already possesses basic numeracy.

Primary Schools

The Association believes that some primary schools are failing to teach the basic core of mathematical knowledge which is essential to develop children's full potential. ........ teachers with little knowledge of or competence in mathematics have tended to teach other subjects during time which should be used for maths .... the 11+ examination did provide very considerable pressure to maintain a high level of standards in this area."
The following table shows the mathematical requirements of industry from a survey by Burton-upon-Trent and District Steering Committee for the development of co-operation between industries and schools.

**Opinions of Local Companies**

<table>
<thead>
<tr>
<th>Subject</th>
<th>% of firms who require proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition and subtraction of decimals</td>
<td>80</td>
</tr>
<tr>
<td>Muliplication and division of decimals</td>
<td>70</td>
</tr>
<tr>
<td>Percentages</td>
<td>65</td>
</tr>
<tr>
<td>Conversion of vulgar fractions to decimals</td>
<td>60</td>
</tr>
<tr>
<td>Use of 4 figure tables</td>
<td>60</td>
</tr>
<tr>
<td>Addition and subtraction of vulgar fractions</td>
<td>60</td>
</tr>
<tr>
<td>Muliplication and division of fractions</td>
<td>55</td>
</tr>
<tr>
<td>Transposition of formulae</td>
<td>50</td>
</tr>
<tr>
<td>Knowledge of Mensuration</td>
<td>50</td>
</tr>
<tr>
<td>Use of $\sqrt{}$</td>
<td>50</td>
</tr>
<tr>
<td>Square Roots</td>
<td>30</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>30</td>
</tr>
</tbody>
</table>
Evidence Concerning Standards

1976 Evidence

Test results published in 1976 by Mr R Gilbert, training executive of Coventry Engineering Employers' Association, suggested that applicants for apprenticeship were getting worse at English and Mathematics, while their intelligence remained constant (Ref 11).

The 1976 figures are shown on page 41. Ref (5) claims that this was "about the only concrete evidence to support the view that standards were falling" and was "soon followed by the Great Debate."

1980 Evidence

New figures from the same source show an apparent improvement in arithmetic and English. Mr Gilbert points to the danger of conclusions based on limited samples and thought the upturn might be due to the schools' response to the "alarming indications of 1976". The schools were now "very much more conscious of the need to look at pupils' requirements after they have left school."

Mr. Gilbert did not think the increased number of applications was responsible for the apparent improvement: "we still get a hell of a lot who haven't got a cat in hell's chance."

Response to this Research by HII

Coventry's chief inspector, Mr Sanday, stated that while he had reservations about some of tests (all supplied by the National Institute of Industrial Psychology), he thought that the Coventry Schools had responded well to the employers' concerns. This response had included a maths and English task force. Mr. Sanday, however, regarded both the previous downturn and the upturn in 1980 with suspicion, questioning the sensitivity of the tests.
Other Evidence Concerning Standards

In "Standards of Numeracy and Literacy in Wales," CBI Wales, 1977, (30), it was stated:

"By 1975, however, the concern was more widespread throughout industry in Wales as more and more companies found themselves unable to fill apprenticeship vacancies with young persons of suitable calibre."

One large company found that in 1974, 86% of applicants were unacceptable because of arithmetic, compared with 30% in 1966 using identical criteria.

"While accepting that the sector of school-leaving population supplying apprentices had changed due to extra sixth-form provision, etc., the report suggests that higher attainment would be achieved by "more - and perhaps better - teaching."

This view was supported by a claim that "Much progress is made in developing literacy and numeracy skills during the early period of apprenticeship."

Summary of Points suggested by Industrial Visits and Employers' Reports

1. The remedial maths being taught by employers should all be covered in school.
2. Both Metric and Imperial Units were widely required.
3. Engineering craftsmen were being recruited from the lower end of the mathematical ability range by some firms.
5. The book 'Apprentice Maths' was considered by training officers to be very suitable for preparing students for the mathematics needed in craft apprenticeships.
6. Standards amongst craft trainees might be improved if more girls were persuaded to apply for apprenticeships.
Chapter 2

EDUCATIONALISTS’ VIEWS, RECENT HMI REPORTS, ETC:
REPORTS BY TEACHERS’ ON SECONDMENT TO INDUSTRY

During the period of this work, from 1979 to 1981, a substantial number of reports were produced by HMI and the teachers' organisations, partly in response to the publicity over "falling standards."

Sections of these reports are included in the following chapter, to balance the industrialists' views given previously.

Also included in this chapter are the reports by 16 senior teachers of their secondment to the engineering industry for a week in 1979, in which they spoke to apprentices, managers and workers and discussed the transition from school to craft apprenticeship.

1. NUT Report p. 43
2. Educational Philosophy p. 48
3. Talk given to Industrialists by Head of Maths p. 51
'Primary Questions': NUT response to the HMI primary survey

HMI found that although considerable attention was paid to computation, measurement and calculations involving money, results were sometimes disappointing.

N.U.T. suggest that one weakness may be LEA's inadequate provision of remedial teaching.

Work cards and individual learning

If teachers have come to work in this way it is because these methods were commended to them by their training college lecturers and LEA advisers.

Teaching from the blackboard has become almost taboo, and now we find HMI exhorting teachers to use the very methods which had been regarded as old-fashioned.

HMI condemns 'repetitive practice', while parents see it as vital to children's progress, especially in learning tables.

HMI consider that most able children are not being adequately stretched, the Union demands 'curriculum enrichment materials'.

Language and Symbols

Least able have, according to HMI, been handicapped by proliferation of symbols in mathematics text books and work cards.
Metric and Imperial Units
The Union considers that learning to use mathematics in everyday situations is vital, but has been hampered by metrication and the pressure from LEA's to use metric scales alone, while children need to use both.

The HMI survey states that locality of the school was the most dominant characteristic and that NFER were 'significantly lower in inner city areas where deprivation and poor environmental conditions will inevitably lower performance. The Union considers that 'the content of initial training courses in basic subject teaching should be reviewed. The HMI found that 'there is no evidence .... to show that a narrower curriculum enabled children to do better in the basic skills ....' HMI state 'basic skills are more successfully learnt when applied to other subjects.'

Young Teachers
'Head teachers .... have a particular responsibility to see that young and inexperienced teachers, facing the problems of establishing control and methodology, are not pressed into ....'

Children working at their own pace
'... teachers have suffered in the past from being told by experts that children learn best in mathematics by all working at their own pace, which has led to uneconomical use of teachers' time.'
Report on Comprehensive Schools by the N.U.T. Sept 1979
in defence of Comprehensive Schools and
present Primary Schools.

The report states that 83% of the nation's secondary school children are in comprehensive schools.

Lack of Resources

The N.U.T. considers that the real problems facing teachers are declining resources for books and equipment, oversized classes, insufficient in-service training and delapidated buildings; the Union also states that schools are blamed as 'scapegoats' for many other social problems, including high youth unemployment, poor housing and home surroundings.

The project 'Fifteen Thousand Hours' which monitored 1400 children through school from 11 - 16 in south-east London confirmed that resources are crucial in developing children's potential.

Contradiction of the idea of falling standards (Literacy)

In contrast to the idea that standards are falling, the report quotes that one out of five adult males during World War II was illiterate or semi-literate (reading age below 10) and Vernon found that roughly half of a large group of Ordinary Seamen, in 1943, ...'were clearly incapable of writing an intelligible and reasonably grammatical, even if simple, sentence.' The men concerned were educated in the 1920's and 1930's.

The N.U.T. state that in 1971 the percentage of semi-literate 15 year olds was 3.2%.
Comparison of G.C.E. results 1964 - 1974

Table 1

<table>
<thead>
<tr>
<th>No. in Comprehensives</th>
<th>Obtained 1 - 4 'O' levels</th>
<th>Obtained 1 'A' level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964 8%</td>
<td>15%</td>
<td>11%</td>
</tr>
<tr>
<td>1974 70%</td>
<td>25%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 2

Output of students 1966 and 1976

<table>
<thead>
<tr>
<th>Number of 'O' levels or higher grade CSE</th>
<th>% of age group 1966</th>
<th>% of age group 1976</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>58.6</td>
<td>47.4</td>
</tr>
<tr>
<td>1 - 2</td>
<td>8.4</td>
<td>17.0</td>
</tr>
<tr>
<td>3 - 4</td>
<td>6.6</td>
<td>8.7</td>
</tr>
<tr>
<td>5 or more</td>
<td>18.0</td>
<td>22.4</td>
</tr>
<tr>
<td>1 or more</td>
<td>33.0</td>
<td>48.1</td>
</tr>
<tr>
<td>Number of 'A' levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2.3</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>3.2</td>
<td>4.2</td>
</tr>
<tr>
<td>3 or more</td>
<td>5.6</td>
<td>8.3</td>
</tr>
<tr>
<td>1 or more</td>
<td>11.1</td>
<td>15.5</td>
</tr>
</tbody>
</table>
Table 3

<table>
<thead>
<tr>
<th>% School leavers with:</th>
<th>1956</th>
<th>1976</th>
</tr>
</thead>
<tbody>
<tr>
<td>'O' level maths or</td>
<td>15.6%</td>
<td>23.6%</td>
</tr>
<tr>
<td>equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'O' level English Language or equivalent</td>
<td>22.3%</td>
<td>35.8%</td>
</tr>
</tbody>
</table>

References


4. DES school leavers CSE and GCE 1976 (Vol 2)

Primary Mathematics

The HMI's survey on Primary education in England (HMSO 1978) included a mathematics test standardised in 1973 when the mean score was 25; in 1976/77 the mean score was 28.

Needs of local industry

Reference page 8 of the report

"At the same time, educational and vocational counselling has grown with teachers trying to meet the real needs of children without succumbing to the often unreasonable clamour of demands from national and local industry."

HMI's report that: 'Teachers in primary schools work hard to make pupils well behaved, literate and numerate.'
Educational Philosophy

There are different opinions amongst teachers and the public about the purpose of a school and the measure of its success.

Parents often judge the school on the quality of its 'A' and 'O' level results; some teachers oppose the idea of competition and value personal qualities more highly.

These contrasting pressures often cause conflict amongst teachers, particularly over the purpose of teaching mathematics; Blackie (Ref 13) stated that 'on the grounds of utility the claims of mathematics are not very strong.'

'If we are teachers, or chemists, or physicists or engineers, or computer-programmers we may be using mathematics all the time, but the great majority use it very little.' 'The real reason for learning mathematics is that it is part of man's cultural heritage and is, or can be, tremendously interesting and exciting ...'

The above was the view of a Chief Inspector of schools in the 1960's; craft apprentices form the largest sector of the male school-leaving population and may see mathematics in a more vocational light.

The H.M.I. Report 'Mathematics 5 - 11' in 1979 (Ref 14) identified three purposes; utilitarian, cultural and training of the mind for both primary and secondary education. The utilitarian argument presented includes the narrow needs for everyday life and the broad needs for employment, science and technology.

The report emphasised the need to establish common objectives so that teachers with differing outlooks on culture and utility can work together.

Mathematics according to H.M.I. 'can be justified as training for the mind; but the training also needs to serve other purposes which can be understood by the pupil at the time.'
H.M.I. stated that primary teachers are not agreed on common aims and objectives. 'Some stress factual knowledge to the exclusion of other objectives; others emphasise the importance of processes and understanding and the enjoyment of mathematics. The formation of minimum requirements could be a helpful step, but unless the formulation is accompanied by continuing attempts by teachers to develop their professional judgement, minimum standards could too easily become an accepted norm.'

The lack of agreement between teachers on the purpose of mathematics implies a variation of emphasis on basic skills in arithmetic even amongst qualified mathematics teachers.

The D.E.S. survey (Ref. 15) found that in January 1979 there were 463 vacancies for mathematicians. Of the 43,400 actually teaching mathematics only 30,600 were qualified. 18,800 qualified mathematics teachers were in schools but were not teaching their subject.

The Standing Conference on Schools' Science and Technology resolved to make the shortage of specialist teachers in maths (and others) a top priority. It was suggested that people from industry should be seconded to teach in schools and retired industrial scientists be employed.

The Hadow Report of 1931 (Ref. 14) stated that: 'It is essential that these fundamental processes of arithmetic become automatic before the child leaves the primary school. Unless he can add, subtract, multiply and divide accurately, quickly and without hesitation, his future progress will be severely handicapped. This means that he must know his addition and multiplication tables through and through as certainly as his own name.'

H.M.I. stated that 'in recent years less emphasis has been given to arithmetical skills.' H.M.I. argued that the extra time needed for the broader practical activities was available because of the saving in computation caused by decimilisation of money in 1971 and the reduced use of
Imperial Units.

The report recommended that measuring with Imperial Units should continue but 'written calculations with Imperial Units are not normally necessary for primary children, and they should be encouraged to think and work in metric units.'

Summary

1. The teaching profession are not united in their emphasis on arithmetical skills.

2. Metrication and decimalisation were seen as creating more time for a broader mathematics syllabus; with understanding stressed more than 'rote' learning.

3. 12,300 teachers of mathematics in 1979 were not qualified. Efforts were being made to recruit more qualified staff within the existing financial limitations.

Implications for the Craft Apprentice

It is sometimes argued by teachers favouring traditional methods that the average and less able pupil learns more effectively from habitual practice than by discovery methods which it is claimed stimulate only the brighter child. Craft apprentices generally are drawn from the 'average' group.

The headmaster of a large comprehensive school in Derby (South) stated that while comprehensives catered well for the very able and the remedial pupil, the 'average' was a much neglected group.

Steggals (Ref 16) called for the standardisation of maths syllabuses on a national level and at the same meeting a standard numeracy test for all leavers was advocated.
"One gets the impression when reading the national press that teachers generally, and maths teachers particularly, are not doing their jobs. Obviously there has been a lowering of standards over the last few years, but this is not wholly due to a deterioration in the competence of teachers."

"Just over a decade ago mathematics taught in schools was the subject of radical reform. 'New maths' was introduced and with it 'self-discovery' methods. This change was optional and eventually maths departments polarised into two types; modern and traditional. Obviously some changes had to be made because of the introduction of decimal currency and a tendency towards metrification generally, but I doubt the wisdom of such wholesale changes."

"The main culprit is the diversity of the means of presentation of basic processes. I know of two ways to subtract whole numbers and three ways of carrying out long multiplication. It is very confusing for a child when he changes teachers, but even worse when he changes schools. Something the pupil thought he was familiar with suddenly becomes strange. The resulting confusion forms a barrier to new learning, and possibly a dislike of mathematics generally. I see no need for this confusion. There is surely a case for deciding nationally on the best way to carry out each process and insist that all teachers adhere to this. The method of teaching the process could be varied according to the personality of the teacher and the level of ability of the class, but I am making a plea for the end result to appear the same in every case. In fact there is at present a move in the Derbyshire authority towards standardisation. The heads of mathematics departments over the county are discussing the
Talk by a Head of Maths - continued

nature of a document which will be circulated to all Derbyshire schools recommending efficient ways to set out each process."

"Almost as much to blame are the self-discovery methods used in many schools. This sounds ideal in theory, but in practice it is very slow and inefficient. What is wrong with telling someone how to do something. The whole basis of mankind's progress is that knowledge accumulated by one generation is passed on to the next. Surely it is better to tell a child that he will burn his fingers if he puts them in the fire than to allow him to find this out for himself?"

"The problem of lack of standardisation will probably diminish as more schools change over to the 'middle of the road' courses. These courses combine all the arithmetic and most of the algebra used in traditional courses, together with some of the more useful topics of the modern courses like statistics, matrices and vectors. There has also been a move away from the more obscure parts of Euclidean geometry towards analytical geometry and calculus, and transformation geometry. However the circle theorems, Pythagoras' theorem and the properties of plane figures remain."

"I consider that the common examination system, soon to be introduced, will also be a move in the right direction. At the risk of being branded an extremist I would like to say that I would welcome the introduction of a national syllabus, with a limited choice of textbooks to back it up. The French operate this system at present. It releases teachers from deciding what to teach and allows them to concentrate on how to teach it."
"I am also in favour of learning by rote in the early stages. Constant drilling leads to confidence and understanding comes later with maturity. If this sounds dull and unimaginative I can assure you that nothing gives greater pleasure than a page full of ticks and the award of a gold star, house point or similar. Lengthy explanations confuse most children; in fact they are likely to confuse the explanation with the method."

"I would like to share with you a real problem which we have. About 18 months before the final examinations we have to decide which examination, CSE or GCE, a pupil will be entered for. Most students are easy to place, but inevitably we have a few borderline students. Do we enter them for GCE risking a grade D or E, or do we enter them for CSE which is regarded as a secondrate examination? The D and E grade represent 5% bands below the previous pass level and are near misses. They ought to receive more recognition than they do at present. The CSE examination is quite difficult nowadays and the average grade awarded is grade 4, so anyone with 1, 2 or 3 grades is quite able to cope with quite difficult tasks. However, anything less than grade 1 is looked on as worthless. I would like to see GCE grades D and E and CSE grades 2 and 3 accepted as evidence of mathematical competence."

"Finally I would like you to set entrance tests for your establishment with the greatest care. I have seen one which consisted of about a dozen questions. A quarter of these were concerned with distance, speed and time. No examination should contain repeats, since the inability to cope with one question rules out success in the others, thus eliminating much of the examination as a means of finding out what the pupil does know. This same paper contains the old chestnut of a bath being filled by two taps, while the plug was removed, and a question about the
distance between the first and last in a row of telegraph poles. Trick questions are good classroom entertainment, but are hardly appropriate to examinations. A good test should contain a wide range of questions which test skills in a straightforward manner. It should be constructed with reference to the syllabuses used in the schools in the area. Bias toward directly useable skills could be built in, but a person who is generally competent could easily be trained for specific tasks after competence has been established."

"If anyone has questions regarding the syllabuses or methods we use at this school I would be happy to answer them. I think that our general structure is moving towards that which I have detailed in this talk; a structure which I am convinced will improve the lot of all the pupils at this school."

John Steggals
Head of Maths,
Derby School.
Summary of some of the mathematical findings

The report was carried out from 1975 - 1978 on 384 maintained secondary schools (10% of the total.)

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional vs Modern</td>
<td>Differences have diminished. Most schools do compromise syllabus with traditional for lower ability 4th and 5th year. Teachers' interpretation and approach more important than type of syllabus. See Table 2.</td>
</tr>
<tr>
<td>C.S.E. courses</td>
<td>Considerable numbers of pupils follow courses in which there is &quot;abstract intellectual content ..... beyond their limits.&quot;</td>
</tr>
<tr>
<td>Less able pupils</td>
<td>In 60% of schools, HMI considered new courses needed for less able.</td>
</tr>
<tr>
<td>Number bases (e.g. base 8)</td>
<td>Useful only as 'illumination' of our tens system.</td>
</tr>
<tr>
<td>Matrices, vectors, sets, etc.</td>
<td>Can be of doubtful value if taught only as low level skill.</td>
</tr>
<tr>
<td>Standards in arithmetic</td>
<td>Weaknesses were hardly ever due to lack of attention to the problem -</td>
</tr>
<tr>
<td>Aspect</td>
<td>Finding</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>not infrequently linked to difficulties from catchment area. &quot;Improvement involves more than teaching method alone.&quot;</td>
</tr>
<tr>
<td></td>
<td>Proper level can be achieved with both Traditional and Modern system.</td>
</tr>
<tr>
<td></td>
<td>&quot;Unrelieved diet of further practice on a succession of narrow techniques,&quot;</td>
</tr>
<tr>
<td></td>
<td>not likely to solve longstanding difficulties with fractions and decimals.</td>
</tr>
<tr>
<td>Applications</td>
<td>Disappointing lack of realistic materials such as plans, magazines, instruction manuals. More linking should be made with craft and technical subjects and their equipment.</td>
</tr>
<tr>
<td>Computers</td>
<td>Only a minority of pupils involved, even computer terminals unused.</td>
</tr>
<tr>
<td>Language</td>
<td>Not enough interchange of ideas between pupils, teachers and use of mathematical sentences.</td>
</tr>
<tr>
<td>Mental arithmetic</td>
<td>Not enough regular practice.</td>
</tr>
<tr>
<td>Aspect</td>
<td>Finding</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Numeracy</td>
<td>Should also include ability to estimate and use appropriate degree of accuracy.</td>
</tr>
<tr>
<td>Objectives</td>
<td>Many were too narrow, too much repetitive mechanical arithmetic without comprehension or ability to apply in fresh situations.</td>
</tr>
<tr>
<td>Suggestions for improvement</td>
<td>1. Diagnosis of individual difficulties 2. Better appreciation of role of language and oral work. 3. More use of applications from world outside.</td>
</tr>
<tr>
<td>Requirements of industry</td>
<td>&quot;... may be a substantial problem&quot; but criticism had reinforced a number of schools in an already narrow approach in mathematics.</td>
</tr>
<tr>
<td>Excessive breadth</td>
<td>Only a problem in a small number of schools - modern syllabuses &quot;more prone to this excess than traditional.&quot;</td>
</tr>
<tr>
<td>Catchment area/social deprivation</td>
<td>In a few cases, &quot;lessons proceeded in an atmosphere of resigned defeat ... most usually in schools where there were problems of social deprivation. &quot;Solution only to be found as part of a larger programme of restoring morale.&quot;</td>
</tr>
<tr>
<td>Aspect</td>
<td>Finding</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Setting and mixed ability.</td>
<td>Only three schools had complete mixed ability across the whole range and these were criticised by HMI.</td>
</tr>
<tr>
<td>Qualification of teachers.</td>
<td>Of 3,365 teachers, 27% maths graduates, 23% not specialising in maths as 1st or 2nd subjects. Between 2,500 to 4,500 of the country's teachers considered inadequate in professional/mathematical capability.</td>
</tr>
<tr>
<td>Marking.</td>
<td>Poor presentation of work associated with poor standards of marking, but over-conscientious teachers might damage health.</td>
</tr>
</tbody>
</table>
Pupils' Behaviour

The inspectors invited the schools to comment on behavioural problems: the results were subjective in that they represent the schools views' about themselves.

The main problem seen by the schools was absence with apparent parental acquiescence affecting about $\frac{1}{5}$ of the 384 schools. Only 24 admitted a considerable discipline problem.

Schools with a Concentration of Problems

Twenty-five schools declared serious problems such as indiscipline, violence between pupils and hostility to teachers. Of these 25, environment was the most common characteristic, 13 being inner city and 6 less prosperous suburbs. These 19 from poor catchment areas had 25% of their intake with serious learning difficulties, but in some cases the figure was as high as 30, 33 or 57%.

The schools had difficulty in attracting and retaining staff, (one had 360 staff changes in eight years), and Mathematics departments had fragmented teaching and leadership. Some 5th year pupils had nine teachers in mathematics since entering the school.

The HMI's mentioned the low expectations which these pupils brought from home and inexperienced teachers aiming for containment rather than learning.
One school in a slum clearance area had a small group of disruptive pupils with court appearances pending and these caused a 'thread of indiscipline' throughout the school.

A School Notably Free from Problems (yet in a poor area)
HMI described a school in a very poor catchment area which suffered virtually none of the problems affecting other schools in the area.

Mentioned were the high quality of concern for the pupils, an effective structure of pastoral care and good communications. There were extensive extra-curricular activities and the school had its own residential centre in Wales.

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In summary, while declaring that the majority of schools present a reassuring picture, the inspectors state that:-

"There may be a threshold beyond which the proportion of pupils of very limited ability, presenting a variety of learning problems, the number of disturbed and disturbing children, the proportion with troubled home backgrounds, the inadequacy of resources, whether of specialist skills among the staff, or in the facilities offered by the buildings, the depressing character of the outer environment, may together create problems of a different order."

---oOo---
The following tables were extracted from more comprehensive tables in the report.

**Table 1** Examination Targets

Boys and Girls 384 schools

<table>
<thead>
<tr>
<th>Examination Target</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>'O' level</td>
<td>22%</td>
</tr>
<tr>
<td>O/CSE</td>
<td>7%</td>
</tr>
<tr>
<td>CSE</td>
<td>53%</td>
</tr>
<tr>
<td>Non-Exam</td>
<td>17%</td>
</tr>
</tbody>
</table>

**Table 2** Modern vs Traditional - 384 schools

<table>
<thead>
<tr>
<th>Year</th>
<th>Traditional</th>
<th>Compromise</th>
<th>Modern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29%</td>
<td>43%</td>
<td>35%</td>
</tr>
<tr>
<td>2</td>
<td>33%</td>
<td>44%</td>
<td>33%</td>
</tr>
<tr>
<td>3</td>
<td>36%</td>
<td>43%</td>
<td>34%</td>
</tr>
<tr>
<td>4</td>
<td>50%</td>
<td>45%</td>
<td>33%</td>
</tr>
<tr>
<td>5</td>
<td>53%</td>
<td>43%</td>
<td>31%</td>
</tr>
</tbody>
</table>

(Some schools offer more than one course in a particular year so totals not 100%.

**Table 3** 'Competence' in Arithmetic

<table>
<thead>
<tr>
<th>GCE</th>
<th>Competent in 86% of schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE</td>
<td>&quot; &quot; 62% &quot; &quot;</td>
</tr>
<tr>
<td>Non-exam</td>
<td>&quot; &quot; 37% &quot; &quot;</td>
</tr>
</tbody>
</table>
### Table 4  
**Class Size - 384 schools**

<table>
<thead>
<tr>
<th>Class Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCE</td>
<td>26.5</td>
</tr>
<tr>
<td>GCE/CSE</td>
<td>27.7</td>
</tr>
<tr>
<td>CSE</td>
<td>25.0</td>
</tr>
<tr>
<td>Mixed targets</td>
<td>21.1</td>
</tr>
<tr>
<td>Undecided and arithmetic</td>
<td>20.9</td>
</tr>
<tr>
<td>Non-examination</td>
<td>18.7</td>
</tr>
</tbody>
</table>

### Table 5  
**HEI's assessment of mathematical provision and pupils' response in 384 schools**

<table>
<thead>
<tr>
<th>Mathematical Provision</th>
<th>More Able %</th>
<th>Average %</th>
<th>Less Able %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creditable</td>
<td>17</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Acceptable</td>
<td>68</td>
<td>64</td>
<td>44</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>15</td>
<td>26</td>
<td>47</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pupils' Response</th>
<th>More Able %</th>
<th>Average %</th>
<th>Less Able %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creditable</td>
<td>26</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Acceptable</td>
<td>68</td>
<td>69</td>
<td>54</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>6</td>
<td>19</td>
<td>34</td>
</tr>
</tbody>
</table>
Shortage of Mathematics Teachers

HMI (15) noted that "between 2,500 and 4,500" of the country's mathematics teachers were lacking in either professional or mathematical capability.

Doe (33), commenting on the introduction of micro-computers into schools, stated that most of this work was being undertaken by maths teachers, thus exacerbating the shortage of mathematics teachers.

Quadling (34) described the computer as "a normal part of the furniture" - "We do not take up time teaching children about Caxton bookbinding and the invention of the monotype machine ......

Some children, it was thought, should not receive maths lessons until they left school "But we are also forcing many teachers to attempt to teach mathematics, often against a dead weight of indifference, to children "who are more likely to find their motivation for continuing mathematics in a wider context."
Current Government Policy

The Conservative Government under Mrs. Thatcher was likely to be in office at least for the beginning of the 1980s. Wilby (Ref. 20) reported the Government's policy of retaining 'O' levels, planned to be abolished by the last administration. They were concerned that children were attempting examinations beyond their capabilities.

"'O' levels and C.S.E. were designed for the most able 60% .... but now they are attempted by more than 90%.

Mr. Carlisle, the education secretary, had argued that 'O' level was the only exam whose standards were clearly understood and accepted by employers.

The Government wanted to reduce the number of syllabuses with a 'common core' in maths, and adopt a common grading system between 'O' level and C.S.E.

Of relevance to weaker craft apprentices (say Grade 5 C.S.E.) the government wanted to reduce the importance of exams - or get rid of them entirely - for the below-average children.

Alternative methods of assessment would be 'profiles,' in which teachers rate character (punctuality, determination, etc.) and mastery of specific skills (e.g. ability to operate a lathe).
SECONDMENT OF TEACHERS TO INDUSTRY

Introduction

The Derbyshire Education Committee Working Party Report on Careers Education and Guidance 1975 said that "Relatively few teachers ...... have had the opportunity to spend time at employers' premises since entering the teaching profession. The Working Party is convinced of the merit of ...... developing a greater mutual understanding between teachers and employers ...." 

As a result a one week course for secondary teachers in the Derby Area was organised with the following stated objectives.

"(i) To enable teachers to examine the training and subsequent working environment of young people.

(ii) To enable employers to understand the educational environment from which young workers have come.

(iii) To enable teachers to understand the reasons for employers requiring certain educational standards.

(iv) To enable employers to appreciate the reasons for and nature of changes in teaching method and subject content.

(v) To create a framework in which continuing dialogue can take place."

Interest in the course was demonstrated by the fact that 16 teachers participated, although initially there were only 12 places available.
Teachers' Conclusions after Secondment to Industry

The teachers wrote reports on their experience in industry and these varied from a handwritten side to a thirty page report. Salient points relating to the mathematical education of craft apprentices are given on the following pages. Many of the points were duplicated by several teachers but only a representative sample is included here.

Head of Physics.

This teacher was surprised at the cleanliness and low noise level - "a pleasant place in which to work." No doubt this will alter the image of engineering which the teacher subsequently portrayed to his pupils.

Selection

The teacher noted "the test is the Vernon Maths Test which involves the four functions, use of decimals, squares, negative and fractional indices, trigonometrical functions including cosec, simple geometrical calculations, factorisation, quadratic equations, simultaneous equations and simple series e.g. seven, ?, sixty-three. The accepted minimum of 30% could be achieved using the four basic functions and nothing else, but about 15% of applicants do not reach this standard. Apart from this numeracy deficiency the firm is concerned about the basic english work, such as spelling ...." "From the school's view-point the instructors, foremen, and most significantly the trainees themselves felt that if a greater emphasis was put on basic mathematics and the rudiments of literacy then they would have progressed faster and could have avoided a lot of frustration."
".... they (the apprentices) did not look upon teachers as knowing the actual work situation - visits from past pupils was suggested".

"These methods would have helped them to appreciate self-motivation, threat of ultimate sanctions, self-reliance, and time-keeping."

"The school leaver must possess the fundamental abilities in mathematics and English. This was evident time and time again from all sides of the industrial scene. Not only would a deficiency in these possibly prevent them from obtaining an apprenticeship, but all along the line it would be a barrier to further progress and a source of frustration to them and the people with and for whom they work."
Mathematics Teacher and Housemaster

This teacher found the craft apprentices very reluctant to talk; "when they were asked about their schools some criticized their mathematics, others said that some of the subjects they took were useless to them. They all agreed that their respective schools did not prepare them adequately for work. They wished they had better careers lessons which were "just a handout of information to be read." They wished they could have seen other works and were given time to spend in these places."

In the works the teacher spoke to management about mathematics:-

"Here schools and teachers came under fire for the appalling state of mathematics some of the apprentices have. The manager asked us simply to teach them the tables! He criticized the trigonometry aspect of mathematics and told us that trainees had no idea of how to manipulate formulae. He showed us some examples of simple mathematics tests and I had to agree with him that the standard of mathematics of some of the apprentices was very poor indeed. I pointed out to him that the craft apprentices are not exactly the cream of our school leavers. Trigonometry and manipulation of formulae could be very difficult to teach and some people of lower ability could never comprehend it. I pointed out that we do teach and teach well things like trigonometry but the children find great difficulty to remember these things. We simply have not got the time to revise all that we do because we have a certain amount of other topics to teach leading to an examination. We in schools are geared towards examinations and not towards industry."

"The manager mentioned that some of these apprentices were so bad in mathematics that they were sent back to the Training School for some more mathematics teaching. He criticized the lack of discipline in Junior Schools for this is where boys and girls ought to learn tables and he
criticized some teaching methods used in some secondary schools where children are left to 'teach' themselves from cards."

"As a mathematics teacher, I could not fail to appreciate the difficulties industry experiences in the field of mathematics. It is not the case that we do not teach certain aspects of mathematics, but it is more the case that pupils from that level cannot retain even simple addition and subtraction rules. As soon as a teacher introduces fractions, trigonometry, or any other subject, the pupils understand it until a new topic is introduced. This not only causes problems to industry, but causes problems to schools, because unless the teacher keeps revising all the time and 'drill' it into the minds of the pupils they will not retain it. This method of rote learning is not only condemned by some educationalists, but it is no guarantee that the students will learn and retain the knowledge either."

"I was pleased to mention that my own school has accepted that there is a problem and the pupils of lower ability can now follow a mathematics course to suit them."
"They have since been forced to lower the standard of entry and yet are still prepared to criticise because the less academic candidate who applies is less academic in his knowledge ....... The other part is that we are failing, somewhere between junior school and sixteen, to teach the basics and we as teachers must accept the blame to a degree and find out why and remedy the situation instead of denying its existence."

The teacher referred to ignorance about industry and quoted an example of a headmaster who scorned engineering and a schoolmistress who showed her pupils a sheetmetal workshop and warned them, "If you don't work hard and do your homework, that is where you will end up."

To overcome this ignorance, the teacher suggested a team of supply teachers to take-over in school while more colleagues were seconded to industry for "enlightenment."

The teacher intended to model his craft teaching in school along similar lines to the E.I.T.B. training modules he had seen at the engineering company.
"Talks with trainees were interesting. The first year Craft Trainee found life little better than when at school - except that he was paid: this gave him freedom and possessions, and this seemed important."

"There was still resentment at such things as school rules, discipline, uniform, homework and particular teachers. Some of the tougher ones spoke of 'retaliation' when punished. The quieter ones were reasonably happy at school, endured it bravely or behaved to avoid trouble with parents. Those we spoke to had been caught up in the change-over to the comprehensive system and had little good to say about it at all - in fact a lot were bitter about their experiences in some of the larger schools."

"Those who did SMP Maths were unanimous that it had done little for them and that the time could have been better spent (what are Venn diagrams?)"

"It was felt by many that it might help if good quality careers advice, visits etc. were given no later than the third year, before options were chosen. Another idea was to have works experience incorporated into the final year. Again visits were useless; one had to be able to identify oneself with the job one would be doing."
Head of Physics

This teacher referred to the criticisms of Modern Maths and poor Careers Guidance and continued:

"It would seem from talking to many of these people that the Comprehensive System of Education has failed in their cases to provide them with the type of schooling which they required. They are the people who should have benefitted most but who seem to be most critical."

"The technician trainees on the other hand were similarly critical of lack of Careers Guidance but they would have preferred a greater amount of discipline in schools, a sentiment also given by the Union Representatives."

English Teacher, Year Coordinator (Pastoral Care)

The teacher mentioned the apparent lack of self-discipline and the need to teach Imperial Units.

She noted that the trainees "preferred the atmosphere of work, more freedom and not being watched all the time" but also pointed to the wage motivation and responsibility for completing a job."

The apprentices were of the opinion that they were treated much better by the instructors who, they felt, cared about them and were sympathetic towards any difficulties. This, they said, was different from school. They felt that in a lot of cases teachers didn't care about them and were unwilling to listen to problems."

"They suggested that perhaps a fifth year forum could be held about once a month where they could meet with teachers away from the classroom situation and talk about school, as they were talking with us."
"The subject about which the strongest opinions were expressed was Mathematics."

"(a) The trainees said that Modern Maths did not seem relevant to their needs.

(b) One supervisor said "What they need is sums," and said he had given his own test to trainees and was most concerned at the low standard."

(c) A standardised test is to be introduced for applicants which they must pass before acceptance.

(d) There is a need for both Metric and Imperial to be taught in schools."

This teacher contrasted the excellent training facilities at this company with the poor facilities of schools, which the Training Staff did not seem to appreciate.

"Spending a week in an Engineering firm was a brand new experience and is something I shall value. I saw the men in an alien environment to my own and was able to speak with young people about school and its relevance to industry."

"I have also learnt a great deal which I think would be of value to my school, particularly concerning the curriculum."
Deputy Head, Director of Studies

"Schools were criticised for an alleged lack of literacy, numeracy and motivation in their leavers; older employees wanted to know why schools did not reach the standards reached by them in their days. The explanation of the advent of new methods such as 'Look and Say' reading and the SMP Mathematics left them unmoved. The reasoning behind the teaching of a much wider curriculum than heretofore in secondary schools merely brought forth the comment that 'the schools are trying to do too much.'

"This attitude helped to resolve my own tentative notion that schools have reached a plateau in experimentation. Should the schools not now look back at the innovations of the last thirty years, reject the failures, nurture the successes, return in some measure to the traditional values of yesteryear and, above all, enter upon a decade of stability free from 're-organisation' and 'new methods.'"

The teacher described the contrast between the 'even tenor' of work in industry and the stressful atmosphere at school:-

"In schools, pupils are under constant pressure to conform, to work hard and pass examinations. Teachers must always 'come up to scratch' and meet the never-ending challenge of being 'on top of' a class of up to thirty pupils, sometimes eight times a day. 4.00 p.m. sees pupils and staff staying at school for extra-curricular activities. Most paperwork is done after 4.00 p.m. often at home. Parents are taking an increasing and more critical interest in their children's schools. Society often demands of schools much higher standards of behaviour than it expects of itself. Parents require the school to discipline their child even when they have failed to do so. The stress in school is ever present and increasing."
Head of Upper School

This teacher noted that to avoid future loss of craftsmen from the shop floor "a relative cross-section of those suitably qualified is eventually offered entry." More relevance was attached to interviews and the school reference than the teacher expected. He was also surprised that 48% of the intake were sons of employees of the Company.

The teacher mentioned the employer's claims of falling standards in the three R's and countered these as follows:

"(a) Thirty years ago a much larger proportion of time was spent in schools on the basics, whereas nowadays far more subjects are included in the school curriculum leaving less time for English and Mathematics."

"(b) Fifteen years ago 40% of the population entered unskilled jobs. Much of this unskilled work has now disappeared and schools have, through curriculum development and CSE examinations, made a nationwide effort to qualify a good proportion of this ability band for entry into craft apprenticeships to avert foreseeable unemployment."
Director of Resources (School)

This teacher most valued the chance to talk to people in industry. He thought the relationship between instructors and apprentices was similar to those between staff and pupils in schools and commented on the different uniforms worn by craft and technician apprentices ('class system'.

"Instruction was initially, as far as I was concerned, directed towards the need for precision and accuracy. I was particularly concerned that schools do not appear, as far as instruction was concerned, to have prepared students leaving school with the fundamental skills required by advanced engineering organisations."

"Particular reference was made to the inadequacy of Mathematics and Technical Drawing Teaching in schools and this particular criticism has been taken very seriously in my present school and major steps taken to improve the situation. I was horrified to hear of bad advice given to applicants by the school when option choices for subjects were made in Year 3 and obtained first-hand experience by observing an interview of a particular case in point."

Amongst his conclusions, the teacher stated, "Having found the secondment of immense value, I would make the following observations:-

1. Teaching and examination syllabi require some re-evaluation.
2. Guidance is essential to prospective engineers before option choices are made.
3. An offer of a place with a firm before examinations in schools take place does make motivation in the last year at school extremely difficult."
Senior Chemistry Master and Head of 5th Year

This teacher thought one reason for the low standard of apprentices was the lower entry standards allowed by firms, and also that between effectively finishing lessons in April/May and starting work in September, they have forgotten a great deal.

"The chief difficulty of teachers is discipline and motivation. Discipline can be more effective (in industry) than in school because sanctions are greater. Motivation is better assured by payment for work and the fact that an employee has chosen to do the job he is employed to do."

"I live in hope that teachers will be allowed the time and resources to provide an equally stimulating period of time in schools."
Work Experience for Teachers - A National Study

In reviewing schemes at a national level, Hiscox (36) stated that visits of one or two days were inadequate, while one year secondments could result in boredom. Teachers of shortage subjects like mathematics were hard to replace while away from school on secondment.

In order for a continuing liaison with industry after the secondment, visits to companies close to the school were desirable.

Some teachers had found little support for new syllabus emphasis based on their experience - on trying to introduce the still necessary Imperial Units one teacher was told that it was "impossible to fit this into the syllabus, there not being time to cover everything."

Again, as noted in the Derby visits, a greater need for precision and the accurate use of precision measuring instruments were observed by the teachers and at least one teacher has incorporated this into his courses.

Hiscox (36) concluded that the teachers appreciated the experience and they supported the suggestion that other teachers should have the same opportunity. This particularly applies to those who have followed the school-university-school route and "have no inside knowledge of the working world to which many of their pupils go when they leave school."
Hiscox (35) described a school where the head of mathematics developed new syllabuses in co-operation with local employers, with apparently "half-hearted" support from other staff and senior management.

This teacher left the profession and was replaced by a head of maths who felt "mathematics should be approached as a subject in its own right and the needs of individuals after they leave school not given excessive emphasis."

The new teacher "had no contact with the local employers ..... it would seem that the growing relationship between them and the school has been suddenly cut short."
SUMMARY

The list of 16 participating teachers showed that most were in senior positions and also that they represented a large cross-section of comprehensive schools. These varied from rural to inner city and from those with a recent history as academic grammar schools to those which had been secondary modern. Also included were three lecturers from the College of Further Education.

The teachers' specialist subjects covered the whole school curriculum and so the opinions expressed should be representative of teachers in general.

General Observations made by the Teachers

All of the participants were impressed by the organisation of the courses and they appear to have been conducted in an atmosphere of open-mindedness and mutual respect.

The teachers claimed that the courses were valuable and should be repeated to allow more staff to benefit.

Reciprocal visits to enable the employers to see life in school were also suggested.

The following is a précis of specific points made by the teachers, with their recommendations for the future.

Recruitment

Some 'lower ability' applicants were accepted by Company B as they would more readily accept life on the factory floor than those of higher potential. (48% of apprentices were employees' sons.)
Working Conditions

The conditions at Company A were highly praised and perhaps the teachers involved will present a favourable image of engineering to pupils in school.

Criticism was made of the differentiation between craft and technical apprentices by colour of overall.

Motivation

The teachers told the employers of the increasingly stressful situation in schools compared with industry, with larger groups and without the sanctions (loss of earnings to maintain discipline, available to employers.)

The definite offer of employment made long before CSE examinations removed motivation for many of the pupils in their final year at school.

School/Industry Liaison

The teachers were concerned at the continued need for Imperial Units and the use of 3rd Angle Projection contrasting with the 1st Angle used at many schools.

Mathematics

Teachers appreciated the need for basic skills in Maths (and English) and accepted that the situation must improve, while arguing that craft apprentices were now recruited from lower down the ability range than previously.

The wide CSE syllabus did not allow time for revision of basic arithmetic.
While there was good teaching of mathematics (on topics relevant to employment), pupils from whom some apprentices were drawn were incapable of understanding and retaining simple maths topics.

One senior teacher thought change and experimentation should be arrested and replaced by a period of stability, evaluation and, perhaps, some return to traditional methods.

**Careers Education**

The teachers thought that careers education should begin in the third year simultaneous with the choice of optional subjects for years 4 and 5.

Work experience was recommended for year 5 to replace inadequate half-day visits.

**Discussion with Apprentices**

Talks with apprentices revealed criticism of school as follows:-

. **Discipline**
  School rules were resented by some, while others wanted stricter control.
  Union Representatives also recommended more discipline.

. **Careers Advice**
  Lessons were inadequate, visits too brief. Teachers lacked the experience to speak with authority about industry.
. **Curriculum**

Time wasted on 'useless' subjects, more needed on Maths and English.

. **Mathematics**

'Scathingly' criticised especially Modern Maths (e.g. Venn diagrams) considered irrelevant. Formula manipulation was a major weakness.
Chapter 3

STATISTICS OF PUPILS LEAVING A LARGE COMPREHENSIVE SCHOOL - DESTINATIONS AND STANDARDS IN ARITHMETIC

This chapter analyses the placement of pupils leaving the 5th Year of a large Comprehensive school, involving 280 pupils, in order to establish the relative importance of craft apprenticeships as a destination for school leavers.

Also included is an analysis of the examination grades attained by those who entered craft apprenticeships.

A numeracy test was given to 140 pupils representing the whole of the 5th year ability range and the weaknesses analysed.

The test used was Specimen Employer's Test 1 from 'Apprentice Maths' (4), produced after work by Bond (3) to identify employers' requirements.

Some work from other projects is included, such as the SLAPONS project to standardize numeracy testing.
ANALYSIS OF KNOWN PLACEMENT OF PUPILS ELIGIBLE TO LEAVE THE SCHOOL IN SUMMER 1978

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apprentices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craft Apprentices</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Technician Apprentices</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Draughtsmen</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>55</td>
<td><strong>20%</strong></td>
</tr>
<tr>
<td>2. Semi-skilled Manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.g. Machinists, Press operators, cutters, fettlers, painters.</td>
<td>23</td>
<td><strong>8%</strong></td>
</tr>
<tr>
<td>3. Unskilled manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.g. Labourers, packers, warehousemen, loaders, window cleaners.</td>
<td>30</td>
<td><strong>11%</strong></td>
</tr>
<tr>
<td>4. Commercial and Secretarial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secretaries/Typists</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Clerks</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Receptionists</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Punch Card Operators</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
<td><strong>11%</strong></td>
</tr>
<tr>
<td>5. Service Occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hairdressers</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Shop Assistants</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Police</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Firemen</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Waitress</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Chef</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35</td>
<td><strong>12%</strong></td>
</tr>
<tr>
<td>Category</td>
<td>No.</td>
<td>% of Total</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>-----</td>
<td>------------</td>
</tr>
<tr>
<td>6. Sixth Form</td>
<td>37</td>
<td>13%</td>
</tr>
<tr>
<td>7. Colleges of Further Education</td>
<td>25</td>
<td>9%</td>
</tr>
<tr>
<td>8. Work Experience Program</td>
<td>26</td>
<td>9%</td>
</tr>
<tr>
<td>9. Unemployed</td>
<td>21</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Total Eligible Leavers</strong></td>
<td>280</td>
<td></td>
</tr>
</tbody>
</table>

**Diagram: Known Placement of Eligible 5th Form Leavers Summer 1978**

- **Draughtsmen/Technicians**: 49
- **No. of boys leaving school in 1978**: 150
- **% of male leavers entering apprenticeships**: 33%
- **No. of girls leaving school in 1978**: 130
- **% of female leavers entering craft apprenticeships**: 0.9%
Destinations of Pupils: Further Education versus Full-time Employment

One reason frequently advocated for the apparently declining standard of entrants to industry is that many of the more able pupils are entering further education, either at College or in the 6th Form.

The following figures (Ref. 27) show that while the absolute numbers entering further education have risen, the percentage opting for further education rather than employment has actually declined slightly.

**Pupils entering employment in England and Wales**

<table>
<thead>
<tr>
<th></th>
<th>1966/67</th>
<th>77/78</th>
</tr>
</thead>
<tbody>
<tr>
<td>‰</td>
<td>82</td>
<td>82.2</td>
</tr>
<tr>
<td>1000's</td>
<td>251</td>
<td>324.6</td>
</tr>
</tbody>
</table>

**Pupils entering full-time Further Education in England and Wales**

<table>
<thead>
<tr>
<th></th>
<th>1966/67</th>
<th>77/78</th>
</tr>
</thead>
<tbody>
<tr>
<td>‰</td>
<td>18</td>
<td>17.8</td>
</tr>
<tr>
<td>1000's</td>
<td>55</td>
<td>70.3</td>
</tr>
</tbody>
</table>
Mathematical Qualifications of Pupils Leaving 5th Year of the School in Summer 1978

GRADIENTS IN GCE/CSE MATHS OF CRAFT APPRENTICES COMPARED WITH WHOLE OF 5TH YEAR POPULATION

Most frequent attainment amongst craft apprentices; non-examination

48% of those entering craft apprenticeships obtained Grade 5 or took no examination.
NUMERACY TESTING AT A LARGE COMPREHENSIVE SCHOOL ON THE SOUTH-EAST OF DERBY

Purpose

1. To establish the control group for subsequent comparison with pupils who had taken part in the 'Apprentice Mathematics' course. (This subsequently proved impracticable).
2. To identify those topics in basic mathematics which cause most difficulty; these would be given priority during the lunch-time course and where necessary additional teaching material would be prepared.

Description of Test

The test used was the Employers' Specimen Test 1 in 'Apprentice Mathematics', covering the four operations of addition, subtraction, multiplication and division applied to whole numbers, decimals and fractions.

Pupils Tested

Six classes representing the whole of the 5th Year ability range were tested as follows:

<table>
<thead>
<tr>
<th>Maths Group</th>
<th>Course Followed</th>
<th>No. of Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>G.C.E. 'O'</td>
<td>33*</td>
</tr>
<tr>
<td>2</td>
<td>G.C.E./C.S.E.</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>C.S.E.</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>C.S.E. (Limited Grade)</td>
<td>19 } Potential Craft 18 ) Apprentices</td>
</tr>
<tr>
<td>5</td>
<td>&quot;</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Non-Examination</td>
<td>22</td>
</tr>
</tbody>
</table>

140

All examination courses are basically 'Traditional' Mathematics.
* Group 1 consisted of pupils who would generally obtain 'O' level grades A - C, and almost certainly no future craft apprentices.

Pilot testing showed that the weakest in Group 1 would obtain 100% on the test and it was decided that it would be unproductive to test the whole of this group.

Group 2
This contained some weak 'O' level candidates but was predominantly potential C.S.E. grades 1 - 3 and there were several future craft apprentices.

Group 3
As Group 2 but C.S.E. grades would generally be lower.

Groups 4 and 5 Limited Grade C.S.E.
Grade 4 is the highest achievable with this syllabus. Some pupils would leave school at Easter without taking examinations. Some future craft apprentices.

Group 6
Many of these pupils are 'remedial' standard in Maths and English and unlikely to obtain a craft apprenticeship.

Duration of Test
The pilot testing showed that a single period (30 minutes writing time) was adequate for all pupils to attempt every question. In fact, the less-able had done all they could in less time.
RESULTS OF EMPLOYERS' SPECIMEN ARITHMETIC TEST
APPLIED TO 140 PUPILS REPRESENTING THE WHOLE OF
THE 5th YEAR ABILITY RANGE

Table 1

<table>
<thead>
<tr>
<th>Question</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of 5th Year</td>
</tr>
<tr>
<td>1 1035 + 77 + 988</td>
<td></td>
</tr>
<tr>
<td>2 1915 + 201 + 317</td>
<td></td>
</tr>
<tr>
<td>3 Find sum of 675, 209, 8885</td>
<td></td>
</tr>
<tr>
<td>4 1181 - 997</td>
<td></td>
</tr>
<tr>
<td>5 2141 - 317</td>
<td></td>
</tr>
<tr>
<td>6 888 - 799</td>
<td></td>
</tr>
<tr>
<td>7 Subtract 814 from 2000</td>
<td></td>
</tr>
<tr>
<td>8 113 x 35</td>
<td></td>
</tr>
<tr>
<td>9 729 x 18</td>
<td></td>
</tr>
<tr>
<td>10 1417 + 13</td>
<td></td>
</tr>
<tr>
<td>11 2937 + 11</td>
<td></td>
</tr>
<tr>
<td>12 2.295 + 671 + 25.9</td>
<td></td>
</tr>
<tr>
<td>13 10.2 + 1,901 + 0.037</td>
<td></td>
</tr>
<tr>
<td>14 Subtract 1.913 from 2.803</td>
<td></td>
</tr>
<tr>
<td>15 1.113 x 16</td>
<td></td>
</tr>
<tr>
<td>16 0.002 x 1.2</td>
<td></td>
</tr>
<tr>
<td>17 48 x 0.4</td>
<td></td>
</tr>
<tr>
<td>18 6416 x 0.16</td>
<td></td>
</tr>
<tr>
<td>19 9½ + 3½ + 2¼</td>
<td></td>
</tr>
<tr>
<td>20 2½ + 1½</td>
<td></td>
</tr>
<tr>
<td>21 8½ - 6½</td>
<td></td>
</tr>
<tr>
<td>22 3⅓ - 2⅓</td>
<td></td>
</tr>
<tr>
<td>23 1⅔ x 2⅓</td>
<td></td>
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% OF 5th YEAR POPULATION NOT ACHIEVING CORRECT ANSWERS

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<td></td>
</tr>
<tr>
<td></td>
<td>GCE/CSE 2</td>
<td>8</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>CSE 3</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>CSE 4</td>
<td>0</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>CSE/NE 5</td>
<td>0</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>NE 6</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>49</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35%</td>
<td>22%</td>
<td>43%</td>
</tr>
<tr>
<td>24. ( \frac{3}{8} \times \frac{4}{5} )</td>
<td>GCE 1</td>
<td>33*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GCE/CSE 2</td>
<td>6</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>CSE 3</td>
<td>7</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>CSE 4</td>
<td>1</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>CSE/NE 5</td>
<td>0</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>NE 6</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>47</td>
<td>21</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>34%</td>
<td>15%</td>
<td>51%</td>
</tr>
<tr>
<td>Question</td>
<td>Maths Group</td>
<td>Correct</td>
<td>Incorrect</td>
<td>Not Attempted</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>---------</td>
<td>-----------</td>
<td>---------------</td>
</tr>
<tr>
<td>25. $4\frac{1}{2} \times \frac{1}{2}$</td>
<td>GCE 1</td>
<td>33*</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>GCE/CSE 2</td>
<td>9</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>CSE 3</td>
<td>9</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>CSE 4</td>
<td>3</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>CSE/NE 5</td>
<td>0</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>NE 6</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>54</td>
<td>9</td>
<td>77</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>39%</td>
<td>6%</td>
<td>55%</td>
</tr>
</tbody>
</table>

<p>| 26. $2\frac{1}{2} + 1\frac{1}{2}$ | GCE 1 | 33* | 7 | 4 | 12 |
| | GCE/CSE 2 | 10 | 0 | 15 |
| | CSE 3 | 0 | 2 | 17 |
| | CSE/NE 5 | 0 | 5 | 13 |
| | NE 6 | 0 | 0 | 22 |
| TOTAL | | 50 | 11 | 79 |
| % | | 36% | 8% | 56% |</p>
<table>
<thead>
<tr>
<th>Summary of Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
</tr>
<tr>
<td>Addition of whole</td>
</tr>
<tr>
<td>numbers.</td>
</tr>
<tr>
<td>Subtraction of</td>
</tr>
<tr>
<td>whole numbers.</td>
</tr>
<tr>
<td>Multiplication of</td>
</tr>
<tr>
<td>whole numbers.</td>
</tr>
<tr>
<td>Division of whole</td>
</tr>
<tr>
<td>numbers.</td>
</tr>
<tr>
<td>Addition using</td>
</tr>
<tr>
<td>decimals.</td>
</tr>
<tr>
<td>Subtraction using</td>
</tr>
<tr>
<td>decimals.</td>
</tr>
<tr>
<td>Multiplication of</td>
</tr>
<tr>
<td>decimals.</td>
</tr>
<tr>
<td>Division of decimals.</td>
</tr>
<tr>
<td>Addition of</td>
</tr>
<tr>
<td>Fractions.</td>
</tr>
<tr>
<td>Operation</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Subtraction of Fractions.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Multiplication and</td>
</tr>
<tr>
<td>Division of Fractions.</td>
</tr>
</tbody>
</table>
Variation of Numerical Competence during Secondary School Years 1 - 5

Harris (6) devised a test to examine children's recall of the mathematics covered in primary school, concentrating on the four rules, place value, fractions and decimals.

Children were tested in years 1 to 5 of four schools free from major changes in the previous four years.

The results showed a steady improvement over the pupils' school life, and in particular a sharper improvement by the boys at all academic levels during the 4th and 5th years. It was suggested that the boys improved more because of "increasing interests in the outside world."

---

Individual weaknesses

Harris (6) analysed individual weaknesses and found that the poor numeracy of the weaker children "hinges on failure to appreciate some first principle" such as the likeness of a fraction to a division sum, the meaning of the decimal point, and their lack of literacy, which prevented them understanding the question.
Tuckley (6) demonstrated samples of employers' tests which contained very basic errors in the questions themselves.

One attempt to overcome the situation where a boy/girl may face a variety of tests at different interviews was the SLAPONS system (21). (School Leavers Attainment Profile of Numerical Skills.)

Lindsay et al (21), devised a standardised test of basic arithmetic, the results for each individual being drawn on a standard profile (as below), for presentation at job interviews. The employers were invited to produce a template, in the same format, based on their required attainment, perhaps devised from tests on successful recruits.

![Graph]

Score

N. = natural/whole numbers
F = fractions
D = decimals
REL = related thinking
APP = approximations
EST = estimations

This scheme was still in its embryonic form in 1980.

Girls vs Boys

Harris (6) noted that girls preferred straightforward questions such as money, while boys preferred problems, and suggested a possible cause being the girls' lack of interest in mechanical toys.
Numeracy Testing of Apprentices

CBI Wales (30) tested 679 applicants for craft apprenticeships.

Some of the major weaknesses are shown below:

<table>
<thead>
<tr>
<th>Problem</th>
<th>% Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add 4,532</td>
<td>66</td>
</tr>
<tr>
<td>125</td>
<td></td>
</tr>
<tr>
<td>7,609</td>
<td></td>
</tr>
<tr>
<td>5,431</td>
<td></td>
</tr>
<tr>
<td>892</td>
<td></td>
</tr>
<tr>
<td>Subtract 547</td>
<td>24</td>
</tr>
<tr>
<td>139</td>
<td></td>
</tr>
<tr>
<td>Subtract 4,877 from 21,342</td>
<td>34</td>
</tr>
<tr>
<td>Multiply 267</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Work out 625 x 57 x 16</td>
<td>75</td>
</tr>
<tr>
<td>Divide 7,966</td>
<td>63</td>
</tr>
<tr>
<td>Divide 41,128 by 32</td>
<td>61</td>
</tr>
<tr>
<td>Add $1\frac{3}{4}$ and $2\frac{1}{3}$</td>
<td>70</td>
</tr>
<tr>
<td>Add 13.27 and 27.9</td>
<td>33</td>
</tr>
<tr>
<td>Subtract 23.12 from 436.4</td>
<td>58</td>
</tr>
<tr>
<td>What is $\frac{5}{6} \times \frac{2}{3}$?</td>
<td>73</td>
</tr>
</tbody>
</table>

Practical questions involving sentences were generally incorrectly answered by 80 - 100% of the 679 applicants, e.g.

A rectangular sheet of metal is 40 inches by 30 inches. What is the length of the diagonal? (Correct 20%, Incorrect 80%).
Summary

The Craft Apprenticeship was the largest single category of employment for the 5th year leavers, attracting 33% of the boys. The significance of this type of work is further increased by those entering industry after the 6th form and those entering semi-skilled work in engineering.

The analysis of qualifications of craft apprentices revealed that, in general, recruitment was from pupils leaving with grade 4 CSE or below.

Numeracy testing of the whole of the 5th year ability range showed that approximately half or more of the pupils were incompetent at multiplication and division including the decimal point and more than half were incapable of the four operations with fractions.

The setting of a question in words rather than a straight 'sum' also caused problems, and this was noted by Harris in his testing.

The attempts by Lindsay et al (21) to standardize testing in school, together with the numeracy testing being introduced in school administered by the CSE boards should focus more attention on the need for competency in basic skills.
Chapter 4

SOCIAL FACTORS: EFFECTS OF CATCHMENT AREA IN THE CLASSROOM: APPARENT DECLINE IN SOCIETY

This section of the work was included partly because Bond (3) offered an apparent decline in society as a factor in the poor attainment of some pupils in mathematics.

The author became aware of two pupils from the school who had been placed top in the selection tests for one large organisation; simultaneously other pupils taught by the same teacher had failed miserably.

Therefore the school system was, at the same time, both fulfilling and failing to satisfy industry's requirements and this suggested a close examination of the pupils themselves.

A report in the USA by the National Advisory Committee in Mathematical Education (NACOME) warned against "facile dichotomies, against naively attributing their present problems to a supposedly monolithic structure termed 'new math', and advises that solutions must be based on a deeper appreciation of many interacting social and educational factors."
SOCIAL ASPECTS

Introduction
This section is based on several years observation at the school and familiarity with the catchment area; it attempts to describe the environment in which the teachers work in dealing with the whole of the ability range rather than the selected intake received by employers.

Discussion with several supply teachers with recent experience in a large number of local schools suggested that 'discipline' in the school was good, and considerably better than many other large comprehensives.

The newly established sixth form achieved several university places in its first year of results and in 1979 there were ten 'A' level passes in mathematics, and twenty grade A or B 'O' level passes. Several pupils obtained eight or more 'O' levels.

These academic results were better than many other local schools and were obtained with a catchment area such that the school had been assessed for the possible classification 'as one of exceptional difficulty.'

This section concentrates on the 'average and below' children, from whom many craft apprentices are drawn, and ignores the more academic work which was continuing throughout the school. It does not, therefore, give an overall view of the whole school.

Disruptive pupils are discussed, because while only a small minority, they have a significant effect on the energy and efficiency of the staff, and considerable school resources are deployed in order to 'rehabilitate' or remove them.
CATCHMENT AREA

The school catchment area has changed in recent years; initially a county secondary modern school, then a mixed suburban and rural comprehensive, and now becoming predominantly urban and 'inner city.'

Most of the rural and suburban children in the old catchment area attended a new comprehensive school and some parents moved house to the new school's catchment area.

'Inner City Area'

Industry in Derby, which is mainly heavy engineering, is concentrated on the south of the city, close to the school. The neighbouring houses are affected by pollution (noise and dirt) and many of these houses are in the catchment area. The houses are of two types; (a) older terraced property, much of it being demolished and cleared for redevelopment and (b) ageing council houses in need of modernisation.

The north side of Derby is almost entirely residential and traffic flow shows that large numbers commute between north and south for work. The residential north side has the most 'sought after' comprehensive schools and ambitious parents.

The test school, drawing heavily from the poorer housing conditions on the south of the town receives the children of families who are unable to cope, suffering from 'urban deprivation'. A check on one class revealed only ten pupils who lived with both natural parents.

Dean (Ref 22) reported that in 1967 there were 142,000 one-parent families on supplementary benefit in the U.K., while in 1977 there were 326,000.
Fig 1

Number of Children appearing in Court

<table>
<thead>
<tr>
<th>Number of pupils appearing in court</th>
<th>Boys &amp; Girls</th>
<th>1977-78: First year of 'new' split site school after merger and new structure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>77-78</td>
<td>78-79</td>
<td>79-80</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


1979-80: creation of 5th year recreation centre.

Table 1

Analysis of Offences during each year (Boys and Girls)

<table>
<thead>
<tr>
<th>Offence</th>
<th>77-78</th>
<th>78-79</th>
<th>79-80</th>
<th>Total 77-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary (with and without theft)</td>
<td>17</td>
<td>3</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Theft</td>
<td>22</td>
<td>30</td>
<td>10</td>
<td>62</td>
</tr>
<tr>
<td>Taking vehicle/driving</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Criminal damage</td>
<td>8</td>
<td>9</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>Indecent assault</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Handling stolen goods</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Assault/wounding</td>
<td>2</td>
<td>-</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Insulting language</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL OFFENCES</td>
<td>58</td>
<td>47</td>
<td>28</td>
<td>133</td>
</tr>
</tbody>
</table>

Some pupils had more than one offence so these totals do not agree with number of appearances in court.
## Table 2

### Analysis of Offences by Year Group

*(Boys and Girls)*

<table>
<thead>
<tr>
<th>Offence</th>
<th>3rd Year</th>
<th>4th Year</th>
<th>5th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theft</td>
<td>14</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Burglary</td>
<td>3</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Taking vehicle/driving</td>
<td>4</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Criminal damage</td>
<td>1</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Indecent assault</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Handling stolen goods</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Assault/wounding</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Insulting language</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>25</strong></td>
<td><strong>46</strong></td>
<td><strong>62</strong></td>
</tr>
</tbody>
</table>

## Table 3

### Analysis of Offences by Sex

<table>
<thead>
<tr>
<th>Offence</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>Theft</td>
<td>51</td>
<td>11</td>
</tr>
<tr>
<td>Taking vehicle/driving</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Criminal damage</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Indecent assault</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Handling stolen goods</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Assault</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Insulting language</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>115</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>
Dean (22) reported that juveniles from 14 - 16 years had the greatest increase in serious crime in the U.K., rising from 50 per 1000 in 1969 to 80 in 1974. This was four times the rate for all other age groups.

**Definition of a Deprived Pupil**

Here the term deprived is assumed to mean a pupil having a home background which fails to support him/her emotionally and/or materially. This might include living in a local authority home, a violent or chronically sick parent; lack of adequate food, hygiene or clothing; lack of study facilities, social experience, and moral encouragement.

The disruptive children mentioned later experienced most of these deprivations.

**Effects of Urban Deprivation in the Classroom**

While the deprived children are unlikely to achieve a craft apprenticeship their presence in the classroom often has some of the following detrimental effects on lessons, which do contain potential craft apprentices.

1. Aggressive, anti-social behaviour, rudeness to teacher, peers.
2. Delays due to lack of equipment, pens, pencils, books, etc.
3. Refusal to work, do homework.
4. Ridicule of conscientious pupils (recorded on cassette).
5. Poor attendance, preventing continuity of lessons and progression on long topics.
In the medical profession difficulty has been experienced in recruiting doctors for inner city practices. Phillips (23) quoting the 1979 report of the National Health Service said, "services in some places were inadequate. G.P.s, nurses, health visitors, social workers and receptionists were unlikely to want to work and live in unattractive areas ... Some population groups, for example, may impose a heavier demand than average on G.P.s. Illness levels may be affected by the local physical and social environment and by the main types of local employment."

Rutter et al (17) listed the various types of family adversity in Inner London. Depressive conditions of mothers, overcrowded homes, homes broken by death or divorce (27%). These were characteristics associated with higher rates of behavioural and educational difficulties in children.

**Absenteeism**

Absenteeism for the 5th year as a whole averaged 20% in 1979-1980, but there were many pupils attending only rarely and this was often because they were needed at home to help chronically sick parents, etc. Truancy, including illegal employment also existed amongst the pupils.

The problem of absence amongst 'lower ability' children and its effect on continuity means that individual work must be set using work cards, etc. 'Apprentice Maths' was also successfully used in this context.

**Motivation**

With a few of the more deprived children there was already an expectation of a life of unemployment, social security payments being supplemented by crime. A significant minority of pupils at the school were involved in crime.
Parents

Typical attendance at a parents evening would be 90% or more representation for mathematics set 1 ('0' level) and less than 10% for mathematics set 13 (non-examination).

In the 1979 mathematics set 1 the parents included managers, a doctor, teachers, a farmer, and professional engineers. In the bottom set parental occupations included labourers, a hospital porter, lorry drivers, unskilled workers and unemployed, plus single parents on social security.

Dean (22) stated that in 1969 unemployment was 580,000 compared with 1,430,000 in 1979.

Examples of Disruptive Children

It was noted that:-

1. Many very deprived children were in no way disruptive.

2. The Head of School, responsible for dealing with all disruptive pupils, considered that over 95% of all disruptives were from broken or disturbed homes.

3. The disruptive pupils were subject to frequent changes of mood, and on occasions were quite helpful. This was thought by year tutors (pastoral care to be due to changes in external 'home' (often local authority) factors.

Gary

Successive family separations removed Gary from both natural parents. The 'father' was violent to the boy who
was moved to a childrens' home several miles from the school.

The boy caused problems in several subjects; he was restless, involved in minor fights and arguments, and threw furniture about the class room.

His ambition was to join the army to acquire the physical strength to seek revenge on the 'father.'

Three of the pupils in Gary's maths group joined the 'Apprentice Maths' club because they felt they were not learning in class. Their teacher, (a science specialist transferred into maths) was absent for many months prior to early retirement, and his classes were taught by supply teachers.

Dickson (24) in her study of London Transport Apprentices noted the high turnover of maths teachers and inadequate class control of young teachers.

In 1982, the turnover of mathematics teachers has slowed considerably.
Ian

Ian lived with his grandmother following his mother's recent death from a progressive illness. He was then moved to a children's home.

His behaviour varied from aggressive and disruptive to helpful and interested in mathematics. When aggressive, he would overtly refuse to do any work, accept any punishment or make any apology; when helpful he would work hard, invent mathematical puzzles and set tests for the class. One incident involved embedding a one-inch spike in a chair in a dangerous manner for the next occupant.

During the 4th year he appeared in court on a wounding charge, but continued to attend school, erratically.

These examples were a small minority (perhaps 5 - 10 similar types in each year group) but most teachers made regular contact with them and they could affect the classes of weaker potential craft apprentices.

Continual dealings with pupils of this type caused some teachers to suffer from stress, exhaustion and in some instances, to leave the profession.

It must be pointed out, however, that in the school described very many experienced teachers had found methods and techniques of obtaining good relationships with 'difficult' children, and avoiding the confrontation which some pupils were obviously seeking.

The effort required to fulfil this social role, however, required energy and teachers' resources which, in a different school, would be available for further improvement of academic 'standards' and personal development of all pupils.
Some Evidence of Declining Social Conditions in England and Wales

Bond (ref. 3) suggested that one reason for the apparent decline in mathematical standards was a simultaneous change in society. It is felt by many teachers that children from one-parent families, or those without both natural parents, form the bulk of the seriously disruptive pupils. Similarly children in the care of the local authority often find it difficult to cope with the school situation and may disturb lessons.

The following statistics were given in Ref. for England and Wales.

<table>
<thead>
<tr>
<th>Divorce</th>
<th>1971</th>
<th>1977</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>74,000</td>
<td>129,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Children under 16 of divorcing couples</th>
<th>1971</th>
<th>1977</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>82,000</td>
<td>149,000</td>
</tr>
</tbody>
</table>

Eleven per cent of couples who married in 1968 were divorced within 10 years - 4 times the figure for those married in 1953.
Children of Compulsory School Age in Care of Local Authority

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of children in care</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>20,000</td>
</tr>
<tr>
<td>1965</td>
<td>30,000</td>
</tr>
<tr>
<td>1969</td>
<td>40,000</td>
</tr>
<tr>
<td>1973</td>
<td>50,000</td>
</tr>
<tr>
<td>1977</td>
<td>60,000</td>
</tr>
</tbody>
</table>

Pupils aged 14 - 16 involved in serious crime

<table>
<thead>
<tr>
<th>Year</th>
<th>Gender</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>Male</td>
<td>25</td>
</tr>
<tr>
<td>1978</td>
<td>Male</td>
<td>78</td>
</tr>
<tr>
<td>1957</td>
<td>Female</td>
<td>2.3</td>
</tr>
<tr>
<td>1978</td>
<td>Female</td>
<td>16</td>
</tr>
</tbody>
</table>

Effects of Broken Homes

Douglas (29) noted, "Broken homes are more common among the delinquent than non-delinquent boys, but it is divorce and separation that are important, the delinquency in these circumstances being twice as high as expected."

"It is recognised that many delinquents are poor scholars and appear to their teachers as bored, inattentive and badly behaved in class."
ATTEMPTS BY THE SCHOOL TO ALLEVIATE NEGATIVE BEHAVIOUR

The school made substantial efforts to cope with deprived and disruptive pupils especially under the new administration formed following the merging with the feeding junior high school into a single comprehensive school.

These changes mainly took place during 1977 - 1979 and were as follows:

1. Pastoral Care System under Head of School (not Headmaster).
2. Establishment of Special Unit.
4. Provision of Recreational and Social Facilities for 5th Year pupils.
5. Link Courses at College of P.E. and careers visits.

These changes are examined closely as they are considered central to the problem of low motivation and negative behaviour contributing to poor numeracy amongst school leavers.

Pastoral Care

In each year group there were two year coordinators under the supervision of the Head of School. Their daily work involved helping pupils like Gary and Ian (and punishing when appropriate). Contact was made with parents of difficult children and the coordinators frequently attended case conferences with social workers.

The usual courses of action for serious disruptive behaviour were:

1. Parents sent for.
2. Withdrawal from normal lessons (perhaps isolating in a very academic class)

3. Suspension for three days

4. Exceptionally, depending on medical reports, removal permanently from school.

5. Transfer to Special Unit (numerically limited).

One disruptive boy was sent on an outward bound course as a last resort; he was promptly returned for breaking all of the rules at the hostel. He therefore had to be 'contained' by the school pending medical reports.

**Special Unit**

This was established in 1977-78 and accommodated approximately ten pupils; these were not necessarily disruptive, several being school 'phobics'. Pupils were given social experience, preparing and eating their own meals and making trips locally and abroad.

(Three of these pupils were given copies of 'Apprentice Maths' to work through).

A specific example of the value of the unit was a particularly difficult boy, Billy; he had frequently disrupted maths lessons, had injured another pupil and been suspended from school.

Billy had resisted arrest by police, and appeared in court for theft, arson and malicious damage. Lack of suitable special accommodation meant that Billy was returned to be 'contained' by the school.

It was obvious that after a period in the special unit Billy had become polite, cooperative and willing to work.
Had he remained in the normal classroom situation this boy would have continued to spoil lessons and damage the learning of other pupils including some potential apprentices.

The Special Unit is therefore a successful, but numerically limited, way of removing exceptionally difficult pupils and reducing their anti-social behaviour.

Mixed Ability Registration Groups
(Personal observation of one group 1977-1980)

Registration groups were together for up to 30 minutes each morning and 5 minutes each afternoon. They were also together for non-academic subjects and were in ability sets for maths, English and certain optional subjects.

The previous school structure placed the children in registration forms according to ability; this produced approximately three classes in each year of pupils of very low academic ability and a concentration of the school's deprived intake with high absenteeism, poor behaviour and low morale.

This system produced an explicit labelling of children as non-examination candidates; they were heard to quote their form as proof of no ability and had low expectations.

The mixed ability system (based also on social background) reduced this non-examination 'syndrome' and the forms became more evenly balanced in representative sport etc. (The academic forms previously also were best able to provide sports teams.)

There were less opportunities for the formation of rebellious or criminal liaisons as when the low achievers were all together; the pressure on form teachers was more evenly distributed whereas previously certain form teachers enjoyed all the academic and sporting success while others had most of the behaviour problems.
There were, however, clearly identifiable peer groups within each form; one group of the most academic and conscientious girls; the non-academic girls; a group of boys mainly interested in motor-cycles; a group of academic boys from the same suburban district. A large group of inner city boys, some deprived materially and emotionally.

Pupils generally talked to those of equivalent academic ability; the 'O' level girls did not talk to the non-examination pupils. They resented the limited opportunity to talk to girls of similar outlook.

The rural pupils mixed freely with the 'inner city' types; four West Indian boys integrated without tension with the others in the large 'inner city' group.

During free time, when there was no assembly, the less academic pupils would jostle and argue in a friendly way; the academic pupils would use any spare time to discuss homework or revise.

The intending craft apprentices could be identified between the academic and less able groups; they would spend their spare time quietly discussing cars, motor-cycles, and music or reading magazines.

The potential apprentices displayed neither the extremes of boisterous behaviour nor the application to study noted in the other groups.

It was generally felt by the staff that the mixed ability system was successful in producing a more balanced year group and in reducing the formation of self-fulfilling low expectation groups.
The Fifth Year Centre

Previously fifth year pupils had nowhere to spend breaks etc. except the playground, with few sheltered areas and no refreshment facilities (other than school dinners).

Most pupils attended link courses and experienced superior conditions at college; there was boredom, resentment, vandalism and anti-social behaviour amongst the maturing 5th form pupils during school break-times.

One suite of rooms was converted into a recreational area, with facilities for hot drinks at break, games and lounge areas. The pupils, particularly known difficult characters, were involved in the running of the centre.

The centre was extremely popular and was used heavily; the problem of anti-social behaviour of 5th year pupils around the school diminished greatly. Part of the school had become their own, rather than a separate entity. The centre was particularly appealing to the type of pupil likely in the past to cause trouble and damage. It was also a source of shelter for deprived pupils who were poorly fed and clothed.

Link Courses and Careers Visits

The 4th and 5th year pupils spent half a day per week at the college of further education; the courses included automobile engineering, plumbing, building and computing. The pupils found the college atmosphere agreeable and the courses were popular and often oversubscribed.

The careers visits were generally of one half day and the pupils completed a simple questionnaire; they said the visits
were valuable for assessing working conditions and some previously interested pupils were put off by noise, dirt and conduct of a few employees. Others were encouraged, by the high training standards and pleasant working conditions of one of the major employers.

Prospects for the Future

In an edition reviewing the 1970s and making predictions for the 1980s the Sunday Times carried the following statements.

Townsend: Professor of Sociology, Essex.

"The change since the late Forties is quite dramatic. The possibilities of developing that tentative but fairer society were frittered away.

In these two decades the single greatest failure has been to integrate social and economic management... that social justice involving a better deal for our 14 million poor, is a prior condition for economic recovery.

......There are bound to be social and political repercussions in the coming years which have been quite unknown in post-war Britain."

Mia Kellmer Pringle, National Children's Bureau

"If we were to make a new commitment with a more human face, then a socially fairer society would become our goal ...... "

Crick, Professor of Politics, Birkbeck, London

"Basic political changes are unlikely in the coming decade - just a precarious, irritable and shoddy continuation of
relative affluence among the majority amid growing poverty among the unemployed and low paid."

"..... but that is not going to help the unemployed and young people in city schools who will never get jobs. Society grows more and more divided."

At the Oxford Conference in Education at St. Catherine's College, Made, head of Islington Green Comprehensive School said that schools were being asked to respond to "calls for higher standards in mathematics teaching .." "all at a time of financial constraint."

" .. schools had become nervous and were deciding to play safe and concentrate on gaining good examination results."

" .. schools which are contracting are choosing to ease out the odd remedial teacher."

Finally, in agreement with the experience at the test school in Derby, the headmistress said:-

"Comprehensive schools are being asked to solve social problems, without anyone really understanding how intractable these problems are."  

In December, 1981, Heywood (38), Headmaster of a comprehensive school in Staffordshire said, "School staff were rapidly becoming social worker, welfare officer, judge, jury and sometimes doctor and nursemaid for an increasing number of problem children ..... Eyebrows were raised when teachers admitted they could not cope when pressures on them were enormous. They were expected to raise standards for the majority and cater for an increasing number of individual problems."
Responses to Disaffected Pupils in Other Schools

Johnson et al (37) observed the way disaffected pupils were treated in six London Comprehensive Schools.

These included:

- Turning a blind eye to the truancy or work evasion of the pupils .... as a strategy of class management.
- Silencing the complaints of more activist pupils through repressive discipline, or by eviction from class.
- Excessive use of unofficial physical punishment.
- Bartering - agreement to turn a blind eye provided pupil is quiet.

Unacceptable behaviour, according to Johnson et al (37), "may be interpreted as an implied critique of education and school," and they suggest that schools:

"attempt to hear the pupil voices which disaffected behaviour may be seeking to express."

Further suggestions, accepting that teachers are already aware of the mismatch between many pupils' school, family and social likes, are for teachers to:

- Observe the pupils' friendships and support.
- Consult the parents and learn about the neighbourhood.
- Share pupils' acquaintance with part-time employers, etc.

Staff Coherence

Where the staff were united, the local community etc. were able to "read" the school and its objectives (Johnson et al (37)) and either support or reject them and look elsewhere for alternative education.

Most undesirable was the school containing rival teacher factions who "regularly confronted one another in meetings, releasing their frustrations in acrimonious debate."
Disaffected Pupils

Johnson et al (37) studied pupils in six Outer London Comprehensive Schools from 1977-1980, chosen because they were 'ordinary.'

The research concentrated on those children who had become 'disaffected', (mainly in years 3, 4 and 5), i.e. they were no longer trying to succeed academically. This took the form of disruption of lessons, truancy, (including internal truancy i.e. hiding within the school grounds) and opting out of work by settling for a quiet life and avoiding confrontation.

The work being of an interactive nature, it was claimed to have "a resource of time not available to H.M.I." The implication is that the problem of "disaffected" pupils is more serious than schools admit or H.M.I.'s are able to discover:-

"Even if schools in general define themselves to H.M.I. as only having minor resolvable problems of behaviour, our own study indicated that many pupils were behaving in ways which teachers found unacceptable and difficult to deal with."

The study revealed several reasons for disaffection, by interviewing the pupils, and these included:-

1. The pupil's perception of school and examinations as irrelevant to their future career e.g. destined for family business, etc.

2. Problems in the home e.g. a girl brought up as a son rather than a daughter became a 'fighter.'

3. Alternative family values: "They did not, for instance, exercise vigilance over their children's attendance, or homework performance: they did not attend parents' evenings: they did not always assist the school in matters of discipline."
"The whole family seemed united in treating the educational welfare officer as an impertinent intruder, and expelling him from the house."

Social Life

Maturing girls were seen to lose interest in academic work when their social life increased and they only wanted a job to finance this and eventually secure a husband.

'Non-examination' Syndrome

Whereas the school placed high importance on the examination system, pupils who did not expect to be examination candidates "found little of relevance for them in school and had no reason to legitimise the authority to which they were subject during these years of compulsory schooling. They saw school as an unjustifiably oppressive regime of containment and control and found ways of actively rejecting authority by challenging and threatening behaviour.

Varying Rates of Maturity

Some pupils resented being treated as 'kids': "She had always been treated in an adult fashion at home and acted in a way which belied her years. The school found itself dealing with a mature, articulate thirteen year old within a class of immature pre-adolescents."

"Not surprisingly she created sufficient trouble within her classes to be withdrawn from many of her lessons."

Broken Homes

"Well, my mum's left again ....... I have to get up at five o'clock in the morning to get my brothers off to work. And I've got all the housework to do. I can't just come into school like that .... My dad doesn't care. He hasn't got any qualifications and doesn't see why we should have any. I suppose I'll just have to stay at home."
A Hierarchy of Needs

In the school in Derby, it was obvious that many children were inadequately clothed, dirty, and some said they didn't eat breakfast.

In a few instances children were tactfully requested to shower and wash at school for hygiene reasons.

No statistical records were kept on the proportion of deprived children; one third-year teacher noted that only 10 out of 30 pupils in her form lived with both 'natural' parents.

There was, however, definitely a substantial number of children who lacked food, adequate clothing, and affection from a home with two caring parents.

As these basic needs were not satisfied it seems reasonable to suggest that the need for Understanding and Knowledge would not be strongly felt.

Child (25) stated, "Hungry or frightened children are less likely to aspire to the requirements of school than well-fed or secure children. Children starved of affection at home are less likely to cope than those from emotionally well-balanced home backgrounds."

Maslow (25) expressed these needs in the form of a pyramid, Understanding and Knowledge not being needed until others had been satisfied.
Attainment related to home-background

Douglas (26) noted in a survey of primary schools, the poorer performance of pupils from working-class homes.

<table>
<thead>
<tr>
<th></th>
<th>Middle Class</th>
<th>Manual Working Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>Average scores in Arithmetic Test</td>
<td>57.18</td>
<td>54.43</td>
</tr>
<tr>
<td>Age 11 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mathematical Attainment Related to the Affluence of the Catchment Area


The % of pupils taking free school meals was used as a measure of the relative affluence of the catchment area.

<table>
<thead>
<tr>
<th>All pupils</th>
<th>% free school meals (Maintained sector only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15</td>
<td>15-30</td>
</tr>
<tr>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>Concepts</td>
<td>55</td>
</tr>
<tr>
<td>Skills</td>
<td>55</td>
</tr>
<tr>
<td>Applications</td>
<td>45</td>
</tr>
<tr>
<td>Measures</td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>55</td>
</tr>
<tr>
<td>Rate and ratio</td>
<td>31</td>
</tr>
<tr>
<td>Mensuration</td>
<td>31</td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>43</td>
</tr>
<tr>
<td>Traditional</td>
<td>34</td>
</tr>
<tr>
<td>Modern</td>
<td>32</td>
</tr>
<tr>
<td>Graphical</td>
<td>33</td>
</tr>
<tr>
<td>Geometry</td>
<td></td>
</tr>
<tr>
<td>Descriptive</td>
<td>43</td>
</tr>
<tr>
<td>Modern</td>
<td>27</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>21</td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>40</td>
</tr>
<tr>
<td>Statistics</td>
<td>38</td>
</tr>
</tbody>
</table>

Without exception, for every mathematical concept listed, the scores varied according to the relative affluence of the catchment area.

In the Derby school, it was estimated that more than 50% of the school meals were free.
The H.M.I. Report of 1980 (15), tested nearly 14,000 pupils in 563 schools in Britain.

Their relative affluence was measured by the % of the school dinners which were supplied free by the Local Authority.

### Differences from Overall Mean Test Scores

<table>
<thead>
<tr>
<th>Number Measures</th>
<th>Concepts</th>
<th>Skills</th>
<th>Applications</th>
<th>Unit</th>
<th>Rate + Ratio</th>
<th>Mensuration</th>
<th>General</th>
<th>Traditional</th>
<th>Modern</th>
<th>Graphical</th>
<th>Descriptive</th>
<th>Modern</th>
<th>Trigonometry</th>
<th>Probability</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra</td>
<td>Least Affluent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Most Affluent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- • < 15% Free Dinners
- • 15 - 30% Free Dinners
- • > 30% Free Dinners
Mathematical Attainment Related to the Location of the Education Authority - Metropolitan versus Non-Metropolitan

The 1980 Report of the D.E.S. Assessment of Performance Unit (28) analysed the mathematical attainment of 13,879 pupils aged 15 years and related this to the type of education authority in which the schools were located.

The Metropolitan Authorities included Merseyside, Greater Manchester, South Yorkshire, West Yorkshire, Tyne & Wear, West Midlands and Greater London.

<table>
<thead>
<tr>
<th>All Pupils</th>
<th>Location Non-M</th>
<th>Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concepts</td>
<td>64</td>
<td>66</td>
</tr>
<tr>
<td>Skills</td>
<td>55</td>
<td>57</td>
</tr>
<tr>
<td>Applications</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td>Measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>55</td>
<td>57</td>
</tr>
<tr>
<td>Rate and Ratio</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Mensuration</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>Traditional</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>Modern</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Graphical</td>
<td>33</td>
<td>35</td>
</tr>
<tr>
<td>Geometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Descriptive</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>Modern</td>
<td>27</td>
<td>29</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td>Statistics</td>
<td>38</td>
<td>39</td>
</tr>
</tbody>
</table>

The results indicate that the metropolitan authorities, containing, by definition, the large industrial areas and inner city conditions, score less well on every topic than the non-metropolitan districts.
Mathematical Ability at Secondary School
Related to Social Class

Mean scores at age 15 years from 5,000 children tested by Douglas et al (29), tested on 47 questions on graded Arithmetic.

<table>
<thead>
<tr>
<th>Mean Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Class</td>
</tr>
<tr>
<td>Manual - Upper</td>
</tr>
<tr>
<td>- Lower</td>
</tr>
</tbody>
</table>
% of Boys hoping to enter Manual Work
in relation to Social Background

From a survey of 5,000 children by Douglas et al (29).

<table>
<thead>
<tr>
<th>Ability at 15</th>
<th>Middle Class</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>60 and over</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>55 - 59</td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>50 - 54</td>
<td>*</td>
<td>32</td>
</tr>
<tr>
<td>45 - 49</td>
<td>*</td>
<td>56</td>
</tr>
<tr>
<td>0 - 44</td>
<td>*</td>
<td>71</td>
</tr>
</tbody>
</table>

% hoping to enter manual work

<table>
<thead>
<tr>
<th>Ability at 15</th>
<th>Middle Class</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>60 and over</td>
<td>79</td>
<td>62</td>
</tr>
<tr>
<td>55 - 59</td>
<td>48</td>
<td>31</td>
</tr>
<tr>
<td>50 - 54</td>
<td>*</td>
<td>16</td>
</tr>
</tbody>
</table>

% hoping to enter the professions

<table>
<thead>
<tr>
<th>Ability at 15</th>
<th>Middle Class</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>60 and over</td>
<td>39</td>
<td>29</td>
</tr>
<tr>
<td>55 - 59</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>50 - 54</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

* Negligible

The above tables show the tendency for the children of manual workers to follow their parents, including 36% of the most-able, unlike the children of middle-class parents. The latter were more orientated towards professional work.
SUMMARY

IMPLICATIONS FOR CRAFT APPRENTICES

1. Recently published statistics suggest that there has been a decline in social conditions characterised by increased unemployment, divorce and single parent families and juvenile crime.

2. Families least able to cope with these problems must tend towards cheaper and unattractive housing in 'inner city areas' often close to industry.

3. Schools serving these areas are highly stressed and teachers are not attracted to them; neither are doctors attracted to the same areas.

4. The areas close to industry in towns like Derby are also the areas of poor housing; future craft apprentices often follow parents into convenient local firms. Many potential craft apprentices therefore attend schools which struggle to cope with the products of urban deprivation.

5. The school under test had countered these problems positively by increased pastoral care, a special withdrawal unit, mixed ability registration groups and recreational and social facilities for 5th year pupils.

6. Society and industry must recognise the problems schools cope with in dealing with a non-selective intake, and appreciate that it is difficult to obtain high standards of numeracy across the whole ability range without vastly increased resources for inner city areas and the schools which serve them.

7. It is suggested that this pattern of educational disadvantage is general to many industrial areas; Dickson (24) retrospectively tracing the schooling of London Transport apprentices noted one head of
mathematics who described teaching the lower middle band as 'nothing much more than a holding operation.'

Seven apprentices out of the ten in Dickson's study were critical of the lack of class control.

Dickson noted, "... a few disrupted their classes to such an extent that very little was achieved at the best of times."

The class control is considered by experienced teachers to be harder to achieve in the industrial areas than in the suburban and rural areas.

The main conclusion from this section is that falling standards of numeracy amongst many craft apprentices are inextricably linked to declining social conditions in industrial cities.
Chapter 5
SURVEY OF 132 5th YEAR PUPILS - BIOGRAPHICAL FACTORS RELATED TO ATTAINMENT IN MATHEMATICS.
EXTRACTION OF DETAILS OF 32 ASPIRING APPRENTICES

The questionnaire (App 3) was given to the 5th Year in 1979-80 on a purely voluntary basis.

The forms were distributed by the careers master, who had contact with a large number of pupils and was interested in the work.

This was considered preferable to distribution during mathematics lessons, which might have inhibited constructive criticism of teaching methods and would also have used valuable teaching time preceding final examinations.

It was decided to make an open-ended request for pupils to "suggest ways of improving learning in mathematics .." in order to obtain their own suggestions. These were considered more likely to be original and reflecting the individual's own outstanding impressions than obtaining their responses to a standardized set of questions.

Definitions

Rural (R): A set of 4 very small isolated villages, surrounded by fields, market gardens.

Suburban (S): Mainly privately owned, modern property built around an old village close to countryside but convenient to town and all amenities.

Urban (U): A mixture of ageing council houses - pre-war, many without bathrooms, in the process of modernisation; and typical 'inner city' streets with 'slum' clearance areas.

This 5th year was the school's last to include such a wide range of housing areas, future catchment area changes removing all rural and the majority of suburban pupils.
<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Home Area Type</th>
<th>Parental Occupation</th>
<th>Pupil's Intended Career</th>
<th>Age When Decided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>R</td>
<td>Nursing Asst.</td>
<td>College</td>
<td>15</td>
</tr>
<tr>
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**Key**

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<td>117</td>
<td>M</td>
<td>U</td>
<td>Fitter</td>
<td>-</td>
<td>App. Technician</td>
</tr>
<tr>
<td>118</td>
<td>M</td>
<td>U</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>119</td>
<td>M</td>
<td>R</td>
<td>Work Inspector</td>
<td>Secretary</td>
<td>Craft App.</td>
</tr>
<tr>
<td>120</td>
<td>F</td>
<td>U</td>
<td>Sand Blaster</td>
<td>-</td>
<td>Factory Work</td>
</tr>
<tr>
<td>121</td>
<td>M</td>
<td>U</td>
<td>Grinder</td>
<td>Cleaner R.R.</td>
<td>Army or Baker</td>
</tr>
<tr>
<td>122</td>
<td>M</td>
<td>U</td>
<td>Warehouseman</td>
<td>Home Help</td>
<td>Driver's Mate</td>
</tr>
<tr>
<td>123</td>
<td>M</td>
<td>U</td>
<td>B.R.</td>
<td>Co-op</td>
<td>Craft App.</td>
</tr>
<tr>
<td>124</td>
<td>M</td>
<td>U</td>
<td>Building Worker</td>
<td>-</td>
<td>Army or Machinist</td>
</tr>
<tr>
<td>125</td>
<td>M</td>
<td>S</td>
<td>Taxi Driver</td>
<td>Infirmary</td>
<td>-</td>
</tr>
<tr>
<td>126</td>
<td>M</td>
<td>U</td>
<td>Bricklayer</td>
<td>-</td>
<td>Factory Worker</td>
</tr>
<tr>
<td>128</td>
<td>M</td>
<td>U</td>
<td>Car Park Attendant</td>
<td>-</td>
<td>App. Car Mechanic</td>
</tr>
<tr>
<td>129</td>
<td>M</td>
<td>U</td>
<td>R.R.</td>
<td>-</td>
<td>Cycle Worker</td>
</tr>
<tr>
<td>130</td>
<td>M</td>
<td>U</td>
<td>British Celanese</td>
<td>-</td>
<td>App. Mechanic</td>
</tr>
<tr>
<td>131</td>
<td>M</td>
<td>U</td>
<td>R.R.</td>
<td>-</td>
<td>App. Joiner</td>
</tr>
<tr>
<td>132</td>
<td>F</td>
<td>U</td>
<td>Unemployed</td>
<td>Factory Worker</td>
<td>Secretary</td>
</tr>
</tbody>
</table>
Father's Occupation (All Pupils)

Precise division was not possible, but broad categories were definable as follows.

A. Professional/Managerial  
   e.g. Lecturer, Accountant, Surveyor, Manager, Designer.

B. Technical, Supervisory  
   e.g. Foreman, Farmer, Nurse, Self-employed builder, Technical Librarian, Radiographer.

C. Manual  
   e.g. Fitter, Machinist, Lorry Drivers, Coppersmith, Electrician.

Obviously these categories are not entirely satisfactory e.g. not differentiating between skilled and unskilled workers and therefore the figures below only give an approximate analysis. 'Farmer' could also be considered professional/managerial or manual.

<table>
<thead>
<tr>
<th></th>
<th>'O'</th>
<th>CSE</th>
<th>C/N.Ex</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional</td>
<td>9</td>
<td>6</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td>Technical, Supervisory</td>
<td>12</td>
<td>7</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23%</td>
</tr>
<tr>
<td>Manual</td>
<td>13</td>
<td>25</td>
<td>14</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60%</td>
</tr>
</tbody>
</table>

It can be seen that of the 34 'O' level pupils who stated father's occupation, 21 were the children of Professional/Technical fathers.

The lower ability children were exclusively the offspring of manual workers, one parent being a self-employed builder.
### Analysis of Home Area Types within Each Course

<table>
<thead>
<tr>
<th>Area</th>
<th>'0'</th>
<th>CSE</th>
<th>C/N,Ex</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>21%</td>
<td>25%</td>
<td>12.5%</td>
<td>100%</td>
</tr>
<tr>
<td>Suburban</td>
<td>26</td>
<td>17</td>
<td>1</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>59%</td>
<td>39%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>Urban</td>
<td>12</td>
<td>40</td>
<td>20</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>17%</td>
<td>55%</td>
<td>28%</td>
<td>100%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>48</td>
<td>61</td>
<td>23</td>
<td>132</td>
</tr>
<tr>
<td>% of Total</td>
<td>36%</td>
<td>46%</td>
<td>18%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Distribution of Pupils to Courses from Each Area Type

<table>
<thead>
<tr>
<th>Area</th>
<th>'0'</th>
<th>CSE</th>
<th>C/N,Ex</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Rural</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>62.5%</td>
<td>25%</td>
<td>12.5%</td>
<td>100%</td>
</tr>
<tr>
<td>Suburban</td>
<td>26</td>
<td>17</td>
<td>1</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>59%</td>
<td>39%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>Urban</td>
<td>12</td>
<td>40</td>
<td>20</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>17%</td>
<td>55%</td>
<td>28%</td>
<td>100%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>48</td>
<td>61</td>
<td>23</td>
<td>132</td>
</tr>
<tr>
<td>% of total</td>
<td>36%</td>
<td>46%</td>
<td>18%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Analysis of Home Area Types within each Course

All Pupils (132)

No. of Pupils

<table>
<thead>
<tr>
<th>No. of Pupils</th>
<th>R</th>
<th>S</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>70</td>
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</table>

'O' Level Mathematics

No. of Pupils

<table>
<thead>
<tr>
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<th>S</th>
<th>U</th>
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<tr>
<td>0</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10</td>
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<tr>
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</tr>
<tr>
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</table>

CSE Mathematics

No. of Pupils

<table>
<thead>
<tr>
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<th>S</th>
<th>U</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
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<td></td>
</tr>
<tr>
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C/N.Examination

No. of Pupils

<table>
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<tr>
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<th>S</th>
<th>U</th>
</tr>
</thead>
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<tr>
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<td></td>
</tr>
<tr>
<td>20</td>
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</tbody>
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Key
R = Rural
S = Suburban
U = Urban
Distribution of Pupils to Courses from each Area Type

All pupils (132)

<table>
<thead>
<tr>
<th>No. of Pupils</th>
<th>O</th>
<th>C</th>
<th>C/N.Ex</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td></td>
</tr>
</tbody>
</table>

Rural Pupils

<table>
<thead>
<tr>
<th>No. of Pupils</th>
<th>O</th>
<th>C</th>
<th>C/N.Ex</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
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</tr>
</tbody>
</table>

Suburban Pupils

<table>
<thead>
<tr>
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<th>O</th>
<th>C</th>
<th>C/N.Ex</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Urban Pupils

<table>
<thead>
<tr>
<th>No. of Pupils</th>
<th>O</th>
<th>C</th>
<th>C/N.Ex</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
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<td></td>
</tr>
</tbody>
</table>

Key: O = O level, C/N.Ex = Limited Grade CSE or non-examination
### PUPILS' SUGGESTIONS FOR IMPROVING MATHS
#### 'O' LEVEL PUPILS

<table>
<thead>
<tr>
<th>Pupil Ref No.</th>
<th>Sex</th>
<th>Suggestions from Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Primary</strong></td>
</tr>
<tr>
<td>1</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>Make more interesting,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>improve understanding.</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>Emphasise basics,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>prepare for secondary.</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>Varied subjects,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>emphasise importance.</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tests instead of one</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>More basic maths</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>Better Scope (?)</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>Make it interesting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>More interest</td>
</tr>
<tr>
<td>13</td>
<td>F</td>
<td>More interest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>Teach tables, basics,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>long division.</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>More basics, tables,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>decimals, more time.</td>
</tr>
<tr>
<td>16</td>
<td>M</td>
<td>Make more active,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a game, not sitting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>down.</td>
</tr>
<tr>
<td>17</td>
<td>M</td>
<td>Don't rush, plenty of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>practice, make it fun.</td>
</tr>
<tr>
<td>18</td>
<td>M</td>
<td>Give certificates,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>prizes for reaching</td>
</tr>
<tr>
<td></td>
<td></td>
<td>standards.</td>
</tr>
<tr>
<td>19</td>
<td>M</td>
<td>Better facilities</td>
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</tbody>
</table>
### 'O' LEVEL PUPILS - continued

<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>F</td>
<td>-</td>
<td>Same teacher throughout course</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>M</td>
<td>More basics</td>
<td>Less maths that won't be needed later.</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>M</td>
<td>Learn basics, tables, multiplication, division, also modern maths.</td>
<td>Make more interesting, more time on understanding</td>
</tr>
<tr>
<td>27</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>29</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>F</td>
<td>Stay as they are</td>
<td>More emphasis on understanding before practice.</td>
</tr>
<tr>
<td>31</td>
<td>F</td>
<td>More number games, more advanced maths.</td>
<td>More individual attention, extra tuition in year 5.</td>
</tr>
<tr>
<td>32</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>33</td>
<td>F</td>
<td>More advanced maths.</td>
<td>-</td>
</tr>
<tr>
<td>34</td>
<td>M</td>
<td>Serious learning, not playing, more advanced.</td>
<td>Harder work earlier.</td>
</tr>
<tr>
<td>35</td>
<td>M</td>
<td>Start secondary work in Year 4, e.g. algebra.</td>
<td>Concentrate on work for O/CSE.</td>
</tr>
<tr>
<td>36</td>
<td>M</td>
<td>Prepare for secondary school, schools 'combine'.</td>
<td>Concentrate on maths for later in life and not 'wander.'</td>
</tr>
<tr>
<td>37</td>
<td>M</td>
<td>Start 4 rules at an early age.</td>
<td>-</td>
</tr>
<tr>
<td>38</td>
<td>F</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

continued ..
### 'O' LEVEL PUPILS - continued

<table>
<thead>
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<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Suggestions from Pupils</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Primary</strong></td>
</tr>
<tr>
<td>39</td>
<td>F</td>
<td>More emphasis on maths, replace French by more maths.</td>
</tr>
<tr>
<td>40</td>
<td>F</td>
<td>Make sure of basics.</td>
</tr>
<tr>
<td>41</td>
<td>F</td>
<td>Make maths fun to learn</td>
</tr>
<tr>
<td>42</td>
<td>M</td>
<td>Use colours, shapes, relate to surrounding events.</td>
</tr>
<tr>
<td>43</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>44</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td>45</td>
<td>F</td>
<td>Younger: number games, songs for enjoyment. Older: more pupil involvement.</td>
</tr>
<tr>
<td>46</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>47</td>
<td>F</td>
<td>Everyday applications, larger objects than 'cakes.'</td>
</tr>
<tr>
<td>48</td>
<td>M</td>
<td>-</td>
</tr>
</tbody>
</table>
### Pupils' Suggestions for Improving Maths

#### CSE Pupils

<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Suggestions from Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>F</td>
<td>Learn the basics</td>
</tr>
<tr>
<td>51</td>
<td>F</td>
<td>Learn basics when you are young.</td>
</tr>
<tr>
<td>52</td>
<td>F</td>
<td>Learn tables, weekly tests.</td>
</tr>
<tr>
<td>53</td>
<td>F</td>
<td>More strict teachers.</td>
</tr>
<tr>
<td>54</td>
<td>F</td>
<td>More advanced work, then senior work 'wouldn't be so hard.'</td>
</tr>
<tr>
<td>55</td>
<td>M</td>
<td>Let pupils work at own pace.</td>
</tr>
<tr>
<td>56</td>
<td>F</td>
<td>More teaching aids.</td>
</tr>
<tr>
<td>57</td>
<td>M</td>
<td>Have a shop, learn to give change.</td>
</tr>
<tr>
<td>58</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td>59</td>
<td>M</td>
<td>Learn harder maths.</td>
</tr>
<tr>
<td>60</td>
<td>F</td>
<td>Keep it simple and interesting.</td>
</tr>
<tr>
<td>61</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>62</td>
<td>M</td>
<td>More homework.</td>
</tr>
<tr>
<td>63</td>
<td>M</td>
<td>More advanced maths.</td>
</tr>
<tr>
<td>64</td>
<td>M</td>
<td>More discipline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miss out things e.g. trigonometry, as not needed for interview.</td>
<td>More basic maths.</td>
</tr>
<tr>
<td></td>
<td>Have only one teacher, less different ways of solving a problem.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Make everyone understand thoroughly; monthly tests.</td>
<td>Explain more fully, omit irrelevant material.</td>
</tr>
<tr>
<td></td>
<td>Stricter teachers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concentrate on basics: special classes for those who want to do trig and geometry for jobs.</td>
<td>Maths Club, get rid of topics not used in a job.</td>
</tr>
<tr>
<td></td>
<td>Stricter teachers to make pupils listen and learn.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Make maths more interesting explain better.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More discipline, learn basic facts. Same teacher throughout secondary.</td>
<td></td>
</tr>
</tbody>
</table>

**continued ..**
CSE PUPILS - continued

<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Suggestions from Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Primary</strong></td>
</tr>
<tr>
<td>65</td>
<td>M</td>
<td>More basic arithmetic</td>
</tr>
<tr>
<td>66</td>
<td>M</td>
<td>Harder 'suns'</td>
</tr>
<tr>
<td>67</td>
<td>M</td>
<td>—</td>
</tr>
<tr>
<td>68</td>
<td>F</td>
<td>No changes to teaching, only smaller classes.</td>
</tr>
<tr>
<td>69</td>
<td>F</td>
<td>Reduce 'new maths', concentrate on basic arithmetic for sound basics.</td>
</tr>
<tr>
<td>70</td>
<td>F</td>
<td>More time on maths instead of games and dance. Concentrate on basics.</td>
</tr>
<tr>
<td>71</td>
<td>F</td>
<td>More basic maths, better books.</td>
</tr>
<tr>
<td>72</td>
<td>F</td>
<td>Cut out useless maths e.g. binary</td>
</tr>
<tr>
<td>73</td>
<td>M</td>
<td>—</td>
</tr>
<tr>
<td>74</td>
<td>M</td>
<td>More interesting, use rewards.</td>
</tr>
<tr>
<td>75</td>
<td>F</td>
<td>Already good.</td>
</tr>
<tr>
<td>76</td>
<td>M</td>
<td>—</td>
</tr>
<tr>
<td>77</td>
<td>M</td>
<td>Older unqualified teachers need replacing or retraining.</td>
</tr>
<tr>
<td>78</td>
<td>F</td>
<td>Better understanding of very basic maths.</td>
</tr>
<tr>
<td>79</td>
<td>F</td>
<td>—</td>
</tr>
</tbody>
</table>

continued ..
<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Suggestions from Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>M</td>
<td>Start secondary maths in 3rd Year</td>
</tr>
<tr>
<td>81</td>
<td>M</td>
<td>Find the best textbook and use for all pupils. Concentrate on Maths/English.</td>
</tr>
<tr>
<td>82</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td>83</td>
<td>F</td>
<td>Make sure of tables as these are basis of all maths.</td>
</tr>
<tr>
<td>84</td>
<td>F</td>
<td>Extend to applications of maths in surroundings.</td>
</tr>
<tr>
<td>85</td>
<td>M</td>
<td>More basic maths.</td>
</tr>
<tr>
<td>86</td>
<td>M</td>
<td>More time on maths, strict teachers.</td>
</tr>
<tr>
<td>87</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>88</td>
<td>F</td>
<td>Basic maths, addition, subtraction, multiplication.</td>
</tr>
<tr>
<td>89</td>
<td>F</td>
<td>-</td>
</tr>
<tr>
<td>90</td>
<td>M</td>
<td>'Decent' teachers, friendlier atmosphere, easier maths.</td>
</tr>
<tr>
<td>91</td>
<td>F</td>
<td>Make them more interested in their work, include games.</td>
</tr>
<tr>
<td>92</td>
<td>F</td>
<td>Games to help with numbers</td>
</tr>
<tr>
<td>93</td>
<td>M</td>
<td>Better facilities.</td>
</tr>
<tr>
<td>94</td>
<td>M</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>95</td>
<td>F</td>
<td>Teacher more strict.</td>
</tr>
<tr>
<td>96</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>97</td>
<td>F</td>
<td>Stricter teachers.</td>
</tr>
</tbody>
</table>

Primary | Secondary
--|--
Apply more; harder maths. | -
More interesting and make sure everyone understands. | -
Relate to science subjects. More individual attention. | -
Teach the basics. | -
Explain more so we can understand | -
More maths used in works (industry) | -
As primary: friendly teachers, 'take a joke', teach with interest. | -
Do tests likely for a job or college. | -
Video about jobs and maths needed. | -
Better facilities. | " "
Better facilities. | -
Explain more. | -
Special courses at college. | -

continued ..
<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>M</td>
<td>Start early, really learn basics as foundation.</td>
<td>Concentrate on things needed for life.</td>
</tr>
<tr>
<td>99</td>
<td>F</td>
<td>More examples, e.g. cutting a cake.</td>
<td>Make pupils understand, make pupils write on the board.</td>
</tr>
<tr>
<td>100</td>
<td>F</td>
<td>-</td>
<td>Explain more until pupils understand. One teacher spends more time telling pupils off.</td>
</tr>
<tr>
<td>101</td>
<td>F</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>102</td>
<td>F</td>
<td>Learn basic maths when young.</td>
<td>I can't understand trigonometry, so perhaps go to basic maths.</td>
</tr>
<tr>
<td>103</td>
<td>F</td>
<td>Little games to help with maths.</td>
<td>Work on their own, but ask for help if needed. Emphasise importance of passing maths.</td>
</tr>
<tr>
<td>104</td>
<td>M</td>
<td>Better tools, use shapes and relate to world around.</td>
<td>One teacher not different one every term.</td>
</tr>
<tr>
<td>105</td>
<td>M</td>
<td>A lot of homework.</td>
<td>Learn the right maths that will be needed.</td>
</tr>
<tr>
<td>106</td>
<td>M</td>
<td>Do the things for Secondary. Tests to show weaknesses.</td>
<td>Work from books at own speed.</td>
</tr>
<tr>
<td>107</td>
<td>F</td>
<td>Games with numbers on the board to make interesting. Better books and allow to help each other.</td>
<td>Keep pupils quiet. Those who don't want to work, put them in a class of their own.</td>
</tr>
<tr>
<td>108</td>
<td>F</td>
<td>Make lessons interesting and varied.</td>
<td>As for primary.</td>
</tr>
<tr>
<td>109</td>
<td>F</td>
<td>-</td>
<td>Stick to one teacher.</td>
</tr>
</tbody>
</table>
# PUPILS' SUGGESTIONS FOR IMPROVING MATHS

## NON-EXAMINATION/LIMITED GRADE CSE

<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Primary Suggestions</th>
<th>Secondary Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>F</td>
<td>-</td>
<td>More attention towards the pupils.</td>
</tr>
<tr>
<td>111</td>
<td>F</td>
<td>Explain the work more.</td>
<td>More attention, give pupils confidence in their work and to ask for help with problems.</td>
</tr>
<tr>
<td>112</td>
<td>F</td>
<td>Teachers should learn more about Maths and English.</td>
<td>More teachers and give more attention.</td>
</tr>
<tr>
<td>113</td>
<td>F</td>
<td>Pupils should learn more about Maths than any other subject.</td>
<td>More teachers.</td>
</tr>
<tr>
<td>114</td>
<td>F</td>
<td>Explain more slowly so that you understand.</td>
<td>More teachers and go over things twice if you don't understand.</td>
</tr>
<tr>
<td>115</td>
<td>M</td>
<td>More maths lessons. More time spent on blackboard work.</td>
<td>-</td>
</tr>
<tr>
<td>116</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>118</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>119</td>
<td>M</td>
<td>Learn harder things earlier.</td>
<td>-</td>
</tr>
<tr>
<td>120</td>
<td>F</td>
<td>Taught to sit and listen.</td>
<td>Very strict teacher.</td>
</tr>
<tr>
<td>121</td>
<td>M</td>
<td>More lessons, up-to-date books.</td>
<td>As primary.</td>
</tr>
<tr>
<td>122</td>
<td>M</td>
<td>Make it interesting.</td>
<td>Decent teachers.</td>
</tr>
<tr>
<td>123</td>
<td>M</td>
<td>-</td>
<td>Smaller class size.</td>
</tr>
<tr>
<td>124</td>
<td>M</td>
<td>More interesting; homework in 4th and 5th year.</td>
<td>More interesting.</td>
</tr>
<tr>
<td>125</td>
<td>F</td>
<td>More interesting.</td>
<td>Allow pupils to drink coffee, tea, smoke, and they might get on better.</td>
</tr>
</tbody>
</table>

continued ..
<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Sex</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>126</td>
<td>F</td>
<td>Better books.</td>
<td>As primary</td>
</tr>
<tr>
<td>127</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>128</td>
<td>M</td>
<td>Make it more interesting: work at their own pace.</td>
<td>-</td>
</tr>
<tr>
<td>129</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>130</td>
<td>M</td>
<td>-</td>
<td>Better teachers</td>
</tr>
<tr>
<td>131</td>
<td>M</td>
<td>Make it interesting.</td>
<td>Better teachers</td>
</tr>
<tr>
<td>132</td>
<td>F</td>
<td>&quot;</td>
<td>Go everyday</td>
</tr>
</tbody>
</table>
# PRIMARY SCHOOL MATHEMATICS

**Retrospective Suggestions for Improvement from 5th Year Pupils**

<table>
<thead>
<tr>
<th>Suggestions/Words Used by Pupils</th>
<th>No. of Pupils making suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'O'</td>
</tr>
<tr>
<td><strong>A. MOTIVATIONAL</strong></td>
<td></td>
</tr>
<tr>
<td>More interesting, more games,</td>
<td>9</td>
</tr>
<tr>
<td>activity, fun, songs.</td>
<td></td>
</tr>
<tr>
<td>Offer prizes, rewards.</td>
<td>1</td>
</tr>
<tr>
<td>Apply maths to real world.</td>
<td>3</td>
</tr>
<tr>
<td><strong>B. TEACHING METHODS</strong></td>
<td></td>
</tr>
<tr>
<td>Emphasize basic skills, tables,</td>
<td>8</td>
</tr>
<tr>
<td>x, +, +, -.</td>
<td></td>
</tr>
<tr>
<td>Prepare for secondary,</td>
<td>6</td>
</tr>
<tr>
<td>more advanced maths.</td>
<td></td>
</tr>
<tr>
<td>Less rushing, work at own pace.</td>
<td>1</td>
</tr>
<tr>
<td>Less playing, stricter.</td>
<td>1</td>
</tr>
<tr>
<td>Set homework.</td>
<td>0</td>
</tr>
<tr>
<td>Improve explanations,</td>
<td>1</td>
</tr>
<tr>
<td>understanding, 'better' teachers.</td>
<td></td>
</tr>
<tr>
<td>Omit binary, new maths.</td>
<td>0</td>
</tr>
<tr>
<td><strong>C. EDUCATIONAL PROVISION</strong></td>
<td></td>
</tr>
<tr>
<td>Better facilities, books,</td>
<td>1</td>
</tr>
<tr>
<td>equipment, teaching aids.</td>
<td></td>
</tr>
<tr>
<td>More time for maths relative to</td>
<td>2</td>
</tr>
<tr>
<td>other subjects e.g. French/Dance</td>
<td></td>
</tr>
<tr>
<td>Drama.</td>
<td>0</td>
</tr>
<tr>
<td>Smaller classes.</td>
<td></td>
</tr>
<tr>
<td><strong>D. System already good.</strong></td>
<td>1</td>
</tr>
</tbody>
</table>
Suggestions for Improvement by 5th Year Pupils

<table>
<thead>
<tr>
<th>Suggestions</th>
<th>No. of Pupils making suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>More interest, games, fun, enjoyment.</td>
<td></td>
</tr>
<tr>
<td>Emphasis of basic skills, tables.</td>
<td></td>
</tr>
<tr>
<td>More preparation for Secondary.</td>
<td></td>
</tr>
<tr>
<td>Stricter discipline, less playing.</td>
<td></td>
</tr>
<tr>
<td>Better explanations, understanding.</td>
<td></td>
</tr>
<tr>
<td>More applications.</td>
<td></td>
</tr>
<tr>
<td>Better books, equipment.</td>
<td></td>
</tr>
<tr>
<td>More time relative to other subjects.</td>
<td></td>
</tr>
<tr>
<td>Work at own pace, not rush.</td>
<td></td>
</tr>
<tr>
<td>System already good.</td>
<td></td>
</tr>
<tr>
<td>Offer prizes, rewards.</td>
<td></td>
</tr>
<tr>
<td>Set homework.</td>
<td></td>
</tr>
<tr>
<td>Omit 'new' maths, e.g. binary.</td>
<td></td>
</tr>
<tr>
<td>Smaller classes.</td>
<td></td>
</tr>
</tbody>
</table>
### Suggestions for Improvement by 5th Year Pupils

<table>
<thead>
<tr>
<th>Suggestions/Words Used</th>
<th>No. of Pupils making suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'0'</td>
</tr>
<tr>
<td>Keep the same teacher/methods.</td>
<td>6</td>
</tr>
<tr>
<td>Regular tests.</td>
<td>2</td>
</tr>
<tr>
<td>Concentrate only on maths needed later in real life, omit sets, binary, algebra, trigonometry.</td>
<td>10</td>
</tr>
<tr>
<td>Practical work with equipment, calculators, computers.</td>
<td>5</td>
</tr>
<tr>
<td>More basic maths.</td>
<td>0</td>
</tr>
<tr>
<td>Make it more interesting.</td>
<td>3</td>
</tr>
<tr>
<td>More help with understanding, individual attention, better explanation.</td>
<td>9</td>
</tr>
<tr>
<td>Work at own pace, more time.</td>
<td>3</td>
</tr>
<tr>
<td>Stricter teachers, less noise.</td>
<td>1</td>
</tr>
<tr>
<td>Print revision notes.</td>
<td>1</td>
</tr>
<tr>
<td>More freedom e.g. smoking, tea, coffee.</td>
<td>0</td>
</tr>
<tr>
<td>Improved attendance.</td>
<td>0</td>
</tr>
</tbody>
</table>
# Suggestions for Improvement by 5th Year Pupils

<table>
<thead>
<tr>
<th>Suggestions</th>
<th>No. of Pupils making suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>More help, individual attention, better explanations.</td>
<td></td>
</tr>
<tr>
<td>Concentrate on maths for later life, careers.</td>
<td></td>
</tr>
<tr>
<td>Keep same teacher/methods.</td>
<td></td>
</tr>
<tr>
<td>Make it more interesting.</td>
<td></td>
</tr>
<tr>
<td>More practical work, equipment, calculators, computers.</td>
<td></td>
</tr>
<tr>
<td>Stricter teachers, less noise.</td>
<td></td>
</tr>
<tr>
<td>Work at own pace, more time.</td>
<td></td>
</tr>
<tr>
<td>Regular tests.</td>
<td></td>
</tr>
<tr>
<td>More basic maths.</td>
<td></td>
</tr>
<tr>
<td>Print revision notes.</td>
<td></td>
</tr>
<tr>
<td>More freedom, e.g. smoking, tea, coffee.</td>
<td></td>
</tr>
<tr>
<td>Improved attendance.</td>
<td></td>
</tr>
</tbody>
</table>
**BIOGRAPHICAL DETAILS OF 32 ASPIRING APPRENTICES**  
(All Male)

<table>
<thead>
<tr>
<th>Pupil Ref No.</th>
<th>Home Area</th>
<th>Father's Occupation</th>
<th>Hobbies</th>
<th>Maths Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>U</td>
<td>Retired Engineer</td>
<td>Football</td>
<td>'0'</td>
</tr>
<tr>
<td>16</td>
<td>U</td>
<td>Builder</td>
<td>M/cycles, Electronics</td>
<td>'0'</td>
</tr>
<tr>
<td>17</td>
<td>U</td>
<td>Foreman R.R.</td>
<td>Sports, Reading</td>
<td>'0'</td>
</tr>
<tr>
<td>18</td>
<td>S</td>
<td>Manufacturing Supervisor</td>
<td>Football, Electronics, Chess</td>
<td>'0'</td>
</tr>
<tr>
<td>22</td>
<td>R</td>
<td>B.R. Examiner</td>
<td>Sports, Astronomy, Chess</td>
<td>'0'</td>
</tr>
<tr>
<td>29</td>
<td>R</td>
<td>-</td>
<td>Scouts, Reading</td>
<td>'0'</td>
</tr>
<tr>
<td>36</td>
<td>S</td>
<td>Builder (S/E)</td>
<td>Modelling, Sport, Art</td>
<td>'0'</td>
</tr>
<tr>
<td>55</td>
<td>U</td>
<td>-</td>
<td>Sport, Gardening</td>
<td>CSE</td>
</tr>
<tr>
<td>62</td>
<td>U</td>
<td>-</td>
<td>Football, Snooker</td>
<td>CSE</td>
</tr>
<tr>
<td>63</td>
<td>S</td>
<td>Storekeeper</td>
<td>Cycle Riding, Table-Tennis</td>
<td>CSE</td>
</tr>
<tr>
<td>64</td>
<td>R</td>
<td>Planning Controller R.R.</td>
<td>Model Railways, Boating</td>
<td>CSE</td>
</tr>
<tr>
<td>65</td>
<td>U</td>
<td>Instructor B.R.</td>
<td>Athletics, Football, Cricket</td>
<td>CSE</td>
</tr>
<tr>
<td>67</td>
<td>U</td>
<td>-</td>
<td>All sports</td>
<td>CSE</td>
</tr>
<tr>
<td>73</td>
<td>U</td>
<td>Vehicle Builder</td>
<td>Football, Music</td>
<td>CSE</td>
</tr>
<tr>
<td>76</td>
<td>S</td>
<td>-</td>
<td>Buses</td>
<td>CSE</td>
</tr>
<tr>
<td>77</td>
<td>R</td>
<td>Builder S/E</td>
<td>Guns, Modelling, Electronics</td>
<td>CSE</td>
</tr>
<tr>
<td>80</td>
<td>U</td>
<td>Accountant</td>
<td>Sport</td>
<td>CSE</td>
</tr>
<tr>
<td>85</td>
<td>U</td>
<td>Strander</td>
<td>Table-Tennis</td>
<td>CSE</td>
</tr>
<tr>
<td>90</td>
<td>U</td>
<td>Service Engr.</td>
<td>Motor-cycles, Shooting, Fishing</td>
<td>CSE</td>
</tr>
<tr>
<td>93</td>
<td>U</td>
<td>Machine Foreman</td>
<td>Motor-cycles, Table-tennis</td>
<td>CSE</td>
</tr>
<tr>
<td>94</td>
<td>U</td>
<td>R.R.</td>
<td>Fishing, Shooting, Ornithology</td>
<td>CSE</td>
</tr>
<tr>
<td>96</td>
<td>U</td>
<td>Foreman</td>
<td>Modelling, Football, Badminton</td>
<td>CSE</td>
</tr>
<tr>
<td>98</td>
<td>S</td>
<td>Plumbing Estimator</td>
<td>Motor cycles</td>
<td>CSE</td>
</tr>
<tr>
<td>105</td>
<td>S</td>
<td>-</td>
<td>Motor cycles</td>
<td>CSE</td>
</tr>
</tbody>
</table>

*continued...*
### BIOGRAPHICAL DETAILS – cont'd

#### 32 ASPIRING APPRENTICES

<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Home Area</th>
<th>Father’s Occupation</th>
<th>Hobbies</th>
<th>Maths Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>U</td>
<td>-</td>
<td>Discos, Music, Bikes, Reading</td>
<td>C/N.Ex</td>
</tr>
<tr>
<td>117</td>
<td>U</td>
<td>Fitter</td>
<td>Discos, Table-tennis, Bikes</td>
<td>C/N.Ex</td>
</tr>
<tr>
<td>119</td>
<td>R</td>
<td>Work Inspector</td>
<td>Fishing, Sailing, Walking</td>
<td>C/N.Ex</td>
</tr>
<tr>
<td>123</td>
<td>U</td>
<td>B.R.</td>
<td>Modelling</td>
<td>C/N.Ex</td>
</tr>
<tr>
<td>127</td>
<td>U</td>
<td>R.R.</td>
<td>Football</td>
<td>N.Ex</td>
</tr>
<tr>
<td>128</td>
<td>U</td>
<td>Car Park Attendant</td>
<td>Football, Skating</td>
<td>N.Ex</td>
</tr>
<tr>
<td>130</td>
<td>U</td>
<td>British Celanese</td>
<td>Building Engines</td>
<td>N.Ex</td>
</tr>
<tr>
<td>131</td>
<td>U</td>
<td>R.R.</td>
<td>Motor-cycles</td>
<td>N.Ex</td>
</tr>
</tbody>
</table>

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Father's Occupation (32 Aspiring Apprentices)

Of the 32 pupils, 20 gave an accurate description of the father's job. ('Service Engineer' was assumed to be a skilled occupation.) 'Retired Engineer' is not included as this might, in practice, have been professional, technical or skilled.

<table>
<thead>
<tr>
<th>Father's Occupation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional; Managerial</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>(i.e. manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>supervisor, planning controller, accountant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical, Supervisory</td>
<td>5</td>
<td>25%</td>
</tr>
<tr>
<td>Manual</td>
<td>12</td>
<td>60%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
<td>100%</td>
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</tbody>
</table>

FATHER'S OCCUPATION

- Technical, Supervisory (25%)
- Professional (15%)
- Manual (60%)

20 Aspiring Apprentices
### ASPIRING APPRENTICES (ALL MALE)

#### SUGGESTIONS FOR IMPROVING MATHEMATICS

<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Maths Course</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>'O'</td>
<td>Better scope (?)</td>
<td>More specified lesson (?)</td>
</tr>
<tr>
<td>16</td>
<td>'O'</td>
<td>Make more active, a game, not sitting down</td>
<td>Make it practical, what you need to know</td>
</tr>
<tr>
<td>17</td>
<td>'O'</td>
<td>Don't rush, plenty of practice, make it fun</td>
<td>Don't rush, teach in stages</td>
</tr>
<tr>
<td>18</td>
<td>'O'</td>
<td>Give certificates, prizes for reaching standards</td>
<td>Keep same teacher, print out year's revision notes</td>
</tr>
<tr>
<td>22</td>
<td>'O'</td>
<td>More basics</td>
<td>Less maths that won't be needed later</td>
</tr>
<tr>
<td>29</td>
<td>'O'</td>
<td>More homework</td>
<td>Concentrate on maths for later in life and not wander</td>
</tr>
<tr>
<td>36</td>
<td>'O'</td>
<td>Prepare for secondary school, schools 'combine'</td>
<td>As primary</td>
</tr>
<tr>
<td>55</td>
<td>CSE</td>
<td>Let pupils work at their own pace</td>
<td>Stricter teachers to make pupils listen and learn</td>
</tr>
<tr>
<td>62</td>
<td>CSE</td>
<td>More homework</td>
<td>Make maths more interesting, explain better</td>
</tr>
<tr>
<td>63</td>
<td>CSE</td>
<td>More advanced maths</td>
<td>More discipline. Learn basic facts. Same teacher</td>
</tr>
<tr>
<td>64</td>
<td>CSE</td>
<td>More discipline</td>
<td>Maths not needed in future, so less maths</td>
</tr>
<tr>
<td>65</td>
<td>CSE</td>
<td>More basic arithmetic</td>
<td>Less maths topics not needed later</td>
</tr>
<tr>
<td>67</td>
<td>CSE</td>
<td>More discipline</td>
<td>More discipline. Learn basic facts. Same teacher</td>
</tr>
<tr>
<td>73</td>
<td>CSE</td>
<td>More basic arithmetic</td>
<td>Maths not needed in future, so less maths</td>
</tr>
<tr>
<td>76</td>
<td>CSE</td>
<td>Older unqualified teachers need replacing or retraining</td>
<td>Introduce 'Apprentice Maths' earlier. Leave out things like 'sets.'</td>
</tr>
<tr>
<td>77</td>
<td>CSE</td>
<td>Start secondary maths in 3rd yr</td>
<td>Apply more; harder maths</td>
</tr>
<tr>
<td>80</td>
<td>CSE</td>
<td>Start secondary maths in 3rd yr</td>
<td></td>
</tr>
</tbody>
</table>

*continued ..*
<table>
<thead>
<tr>
<th>Pupil Ref. No.</th>
<th>Maths Course</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>CSE</td>
<td>More basic maths.</td>
<td>Teach the basics.</td>
</tr>
<tr>
<td>90</td>
<td>CSE</td>
<td>'Decent teachers', friendly atmosphere, easier maths.</td>
<td>Friendly teachers, 'take a joke', teach with interest.</td>
</tr>
<tr>
<td>93</td>
<td>CSE</td>
<td>Better facilities.</td>
<td>Better facilities.</td>
</tr>
<tr>
<td>94</td>
<td>CSE</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>96</td>
<td>CSE</td>
<td></td>
<td>Special courses at college</td>
</tr>
<tr>
<td>98</td>
<td>CSE</td>
<td>Start early, really learn basics as foundation.</td>
<td>Concentrate on things needed for life.</td>
</tr>
<tr>
<td>105</td>
<td>CSE</td>
<td>A lot of homework.</td>
<td>Learn the right maths that will be needed.</td>
</tr>
<tr>
<td>115</td>
<td>C/N.Ex</td>
<td>More maths lessons. More time spent on blackboard work.</td>
<td></td>
</tr>
<tr>
<td>119</td>
<td>C/N.Ex</td>
<td>Learn harder things earlier.</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>C/N.Ex</td>
<td>-</td>
<td>Smaller class size.</td>
</tr>
<tr>
<td>127</td>
<td>C/N.Ex</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>C/N.Ex</td>
<td>Make it more interesting, work at their own pace.</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>C/N.Ex</td>
<td>-</td>
<td>Better teachers</td>
</tr>
<tr>
<td>131</td>
<td>C/N.Ex</td>
<td>Make it interesting</td>
<td>Better teachers.</td>
</tr>
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</table>
Home Area Type and Maths Course for the 32 Aspiring Apprentices

### Home Area Type

<table>
<thead>
<tr>
<th>Home Area Type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>5</td>
</tr>
<tr>
<td>Suburban</td>
<td>6</td>
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<tr>
<td>Urban</td>
<td>21</td>
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<tr>
<td><strong>Total</strong></td>
<td>32</td>
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</table>

### Maths Course

<table>
<thead>
<tr>
<th>Maths Course</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>'O'</td>
<td>7</td>
</tr>
<tr>
<td>CSE</td>
<td>17</td>
</tr>
<tr>
<td>C/N. Ex</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>32</td>
</tr>
</tbody>
</table>

---

Home Area Type
32 Aspiring Apprentices

Maths Course
32 Aspiring Apprentices
SUMMARY

All 132 Pupils

1. Father's Occupation

. The children of manual workers dominated completely the non-examination and limited grade CSE classes.

. Children of professional/technical fathers formed only 40% of the sample, but provided over 60% of the 'O' level pupils.

. Of the 35 children of professional/technical fathers, only one was placed in a non-examination/limited grade CSE group for mathematics.

Conclusion

The children were placed in groups according to mathematical ability and it must be concluded that mathematical attainment as measured by the school was closely related to father's status.

2. Home Area Type

. The urban pupils formed 55% of the sample but provided only 25% of the 'O' level candidates, while providing 87% of the non-examination/CSE classes.

. The suburban children represented only 33% of the sample but provided 54% of the 'O' level candidates.

. Rural children provided only 12% of the sample but 21% of the 'O' level pupils.

. The proportions on the CSE course roughly reflected those in the whole sample.

cont'd ..
Conclusions

Children from the urban areas were much less successful in being placed in the higher maths sets than suburban and rural pupils.

3. Suggestions for Improving Mathematics

(a) Primary School

The pupils most frequent request was for maths to become more interesting and enjoyable (23% of the sample.)

Of almost similar priority was the need for more emphasis on basic skills and tables, with better preparation for the more advanced work of secondary schools.

Stricter discipline and less playing was suggested by approximately 10% of the pupils, while better explanations and teachers were requested by 8%.

(b) Secondary School

31% of the pupils felt more help and attention was needed in mathematics.

25% gave the need to concentrate on maths needed in employment as the first priority.

11% suggested fewer changes of teacher.

Other less frequent suggestions included stricter discipline (6%) and more interesting work (6%).
The intending apprentices were mainly the sons of fathers engaged in similar work, i.e. industrial manual.

The majority were following a full GSE course in mathematics i.e. sets 2 and 3 out of sets 1 to 5 based on ability.

Several very weak non-examination pupils aspired to apprenticeships but were subsequently unsuccessful in obtaining them. They would exhibit at interview the poor basic arithmetic about which employers complain, but which the schools even with remedial help have little hope of improving.

The potential apprentices came mainly from an urban environment; they had a wide range of hobbies, with sport, motorcycles and modelling being popular.

Their main suggestion for improving mathematics was to concentrate on topics needed for employment, confirming the need for a course based on a text book like 'Apprentice Maths.'

The potential craft apprentices represented approximately 50% of the male population in the school; when the boys who entered engineering/science after the 6th form were also taken into account, it was clear that such work would be relevant to the majority of boys.
Chapter 6

TRANSCRIPTS OF TAPED INTERVIEWS WITH PUPILS
FROM YEARS 3, 4 and 5 REPRESENTING THE WHOLE ABILITY RANGE

Following the questionnaire given to 132 5th Year pupils, it was decided to question the children more closely about their experiences in school mathematics, and the interviews were recorded on cassette.

Some of the 25 pupils interviewed were members of the 'Apprentice Maths' club and their transcriptions include comments on that text.

Other pupils were interviewed because between them they represented both extremes of the school's ability range in mathematics - from good 'O' level candidates to remedial.

Similarly to add breadth to the work some girls were chosen, even though they had no interest in craft apprenticeships.

Naturally, some pupils did not wish to take part in recorded interviews and so the pupils who contributed could generally be regarded as co-operative rather than anti-social or disaffected.

The interviews took place during school lunch-times or evenings in groups of two or three; in most cases the pupils were very enthusiastic to record their opinions. Except in the group discussions, the pupils were not prompted by hearing the remarks of their colleagues.
TRANSCRIPTS OF TAPE

Kenneth Windridge 1 - 5th Year CSE 'Average'

"What has caused you most difficulty in maths?"

   "Fractions. Not enough time to practise. A couple of examples is not enough."

"What do you feel about the syllabus?"

   "Too many subjects rushed through parrot fashion."

"What about tables?"

   "I think you can't do without them."

"Why are you interested in a craft apprenticeship in engineering?"

   "I've always been handy with engines."

"What do you think of the 'Apprentice Maths' book?"

   "It's brilliant; completely different to other books. Pages and pages showing you how, instead of just a few examples."

"Do you wish you'd had it earlier in school life?"

   "Yes, as a school text book instead of just for the club. People could get on with it on their own, giving teacher time to help individuals."

"Have you read it yourself and understood it?"

   "Yes, it's self-explanatory. Doesn't use all those funny little letters and dots to tell you 'therefore' etc. It makes you think, it gives you the idea, but you have to fill it in yourself." In a normal book they don't explain all the little 'gadgets' and numbers. You are not introduced to new signs (in other books)"
Kenneth Windridge (cont'd)

"Did you buy a copy yourself?"
   "Yes: if you forget something you could just look it up and it will all be there."

"Have you experienced many different teachers?"
   "Some teachers just slap one or two examples on the board and if you don't understand they'll make fun of you." Others will explain time and again. In the first and second year they treat you like little children."

"Do you think some people give up in Maths?"
   "Yes, probably in the 3rd year when sums become long-winded."

   "There is not enough individual attention because the classes are too big."

"What about mixed ability?"
   "The clever ones help the weak."

"Have you ever been stopped from working?"
   "Yes, you always get the occasional idiot" "The old idea to put the clever ones in one class is best. The clever ones think why should I work when he's getting away with it. It's happening all the time. It's the minority: teacher's attention is taken by the class idiot - people can't get help when stuck."

--000--
Kenneth Windridge 2 (After an interview for an apprenticeship)

"Did you feel school had prepared you well for the interview?"

"No, 35 minutes of careers was not enough."

"What about maths?"

"Doing the extra work (on Apprentice Maths) helped me a lot. There were a lot of decimals and fractions which most books just glide over, but this book helped a lot."

"Have you been working from it at home?"

"Yes, I've been doing calculations at home working on my motor-bike. I'm having a rebore done and I've had to calculate the sizes for the piston, bore and rings."

"I flicked through the pages for the part I wanted."

"What about the practical applications?"

"They give you a ladder against a wall instead of a triangle, or a set of stairs instead of just pencil lines."

"Would you have liked the book earlier?"

"Yes, for the actual lessons for the boys, it does not matter for the girls, who do not want to be apprentices."

The tests at the beginning were helpful."

"What would you alter in school?"

"More maths teachers; same teacher all through your career. You fall behind because of teachers' different methods of showing examples."

"What about maths in the primary school?"

"They are alright because you have the same teacher for more than one lesson."

"Overall, has school treated you well?"

"I've taken advantage of the help which is there, most don't and fall by the wayside."

"Are the teachers doing their best?"

"Yes, they are all too willing to help. Those that
want to get on. Those that don't want to get on, they just leave to do what they want."

"Where does the fault lie?"
"In the family of the children. If the family is no good, the child will be no good."

"Is there anything in common about those who do not bother?"
"I'm not being nasty, but they are always the scruffy lot, go around in gangs, acting big in class; not doing work is big."

"Who are the ones who do well?"
"Those who have respect for someone else; if you have a friend you can trust and everything is alright at home. If you have a worry at home you cannot concentrate at all."

"Then does the fault lie in the home rather than the school system?"
"Yes, because if people are brought up wrongly they cannot correct themselves."

"What do you think of the Comprehensive System?"
"The weaker ones work and work to catch up; when they get clever people will start talking to them, because no-one wants to talk to a drop-out."

"What do you think of the 5th Year Centre (Recreational)"
"It's good, people from other schools think this school is paradise. People have matured, realise they're being treated like adults."

"What would they do without the Centre?"
"Get wet, stay in small groups of 2 or 3 instead of getting together like we are doing and this continues into the lessons because you know them and can talk to them."

"What about Tech.?"
"There are more facilities at tech. There's a canteen for snacks - it's a good place."
"What about the teachers?"
"They are more 'with it,' with having older pupils.
You can understand the teacher more than you can here."

"Is the standard of teaching higher?"
"Yes, because they teach mainly apprentices and they
have to learn a lot in four years."

"Give one major reason for difficulty with maths."
"Changing teachers."
Graham Prime - 5th Year GSE/Non-examination

Very weak. Father has tried to help. Wants an apprenticeship in the building trade.

"Have you been for interviews?"
"Yes, I've written letters and been for tests, but mostly it's 'we don't need anyone' or 'we want 'O' levels."

"Has school prepared you well?"
"No, not really."

"What has let you down?"
"The maths, some questions I could do, others I hadn't seen before."

"What has been the main problem with school maths?"
"In the primary school, they just work on the clever pupils. Me and some others, they just say 'you do this' and then go back to the clever ones. Too many in the class, about 35." "Secondary school was better, stricter."

"Are you happy with 5th year maths?"
"You think you are getting away with it, not doing homework. At the end you regret it."

"What would have helped?"
"Bring a careers officer in to tell you how hard it is to get jobs."

"When should that be done?"
"In the first and second years."

"Why did you attend the 'Apprentice Maths' Club?"
"As a last resort to try and get some Maths and learn something."

"What did you think of the textbook?"
"I've bought one and do a few examples every week or a few a night."

"Has it been helpful?"
"Yes, you learn more and drive yourself to do it."
"Can you describe a typical maths lesson?"
"Yes, you just get there when you want to. If you haven't got a pencil, you say so. You either lend one or he'll give you one."

"Is the lesson quiet?"
"No, say 'I've forgotten my book' and 99% of people don't bring one." "People move desks, fighting, arguing; in the end he gets fed up and gives up."
"People who want to learn have got no chance."

"What's the answer?"
"Stricter teachers, those who don't want to learn, put them on their own and let them do what they want."

"What do those who don't want to work do?"
"Just mess around, listen to teacher's tape recorder (pop music)."

"Have you had many different teachers?"
"We've had four this year, they come for a month or so, you don't learn with them. Fractions one lesson, then something else."

"Have the teachers been firm enough in the 4th and 5th year?"
"We have had seven at this school. Three have been good teachers and strict; the rest haven't."
Iain, 4th year, limited grade, CSE

"What are twelve sevens?"
"72?"
"83?"
"What do you want to do when you leave school?"
"Get an apprenticeship, want a trade to help if you are redundant."
"Do you think maths is important?"
"Firms don't take you if you have no maths. My parents told me in the second year."
"Have you had trouble with maths?"
"Never been able to do tables."
"How did you get on in junior school?"
"Not very well really, there was no control there. The teachers were hardly ever there. The Head and Deputy used to stand in, but they weren't specialist maths teachers like here. Spent too much time on English, not enough on Maths. Did not make you learn tables, just let you muck around with sand. Secondary school had a lot more work involved."
"What would you change in secondary schools?"
"More Maths in first year on things like tables and division."
"Has 'Apprentice Maths' helped?"
"Yes, it's helped in Maths and Physics and Technical Drawing. Read it when no homework was set. Used it for square roots, circle and density."
"What else has stopped you from learning?"
"They didn't tell you how much it mattered. Jobs were easier then. A friend of mine was out of work for a year."
"What else would help?"
"Parents and people coming into school and telling them."
Iain, continued

"You know your parents were right when you look back."

"Mention different types of teacher?"

"Our old teacher in the primary school, who has just retired just left you to work through the 'Beta' books and she would help you if you couldn't do it. In the secondary school you are just told the pages to do and if you couldn't do it, the teacher stopped the whole class. I suppose it was O.K."

"What about behaviour?"

"People muck around too much. I did myself until the third year."

"What has been the biggest factor damaging your maths?"

"Not knowing tables and missing time at school."

"How many teachers have you had for 4th year maths?"

"We have had nine, one all the time for one of the lessons, but in all we have had nine!(in 1½ terms)."

"How has that affected your lessons?"

"We have had different methods and different ways. It's been up and down. This one we have got now is very nice, he sets it out and gives a bit of writing to explain it."

Paul added, "With so many different teachers you just mess around 'cause you know they will only be there for about three weeks."

"How many of the nine teachers have you been happy with the class behaviour?"

"I'd say two."

"You weren't satisfied with seven?"

"No."
Richard, 4th year non-examination.

"What are seven sixes?"
"36.
"What are twelve sevens?"
"60"
"Have you always struggled in maths"
"Yes, right from the primary school"
"What stopped you from learning?"
"Me messing about."
"Are you beginning to realise it was wrong?"
"Yes, the most important things for a job are Maths and English, and messing around doesn't get you anywhere."
"When did you realise that.?"
"This morning."
"If you learned to do long multiplication, e.g. 15 x 37 and can do it properly, how long would you remember it?"
"About a week."
"Then would it be gone?"
"Yes."
"Can you thing of anything to improve the way you have been taught?"
"No, I've been taught good here. I just don't listen. I got a bad report in the third year and now I want to work hard to get a good report."
"Do you think the teacher should have been more strict.?"
"Yes."
"What do you want to do when you leave?"
"Haven't really thought about it." Careers lessons have given me an idea about the railway."
"Would films showing the use of maths help in the 3rd year?"
"Yes."
Steven, 4th year non-examination maths

"What are nine sevens?"
"Don't know"
"Do you work hard?"
"Yes, want to get through examinations."
"What do you think of the way you have been taught?"
"Very good, I've learned a lot."
"What do you think of primary school?"
"Didn't learn much there." Only had maths twice a week. Did times and add."
"Has anything stopped you from working?"
"Playing about. Other people put me off. My parents want to get me to get through maths and english."
"How long does it take for you to forget things after you have learned them properly?" e.g. long division."
"About three days."
"Would regular practice help?"
"Yes, in dinner hours and breaks."
"Have you thought about a job?"
"No, not yet."
"Have your teachers always helped you?"
"Yes, they have helped a lot"
Paul, 4th year, limited grade, CSE

"What are nine eights?"
"72."
"What do you want to do when you leave?"
"Take an apprenticeship"
"When did you think about jobs?"
"In the third year."
"Mention any problems in maths."
"Move on to things too quickly. The classes are always talking. The teacher spends half the time saying 'Shut up'. We don't spend enough time on one topic and it doesn't sink in. If we only spend two weeks on a topic, I only remember it about a week."
"What was primary school like?"
"The classes were too big and we didn't get enough of the teacher's time. At that age the children behaved well and respected the headmaster. At fourteen you just can't care less. There is no respect for teachers. Kids think the teacher can't hit me or I will get my dad on to them."
"What would you like to see?"
"Stricter rules and extra lessons. We have not really had enough time on maths. I would rather drop P.E. and do more maths and english."
"Why did you come to the Apprentice maths lessons?"
"I wasn't learning in my lessons and had to catch up. My parents help me as far as they can."
"Have you used 'Apprentice Maths'?"
"Yes, I've used it a lot. It lets you know what you need to concentrate on. I have been able to read it for myself."
"I want to take 'A' levels and a degree in Maths".

"Have you never been interested in engineering or computing?"

"I like to work things out myself, not use a machine."

"What is your idea of an engineer?"

"Like a lot of other people, a bloke who gets dirty and grubby and messes about with machinery, not a very clever person at all really."

"When you were recently shown sample mathematical calculations from industry, did your opinions alter?"

"Yes, they did, because the maths was fairly complex and I thought it would just be simple addition and subtraction."

"Would it help to show these applications to other pupils?"

"Yes, a lot of people think engineering is for non-examination people, whereas you should be aiming at the top sets who can do maths."

"There has been talk of so-called falling standards."

"Yes, I agree there has been falling standards due to lack of discipline at home from parents, so they don't behave at school."

"You only have to look around a classroom, the kids misbehave and give a mouthful of cheek; most of the time the teacher says 'go to the year co-ordinator' or tries to ignore them. They just disrupt the whole class."

"Is that happening in your 'O' level classes?"

"It isn't now but it was last year" (top 3rd year maths set.)
"Has your progress suffered?"

"No, we said we would get on, but other people were distracted by their friends."

"Why don't parents have control?"

"I don't know; youngsters have freedom in pubs, out in streets, smoking, violence in the world has increased."

"Do you think bad behaviour is the main factor in falling standards?"

"It's one of them, but not the only one."

"What do you think of the Comprehensive System?"

"It's a good idea. Alright for the late developers."

"In the old grammar schools people who'd been clever would have got a better education."

"Do you think you've been stretched?"

"No, I don't. "In the last four years we've been messed around and never settled in one set and had different teachers. We've been juggled about every year."

"We should have the same sets all the way through with special classes for late developers. The answer is to introduce careers in the first and second years. It definitely enlightens people on the job shortage and qualifications needed. Alert people at an early age that if they don't get qualifications they won't get a job, they will start working for them."
Michael

Very weak non-examination 5th Year. Hoped to get an apprenticeship in aviation but rejected. At weekends he worked as a sweeper at the East Midlands Airport.

"Why have you had difficulty with maths?"

"It all started in the primary school. People on the Alpha books were more cared for. Those on Beta books had to work things out for themselves. We were neglected."

"It was the same in the secondary school first year, but better later."

"How would you change the way you've been taught?"

"More time on going over new things: say 35 mins on a new subject."

"Do you understand explanations?"

"Not all of them."

"Have you had a big variety of teachers?"

"Yes, I've had four since the third year."

"What methods did the good teachers use?"

"They spent more time on explaining and going round putting you right."

"What causes you most trouble in maths?"

"Fractions. We just rushed through the work."

"Explanations were too quick. I gave up."

"What do you think of 'Apprentice Maths'?"

"It's good. It puts things clearer to you, more simply."

"Have you used many text books in school?"

"About one."

"Have you had a text book you could learn from?"

"No."
"How much homework have you done in the 5th year?"
"Not much at all."
"Less than one hour a week?"
"Yes."
"Have you thought of asking for some?"
"No."
"Have you given up?"
"Yes."
"Do your parents want you to do homework?"
"Yes. They say I should get some work to do at home."
"Have your parents tried to help with tables, all the way through?"

Michael still took a very long time to answer $9 \times 7$. His parents had bought him "Revision Notes for GCE and CSE" but it was far too difficult. In contrast he repeatedly asked to borrow 'Apprentice Maths.'

Michael received an interview for an aviation fitting apprenticeship and was warned that he would be tested on engineering drawing interpretation. The samples provided by Rolls-Royce were loaned to him.
Alan 3rd Year 'O' Level
(Top in mathematics)

"I want to go into one of the sciences. At school, there is no force behind you to work at things you don't want to. You just do what you think is necessary."

"Teachers should be stricter but maintain a friendly relationship, or pupils might decide not to work at all if the teacher is mean to them." "They should make the lessons more interesting."

"In some lessons you are held back by people who don't understand."

"What about teaching methods?"

"In primary school we had cards; if you didn't feel like doing it you just messed around. You had no proper help if you were stuck."

"Was it a poor system?"

"Yes, really."

"I prefer to be taught from the blackboard, not out of books starting by yourself because you go at your own pace and are held back because the teacher says 'don't go on to that yet.'"

"What about Comprehensives?"

"They are alright, maybe teachers aren't strict enough now and again, but otherwise it's okay."

"Do you agree with sets?"

"Yes, I know people in other schools where they don't have sets and they're held back by slower people. The teacher stops the whole class when they want to get on just for one person, and keeps repeating it. Lazy ones deliberately act stupid and hold the class up."
"What about homework?"

"I can't stand it and do as little as possible. There's little enough recreation as it is round here. It's bad enough in school as it is."

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Gary 3rd Year (Probable CSE)
Exceptionally well-motivated and hardworking.

"I want to be a chef in the merchant navy. My parents told me to go to the Sea Cadets to keep me off the streets."

"Why do you work so hard?"
"To get a job, not for my parents, but to be a chef."

"Why do a lot of pupils waste their time?"
"They think they'll get the dole. The world's overpopulated and there will be no money left."

"What should be done to improve schools?"
"The teachers should be stricter."
"I get too much homework, sometimes four lots a night, two would be better."

"Have you been happy with the teaching at Secondary School?"
"Yes, some teachers are helping me and I'm getting more confident. People in class encourage you to mess about, call you 'chicken', shout across the room and throw rubbers at your head."

"Is that widespread?"
"Yes, you come to learn, not to mess about."

"What about primary school?"
"Very good for maths and English, but not much else."
Discussion with Gary (GSE and Alan (O Level - outstanding)

Gary: "Teachers explain a thing twice and someone at the back keeps saying they don't understand. There's no time left to work.

Alan: "The classes are too big, while teacher is explaining you can make yourself invisible and lie back. I used to fall asleep in lessons in the junior school quite regularly. I go to extra lessons on a Sunday in French and German, because I get personal attention, unlike school."

Gary: "Teachers don't look as if they're interested in the work. They just say 'You do that,' especially the language teachers."

"How could teachers be more strict?"

Gary: Have a cane in the corner of the room and show it to the pupils when they came in."

"Do you learn if you talk while you work?"

Alan: "Yes, it helps to compare work with a friend to correct mistakes."

Gary: "I think music and P.E. don't help you and should be dropped for more maths and English."

Alan: "Classical studies is a waste of time."

"What is most useful at school?"

Alan & Gary: "Maths."

Alan: "Maths is used in physics, chemistry, engineering and technical drawing."

continued..
Discussion with Gary & Alan (continued)

Gary:  "Attendance at school is bad because people think it is boring. Most are present when it is football and sport, not English and Maths."

"What about careers lessons?"

Alan:  "Leave 'till 4th and 5th years, but one interview in the 3rd year. If you're too young, you don't know what you're aiming for."

-----o0o-----
Jeannine - 5th Year CSE (but 'O' Level in other subjects)
Hardworking but has difficulty understanding.

"I'd like to go to University sponsored by the police, after 'A' Levels."

"Have you been well-prepared by school in maths?"
"I've had an excellent maths education, it's just that I can't understand. That's why I'm bad."
"I can't memorize it all, it's easy at the time of homework, but 3 months later I can't remember it."
"At primary school I had an excellent grounding, I knew all my tables at seven."

"What do you think of comprehensives?"
"I prefer the grammar school system, but at 13+ for late developers."

"Why not comprehensives?"
"There are some very disruptive elements in the classes. There is a world of difference between the 'O' level and the CSE classes."

"What are the causes of disruption?"
"Children not understanding and getting bored with the subject."

"What are the differences between 'O' level and CSE classes?"
"'O' level people know that education is the key to their lives. In CSE classes they are more concerned with who is going out with who and trying to 'skive' it."

"What causes the 'O' level people to be well-motivated?"
"The parents and home background."

continued ..
Jeannine - continued

"What about teaching methods?"

"My cousin in Nottingham was taught by colours in primary school e.g. 1 is blue, 2 is red, blue + red = green = 3. He is now hopeless at maths although he is a very intelligent boy taking several 'O' levels in other subjects."

---0oO---
Sheridan - 5th Year CSE 'Average', Weak understanding

Taking some 'O' levels and determined to be a physiotherapist.

"I read a book about a girl being helped by a physiotherapist and decided on this at the end of the 4th year.

"I like the comprehensive system, but there should be streams. The comprehensive gives experience of people from different backgrounds."

"Have you any criticisms of maths teaching.?

"In South Africa, I was taught very badly by one teacher and I went right off the subject and now I can't concentrate. If you got your homework wrong you got the cane (in S.Africa.)

"Have you been happier with secondary school?"

"Yes, it is steadier and you can ask if you don't understand."

"What changes would you make in the teaching of maths in school?"

"Divide maths into the basics for 'thick' ones like me, fractions, etc. but algebra would be no use for me, alright for accountants."

---00o---
Discussion with Jeannine and Sheridan

"What do you think of mixed ability groups?"

Sheridan: "I don't agree with them; the intelligent ones get bored. It was better before we were mixed."

Jeannine: "We go into little groups based on intelligence."

"What about mixed ability lessons?"

Jeannine: "It was awful, nobody worked. The weaker ones pulled the brighter ones down. We had to wait for the others to catch up - they picked my brains and I was held back.

Sheridan: "There's a general feeling that if you get too pally with the teacher you're a creep. I wouldn't like to let my friends know. That didn't happen when we were in streamed sets, it was a completely different atmosphere."

"What motivates you?"

Sheridan: "Being a physiotherapist."

Jeannine: "Getting 'O' levels."

"Are you fortunate compared with many?"

Sheridan: "I've noticed children from poorer areas and poor upbringing go with not being intelligent. In our 'O' level group most of us are quite well off."

Jeannine: "Then asked in our 'O' level geography group, all but two came from Chellaston (a residential village/suburb.)"
Wayne - 'Average' CSE

"I want to be an apprentice plumber."

"How would you change your maths education?"

"At primary school, most of the time was just 'kidding about."

"Have you always worked hard?"

"Not always, no."

"What would have made you work hard?"

"Teacher being stricter."

"Were many people working hard?"

"Yes, most, but there's always some who drag the rest down."

"When did you realise you needed to work?"

"At the end of the 3rd year."

"What made you work harder?"

"When you start writing for jobs it downs on you."

"Did the careers lessons help?"

"Sometimes, but we'd already decided on a job, the time would be better spent finding out more about it."

"Why are you interested in plumbing?"

"My uncle has his own business and he is never out of work."

"Have you been happy with your schooling?"

"Overall, yes, but some of it was no good."

"The proof of it is when you're at work. I'd definitely have careers advice earlier on."

"Has 'Apprentice Maths' helped?"

"Yes, it's been a great help. When I went to the Gas Board I had a good look at it. It set it out easily. It explained itself. You could work from it without a teacher."

continued ..
Wayne - continued

"Have you been able to do that before with text books?"

"Not usually, No."

"Do you wish you had seen the book earlier?"

"Yes, in the 3rd Year when you're choosing your options."

---oOo---
Neil - 5th Year 'O' Level

Very conscientious, able and determined to become a manager with a bus company.

"Has school prepared you well?"
  "I think so but I won't really know until I start work."
"Can you point to any weaknesses in teaching?"
  "At junior school: they didn't really teach you much."
"Did you feel you were wasting time?"
  "Basically yes."
"How did Secondary School contrast?"
  "Had to work harder, instead of playing with maths."
"Have you been happy with Secondary maths?"
  "Yes."
"Have all the teachers been efficient?"
  "One didn't explain well, but my father helped me."
"Why have you always worked hard?"
  "I've had good teachers and my parents have urged me too."
"Have you any suggestions for improving the teaching of maths?"
  "Introduce harder work at junior school. They don't prepare you for the change. I enjoyed the discovery methods but I don't think they teach you as well as the text book."
"If you had problems, did you ask for help?"
  "No, I prefer to work things out myself."
"Have you found careers lessons helpful?"
  "Careers lessons aren't that important. I had started writing to bus firms before we had careers lessons."

continued ..
"When do you think people should start to think of careers?"
"In first and second year because of choosing options in the third year."

"What do you think of the Comprehensive System?"
"I think it is good because you learn to work with all sorts of people. I prefer it to a school like Radley in the television Public School series."

---oOo---
Andrew - 4th Year 'O' Level, very hardworking and capable

"I want to go into political journalism - I'd like to be active in politics" (like father.)

"Do you have any criticisms of maths teachers?"
"At primary school, make it interesting for you. As you progress emphasis is on learning and usefulness. Some parts of maths I don't see the point of, aren't associated with any job. I'm not sure what use the difference of two squares is."

"What effect have other people in your class had?"
"Troublemakers and noisy ones stop you working. (Andrew had always been in the top set.) Otherwise people have been quite nice."

"What do you think of the comprehensive system?"
"The idea is good but I'm not sure if it works well."

"What's wrong with it?"
"They don't split you up properly till 3rd and 4th Year, should do it from 1st and 2nd year."

---o00---
Richard 4th Year 'O' Level, conscientious and very capable.

"Have you decided on a career yet?"

"No, not yet; I hope to stay on at school or college."

"What points are there for school sixth form versus college of further education?"

"At school, I would carry on without interruption; at college I'd have specialist teachers for 'A' level maths."

"How do you feel about your school life?"

"Up to now it's gone very well."

"Do school rules bother you?"

"No."

"Were you happy with primary school?"

"Fairly happy."

"Did you progress at your full potential?"

"No, not in maths, it was a bit too basic, we just kept practising over and over again."

"Did they stretch you?"

"Yes, after the 4th year, but not earlier."

"What about secondary school maths?"

"Wider variety of topics in maths, a bit harder but it got better."

"What could be done to improve?"

"Not a lot, I think it's taught very well in the secondary school, it's just the primary school that could be a bit better."

"Are there pressures against working hard?"

"There were when we weren't in sets from children who weren't as clever as you in first and second year in mixed ability groups."
Richard - continued

"If you tried to get on they just laughed at you and said "What's he doing trying to work" as if you shouldn't try and get on. When we went into sets all that stopped. Now if you should be doing well and aren't, your friends egg you on to do better."

---oOo---
Discussion between four 'O' level boys

- Mark, Richard S, Richard T, Andrew

Mark: "Four years work in the primary school could have been done in 1½, you weren't pushed. You get all your addition right and then do the same again next week. It was boring." If you're not pushed you don't get used to working.

Richard S: "You need a good foundation to build on."

Andrew: "If you're pushed too hard at an early age you'll put them off school."

Simon: "A child is as lazy as an adult."

Richard T: "We did games everyday, we made two cinefilms, that's all we did."

Mark: "Games were alright but it was 2½ days a week. If you behaved well, he'd say 'we'll do games this afternoon'."

"Didn't you tell the teacher you wanted to work?"

Mark: "He wouldn't have listened to you."

"Then did it occur to you that you had wasted time at primary school?"

Richard S: "Not until you think about it."

Richard T: "Yes, but you can be overstretched."

Mark: "It's better to be overstretched than understretched.

Andrew: "I don't think you are, there's a limit to what you can take in."

Mark: "Not all kids are the same, the teacher can pick out the clever ones and put them in other classes. It should be done at primary school."
Richard S: "At that age they're more bothered about playing in the sand."

"How would you organise a school?"

Mark: "Get the trouble makers out at an early age into the annexe. Some of the clever ones, six girls in the top group didn't want to work and just messed around. They could do 'O' level if they want to. The teacher couldn't control them, although she tried." (This was the top 3rd year set out of 10.)

Richard S: "Give them tests every six weeks like they do at another school."

"Who do you blame?"

Mark: "The teacher should contact higher authority and get troublemakers moved. They got in with the wrong crowd."

"Do you think this is a widespread problem in schools?"

Mark: "Yes, it's everywhere. When you travel to other schools for sport you see the writing on the walls."

Richard S: "All kids are the same. If you think this school's bad, you should hear about other schools."

Mark: "Yes, but it could be minimised."

"What do you think of the 5th year (Leisure) Centre?"

Mark: "If it's theirs, they'll respect it. It's worked well."

Richard S: "Teachers are scared to stop kids vandalizing."
Discussion - continued

"Why have you worked hard?"

Andrew:  "Because our parents want us to."
Richard S:  "The teachers."
Simon:  "I find maths interesting."
Richard T:  "Teachers and self-motivation. Parents shouldn't push you too much because relationships become strained."
Mark:  "Pressures from the outside world, the job situation and the will to get on."

"What are the differences between the people in the top and bottom sets?"

Mark:  "People in the top are more mature in their outlook on life and speech. Those in the bottom set couldn't care less about exams, they play 'chase' at break."

"What about their backgrounds?"

Simon:  "I think they come from the rougher areas. Older brothers and sisters weren't too clever, motorbike mad even if they're clever - they'll pull the other ones down."

Andrew:  "None of us are very poor are we really? We're all in school uniform."

"Do you think home-background is a major factor?"

Andrew:  "It's the major factor". (unanimously agreed.

Mark:  "Also origins. Very few Jamaicans in the top set. Jamaicans think 'why bother?'"
Discussion - continued

Andrew: "Not many Jamaicans live in £20,000 houses, most of them live near centre of town in poorer areas."

"If they live in a rough area, they have to have the will to survive, they think they’ll be tough and not do the lessons because of their friends."

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Discussion between three 5th Year 'O' level girls:
Deborah          , Penelope       - good 'O' level
Lesley           - average 'O' level

All three intended to enter the 6th form and were in the top set for maths. Penelope had been giving paid private tuition for 'O' level maths for an 18 year old who had failed several times.

"What pressures do you feel?"
Penelope: "Everyone's going on about the exams you've got to pass."

"Are you worried about job shortage?"
Deborah: "Some people with lots of qualifications don't get jobs."

"What pressures are there to work hard?"
Deborah: "Depends on the people you go around with."
Lesley: "Rivalry with friends, be bigger than them."

"What pressures are there not to work hard?"
Deborah: People you don't go around with. Generally it is not a problem because you don't associate with them.

"Can you describe something which has happened?"
Penelope: "If you come early and do homework then people call you names and say 'you don't do homework do you, we never do.'"

"Concentrating on Maths, describe an ideal lesson".
Deborah: "Explain it all first."

"Have you noticed a difference in quality of explanations from different teachers?"
Discussion between 35th year girls - continued

Deborah: "Yes, if they don't explain it properly you don't like to ask questions because everyone else thinks you're stupid."

Penelope: "It's better if the teacher turns round and asks you questions about the new topic to make sure you understand it."

"Are there many cases when the majority of the class would like to ask questions but don't?"

Lesley: "Yes."

"They ask their next-door neighbour and sort it out that way."

"Have you experience of mixed ability?"

"Not in main subjects."

"Only in the 3rd year."

"Does it work?"

Deborah: "People who do work hard don't influence the others."

"If they don't work and don't get told off then you don't bother either."

Lesley: "You're on your own if you start working."

"What about regular tests?"

Penelope: "Yes, it's a good idea in all subjects, it makes you learn."

"Is there too much homework?"

Penelope: "Yes, if you get a lot of subjects on one night."

"Is the maths syllabus too big?"

Penelope: "Yes, we don't cover it sufficiently, better with deeper detail."

continued ..
"Has maths been useful to you?"

Penelope: "Yes, it helps you understand things better, but you can't apply many things. I don't walk along the street trying to find out how to use the cosine formula."

Lesley: "It makes you look at things and makes you try to discover answers to problems in any walk of life. You don't use maths, but you use the methods like tools."

"Does it make you think harder than any other subject?"

All: "Yes."

"Have you thought of a career in Engineering?"

All: "No."

Deborah: "We don't know if we'd like it, you always associate it with boys jobs."

Penelope: "It's just a word, nobody's told us about the different aspects of it. It doesn't seem very interesting."

"What about primary school, how were you taught?"

Deborah: "We weren't really taught, half of the day you just played around and messed about."

"Did you learn tables?"

Penelope: "Yes, before you were seven."

"Was it a good idea?"

Penelope: "Yes, but I knew them more then than I do now."

"Lesley, did you learn tables?"

Lesley: "Yes, I suppose it was really helpful."
Andrew - 5th Year CSE 'Average'

Typical craft apprentice - intended to join Navy as an artificer. Started schooling in Yorkshire, lived in a caravan for a year taught only by his mother - taught multiplication tables by her and very grateful for them. Serious and hardworking.

'I want to be an artificer in the Royal Navy'.

'Has school prepared you for this career?'

'They could have done more, with smaller classes, text books and more explanations.'

'Have you used 'Apprentice Maths'?'

'Yes, quite a few times.'

'Has it been helpful?'

'It's been helpful in that there are more examples for one type of question than in the ordinary text book. There isn't too much or too little.'

'What maths topics have you mainly used it for?'

'Trigonometry and volumes.'

'What about self-assessment tests?'

'First few were easy but they got harder so I read the passage and it was helpful, laid out in understandable English.'

'How does it compare with other books?'

'It was a lot easier to read and understand, other books just have one example and from that one example you have to work out all the different ways whereas in 'Apprentice Maths' there's all the different ways.'
"What about the other revision text book you bought?"

"It is helpful, but the other text book for reading and understanding is a little hard - 'Apprentice Maths' is a lot easier."

"What did you think of the 5th Year 'Apprentice Maths' club?"

"It should have been started earlier."

"The basics should be taught by the Maths teacher and then this book can be used to advance on the basics."

"Generally, what do you feel about your maths lessons?"

"It's been varied, but I've tried to cope with moving from place to place."

"What needs to be done?"

"Smaller classes, stricter discipline."

"What was primary school like in Yorkshire?"

"You could do anything you wanted, you weren't supervised."

"Was it good?"

"No, you weren't learning anything, just passing time away, doing things that weren't important."

"Were you unhappy about it?"

"Yes, if you said anything they answered your question and you never heard anymore about it."

"Was Secondary School an improvement?"

"Yes, a lot better, classes reasonable size and teachers not all that bad."

"What about Comprehensives?"

"I think the grammar schools should be brought back in certain places, but comprehensives are alright for some. For those who have the brains and the knowledge there should
still be the grammar schools instead of having to wait for people of less ability."

"What about learning multiplication tables?"

"My mum taught me when I was away from school (in a caravan) for a year. You can't do maths without tables: if you do something time and time again it eventually sinks in."

"What changes would you make?"

"Smaller classes, stricter teachers, closer pupil/teacher relationship."

"What about the Maths syllabus (CSE)?"

"A few topics too many. I can't see any future use for sets. More teaching on basic maths and maths in engineering and everyday life."
Carl was originally keen to join the Navy, but after obtaining all of the recruiting information modified his aim to a printing apprenticeship. He was in a low ability CSE group (limited grade). Basically sensible and hardworking, but occasionally distrested.

"How do you feel you've been taught?"
"Been treated well, but better treated in junior school, looked after you well."
"Has anything stopped you working in secondary school?"
"Friends talking to you."
"Do you blame the teacher?"
"Teachers could split you up."
"Have careers lessons helped?"
"Yes, told if we don't work hard, we'll miss out on jobs."
"Should careers have come earlier?"
"Yes, in the Lower School (1st and 2nd Year.)"

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Nayan, 5th Year 'Average CSE'

Nayan had travelled widely, after leaving Uganda, and had been to school in Leeds, York and Derby.

"What do you hope to do?"

"To be a banker after the 6th form".

"How do you think you have been taught in Maths?"

"Several different ways: in Africa they were stricter."

"Was that better?"

"It helped a bit, but there wasn't that many people messing around."

"Has that been a problem for you?"

"Yes."

"When did you come to England?"

"I think I was about 10."

"Here it was much different, there it was quite easy."

"What would you change in School Maths?"

"Less pupils in a class; not vary it in different schools."

"What were Leeds and York Schools like?"

"In Leeds it was pretty easy."

"Was it strict enough?"

"No."

"People messing around?"

"Yes. In York, it was strict, but I found the work too difficult."

"Is the 'Apprentice Maths' Club a good idea?"

"Yes, it helps with ordinary maths."

continued...
"Have you borrowed the book?"

"Yes, I did the table of areas of metal and triangle work and percentages for banking."

"Is it helpful?"

"Yes, it is well written with plenty of examples."

"Have you read the explanations?"

"Yes, it's a lot easier than other books which don't explain it very well."

"Has English always been your first language?"

"My parents taught me some Indian and some African, but I learnt English from Nursery School."

"Have you found some books difficult?"

"Yes."

"Do you think Comprehensive Schools work well?"

"Yes, I think they do."
Summary

Several pupils were very critical of the teaching of mathematics in primary school, from the most able who thought too much time was wasted ("games 2½ days a week"), to the less able who thought they had been neglected while the clever pupils received the attention of the teacher.

Mixed ability groups were criticised by the higher ability pupils who felt the clever did not help the weak while the former were ridiculed for wanting to work. The more able pupils were happier to be in the graded ability sets in later years at school where "your friends egg you on to do better."

Low motivation and attainment, "mucking about" etc., were discussed, thought to be a general problem in all schools (games, visits, etc.) and were attributed to factors such as the home, negative pressure from peer groups in "rough areas," poor job prospects and "boring" work in mathematics. Strict but enthusiastic teachers were advocated.

Several pupils mentioned topics like sets and the cosine rule as having no apparent applications in their lives and, unlike some mathematics teachers, usefulness appeared to the pupils to be the justification for inclusion of a topic in the syllabus.

Frequent changes of teacher and methods were mentioned and also teaching by non-specialist teachers of mathematics, together with large classes (35 in primary school) giving freedom to "hide" and "go to sleep."

The general impression gained from this exercise was the overwhelming enthusiasm of pupils of all abilities to think hard and seriously about their experiences in mathematics and it is suggested that pupils might be consulted much more in matters of policy and syllabuses.
Chapter 7

USE OF 'APPRENTICE MATHS' IN SCHOOL: THE
'APPRENTICE MATHS' CLUB AND OTHER EVALUATIONS.

The school had approximately 1400 pupils and was situated on the South East of Derby. The school population ranged from 11 - 18 years and covered a wide social background, including a significant number of socially deprived pupils, many of whom originated from broken homes. These pupils put considerable pressure on the staff and a large pastoral care system was necessary.

Simultaneously academic subjects were taught to 'O' and 'A' level, as well as CSE, and examination results compared very well with schools in the same area.

Large manufacturing companies such as Rolls-Royce and British Rail attracted many craft apprentices (40 - 50 per year), and it was often a case of the boy following the father into a traditional form of employment.

The Maths department had 10 staff and the syllabuses were mainly traditional with emphasis on basic skills, both the Head of Department and Second having experience in engineering.

Each year group consisted of 12 forms, divided into two equal ability bands; the bands were then sub-divided into sets based on ability in mathematics. In the 4th and 5th year these covered the range from 'O' level to remedial.
The 'Apprentice Maths Club'

This was advertised by the letter sent to the whole of the 5th Year.

There was an immediate response with 35 - 40 pupils quickly volunteering to give up either lunchtimes or evenings. (Established examination courses meant that normal lesson time could not be used).

Individual convenience and the need for small groups for detailed observation meant that the pupils were divided into four groups of approximately 8.

The main reasons for attending the course were as follows:-

1. Interest from 'able' C.S.E. pupils in the maths applications required during apprenticeship.

2. 'Average' pupils wanting to improve their chances of obtaining an apprenticeship.

3. Very weak C.S.E. and non-examination pupils wanting to improve their basic mathematics.

A fourth and very important group was identified as follows:-

The shortage of mathematics teachers and an embargo on recruitment had resulted in some pupils being taught during the previous year by a succession of supply teachers, several of whom were not mathematics specialists.

These pupils, therefore, turned to the maths club as a direct response to the inadequate supply of competent maths teachers.

A fifth group consisted of seven fourth year pupils; these were mainly very weak in mathematics while being enthusiastic to improve. (One boy was struggling with Physics because of poor mathematics.)
The Headmaster

Derby
Telephone: Derby

Headmaster:

10th September 1979

Dear Parent,

We are planning to form a Mathematics Club of particular interest to those pupils who intend to apply for a Craft apprenticeship or similar employment.

The work will be based on a new text book "Apprentice Maths" produced by the University of Loughborough (CAMET, Department of Engineering Mathematics), after examining the needs of apprentices in many companies. The material will also help with revision for C.S.E. Mathematics, and includes samples of selection tests given by employers.

While we provide all text books necessary for the school curriculum, including G.C.E. and C.S.E. examinations, pupils who are keen to obtain Craft apprenticeships may wish to purchase their own copy of the new book for private study. This would give the students practice in the uses of Mathematics in industry in greater depth than is possible during the normal school timetable.

Self-assessment tests throughout the book enable students to discover their weaknesses which can be corrected at the next meeting of the Club.

Mr. Gatenby will be pleased to meet any parent wishing to discuss this work or to see a copy of the text book.

Pupils wishing to take part in the Club, which will probably meet at lunchtime, should see Mr. Gatenby in Room 28 or Room 20 as soon as possible, as numbers may need to be limited.

Yours sincerely,

Headmaster
Programme of Work

The datum for the work was the basic numeracy test given to the whole of the 5th year ability band. (Employers Specimen Test 1 in 'Apprentice Maths'.)

The initial aim was to correct the basic weaknesses revealed by the test; this was done by individual reading from 'Apprentice Maths' of those topics answered incorrectly on the test. It was decided that individual reading would lead to a true evaluation of the text alone and therefore formal teaching was avoided.

The pupils with no basic maths problems (probable C.S.E. grade 1) went immediately to the practical applications.

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<td>Actual Achieved</td>
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<tr>
<td><strong>'O' Level</strong></td>
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<tr>
<td>Tim H.</td>
<td>C 18</td>
<td>Poor basics</td>
<td>C.A. B.R.</td>
<td>D/E 3</td>
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<tr>
<td>Gary H.</td>
<td>C 42</td>
<td>Conscientious, lacks confidence</td>
<td>C.A. Cel.</td>
<td>C 1</td>
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<td><strong>Full CSE</strong></td>
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<tr>
<td>Bryan H.</td>
<td>B 49</td>
<td>Hard worker</td>
<td>C.A. ?</td>
<td>3 4</td>
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<tr>
<td>Colin</td>
<td>B 71</td>
<td>Able, determined</td>
<td>C.A. Elec.</td>
<td>1 1</td>
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<tr>
<td>Wayne</td>
<td>C 51</td>
<td>Quiet, steady</td>
<td>C.A. Build.</td>
<td>4 3</td>
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<tr>
<td>Kamaljit</td>
<td>C 50</td>
<td>Enthusiastic</td>
<td>2 C.A.s offered, R-R + B.R.</td>
<td>2 2</td>
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<tr>
<td>John H.</td>
<td>B 72</td>
<td>Able, interested</td>
<td>C.A. Elec.</td>
<td>1 1</td>
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<tr>
<td>Kenneth</td>
<td>C 56</td>
<td>Polite, reliable</td>
<td>C.A. R-R.</td>
<td>4 2</td>
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<tr>
<td>Steven H.</td>
<td>C 66</td>
<td>Able, too easy-going.</td>
<td>C.A. Chemical Eng.</td>
<td>3 2</td>
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<tr>
<td>Steven R.</td>
<td>C 63</td>
<td>Able, well-behaved</td>
<td>6th Form</td>
<td>2 1</td>
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<tr>
<td>Peter H.</td>
<td>B 52</td>
<td>Enthusiastic</td>
<td>C.A. R-R.</td>
<td>2 4</td>
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<tr>
<td>John D.</td>
<td>C 50</td>
<td>Quiet, sensible</td>
<td>6th Form</td>
<td>3 4</td>
<td></td>
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<tr>
<td>Lorna</td>
<td>A 61</td>
<td>Excellent attitude</td>
<td>6th Form</td>
<td>2 3</td>
<td></td>
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<tr>
<td>Dameon</td>
<td>C 44</td>
<td>Weak, tries hard</td>
<td>C. of F.E.</td>
<td>4 4</td>
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<tr>
<td>David W.</td>
<td>C 38</td>
<td>Quiet</td>
<td>C.A. R-R.</td>
<td>5 5</td>
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<td>Stephen C.</td>
<td>D 39</td>
<td>Poor attitude, under-achiever</td>
<td>C.A. B.R.</td>
<td>4 4</td>
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<tr>
<td>Nayan</td>
<td>C 45</td>
<td>Willing, but weak</td>
<td>6th Form</td>
<td>3 4</td>
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<tr>
<td>Roy</td>
<td>C 51</td>
<td>Quiet, popular</td>
<td>C.A. Foundry</td>
<td>3 3</td>
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<tr>
<td>Paul D.</td>
<td>C 49</td>
<td>Enthusiastic</td>
<td>C.A. R-R.</td>
<td>4 4</td>
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<tr>
<td>Gary B.</td>
<td>C 32</td>
<td>Tries hard, weak</td>
<td>C.A. B.R.</td>
<td>4 4</td>
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<tr>
<td>Andrew A.</td>
<td>B 43</td>
<td>Determined, hard-working.</td>
<td>6th Form</td>
<td>3 4</td>
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<tr>
<td>Peter R.</td>
<td>C 52</td>
<td>Poor attitude and attendance</td>
<td>C.A. B.R.</td>
<td>3 3</td>
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<tr>
<td>Stewart C.</td>
<td>D 29</td>
<td>Easily distracted</td>
<td>Auto-Spares</td>
<td>4/5 5</td>
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<tr>
<td>Shaun M.</td>
<td>D 37</td>
<td>Wastes time</td>
<td>C.A. International Combustion</td>
<td>4/5 5</td>
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</table>

C.A. = Craft Apprentice  B.R. = British Rail
R-R = Rolls-Royce  Cel. = Celanese
Elec. = Electronics  C. of F.E. = College of Further Education

cont'd ..
### Limited Grade CSE

<table>
<thead>
<tr>
<th>Pupil</th>
<th>Grade</th>
<th>%</th>
<th>Comment</th>
<th>Job obtained</th>
<th>CSE</th>
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<tbody>
<tr>
<td>Carl R.</td>
<td>B</td>
<td>44</td>
<td>Reliable, co-operative</td>
<td>C.A. Foundry</td>
<td>4/5</td>
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<tr>
<td>Graham P.</td>
<td>C</td>
<td>30</td>
<td>Pleasant, willing but distracted easily</td>
<td>C.A. Building</td>
<td>4/5</td>
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<tr>
<td>Richard E.</td>
<td>C</td>
<td>Abs</td>
<td>Reliable but weak</td>
<td>Butcher</td>
<td>4/5</td>
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<tr>
<td>David T.</td>
<td>B</td>
<td>35</td>
<td>Easily distracted</td>
<td>C.A. Building</td>
<td>4/5</td>
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<tr>
<td>Gary G.</td>
<td>B</td>
<td>46</td>
<td>Sensible, tries hard</td>
<td>C.A. Electrical</td>
<td>4/5</td>
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<tr>
<td>Andrew</td>
<td>B</td>
<td>41</td>
<td>Domestic problems, willing and well-behaved</td>
<td>C.A. B.R.</td>
<td>4/5</td>
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<tr>
<td>Genevieve</td>
<td>C</td>
<td>29</td>
<td>Weak at basics</td>
<td>C. of F.E.</td>
<td>4/5</td>
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<tr>
<td>Steven I.</td>
<td>C</td>
<td>44</td>
<td>Lacked maturity, poor concentration</td>
<td>C.A. B.R.</td>
<td>4/5</td>
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<tr>
<td>Non-Examination</td>
<td>D</td>
<td>66</td>
<td>Weak, wastes time</td>
<td>6th Form N.Ex.</td>
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</table>

**Key**

- C.A. = Craft Apprentice
- B.R. = British Rail
- R-R = Rolls-Royce
- C. of F.E. = College of Further Education

\*E = Effort \ M = Mock \ F/C = Forecast \ A = Actual

**Limited Grade Pupils**

The Limited Grade CSE pupils could, in theory, only obtain grades 3, 4 and 5 CSE: in previous years they would have certainly been non-examination but were following this course in an attempt to improve motivation.

Several changes of teacher meant forecast grade was only a statement of possible pass grades.
Some of the Pupils who Attended the Maths Club

Colin

Had few basic maths problems. He hoped to become an electrical apprentice - his brother had been successful on a similar course. He was a good CSE candidate and regularly did two homeworks per week. Colin was co-operative, well-behaved and went to great lengths to obtain 'Apprentice Maths'. Careers visits made him dislike large firms and fear the competition for the few available electrical apprenticeships.

Colin attended the Maths Club regularly; he had considerable difficulty in obtaining an apprenticeship.

Kenneth

Very talkative and argumentative in maths lessons when not understanding work. Erratic in homework - average/weak CSE. Blamed his weakness in basic maths on frequent moving of schools, insufficient practice.

Kenneth's father was in engineering and encouraged him in his fanatical interest in motor-cycles. Kenneth's school work suffered because of his garage job in the evenings.

Kenneth attended the maths club enthusiastically and bought the book 'Apprentice Maths.'

Kenneth obtained an apprenticeship at Rolls-Royce as an engine fitter.
Graham

One of a very poor, low ability and badly behaved group. He genuinely wanted to work in difficult circumstances; during the first term in the 5th year he had three different teachers for maths, including a biology teacher on supply. Graham wanted to enter the building trade as a craft apprentice; his father was a self-employed builder but wanted his son to start off with another firm.

Graham's father liked 'Apprentice Maths' and helped Graham with it at night.

Graham was unlikely to have done any maths homework in the 4th or 5th year - unfortunately he was influenced by the badly behaved pupils around him. His attendance at the Maths Club was erratic.

Typical question: "Do you take the top number from the bottom, or bottom from the top?"

Had great difficulty in obtaining interviews for craft apprenticeships.

Michael - Non-examination maths

Very ambitious considering his low ability. Initially aspired to be a pilot, (father on ground staff at airport) but modified this to be technician and finally failed to obtain a craft apprenticeship in aviation.

Michael blamed his poor maths on 'playing around' at a village primary school (claiming that less-able were ignored.)

Poor concentration in maths lessons, preferred to 'clown'. No homework done in 4th and 5th years in maths. Attended link course in plumbing at Technical College.

Decided to stay on at school after failing to get an apprenticeship.
**Carl**

Weak CSE but has been moved up from a lower group where he had shown exceptional application to work against difficult circumstances in the bottom set.

Carl was motivated by an ambition to join the Navy, but was unsuccessful and changed his ambition to printing.

Carl did about one homework per week in the 5th year. He had great difficulty in obtaining employment.

**Lorna**

Extremely hardworking and conscientious. Above average CSE candidate through effort, not ability.

Two homeworks per week regularly done.

Intended to join the army and used 'Apprentice Maths' to revise for CSE - relied very heavily on the book in preference to others.

**Bryan**

Intended to become a diesel mechanic; very quiet and hardworking - a steady 'plodder'. Average CSE candidate.

Regularly and conscientiously did two homeworks per week throughout 4th and 5th year. Went on works visit to engineering works; surprised at noise, smell and poor behaviour of some employees.

Bryan attended the maths club regularly and borrowed 'Apprentice Maths' frequently.

He had considerable difficulty in obtaining employment.
Nayan

Left Uganda in 1972; very conscientious but weak on arithmetic, not helped by frequent changes of school.

Nayan hoped to enter banking work, but this was optimistic as he was a weak CSE candidate.

Two homeworks per week conscientiously attempted with difficulty.

Nayan regularly borrowed 'Apprentice Maths' to revise for his CSE mathematics.

Decided to stay on to improve his qualifications.

Peter R.

'Average' CSE. Initially an 'O' level candidate but relegated because of his attitude and behaviour. He forgot books, distracted other pupils and was a frequent minor nuisance. He appeared in court during his 4th year for theft.

His homework was erratic and did not reflect his ability.

Surprisingly he very quickly obtained a craft apprenticeship with the large firm at which his father was employed.

Steven C.

Very untidy pupil; frequently forgot books; homework poorly attempted. Showed apathy on works visits. Poor concentration in lessons. Unreliable attendance at Maths Club. An underachiever.

He obtained an apprenticeship at the firm where his father was employed.
Gary H.

An 'O' level candidate; intended to become a technician. Very quiet, extremely conscientious but suffered serious illness in year 5.

Gary made several works visits in year 5 and showed keeness for engineering. He attended the maths club regularly for four weeks but eventually thought it was 'too easy'. Two homeworks per week regularly done.

Gary subsequently accepted a craft apprenticeship.

Steven I.

Steven was not a regular attender at the Club, but came once to borrow 'Apprentice Maths' to revise for an interview.

Poor attitude in lessons, relegated to a lower group.

Obtained an apprenticeship at the large firm employing his father.

Wayne - Average/weak CSE maths

Quiet, easy going, regularly forgot books, poor homework and easily distracted.

Intended to become a plumber but capable of aiming higher with more determination. Influenced by his uncle who had his own successful plumbing business.

Attended Maths Club well and worked from 'Apprentice Maths' at home.

Obtained a craft apprenticeship at a large building firm.
Some Comments from those attending Maths Club

Carl (Maths Set 4) wanted to practise fractions for a forthcoming job interview, as did Shaun (set 3). Shaun claimed to have done fractions lots of times, but had 'just forgotten them'.

Simon (4th Year Set 1), although doing 'O' level, considered he needed more time on arithmetic with frequent 'refresher courses.'

Paul and Peter (weak CSE/Non-exam. 4th Year,) thought they covered too many topics and wanted more time on 'useful topics'. They would have liked the 4th and 5th Year to be spent on Maths needed for a job.

Genevieve wanted help with the steps in long division, even with practice from 'Apprentice Maths' she couldn't remember the sequence.

Colin and Steven R. (CSE Set 2), asked to borrow 'Apprentice Maths' for revision for CSE 'Lock' exams. They worked from the section on circles.

Colin, Steven R. and Wayne said they would have liked a CSE course based exclusively on 'Apprentice Maths' and Wayne said he wished he had started on the book in Year 3.

Lorna had kept a copy of 'Apprentice Maths' for nearly two weeks and asked for permission to borrow over the Christmas holiday. Lorna had worked through the Algebra, using the self-assessment tests.

Lorna enjoyed Practise Exercise 7 and did the Practical Applications Exercise 3 up to number 7.
Observations from Lunch-time Meetings
of 'Apprentice Maths' Club

Number in brackets represents pupils' score on initial test (max. 26).

WEEK 1

Attendance 19. There was no meeting for the Monday lunchtime and evening groups because of other school activities.

Sample Observations

Kenneth (16) decided to work systematically through the exercises on decimals. He described the text as 'self-explanatory, straight to the point' and 'not confusing' like other books. He liked the 'common English' with no 'big words'. Kenneth later recorded his opinions on cassette.

Bryan (20) was unable to do 48 + 0.4 but by reading the text understood and practised similar examples correctly. Bryan liked the meaning of the mathematical words given in brackets, said the book was easy to read and found the examples in the exercises 'good.'

Bryan hoped to become a diesel mechanic.

Steven (24) hadn't known what 'find the sum of' meant, but was otherwise sound on basic arithmetic. Steven went straight on to the practical applications of decimals and fractions (cutting on a lathe) and found the work interesting, coping without assistance. Steven hoped to become a draughtsman.
Gary B (13) was able to read and correct his weakness with the decimal point in multiplication.

Gary H ('0' level 26) Gary had no problems with basic arithmetic so was told to choose some work which interested him. He worked through the questions on gears (ratio), which he did correctly and found interesting.

Gary hoped to become a Technician Apprentice. (Eventually accepted a craft apprenticeship.)

Kamaljit (20) couldn't do \( \frac{3}{10} - \frac{7}{5} \). Read the book and understood the correct method.

Lorna (19) corrected her weaknesses on the four operations with fractions (which only needed revision) and went on to the chapter on estimation.

Lorna hoped to join the army and saw the work as useful revision for GSE. She coped with nos. 1 - 5 on the self-assessment test but could not do 6 - 10 so worked through the text.

Nayan (13) learnt to cope with 48 ÷ 0.4 on his own, but would have preferred \( \frac{27.95}{1.3} \) to also be written as 27.95 ÷ 1.3 as he was initially confused. (This was also requested by lecturer at Skill Centre.)

Nayan liked the explanation of maths terms and used the word 'divisor' happily - it was very unusual for these pupils to use maths jargon freely.

Mark (an exceptionally hard-working '0' level pupil)
Used Apprentice Maths to supplement his '0' level exercises on logarithms. Found Exercise 11 fairly easy but worth doing, although struggled with \( \left( \frac{1}{0.00765} \right)^2 \).
The 5th year Wednesday and Friday groups attended for the second time and continued without supervision. There was no formal teaching and the pupils were loathe to finish at the end of the lunch hour. Colin had made two fruitless journeys to the bookshop to obtain his own copy of 'Apprentice Maths.'
WEEK 3 - Attendance 26

Graham - very weak CSE/N. Ex intending to enter the building trade; couldn't cope with the sequence of steps in long division. Practised the examples given in the text but also found the idea of a table of 'guesses' useful.

\[
\begin{array}{c|c|c}
& \text{Quotient} & \text{divisor} \\
\hline
3 & 51 & 6 \\
& 102 & \\
\end{array}
\]

e.g. 

Carl - very weak CSE/N. Ex hoping to obtain an apprenticeship in the Merchant Navy. Wanted help with fractions. Thought the method of drawing boxes useful.

David - weak CSE couldn't see how to do \( \frac{1}{3} \times 5 \), but read the correct method himself from 'Apprentice Maths.'

The able 5th year boys Steven and Colin continued to work with interest through the practical applications including dimensions from drawings using decimals and fractions.

Bryan wanted some work appropriate to a diesel mechanic and was given the section on gears to do.

The general interest and motivation after three weeks was high and the pupils were continuing to work steadily on their own.

Eight pupils asked for copies of the text 'Apprentice Maths' to use for the long weekend.
WEEK 4 - Attendance 18

4th year boys in the evening: Paul and David wanted help with $\frac{1}{3} - \frac{1}{4}$ and it was necessary to show the diagrams in 'Apprentice Maths'. The boys worked through Exercise 7.

Simon (0/CSE) wanted more practice on trigonometry; liked the idea of completing a table of trig. ratios given one fact (p. 232.)

Paul and David borrowed copies of the book.

Nayan (13) was hopeful of employment in banking (though unrealistic) and having worked through basic faults was advised to attempt the percentages.

Nayan was unable to start the self-assessment test (page 429) so worked through the text and practice exercises.

David (18) felt he needed to practice decimal fractions e.g. $1 \frac{1}{100} = 1.01$.

Lorna (19) using the book to revise for CSE worked through the chapter on algebra; coped with most of self-assessment tests 2 and 3; was stretched on the last questions on test 3 and worked through the text.

Andrew (18) continued the exercise on cutting lengths from a bar (addition and division of fractions).

Peter (18) practised multiplication and division of fractions and read and understood problems with mixed numbers.

Lorna and Nayan asked to borrow the books for work at home.
A batch of 15 copies of 'Apprentice Maths' arrived on a sale or return basis.

Without pressure most of these were ordered by 10 pupils who had now been using the book for four weeks and were therefore thoroughly familiar with it. It was made clear that copies would always be available for loan from school, but the boys wanted a personal copy, particularly for reference later, in employment. Other boys said they would probably buy a copy when Christmas was over.

The metalwork/engineering science teachers had examined the text and bought a copy for reference in the workshop.

The engineering science teacher was preparing lessons around the text book and was enthusiastic about its value.

Special Unit

The teacher in charge of this withdrawal unit was firmly convinced of the value of the work and bought two copies of the text.

This was considered valuable, as the special unit, which contained pupils unable to cope with the normal classroom situation, would allow pupils to work steadily through the text during school time. These pupils were not necessarily disruptive; they included pupils who were shy and lacking in confidence and possibly with severe domestic problems.

The work was very informal due to the small numbers and varying ages and abilities; the pupils using the book would therefore be working voluntarily without any pressure or persuasion. Their background in school was likely to have included frequent absence and unhappy experience in lessons. The text would therefore be serving a remedial function to compensate for an unstable background.
'Apprentice Maths' Club – Week 5

During his normal lessons, Andrew, a remedial pupil, could not convert mixed numbers to fractions; he needed some help to draw the boxes as shown in 'Apprentice Maths,' initially drawing $2\frac{1}{3}$ as $1\frac{1}{5}$, but eventually learnt and understood the technique as a result of drawing.

By showing Andrew the 3 examples given, e.g.

$$4\frac{2}{5} = (4 \times 5) + 2 = \frac{22}{5}$$

Andrew was able to understand the method and practised Exercise 3 with the intermediate step

$$1\frac{4}{5} = (\_ \times \_ ) + \_$$

Andrew liked this explanation and was able, for the first time, to do the examples (and understand).

He produced an excellent piece of work, by his standards and asked for 'Apprentice Maths' in several subsequent lessons to continue the work.

The 'concrete' approach of drawing boxes, combined with the intermediate steps in the calculation, had enabled this remedial boy to cope with hitherto impossible work.
Week 5 - continued

Steven said he would like 'Apprentice Maths' as an optional extra subject on the time-table replacing, say, games.

Colin and Dameon thought it might be better to incorporate the work into the main syllabus, and leave out, specifically, sets and Venn diagrams, which they felt they would never use.

When pointed out to the boys that, perhaps, Maths should be interesting for its own sake, Steven and Dameon said 'maths should be useful.'

Carl asked in future for two lunch-time sessions instead of one.

David, Nayan, Andrew, Lorna, Bryan, John and Peter all borrowed copies of 'Apprentice Maths' to revise from over Christmas.

In addition, Kenneth, Dameon, Graham, Gary and Colin bought their own copies and would be revising from them.

Interview with a typical potential Apprentice Andrew S.

The opportunity arose to talk, confidentially to Andrew about his views on school and maths teaching in particular.

Andrew was in 5G4 (limited Grade CSE, Grade 4 best obtainable.)

Hobbies: tenor horn in orchestra (as was father) repairing, cleaning bicycle.

Trade sought: Sheetmetal/coppersmith, stimulated by school metalwork.

First Interview: Thought it was easy going. Too many maths questions.
Andrew felt that he had been well-prepared at school and covered the right things, but needed more time on Maths and English and less on 'Quest' and 'Careers.'

He had always finished his Maths homework in class and had done none at home in the last year.

Andrew said he had been distracted at Primary School, with a lot of 'messing around.'

Various pressures within the school meant that there was little opportunity for regular formal meetings of the Club after Christmas. External/internal examinations, interviews, report writing by staff, etc., suggested that for the future, the Club would be most effective if started at the very beginning of the Autumn term and probably concentrating on 4th year pupils.

Further evaluation of the text book took place whenever the opportunity arose in the normal time-table and when individual pupils came for extra tuition on a casual basis after school and at lunch times.

The pupils continued to borrow the books or use their own copies.
Use of 'Apprentice Maths' during Normal Lessons

As part of their normal syllabus, a 3rd year Maths set containing future GCE and CSE pupils, were tackling volumes.

The need to appreciate prisms as a family of solids of uniform cross-section is a major concept and was inadequately covered by the existing school text-books.

The latter simply gave the definition

\[ V = (\text{area of cross-section}) \times \text{length} \]

and there were no diagrams.

This was inadequate for all but the most able pupils and in the past it had been necessary to make up examples showing the different types of prism.

'Apprentice Maths' provided an excellent introduction and explanation, and practice exercise No. 2 was suitable for determining whether the pupils could identify a prism. The thoroughness of the explanation was superior to any of the school's normal texts, and the children appeared to grasp the work quickly.

The substantial quantity and variety of cross-sections in practice exercise No. 3 were at exactly the right level for this class, with easy examples for the weaker pupils and quite difficult ones for the faster pupils.
Response

It was obvious that the children enjoyed this work; what appeared to interest them was the problem of recognising a cross-section as a combination of several shapes. This work occupied the class for one week and they were given three questions for homework. (Samples of homework are shown in the appendices.)

These questions were particularly relevant, the volume of metal in a pipe, and the swimming pool being very frequent 'O' level and CSE questions.

The question on the pipe was quite well done, the main problems being in the arithmetic for $\pi (R^2 - r^2) \times l$.

The three examples also illustrate the range of ability within one maths group which was a top set out of 5, but which had several pupils who would eventually only manage a poor CSE grade.

The question on the hexagon was only attempted by a few pupils, but exercised the minds of the abler pupils; some divided the hexagon into 6 triangles, while others treated the cross-section as two identical trapezia.

The most able 3rd year pupils were interested by finding the volume of this prism. (Page 206)

The children were asked to explain their enthusiasm for this particular work.
Several of the boys agreed with the ablest, Robert, who said it was a 'challenge', since each shape was different and several different area formula needed to be selected.

This was an instance of applying skills in unfamiliar situations, so frequently advocated by HMI.

The work appealed to most of the 60 pupils who attempted it, not just boys interested in engineering work.
Before attempting compound interest as part of their 3rd year syllabus, a group of future 'O' level and CSE pupils needed to revise percentages.

Self-Assessment Tests

The self-assessment test, p. 149, was given to the whole class. Virtually all coped with q. 1 - 5 (fractions to %) and q. 6 - 10 (decimals to %), but only 2 could do q. 11 - 15 ( % to fractions) and only 9 were able to do q. 16 - 20 ( % to decimals.)

This gave a clear indication of the weaknesses of the class and therefore they were given (after the explanation p. 151) exercise no. 3, page 151, which they were able to cope with well.

Two or three of the more able pupils quickly progressed to the practical applications exercise on page 154. Paul preferred this because 'you have to work out which method to use.'

Exercise 3, p. 151, was successfully completed by all of the class in approx. 30 minutes and after a short explanation as on page 151. Practice exercise 4 was given for homework.

Some pupils had difficulty changing $13\frac{1}{2}$ % to 13.125 while others, like Alan, wrote it straight down. Robert, Paul and Alan did practical applications.

It was apparent that the work was at a suitable level for the majority of the group, and the practical applications provided an extra challenge for the more able pupils who would have been bored or held back by the majority of the pupils who needed to practise the exercises.
Response to Homework

Practice Exercise 4 was completed successfully by over 90% of the class, with the exception of 3 pupils still having trouble with steps like changing $\frac{1}{8}$ to .125. Most pupils got all 15 questions right and claimed to have found the level correct.

The three more-able boys who did the practical applications as far as question 8 were also successful and said they preferred this type of work because:

- It is harder than normal exercises.
- You must find the correct approach.
- The questions add a "new dimension."

Use of 'Apprentice Maths' with a 4th Year CSE Group

This was a particularly restless group, who were having difficulty with standard form. The explanation on p. 67 was given and practice exercises 7 - 9 were done.

These were far more comprehensive than the few examples in the usual CSE text and occupied this difficult class well for a double lesson. The level and grading of the examples were exactly right, taking as a criterion the way the class worked continually without becoming restless, bored or giving up in frustration.
EVALUATION OF 'APPRENTICE MATHS'

A Student Working by Private Study at Home
(Not from the main school in the evaluation)

This girl has always found difficulty with Mathematics while being of O level standard in several other subjects including English. In her fifth year at a comprehensive school, she attempted a C.S.E. basic mathematics test. While questions involving verbal skill were answered well (such as interpreting a graph), the following were answered incorrectly:

1. $13578 + 2$
   Covered in 'Apprentice Maths'
   Pages 46 and 47

2. $3995 + 17$
   Pages 46 and 47

3. $1\frac{1}{3} \times 3\frac{2}{3}$
   Pages 1 - 3, 5, 11

4. $1\frac{2}{3} + 2\frac{3}{4}$
   Pages 9 and 10

5. $100 - 28.73$
   Pages 26, 27, 37, 38 but not 099.91

6. $28.73 \times 100$
   Pages 29, 30

7. $28.73 \div 100$
   Pages 29, 30

8. $5.2 \times 8.6$
   Page 41

9. $47 + 4.7 + 0.47 + 0.047$
   Page 37

10. $\frac{0.8 \times 7 \times 1.5}{2.1 \times 4}$
    Page 48

11. Convert $\frac{2}{5}$, $\frac{3}{7}$ and $\frac{5}{12}$ to decimals.
    Pages 30, 31.
Attendance at 'Apprentice Maths' club

The normal weekly attendance appeared to be around 25. This was regarded as exceptionally good by members of the school staff and there had been no similar success with 5th Year pupils in recent years. There were competing attractions at lunch-times, such as discos and inter-form sport. (Fifth form absence averaged 20% throughout the year and approximately 70% went out of school for lunch.)

Some examples of reasons for non-attendance at Maths Club:

- Paul, Stephen, Andrew: job interviews.
- Roy: appendicitis but asked for 'Apprentice Maths' to work through at home.
- Gary H: the first drop-out: thought the work was 'a bit easy, but could I borrow the book to read at home.'
- Stephen H: regular absence from school with parental support.
- Genevieve: 'Forgot, but will definitely come next week.'
- Simon: 'Had to get my hair cut.'

Summary

The Club could be regarded as a success having repeatedly motivated pupils to give up their lunch times (including bringing sandwiches especially.)

As no teaching was given, the sole motivation was the text book 'Apprentice Maths.'

This was borne out by the large number of loans (at least 20) and individual purchases of the book (10+), especially considering the proximity to Christmas.
The book had then been used by pupils from 'O' level to remedial; there was some evidence that parts of the text were too easy for 'O' level pupils, but there was considerable evidence to show that very good CSE pupils were challenged and interested by the practical applications.

Average and weak CSE pupils had been able to read and understand previously troublesome work and appreciated the straight-forward language.

The level of examples was such that the pupils worked happily on their own, but without boredom.

Pupils (such as Lorna) with no interest in Engineering, were able to find a large amount of suitable material for revision for CSE which stretched them.

The basic mathematical difficulties, especially division of decimals, and multiplication and division of fractions, were covered in such a way as to allow almost all pupils to correct their difficulties without assistance.

The only instance of inadequate coverage was with a very weak pupil who could not follow the routine of long division. Flow charting provides a possible teaching aid.

In the test school, the main CSE 5th Year classes (which included members of the club were covering the compulsory 'modern' mathematics topics (sets, inequalities, transformations, translations.)

When asked to compare this type of work with 'traditional topics', the class overwhelmingly favoured the traditional topics. They asked 'what is the point?' of the modern maths topics.
Chapter 8

TRIALS WITH PUPILS OF ALL ABILITIES USING
PRACTICAL APPLICATION QUESTIONS FROM
'APPRENTICE MATHS'

A set of examples was given to the pupils to undertake
on a voluntary basis; the examples chosen were all from
'Apprentice Maths' and were selected for the following
reasons:-

a. They were representative of those seen
during visits to local industry.

b. They contained explicit diagrams which
illustrated their engineering content, in
contrast to the normal work of a more
abstract nature generally found in the
school text books.

Approximately twenty boys and girls undertook the work in
their spare time, over the half-term preceding Christmas
1980, with the exception of three boys who were able to
use normal lesson time. For the majority, the close
proximity of internal and external examinations meant that
lesson-time must be spent on the school syllabuses.

The pupils represented the whole range of ability and all
had practised the operations needed in the examples during
their previous years at school.

The pupils were taught in various maths sets based on
ability, but all had the same maths teacher.
Objectives

• To obtain the pupils' response to practical applications, compared with their normal, more abstract, mathematics.

• To compare the performances of pupils of various abilities ('0', CSE, Non-Exam) while attempting the same questions.

• As these examples were of the level required by firms visited locally, to determine the calibre of pupil able to cope with this work.

• To compare the standard of those pupils able to do this work with those pupils studied in the previous year, for whom records existed of examination and numeracy test results, and the apprenticeships which they obtained.

Limitations of the Investigation

This work could not be regarded as a controlled experiment in motivation, for some willingness was required to take the work home. (It was explained to the pupils at the beginning that the work was voluntary and should not be allowed to interfere with normal homework.)

However, it was hoped that these pupils would be able to give valid opinions in their comparison of this work with their more usual work.

A further indication would be the amount of work completed over a sustained period, especially as the sample included a few pupils who were unreliable in their normal homework.
**EXAMINATION GRADING SYSTEM**

**EQUIVALENCES OF GCE 'O' LEVEL AND CSE**

<table>
<thead>
<tr>
<th>GCE O</th>
<th>CSE</th>
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</thead>
<tbody>
<tr>
<td>former (A)</td>
<td>equivalent to</td>
</tr>
<tr>
<td>pass (B)</td>
<td>grade C or better</td>
</tr>
<tr>
<td>level (C)</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>unclassified U</td>
<td>4 average standard at 16</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>U unclassified</td>
</tr>
</tbody>
</table>

'0' level is designed for top 20% in each subject.

'0' level and CSE together are aimed at top 60% range of ability in each subject.

Average commitment, six or seven subjects.

90% of all 16 year olds enter at least one CSE or O level.

> 75% of all 16 year olds obtain at least one graded result.

**SOURCE:** "EXAMS BRIEF" ( ) A SCHOOL EXAMINATIONS GUIDE FOR EMPLOYERS - SCHOOLS COUNCIL/UBI.
Categories of Pupil

Good 'O' Level

Two boys who were expected to obtain grade A - enthusiastic, well-behaved, two homeworks completed every week, usually all correct. Attendance of class around 95%. Neither boy had any interest in engineering as a career.

Weak 'O' Level

This boy seemed bright verbally, but made many mistakes with basic concepts; probably placed in this group because of ability in other subjects.

Rejected the advice to enter for both GCE and CSE examinations, wanting 'O' level or nothing - peer group pressure?

CSE Pupils

These formed the majority of the pupils in the trials and are the main source of craft apprentices. A few might 'double enter' for GCE and CSE, but most were capable of CSE grades 1 - 3.

Class attendance usually around 90%. Generally reliable, hardworking and conscientious over homework, except for a few exceptions who had good ability but low motivation.

(One boy from a similar class came top in the recruitment tests of a large Derby firm in 1980)

Limited Grade CSE/Non- Examination - The Domain of those with Poor 'Numeracy'

These pupils were in the lower half of the school ability range; they were offered the chance to sit the Syllabus 2 examination (best possible grade obtainable was 4; some pupils did not wish to take any CSE examinations).
A typical group would contain some regular truants (attendance of class sometimes below 50%), children in care and some with criminal records. Occasionally there would be an unmarried mother.

Continuity of learning following a sequential syllabus was very difficult; (one boy was frequently absent if his father was suffering from epilepsy), others only attended after a visit from the Educational Welfare Officer. A 'disruptive' transferred from Leicestershire was subsequently removed from this new school.

Within such a group there were still willing and conscientious pupils; three of these attempted the examples from 'Apprentice Maths'.

These boys had suffered in their third year when their Maths teacher left to start a family during the year and a replacement was not available.

In the fourth year their maths teacher was ill and they were taught for most of the year by non-specialist supply teachers.

At the beginning of year 5, they were therefore dispirited and lacking in motivation, although still well-behaved and regular attenders.

William, whose parents were West Indian, and Kam Tong Fong (Chinese), were co-operative but had obviously lost the enthusiasm which had been noted in earlier years' school reports.

Neither had a clear idea of a career, and initially they would try to read magazines rather than attempt the 'boring' classwork.
Philip was an extremely keen all-round sportsman and initially intended to enter the Navy. He took part in the 'Duke of Edinburgh's' award scheme. Philip was obviously fluent in conversation and was able to describe in great detail his caving and camping trips.

Against this very positive background, Philip was extremely weak in basic mathematics, e.g.

\[ 1 \times 1 \times 1 = 3 \]

20004 means "Two hundred million and four"

\[ 4 \times 4 \times 4 = 52 \]

1, 8, 27, 64, -- ("No idea")

9 x 8 was computed by adding nine 8's which had been tabulated.

(Philip was subsequently rejected for a career as a chef in the Navy; "You're just the sort we are looking for but your maths aren't up to it". Philip later passed the maths test for the Army).

Each year a few boys from the Limited Grade/Non-Examination classes were accepted for craft apprenticeships in the less sophisticated trades, e.g. heavy engineering, joinery, but such boys had no hope of entering precision engineering, electronics, tool-making, instrument making, etc.

However, these would certainly be the pupils most likely to cause employers to accuse schools of 'falling standards.'
Comparison of Attendances at Maths Lessons for GCE Maths Set 1 and Limited Grade CSE/Non-Examination Set 7

1st September - 5th December 1980

Key

• GCE (Set 1) Tuesday and Wednesday

△ L.G./Non-exam (Set 7) Monday and Friday

N.B. Sets 1 - 10 in Year 5 according to ability in maths
Question A

Cutting Speed on a Lathe (Page 117 in 'Apprentice Maths').

(Substitution in a given formula)

Given \( N = \frac{1000s}{\pi D} \), find \( N \) for given values of \( S, D \) and \( \pi \).

'O' Level pupils

The two very good 'O' level pupils had no trouble with this problem, using logarithms for the division.

The third weaker 'O' level boy cancelled \( \frac{1000 \times 50}{54 \times 3.142} \), unlike the other boys who saw that it was easier to treat \( 1000 \times 50 \) as 50,000. The weaker boy was also happy to write \( 500 \times 50 = 2500 \) and obtain the wrong final answer.
CSE Pupils

Chris, a very keen 'O'/CSE pupil (probable double entry) performed the substitutions correctly, but failed on 50000 by long division as follows:

\[
\begin{array}{c}
169.668 \\
\hline
0.003933
\end{array}
\]

\[
169.668 \div 5000.
\]

Andrew, an 'average' CSE pupil, wrote \( \frac{1000 \times 50}{3.142 \times 54} \) but could go no farther.

Linda, used a calculator and obtained the correct answers.

Brian used logarithms and obtained incorrect answers because of incorrect characteristics.

----------
Question A (continued)

Limited Grade CSR pupils

William and Fong were unable to understand the question. Every step had to be explained to them; even though they had spent time on logarithms in previous years, nothing had been retained. William did long multiplication for 40,000 x 40 and obtained 40,000 as follows:

```
  40,000
x 40
-----
  00,000
  40,000
  40,000
```

Place value, etc.

Fong and William were asked to multiply 1000 x 50 and made several guesses, including 5,000 and 5 million.

(In a later exercise, Philip wrote 20004 as 'Two hundred million and four').

It should be stressed that all three boys were well-behaved, regular attenders at school and were by no means at the bottom of the ability range (being in set 7 out of 10).
Question B

Convert dimensions in inches to mm. p.45 in 'Apprentice Maths'

It was given that 1" = 25.40 mm, and the diagram was to be redrawn with 8 dimensions e.g. 13.375" converted to mm. and corrected to 3 decimal places.

'O' Level

The two very able boys had no trouble with this. Both used long multiplication.

Simon, a weaker boy, had some trouble, having several attempts at 13.375 x 25.40 as follows:-

<table>
<thead>
<tr>
<th>13 .375</th>
<th>25 .400</th>
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<tbody>
<tr>
<td>00 000</td>
<td>127 000</td>
</tr>
<tr>
<td>000 000</td>
<td>1778 000</td>
</tr>
<tr>
<td>450 000</td>
<td>00</td>
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</tbody>
</table>

Simon then drew a grid of vertical columns to help, but still had not seen that the 0's in 25.400 were superfluous (including the extra one he had added). Eventually Simon was able to do the conversion but continued to write the superfluous rows 0000 in the long multiplication.
CSE Pupils

Chris was able to start this question but made two mistakes due to incorrect placing of the decimal point and his final diagram contained the obvious inconsistencies shown below.

Failure to recognise ridiculous answers (place value).

Calculators

Andrew used a calculator and obtained the correct answers - it is probable that he would not have done so well by long multiplication.

Linda also obtained the correct answers with a calculator when experience would suggest that she would have made mistakes in long multiplication.
Limited Grade CSE

William, Fong and Philip, although given that 1" = 25.40 mm, were unable to start the question.

However, once told that they must multiply, their multiplication was quite accurate. (They did need to be reminded about the placing of the decimal point.)

(The fact that these boys had been taught by several non-specialist teachers in the previous year meant that they had probably spent many hours practising basic arithmetic rather than following a more comprehensive syllabus)
Question C

Choosing a bar for machining a certain diameter (convert fractions to decimals, compare relative sizes p. 34, 'Apprentice Maths').

A man is asked to produce a bar of 0.610" dia. In the metal store, the materials available are:

\[ \frac{1}{8} \text{" dia., } \frac{9}{16} \text{" dia., } \frac{5}{8} \text{" dia., } \frac{11}{16} \text{" dia., } \frac{3}{4} \text{" dia.} \]

Which bar will he choose if he is to waste the least amount of material when machining diameter D?

How far will the cutting tool have to be wound (or fed in) to produce the required size? i.e. what is distance x? (D is the diameter of the bar chosen).

'O' Level Pupils

Mark and Richard had no problem with this question and were able to see that the tool only moves 0.0075 in order to remove 0.015 from the diameter. (This confused all of the other pupils, even though several had used a lathe).

Simon had some trouble with converting \( \frac{11}{16} \) to a decimal and incorrectly said that the tool had to move 0.015 and not 0.0075.
CSE Pupils

Andrew correctly converted the fractions to a decimal, using his calculator and chose the right bar. However, Andrew failed to halve the amount of metal to be removed from the diameter.

Linda's solution and mistake was identical to Andrew's, but she also wrote

\[ \frac{9}{16} = 1.77 \quad \text{(Divided 'top' into 'bottom')}. \]

and

\[ D - 0.610 = 0.625 = 0.15 \]

instead of

\[ D - 0.610 = 0.625 - 0.610 = 0.015 \]

again illustrating disregard for the decimal point.

Tim, Jill and Chris had no difficulty with the selection of the correct bar, but failed to calculate the amount to move the lathe tool.
Limited Grade CSE

Philip was unable to understand the question. He needed to be shown how to change fractions to decimals, couldn't do long division and struggled with $\frac{9}{16}$ and $\frac{11}{16}$ by short division.

Philip was able to compare the decimals and decide that $0.625$ was the most suitable and obtained $0.625 - 0.610 = 0.015$" as the amount of metal to be removed. He did not realise that the tool had only to be fed in $0.0075$, even after explanation.

Fong and William both needed explanations to convert the fractions to decimals. Both were able to do the short division but Fong struggled with

$$\begin{array}{c}
16 \left\lfloor 0.5 \\
9.05
\end{array} \quad \text{Fong carried 1 not 10.}
$$

PLACE VALUE

Neither of these boys could compare the sizes to choose the nearest size above $0.610$. Fong thought $0.75$ was smaller than $0.625$, but changed his mind when $0.75$ was written as $0.750$.

Neither boy could see that to find how much metal was to be removed, then $0.610$ must be subtracted from $0.625$.

At this stage the boys said this example was a 'bit too hard' for them, but they did ask to continue with the program of work on practical applications.
Use the Theorem of Pythagoras to calculate:

(a) \( x \)

(b) \( y \)

'O' Level Pupils

This produced a careless mistake in obtaining a dimension to form a triangle by Mark, but otherwise both he and Richard had no real problems with this question.

Simon also managed this question correctly, after a false start, using sine and tangent, although the question specifically instructed the use of Pythagoras.
Question E

Calculate the width of a pulley groove
(Page 244 in 'Apprentice Maths')

(Trigonometry, subtraction of decimals)

The sketch shows details of a groove in a pulley for a vee belt drive.

Calculate $\alpha$

This was the only question to trouble Mark, who made a basic error in using 18 mm. as the length AB.

Mark tried to work out from the triangle below rather than the one suggested by dotted lines in the question. (Mark frequently used unusual approaches to problems, invariably correct.)

Richard used the suggested triangle and obtained the correct answer.

Simon used 40° instead of 20° for the half angle but otherwise used a correct method.
CSE Pupils

Andrew and Linda were unable to attempt this question.

Chris needed help to form the triangle but correctly chose tangent and worked the remainder of the solution correctly, including the use of logarithms with negative characteristics.

Chris made the unusual mistake of using logs to add two numbers.

Tim struggled to form the triangle, initially used sine instead of tangent and instead of subtracting $2 \times 5.848$ from 20, his working was as follows:-

\[
\begin{array}{c}
20.000 \\
- 5.848 \\
\hline
14.152 \\
- 5.848 \\
\hline
8.304
\end{array}
\]

Limited Grade CSE

This question was obviously well beyond the ability of William, Fong and Philip.
CSE Pupils

Andrew was able to form the required triangles, obtain the correct side lengths by subtraction, and correctly use Pythagoras and his calculator to obtain the required hole centre distances.

Linda had to ask for help to form the required triangles, correctly used Pythagoras for the first dimension but her second solution was:

\[
x^2 = 3.1^2 \times 2.0^2 \\
9.61 \times 4.0 \\
38.44 \\
= 6.2
\]

Failure immediately after a successful solution to a similar problem.

Jill, Tim, Chris needed some help to form the required triangles but then completed the solution correctly, on their own.

Limited Grade CSE

William, Fong, and Philip had no recollection of Pythagoras Theorem and were unable to attempt this question. Their non-existent ability with logarithms made it seem pointless to lead them through the question.
Question F
A circular bung fits into a plate as shown. Calculate distances A, B and C. (Answers in dec. form).

This question did not trouble either the 'O' level or the CSE pupils.

Limited Grade CSE
William and Fong were both unable to start this question. Fong couldn't remember how to change $\frac{7}{8}$ to a decimal, although he had done 5 examples, including $\frac{5}{8}$, in the previous week.

Neither boy could deduce that to obtain dimension A, 2.5 must be subtracted from 3.875 and they needed prompting to realise that the answer be divided by 2 to obtain A.

$1.375 \times 2$ caused Fong great difficulty and many attempts were needed to get .6875 including

$$2 \begin{array}{c} 0.516 \hline 1.375 \\ 1.0 \end{array} \quad \text{and} \quad .687 \text{ r } 1$$

POOR KNOWLEDGE OF TABLES
Some of the Pupils' Comments on the Work

Very Good 'O' Level Pupils

Mark

"As a paper for use in class as an alternative to school books I think it would be very useful, bringing a 'mature' aspect into the theorems and proving that theories such as Pythagoras are useful and so ought to be learnt."

"All in all I enjoyed the work and each question tested me but I felt that too much emphasis was placed on arithmetic."

Richard

"I have enjoyed completing this worksheet which I found very interesting. I preferred this type of maths where the question could be linked to a situation in work than copying seemingly endless exercises from text books."

Weak 'O' Level

Simon (who made numerous mistakes).

"This was an interesting sully into a subject I know very little about ..... most of the questions were, when brought down to the basics, simply arithmetic and geometry with occasionally a splash of trig. to liven things up."

"So all in all a good interesting fairly easy to do sheet."
GSE Pupils

Chris (Possibly also double entered '0' level).

"I think that the engineering work is more interesting because we work with real problems e.g. A drawing gives the length of a bar 55.78 mm. ± 0.05. Then we have to find the largest and the shortest length the bar can be. Whereas in normal classwork we just get numbers not diagrams and real live problems.

"People could say the engineering work is harder but I found it easier to understand than normal classwork. This is probably because we have diagrams to help us do the problem."

Tim (CSE grade 3 - 4 forecast).

"I found this work very satisfying to do, the main reason being you get a sense of achievement by doing something like this on your own. It is a better way of doing mathematics because it gives you a chance to look at the item instead of having them described to you.

"The most difficult I found was a pulley groove and I had to calculate using trigonometry."

Chris and Tim both liked the work enough to ask to continue at home with work from 'Apprentice Maths.'

Jillian

"After having done these types of maths problems compared to the ordinary text book problems, I found them relatively easier and the problems, especially with the help of a clear diagram, seems easier to understand and therefore easier to solve."
Limited Grade CSE/Non-Examination

The fact that William and Fong repeatedly asked for this work in normal lessons proved its value as a motivator of two previously dispirited but conscientious pupils.

William, when asked why he liked the work said "You can see what it's for", precisely the answer given by a third year boy in a separate lesson.

Philip said he liked the work because it made him "think harder."
The Failures

Some pupils didn't complete the work within the seven weeks allocated. A brief description of the reasons might illustrate the problems schools face:

Richard: "My father is decorating my bedroom and I can't get in to my folder."

Gary: "It was ever so hard: I looked at it with my mum and we couldn't do any of it."
(Maths Set 2 out of 10).

Gary was spending three nights a week on a part-time job and admitted this was affecting his work.

Andrew: Started well but involvement with school pantomime prevented completion of the work.

Frank: Potentially a good '0' level pupil but associated with a rebellious group and didn't like to be seen carrying books around school - fear of labelling as "creep". Also awaiting court appearance for motor-cycling offence. Applied for craft apprenticeship although quite capable of technical work. Promised to complete the work while doing his evening job as a petrol pump attendant.

Iain: A very willing limited Grade CSE pupil who was genuinely unable to attempt the questions on his own.

Richard: 5th year CSE pupil, left school for two weeks on Mediterranean Cruise (immediately prior to 'Trial' external examinations).
Practical Applications from Rolls-Royce

The sample calculations were incorporated into a short booklet, describing some of the uses of mathematics in the aero-engine industry.

This work was shown to some of the 4th year boys, who were surprised at the high standard of maths used in industry.

Mark, a potential university mathematician, said he was surprised that 'an engineer was not just a man with a spanner who undid things.' Mark was intending to enter accountancy after University: similar views were expressed by Richard, who intended to study law, although from an engineering background.

Two CSE boys, Leroy and Frank, were more interested in work at Craft level. Frank hoped to enter the Navy and Leroy wanted to do welding. Both boys were surprised in the quantity of maths used in industry, and Leroy thought "you just worked the machine without having to do maths."

Leroy and Frank were amongst the best CSE candidates and their ignorance of the need for maths must give concern if typical of the rest of the pupils.

Similarly, Mark and Richard appeared to have 'written off' engineering or never considered, being totally unaware of its mathematical content and seeing it basically as a lowly, practical, non-academic occupation.
EVALUATION OF 'APPRENTICE MATHS'

Motivation from Practical Applications

The training superintendent and a skilled craftsman from Rolls-Royce brought sample calculations and engineering drawings, specially prepared for the 'Apprentice Maths' Club.

These were shown to the boys during a lunch-time session. The obvious authenticity of the drawings, with actual uses of sine, cosine, etc. interested the boys and they were fascinated by the idea of an accuracy limit such as \( \frac{1}{10,000} \) inch and a micron (.002 mm).

The rather complex trig. examples performed in the toolroom led John to remark that while he understood SOH, CAH, TOA, etc. he could not select the correct trig. ratio for a particular situation.

This problem is covered very adequately in 'Apprentice Maths' and John borrowed a copy to work through. Within a week he returned with eight sides of work and claimed he had overcome his difficulties. (A sample of John's work in overcoming his problem is shown as shown in the Appendices.)

While John had been provided with two other text books for his CSE course, he had been unable to read and understand this major O/CSE topic. His work from 'Apprentice Maths' was totally self-taught, it was correct and included practical applications, not simple repetitive examples.

After struggling on the 4th question of the self-assessment test, John had conscientiously worked through the practice exercise before attempting the more difficult practical applications.
Summary

All of this work was of a type seen at craft level industry, yet one of the questions even tested Mark, the most able boy in the school 5th Year.

It is ironic that neither Mark nor Richard, who claimed to have enjoyed the work and were distinctly able, had any intention of entering engineering, even at graduate level.

Simon, although entered for 'O' level, made frequent mistakes in basic processes such as long multiplication.

The CSE pupils, in general, showed competence to carry out the processes, such as trigonometry and Pythagoras, once the problem had been reduced to a simple triangle.

The limited grade CSE pupils (grades 4 and 5) were out of their depth in most of this work. They were totally unable to read and understand any of the questions and had little appreciation of place value (".75 is smaller than .610").

Their knowledge appeared to be limited to the four operations of decimals, without long division. They had no competence in logarithms, fractions, trigonometry or Pythagoras' Theorem - all topics used in engineering at craft level.

In theory, Fong, Philip or William could obtain a CSE grade 4 or 5 and a craft apprenticeship; (in the previous year several boys with grade 5 (and one ungraded), obtained craft apprenticeships. They would surely be struggling with the mathematics involved and their scope of work within a company would be very limited.
It is clear that 'craft apprenticeship' is a blanket term which covers a vast range of abilities (from CSE grade 1 to 5) and as noted by Fitzgerald (8), the maths required varies from firm to firm and, within the same company, from department to department. One company visited had a two-tier apprenticeship scheme (one for CSE grades 1 - 3), another for grades 4 and 5.

There is obviously not a 'typical' craft apprentice, but a continuum of ability varying with the requirements of the job.

The trigonometry involved in the tool-room at Rolls-Royce required competence in maths at near 'O' level standard, and it was noted that craft apprentices specialising in electronics and instrument fitting often had grade 1 CSE or 'O' level.

For heavier work in the locomotive and carriage workshops, British Rail were apparently satisfied by their repeated recruitment of trainees with grade 5 CSE.
Conclusions

This exercise has suggested that even with 'good' CSE pupils (say grades 1 - 3), further instruction would be needed by the employer for problems like:-

(a) Applying trigonometry and Pythagoras in situations where the appropriate triangle must be identified.

(b) Amount a cutting tool moves is half the amount removed from diameter.

There would also be mistakes due to lack of appreciation of place value and failure to recognise ridiculous positioning of the decimal point.

The pupils with CSE grade 4 and below would need close supervision in all mathematical work and would be unlikely to cope with highly skilled craft work.

(c) The only pupils with the 'insight' to solve all of these questions independently were the potential grade A 'O' level candidates, and these had no interest in engineering at any level.
Calculators

Two pupils, Andrew and Jill, obtained more accurate answers by calculator than would have been expected had they used long multiplication and division. The calculator obscured their poor knowledge of place value.

Motivation

Although it was made clear that the work was purely voluntary, and no specific reason was given for setting it, most pupils had completed several hours work at home. Most preferred the work to normal school maths, such words as "real", "live", "Mature," "achievement", "clear diagrams", appearing in their comments.

The three girls who did the work found it enjoyable and this was consistent with the current trend for a few girls to enter craft apprenticeships.

William and Fong, the two very weak boys, had virtually "switched off" in maths as they began the 5th Year, but their interest was revived and sustained when they could see that the work was related to employment.

Brian, a boy capable of 'O' level but poorly motivated, said he wanted to be a draughtsman and attempted the work while 'babysitting.' On realising he needed log tables he made a special journey home for them.

The work Brian produced on this project, although incomplete, was considerably more than his usual homework.
The pupils who did not complete the work were mostly affected by negative pressures outside of school and these, of course, will exist no matter what material is presented with the intention of improving motivation.

There will be some pupils for whom the efforts of the school have negligible success: in December 1980 a boy who had received years of remedial help in English and Maths obtained an interview for a craft apprenticeship. This boy had a score of 1 out of 26 on the 'Apprentice Maths' Specimen Employers Test consisting of basic arithmetic. Obviously the employer should not consider this boy's weakness as representative of the school's leaving population.

The work did show the wide ability range for which schools must cater; it seems reasonable to suggest that employers of craft apprentices, do not generally see either the most able of the school leavers, or the most unsuccessful (and often most difficult).

These two groups often attract the most attention and resources - the academic usually having the most able teachers for the school's prestige i.e. 'O' and 'A' level results - the remedial having much smaller classes. The 'average' pupils containing the potential craft apprentices are perhaps the most neglected in terms of the total school resources devoted to them.
Chapter 9

REPORTS BY PUPILS, TEACHERS, EMPLOYERS
ON 'APPRENTICE MATHS'

The various users of the text were asked to comment on
various aspects of the book, such as scope, quality of
explanations, value of practical applications, etc.

Extracts from the reports were as follows:-

4th Year High Ability 'O' Level Pupil
Mark Earnshaw

".......... I found the book as good, if not in some cases,
better than our present text book, simply because of the
excellent explanations, which were given specifically, not
'decorated' with fancy phrases."

"I sincerely feel it should be used in conjunction with
our present text book." ".... a definite boost for
anyone studying CSE's or 'O' levels."

Practical applications: "I think the book is a real
eye-opener to the work an apprentice has to do. It
surprised me and I'm sure that some students have a nasty
shock when they discover the amount of maths needed for an
engineering apprentice. .... I thought an apprenticeship
was an easy way out if you were unsuccessful at school and
liked getting your hands oily!"

Mark suggested introducing the book in year 3, before
making option choices. "This would show 3rd years what
was needed for an apprenticeship, providing an incentive
to work and prevent disappointment when they found that
after messing about in lessons they require that subject
for an apprenticeship."
Kenneth Windridge
5th Year CSE pupil who obtained a craft apprenticeship in engineering.

"I used the book to help me pass my apprenticeship maths test for a job and I am pleased to say it helped me pass."

"The explaining of the arithmetic is so easy and all the different examples are given."

"The exercises are helpful because the different ways are put in different exercises e.g. fractions instead of multiplication, division, addition and subtraction in one exercise, they have separate exercises."

"The practical exercises are good because the drawings show you will crop up in the actual job and you will recognise it instead of just remembering lines in a book."

"There are enough topics in the book to cope with every aspect of Craft Apprenticeships and that is all we need."

"It is better than other books because they just teach you 'parrot fashion'; with this book the thinking is left up to you."

"I would just like to thank the authors. It has helped me a lot and virtually got me a job. I would like to see the book introduced into the class and not just as an exercise book for extra work."

Kenneth's parents expressed their gratitude for the work at a parents' evening and their comments are recorded overleaf.
Dear Mr. Gatenby,

Kenneth has now obtained employment as an apprentice engine fitter at Rolls-Royce Ltd., Derby.

Until last year we were very concerned about Kenneth's general progress until he started the 'Apprentice Maths' club held in the lunch-hour.

After this his attitude improved and he appreciated the way the School was trying to help him. He used the text-book 'Apprentice Maths' regularly in his spare time at home.

We believe this work helped Kenneth to improve his mathematics and also to obtain an apprenticeship.

Yours faithfully,

Mr. M. J. Windridge
John Hall
5th Year CSE pupil intending to become an apprentice.

"I have used this book for trigonometry because I could not determine which sign to use e.g. tan, cos, sin, but now I have used the book I find it easy. It helped me by taking an example and putting it into an imaginable situation. The book also takes an example and shows you easy ways to do it."

Steven Rhodes
5th Year CSE pupil hoping to become a draughtsman.

"The practical applications are interesting and helpful. This book is far better than any other CSE book at explaining problems. The examples are easier to follow and more numerous. I think the course should have been started earlier, at the beginning of the 4th year.

Wayne Fearn
5th Year CSE pupil who became a craft apprentice in the building trade.

"I found the book very useful, especially before I went to interviews. The night and morning before I went I had a good look at the book. This helped me a lot, especially at the Gas Board test."

"The self-assessment tests save a lot of time doing things which you already know."

"One good idea in the book is the practical exercises. They show you how and where the maths are needed."

"The book far excels any other CSE book."
Simon Robinson
4th Year 'O' level pupil

"The book was used for extra help with trigonometry. The explanations were clear and precise and straightforward and do not 'waffle.'"

"This book is clearer than my text book 'Mathematics Three' by Clarke which misses out steps and in places is very obscure."

Andrew Ashworth
5th Year CSE pupil intending to join the Navy at craft level.

Andrew used the book for revision for exams. at school and at home.

"The quality of the book is excellent, explanations are clear to understand and plenty to learn from."

The diagrams are clear and it is a pleasant book to work from.

"Modern maths should not have been included as modern maths such as sets are no good to anybody, while if they were not included in the syllabus other important topics could be taught."

Nayan Khetain
5th Year CSE pupil intending to stay at school.

"The book is helpful and interesting because it is not too easy and not too hard."
Lorna Powell  
5th Year CSE intending to join the Army

Lorna made excellent use of the book for revision for CSE exams, filling a complete exercise book in addition to her normal lesson work. Her work covered Fractions, Algebra (with practical applications), Specimen Employers' Tests 1 - 7, Trigonometry, Ratio and Proportion, The Circle, Angles, Constructions.

The fact that Lorna regularly came back and asked to borrow this book over a period of a year, and the quantity and quality of work produced, verify its use as a CSE revision text for private study.

Lorna's report included:-

"The explanations are easy to read and with the help of diagrams enable a better understanding of the topic."

"The self-assessment tests are very helpful as they certify just how much of a certain topic you know and how much you must revise, in which area and to what depth to fully understand the topic. I think 5 - 10 questions are enough to certify whether you know a subject or not."

"The practical applications were alright, though I tended to stay more with the practise exercises when I couldn't do the self-assessment tests."

"I think the book could do with some explanations of Transformation, graphs and their gradients and specific gravity and density."

"In 'Mathematics Three', if you get questions wrong and have to revise them, it is a long and tedious way for you are confronted with solid writing, whereas in 'Apprentice Maths' there is not so much writing and the explanation is helped by examples and diagrams."
"I can't really improve the book, only by adding a few more subjects and topics and a few more specimen papers."

"I found 'Apprentice Maths' very helpful and hope I have learn't enough to succeed in my nearing examinations."

Colin Lang
5th Year pupil (CSE) intending to become a craft apprentice

"The quality of the explanation is excellent, because no-one else needs to explain it."

"The self-assessment tests show you the parts where revision is needed."

"The exercises start easy and provided you have read the passage on the exercise you should be able to do the more difficult sums."

Suggestion: "Log. tables should be included to make it a more complete book."
Mr. K. White
Mathematics teacher with previous experience in industrial accountancy.

1. Used the text for teaching of fractions, revision of CSE topics.
2. Explanations are exceptionally well laid out and easy to follow.
3. The self-assessment tests are very useful.
4. For those pupils who are actually involved in apprentice mathematics, the practical applications are helpful and interesting.
5. Obviously as a CSE text book this book is inadequate, there are not enough topics covered. If the book's scope was broadened to encompass a more comprehensive range of material, then the simple explicit fundamentals would make this an excellent CSE handbook.

Mr. R. F. Jenkinson
Mathematics teacher, Bath (obtained the book after seeing newspaper letter describing 'Apprentice Maths' club.)

Used as CSE revision and Technical Drawing source book.

"Well laid out pages, not too much on a page, clear and concise explanations. Most useful having worked examples and then a fair amount of questions for the children."

"Explanations are the teacher's role, not the thing for books to attempt at great length, as some do, especially dealing with less-able children to whom lengthy verbage is a waste of time."

Self-assessment tests:

"When the children couldn't do any of the questions (e.g. fractions), I used the assessment test after covering the work in the book. My pupils were not capable of using the tests in the mature way required for self-assessment."
Mr. R. F. Jenkinson - continued

Practical applications:
"These satisfy a long felt need, not having technical experience it was difficult for me to think up examples. Some of the more technical examples were rather hard to understand, if one had not had an engineering background."

Mr. Jenkinson would have liked additional topics for CSE work to include:
- graphs, distance/time, conversion
- money - salaries, H.P., insurance
- averages
- Compound, Simple Interest
- Scale drawing
- Metric Weights

Mr. Jenkinson suggested using the format for 'Apprentice Maths' to write a specific CSE book, as "every other series 'aimed' for CSE Mathematics is unsuitable for the less able due to cramped presentation, too much explanation, too few examples, too expensive.

"I find the SMP books .... too cramped, writing is too small, examples are too few."

Mr. Jenkinson also requested a non-answer book, because of the self-assessment tests.

"Overall, the book is a useful bridge between theory and practical application in that my less-able pupils see why they must learn certain skills, rather than learning techniques in abstraction."

Mr. Kinsey
Head of Mathematics, Queen Elizabeth's Grammar School, Ashbourne.

"I regret I did not use your book as I could not afford to buy it out of my school allowance."
Mrs. L. White
Mathematics Teacher

"It obviously only covers some areas of CSE work. I would imagine it would be difficult to find a better book for use by apprentices to give them a good basic knowledge."

"The explanations and worked examples are very good, certainly a great improvement on most maths test books."

"The self-assessment tests seem to have value either to encourage a student who has done well, or as an indication that further efforts are required. They also make it possible to short cut work which is already adequately understood."

"Some of the examples seem a bit difficult, especially at the end of the chapters ..." 

Practical Applications

"From limited experience of the needs of engineering I would imagine them to be very helpful indeed. The diagrams are commendable for their clarity."

"Some more work on changing units and expressing e.g. 3 m in cm. could perhaps be useful."

"There are many CSE text books, but it is very difficult to find one which contains good explanations as well as sufficient exercises. I have not seen any CSE text which could be used by a pupil on his own as well as this one could be."

Suggestion: "A few more worked examples for the practical applications exercises."
Mr. K. Cullen  
Teacher of Engineering Science/Metalwork

Mr. Cullen himself served a 5-year craft apprenticeship in engineering and worked as a skilled machinist before teaching.

"The main use was with lower ability pupils when they had specific difficulties such as fractions and decimal points."

"The main areas I found most useful were Algebra (p. 109), Areas, volumes, squares and square roots, powers and indices. I actually based a lesson on volume using the book which proved to be very successful as an aid to learning the principles and calculations involved."

"The feedback from individual pupils who used the book when in difficulty was excellent, with a high success rate in overcoming these problems and difficulties. The self-assessment tests in the book are an excellent idea and help give more confidence to pupils."

"In general, I think this book is an excellent aid to pupils taking Engineering Science and fills a need for pupils and teachers as a refresher in maths relevant to a technical subject.

Suggestions for improvement

1. A more detailed contents table.
2. An index at the end.
3. More practical applications.
4. The short section on inverse proportion, pulleys and gears was most helpful and could be extended.
Mr. J. Walker
A Chartered Engineer turned Maths teacher in a large school.

Mr. Walker claimed he was unable to use the book in school as he taught mixed classes and not all wanted to be apprentices.

This point was contradicted by the very successful experience with pupils like Lorna who made extensive use of the book while not being particularly interested in engineering.
Mr. D. Halfpenny
Chartered Engineer, involved with draughtsmen and graduates at British Rail, discussed the book with people in industry and teachers of maths.

Sample comments:

Teacher: "Some operations are well explained in words and clear diagrams, but others e.g. division of fractions are just stated."

Teacher: "Is 0.649 a realistic degree of precision? Is long division still needed, except as a quick approximation to check calculator? Do people still use logarithms?"

Engineer: "Fluent mix of units is expected still."
Teacher: "Surely engineering is all metric?"

Teacher & Engineer: "A child will need a teacher or mentor to bridge the conciseness of presentation of most topics.

Everyone's opinion: "Well done."

Comments

In fact, the experience in school showed that a teacher was not necessary even with 'average' pupils and the book was far more easy to understand than the very wide range of books available in school.

Similarly, the comment about Metric/Imperial Units is not justified; the visits to industrial firms confirmed the requirement for Imperial Units for many years to come.
Apprentice Training Superintendent,
(after approximately one year's use of the text).

"This book has been used as a teaching aid for Craft Apprentices who are experiencing difficulty with calculations in the Workshop or maths at the College of Further Education."

"It has been used as an aid to overcome his own difficulties ..... its comprehensive cover has catered for all our problems and the success achieved led us to purchase a second copy when the other was temporarily mislaid."

"The apprentices who have used the book speak very highly of it."

Mr. W. Gordon,
Deputy Manager, Skill Centre, Long Eaton.

"The Education Instructors have guidelines in presenting revision applicable to mathematics - we think it covers in a simple and explicit form problems which are encountered by apprentices in the work situation."

The Education Instructor "has found it to be useful in taking various examples from it for use in the classroom situation."

Mr. J. Bassett
Education Instructor, Skill Centre, Long Eaton.

Mr. Bassett answered concisely the 9 topics suggested on the standard review form as follows:-

1. Use of the book
   Revision of basic arithmetic plus geometry, trigonometry and algebra where appropriate for engineering,
electrical and building trades courses in MSC, TSD, Skillcentre.

2. Quality of the explanations
   They are easy to read and understand.

3. Self-assessment tests
   Very helpful.

4. Quantity of questions, examples.
   Adequate.

5. Practical applications
   Helpful and interesting.

6. Scope
   Adequate.

7. Comparison with other tests
   Compares well with existing skillcentre text books.

8. Suggestions for improvement
   "I feel that the description of parts of the circle i.e. circumference, diameter, radius, are required by the student before reaching Chapter II. Suggest inclusion at page 18/19. Page 14 suggest inclusion of explanation that \( \frac{1}{2} \) is the same as \( \frac{1}{2} + \frac{2}{3} \)."

9. "I consider that 'Apprentice Maths' brings to fruition very well the intentions stated in the preface."
Dear Mr Gatenby,

I thought you would be interested to hear about two occasions when we made good use of the 'Apprentice Maths' book you kindly left us after your recent visit.

During a classroom lesson on drawing interpretation, the Instructor asked the Craft Apprentices if they had any questions regarding the calculations they had just completed. One of the students said he was concerned that others in the class were experienced in trigonometry and that this was a subject on which he had no knowledge. The Instructor agreed to give him personal tuition after the normal class hours. This proved to be very time consuming and progress was slow.

When I heard about the situation, I suggested that the Instructor loaned him your maths book and made himself available for any clarification needed. Further tuition did not prove necessary and the apprentice concerned said he had benefited from working through other sections of the book.

The second incident arose when an apprentice showed he was unable to subtract two decimal numbers. Examination of his workings showed he did not always keep the decimals in line and he was not sure which number was placed under the other. Failure to complete the work set led to him giving classroom discipline problems which were uncharacteristic of him. Fortunately, he responded in a positive way when I suggested he borrowed the maths book and did some revision over the Christmas holidays. He returned the book yesterday with a smile saying I can do them now and explaining how he practised through his holiday on examples he had found for himself.

As you can see we have already found the book very useful as a self teaching aid to apprentices who could have lost their way in our training scheme.

Yours sincerely,

Superintendent –
Training Workshop
American Reviews of 'Apprentice Maths'

While this work was proceeding in England, the author became aware of similar evaluation taking place in the U.S.A. Samples of the reviews were as follows:

Thomas F. White - Maths Coordinator, reported that the dropping of the + from \(6 + \frac{2 + 4}{8} - 3\) was confusing, but the presentation was otherwise excellent.

White noted the inclusion of Imperial and Metric Units, and stated that they had tried to make students 'think Metric.'

As noted by the pupils in England, White commented,

"Writing style - excellent - very clear and understandable. In many, many cases their presentations are the best I have seen in any text."

Self-assessment tests - "An excellent idea."

Practical Applications - "good and plenty (not candy) to challenge all students from all vocations."

Duane M. Gowing, Dean of Academic Affairs, Missouri Institute of Technology, suggested the addition of a chapter on calculators and appendices containing all tables, e.g. trigonometry, logarithms, etc.

Gowing continued, "The reading level is appropriate and the number of examples given are more than sufficient ... It introduces the student to not only the math, but also vocabulary that is needed in the trade and technical areas."

Inspite of different conventions in America for decimal point (2.34 vs 2.34), roundingoff, the dollar, double symbols i.e. \(+2 - +3\), (Americans sometimes use \(+2 - +3\), the Dean considered that only 20% of the material needed modification for use in America.
Scope of 'Apprentice Maths' compared with Traditional Maths CSE Syllabus

Introduction

The preface of 'Apprentice Maths' makes no claim for the text as a full-time course book for all CSE pupils; however, a number of teachers liked the format and suggested a CSE text with a similar style; many pupils used the book for revision for CSE while not specifically interested in engineering.

Therefore, it was decided to estimate the extent to which the book covered the traditional CSE maths syllabus as followed by the majority of entrants to craft apprenticeships.

The syllabus used for comparison was the East Midlands Regional Examination Board 'full' CSE (i.e. pass grades 1 - 5) - a small minority of very weak pupils attempted the Limited Grade Syllabus (only pass grades 4, 5).
SCOPE OF 'APPRENTICE MATHS'

RELATIVE TO THE MOST TRADITIONAL CSE SYLLABUS OFFERED BY EAST MIDLANDS REGIONAL EXAMINATIONS BOARD (Used by the Test School)

1980 Syllabus ('Full' CSE)

Coverage in 'Apprentice Maths'

Paper 1 (30% of marks)

Four operations with number, money S.I. units, decimals. Covered.

Prime and composite numbers. Not covered.

Fractions, conversion to decimals and vice versa. Covered.

Approximations, estimates and rounding off. Covered.

Squares and square roots leading to whole numbers < 20. Covered.

Graphical representation of data, graphs, pie charts, etc., mode, mean etc. Not covered.

Percentages, applications. Covered.

Ratio and proportion. Covered.

Speed, distance and time. Not covered.

Number patterns, sequences. Not covered.

Use of letters to represent numbers, simple formulae. Covered.

Symmetry, properties of common figures, plane and solid. Symmetry not covered. Plane figures covered.

N.B. Paper 1 was taken by all CSE pupils (Full CSE and Limited Grade (grades 4, 5 only)
1980 Syllabus

Paper 2(a) (Full CSE only)
(30% of marks)

The four operations for bases other than 10.

The index laws. Standard form (A \times 10^n).

Length, area, volume, triangle, circle, parallelogram, kite, trapezium, prisms.

Sets, union, intersection, complement, subset, empty and universal sets. Venn diagrams, symbols.

Directed numbers, mappings, relations.

Formation of formulae from English sentences.

Inequalities, simple equations, simultaneous equations.

Cartesian co-ordinates.

Angles as measure of rotation.

Compass bearings.

Polygons, tessellations, polyhedra and nets.

Construction using compasses.

Scale drawing, scales and maps.

Transformations, reflections, rotation, etc.

Parallel lines, transversal.

Coverage in 'Apprentice Maths'

Not covered.

Covered.

All covered except kite.

Not covered.

Directed numbers, covered, mappings, relations, not covered.

Covered.

Simple equations covered, simultaneous and inequalities not covered.

Not covered.

Covered.

Covered (as angles 0° - 360°).

Not covered.

Covered.

Not covered.

Not covered.

Covered.
<table>
<thead>
<tr>
<th>1980 Syllabus</th>
<th>Coverage in 'Apprentice Maths'</th>
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</thead>
<tbody>
<tr>
<td>Properties of triangle, parallelogram, trapezium and kite.</td>
<td>All covered except kite.</td>
</tr>
<tr>
<td>Similarity and congruence.</td>
<td>Not covered.</td>
</tr>
<tr>
<td>Pythagoras Theorem.</td>
<td>Covered.</td>
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<tr>
<td>Sine, cosine and tangent.</td>
<td>Covered.</td>
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<tr>
<td>Probability.</td>
<td>Not covered.</td>
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<tr>
<td>Simple interest, Hire Purchase.</td>
<td>Not covered.</td>
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<td>Travel graphs.</td>
<td>Not covered.</td>
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<tr>
<td>Change of units, foreign currency.</td>
<td>Covered (Metric Imperial Not covered.</td>
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<td>Not currency.</td>
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1980 Syllabus

Paper 3 Option A (40% of marks)

Traditional

Trig. ratios, sine, cosine, tan, 0 - 180°. These + Pythagoras applied to 3 dimensions. Angles > 90° not covered. 3 dimensions not covered.

Sine and cosine rules. Not covered.

Factors of algebraic expressions (grouping and quadratics) Covered.

Simultaneous equations. Not covered.

Quadratic equations (graph and algebraic). Not covered.

Re-arrangement of formulae (Transposition. Covered.

Similar and congruent triangles, intersecting chord, secant, tangent. Not covered.

Ratio of areas, volumes of similar figures. Not covered.

Mensuration of cone, sphere, pyramid, sector. Not covered.

Mensuration of annulus. Covered.

y = mx + c, gradient of a line. Not covered.

Properties of the circle, its parts. Covered.

Angle properties, cyclic quadrilateral etc. Not covered.

Constructions: perpendiculars, division of lines, triangles, inscribed, circumscribed circle. All covered.

Locii in 2 and 3 dimensions. Not covered.
Summary

There were approximately 53 topics on the CSE syllabus of which 25 were covered thoroughly in 'Apprentice Maths'.

This quantifies the claim made by some teachers that the book could not be used as a full-time CSE course book. (It was, though, successfully used for many parts of the syllabus and as a 'back-up' for other texts).

However, the evidence at the Derby school confirmed the intentions in the preface for the book to be used as a revision text, particularly for remedial work on basic arithmetic.

The topics not covered in 'Apprentice Maths' (such as sets, Venn diagrams and transformations) were seen as a 'waste of time' by many intending apprentices and they suggested a course based on this textbook.

This would probably need to be an optional Mode 3 CSE, perhaps run in parallel with a similar course based on Commercial/Domestic Arithmetic, of particular interest to the girls (many girls expressed a dislike for topics like trigonometry which is essential in an apprenticeship.)

Breadth

The high praise for the quality of explanations and ample exercises was perhaps partly due to the fact that, unlike standard CSE texts, 'Apprentice Maths' does not attempt an excessively broad coverage with consequent inadequate depth.

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Chapter 10

SUMMARY AND CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

SECTION A - EVALUATION OF 'APPRENTICE MATHS'

Introduction

The visits to industry and consideration of various reports showed that the mathematics required by craft apprentices in engineering was well within the scope of school syllabuses in general. Some of the major needs were competence in the four operations with whole numbers, fractions and decimals, the need to support the potentially unreliable calculator by logarithms, the ability to apply trigonometry and Pythagoras' Theorem, (and therefore squares and square roots) and the need to work accurately with correct placing of the decimal point, after making a rough estimate. Both metric and Imperial Units were requested by the Employers (supply of spare parts, etc.)

It is suggested that schools cover these topics frequently but the problems with some children of motivation, class-control, etc., mean that even if competence is temporarily achieved it is not retained. One teacher during secondment to industry wrote, "pupils from that level cannot even retain simple addition and subtraction rules. As soon as the teacher introduces fractions, trigonometry ... the pupils understand it until a new topic is introduced."

The Work Experience for Teachers course described previously appeared to be a very successful exercise and conveyed to the teachers the emphasis which needs to be placed on the basic topics required. However, several teachers pointed out the advantages of the employer relative to the
teacher in motivating the trainees to learn, the obvious financial sanctions not available to schools and the stressful life in school with a socially comprehensive intake. The general feeling amongst the teachers, however, appeared to be the recognition that a problem of emphasis existed and a determination to apply some of the experience gained on return to school.

The Evaluation of 'Apprentice Maths'

During the visits to several large local engineering training centres, the maths required was noted and some very useful material was prepared by the companies for use in school.

In matching the employers' needs to the scope of 'Apprentice Maths' it was found that an excellent correlation existed, and after a period of evaluation, some of their remarks included:-

"The apprentices who have used the book speak very highly of it."

"We think it covers in a simple and explicit form, problems which are encountered by apprentices in the work situation."

"He returned the book yesterday with a smile saying, 'I can do them now,' and explaining how he practised through his holiday on examples he had found for himself."

This very successful industrial experience satisfied the author that 'Apprentice Maths' was a most relevant text
for those wishing to follow craft apprenticeships and highly suitable for an experiment to attempt to motivate school pupils, by illustrating the use of mathematics in industry.

The popularity of 'Apprentice Maths' with the pupils was extremely high and many pupils decided to buy their own copies. An exceedingly popular out of school club was run with regular attendance and copies of the text were continually requested for private study in preference to standard school mathematics books.

One of the reasons appeared to be the fact that most of the boys wanted to be craft apprentices and the school was offering them exactly what they wanted, rather than the usual syllabus, which many of the pupils regarded as irrelevant to their needs.

Some very able students used the text and the top boy in the 5th year commented on "the excellent explanations given specifically, not 'decorated' with fancy phrases" after comparison with the school text book. (This boy later achieved 8 'O' levels and even he was concerned about language used in text books, so there are obvious implications for pupils of average ability and below.)

Mark also wrote, "I think the book is a real eye-opener to the work of an apprentice ...." and suggested using the book in year 3 to motivate younger pupils, "providing an incentive to work and prevent disappointment when they found that after messing about in lessons they require that subject for an apprenticeship."

Mark and several other able pupils also commented that the quite challenging applications altered their previously
low opinion of engineering, "I thought an apprenticeship was an easy way out if you were unsuccessful ..... and liked getting your hands oily."

Kenneth, a boy who was lacking in motivation before joining the club, became very enthusiastic using 'Apprentice Maths,' for calculations on his motor-cycle engine, and finally credited the book with helping to secure an apprenticeship:-

"I would just like to thank the authors. It has helped me a lot and virtually got me a job."

During the maths club, the author was surprised to see the students working entirely without help - the material was written with such clarity that further explanations were unnecessary:-

Simon: "The explanations were clear and precise and straightforward and do not 'waffle.'"

"My text book ....... misses out steps and in places is very obscure."

Mann (31) noted that 'O' level physics texts had a reading age of 19 years.

John mastered trigonometry on his own, after previous trouble with other texts, "It helped me by taking an example and putting it into an imaginable situation."

Wayne liked the practical applications, "They show you how and where the maths are needed. The book far exceeds any other CSE book."
Practical Applications

Some comments included:-

Mark: "brining a mature aspect into the theorems and proving that theories such as Pythagoras are useful and so ought to be learnt."

Richard: "I preferred this type of maths ... where the question could be linked to a situation in work."

Chris: "In normal lessons we just get numbers not diagrams and real live problems."

Jillian: "With the help of a clear diagram seems easier to understand."

William: "You can see what it's for."

The overwhelming enthusiasm and positive responses to "Apprentice Maths" convinced the author that there is a great benefit to be gained from introducing this material into school. The text highlighted the gulf between what schools provide and what many pupils feel they need. Although potential craft and technical apprentices are not the whole school population, they are a very substantial group and, the author feels, worthy of more consideration. (The author recognises that this evaluation was carried out in a very industrial/technical area and hoped that a similar very favourable reaction would result elsewhere.)

The children frequently commented on the ease with which they could read and understand 'Apprentice Maths' and drew attention to the simple language, clear layout and detailed explanations and diagrams.
The American reviewers of the text felt that it would be very suitable in the USA, with minimal changes, and Gowing (40) noted, "I feel that the Bajpai/Bond text would be a more than adequate text for use in the USA ..." Thomas P. White (39) noted, "Writing style - excellent - very clear and understandable ... their presentations are the best I have seen in any text ...... I would recommend it to my teachers without reservation ......"

Recommendations

1. The good experience with this text relative to others showed that more emphasis on layout and reading ability is needed in producing teaching material. This material, and the industrial visits, provided evidence that both Metric and Imperial Units will be needed by potential craft apprentices for many years.

2. Teachers can improve motivation and relationships with pupils using practical applications including those gathered locally. Work cards, however, can cause problems of organisation and class management, in the author's opinion.

3. The most able pupils should be made aware of the challenging "academic" mathematics involved in engineering, not write it off as a craft subject only for the average and below.

4. Potential craft apprentices still form the largest group of pupils in many schools; teachers should recognise their "customers" desire for vocationally-orientated work in years 4 and 5.
5. Teachers should not be polarized into those who see mathematics as a "tool" and those who see it purely as an academic problem-solving discipline. Mathematics is required as a tool, including use in school science and other subjects, but problem solving, games, etc. must also be included to provide enjoyment and reduce boredom. Advisers could, perhaps, emphasise this dual role of mathematics.

6. Drawing and measuring have an important role in reinforcing order of magnitude, place value, decimal point and rank.

7. Pupils can be very willing to give their opinions, and should be consulted when considering any form of new teaching material.

   Teachers can improve their methods by listening to constructive comments from pupils. This worked well in groups of 3 or 4, where the children had the support of friends around them. From this teachers may learn, say, to avoid constantly "nagging" the children, talking for too long, neglecting marking, using language which the children cannot understand, or going at too fast a pace.

8. Schools should provide a text, such as 'Apprentice Maths' for their pupils to refer to when preparing for interviews, revising for examinations and for self-tuition when struggling to remember basic processes.

9. The contents of 'Apprentice Maths' should be shown to younger children, say in year 3, to show that mathematics will be needed in later life and is important.
Section B - Factors Affecting Attainment in Mathematics

Numeracy testing of the 5th Year showed that there were many children not competent in operations such as long division (~35%), decimal multiplication (~50%), etc. and operations with fractions (~50%).

Amongst these children, many would take interview tests and might cause employers to complain of poor standards in schools. In considering why some of the same school's pupils came top in employers' selection tests and others failed miserably, it was decided to investigate individual differences in the children.

It was found that the 'O' level class was dominated by the children of professional and technical parents and setting in mathematics was closely related to social factors. This was supported by indicators such as attendance at parents' evenings, number of pupils wearing school uniform, truancy, involvement in crime, equipment such as pens, pencils.

During the period of the research, the opening of a new school nearby removed all of the rural and most of the suburban children from the school's catchment area. 'O' level passes in mathematics dropped significantly comparing classes with the same teacher, but different catchment areas. (Similar declines occurred in other academic subjects such as Physics, Chemistry, Language, etc., with experienced teachers.)

In relating these factors to craft apprentices, further larger scale work is needed to identify the principal domain from which they are drawn, but it is suggested that many come from schools including what are referred to as "inner city" areas in their catchment area.
HMI have recently produced some evidence relating mathematical attainment to affluence (as measured by the numbers of free school dinners) and it is suggested that further detailed work is needed.

Dickson (24) discovered that apprentices had suffered from noisy classes in London and clearly the "inner city" schools struggle to attract able teachers.

This work therefore, attempted to demonstrate and identify the problems faced by schools in difficult areas.

Significant numbers of children of the Derby school were shown to be involved in crime. It was noticed by experienced teachers involved in pastoral care that an impending criminal charge often caused pupils to be 'high' and very difficult to handle in class.

Similarly, those children involved in the break-up of a family unit were frequently disturbed and required extra help and support.

Statistics were presented which suggested that these social problems are increasing and schools generally are undertaking a much greater pastoral role.

This involves many staff in a heavy workload of counselling, attendance at meetings and paperwork and reduces the available time for lesson preparation and marking.
Recommendations

These social problems cannot be rectified by teachers, but the situation might be helped if:-

(a) More emphasis on teacher-training was given to coping with "inner city" pupils i.e. those without pens, pencils, homework, parental support, job aspirations.

(b) Antagonism between employers and teachers would be reduced if society in general appreciated the stress under which some schools operate and the resources which must be devoted towards social rather than academic priorities.

(c) The size of the "inner city" area in relation to the whole school catchment area obviously has a crucial effect on the overall ethos of the children. In the reorganisation of schools because of falling rolls attempts should be made to avoid "sink" schools with exclusively poor catchment areas.

(d) The vociferous complaints from industry which prompted much of the recent work in this field may be muted by the current high competition for relatively few apprenticeships, removing the weaker candidates.

This should not mask the fact that society is failing to provide a system in which all children reach an "acceptable" standard in mathematics.
Mathematics Teachers

During the research, children spoke of their lack of learning because of the prolonged absence of teachers. Stress-related illnesses appear to affect comprehensive school teachers more than society in general; further research might indicate the need for new methods of dealing with stress such as:-

- Early retirement for teachers no longer coping.
- "Sabbatical" leave in appropriate cases.
- More free periods for staff in difficult situations.
- Smaller class sizes in "inner city" schools and increased capitation for equipment.

Work experience for teachers in industry appeared to be invaluable in making both sides aware of their respective problems and made the teachers willing to examine their teaching emphasis and consider implementing changes.

Suggestions for Further Research

It was repeatedly suggested by 5th year pupils that 'Apprentice Maths' should form a CSE course in its own right; perhaps this could be examined as an optional CSE Paper 3. While this would appeal mainly to boys, an instance was found where a girl won the Apprentice of the Year award at a large company and more work is needed to encourage girls to enter engineering.

The style and format of this material was successful, and it is suggested that the same approach, including self-assessment tests, simple language, is used for a general text in school mathematics.
A further project might investigate the matching of the reading-age of school pupils to the language used in their text books, many of which, it is suggested, are in language only comprehensible to the most able pupils.

There is also scope for more projects, similar to a part of this work, in the gathering of sample calculations from large local employers, to produce work-cards as an aid to motivation. The possible connection with relatives working in the firms may reduce the gulf between school work and home background frequently referred to in the work by Bird et al on Disaffected Pupils. Actual company documents, names and part numbers serve to convey the idea of authentic work from the "real" world. Of course, the author appreciates the problems of organisation which this work places on the teacher.

The poor control of some teachers referred to by the children in this research was often with probationary or non-specialist mathematics teachers. Other experienced staff may be fully stretched and unable to give the support necessary for the inexperienced teacher to cope. Perhaps more external, advisory support is needed in such situations.

Staff turnover in city schools appears to be much higher than in the schools in prosperous suburban and rural areas. Research on turnover of mathematics teachers and reasons for their moving is suggested. Many able mathematics students reject teaching as a profession and research might indicate methods of overcoming this problem.

Many young teachers spend excessive hours on marking; HMI noted that this can cause ill-health, and instruction should be given in less rigorous, but effective methods of marking and assessment.
The Future

The wide variety of syllabuses, methods and philosophies of mathematics teaching suggests the need for a dialogue between schools, employers, parents and pupils to decide broad objectives. This is opportune in view of the introduction of the Common System of Examinations now being planned and new syllabuses being devised.

In December 1981, MacGregor (42), Chairman of British Steel, expressed "concern as to whether the educational system was doing the job we needed. Britain is a converting country, and in order to maintain the standards of living ..... we have to export ....." Mr. MacGregor wondered, "if there was difficulty in maintaining our position because we are technologically illiterate ..... Those responsibility is this? It must be the responsibility of those who are in the education system from which we spring."

In 1981 the problems of the inner cities and unemployment amongst school leavers have attracted much publicity. New initiatives are being taken to divert more resources to the problems and revised training schemes (41) planned for the very large numbers of young people involved. These trainees, while hoping ultimately for permanent employment, must maintain and improve their standards in numeracy and it is felt that the material contained in 'Apprentice Maths' would most adequately form the basis for any courses in mathematics at Colleges of Further Education or other training establishments.

It is hoped that the work done in this project in evaluating 'Apprentice Maths' will enable the reader to appreciate the value of the teaching material and the role it can play in helping students to prepare for employment. Obviously the situation for the school leaver is very much worse in 1982 than when this project began, but work must continue to improve the standards in mathematics of school leavers so that employers hold the students in higher regard and are more inclined to recruit the maximum number of apprentices.
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<td>Johnson D. et al.</td>
<td>&quot;Disaffected Pupils.&quot;</td>
<td>DES/Educational Studies Unit, Brunel University.</td>
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APPENDIX 1

An Engineering Instructor's Report
on the arithmetical ability of Craft Trainees,
including his own tests and results.
The Instructor's lesson notes are also included.
Arithmetical Ability of Craft Trainees

Report by EITB Instructor

1. Introduction

There have been many instances during the past four years where the lack of arithmetical ability of trainees has been a hindrance to Craft Training.

A trainee employed on lathes was having great difficulty in turning work to given dimensions. Investigation revealed that this was due to his inability to divide accurately by two. He was able to determine the amount of metal to be removed, but was unable to obtain accurately the depth of cut necessary.

In order to establish how widespread the problem might be, all the trainees were subjected to a simple arithmetical test.

2. Test

All Engineering Craftsmen have, on many occasions, to carry out the following arithmetical operations.

(a) Addition and subtraction of vulgar fractions.
(b) Multiplication and division of vulgar fractions.
(c) Addition and subtraction of decimal fractions.
(d) Multiplication and division of decimal fractions.

The Test Paper was set, using numbers which would cancel.

This enabled knowledge of principles to be established in preference to the testing of the ability of trainees to manipulate complex numbers. A copy of the Test Paper is given.
The total number of trainees who attempted the test was 237. The time allowed for completion was 20 minutes. As the test took place during the 14th week of the training year, all the trainees who attempted the test had been attending Technical College, as part-time day students, for a period of 12 weeks.

3. Results
Table 1 shows the number of trainees who obtained the same percentage mark, while Table 2 shows the number of trainees who answered the questions correctly, the number who answered incorrectly, and the number of trainees who did not attempt the questions.

4. Conclusion
The results show that the areas which cause the most difficulty are multiplication and division, eight trainees obtaining below 10%, and four of these were not successful in answering any question correctly.

It would appear from the results that Technical Colleges commence the courses with an assumption that trainees possess a certain amount of arithmetical ability.

Training Centres commence training with the same assumption.

It is not suggested that any trainee should be denied the opportunity of receiving craft training as a result of such a test, but his progress on arithmetical remedial work should be taken into consideration, along with his ability on practical work when deciding his suitability for continued craft training.
5. **Recommendations**

All trainees, on entering the Centre, would be subjected to arithmetical tests and tests to indicate his arithmetical potential.

Remedial arithmetical training to be given, according to a predetermined programme.

Any trainee failing to make satisfactory progress during remedial work to be given serious consideration with regard to his suitability for continued craft training.
EITB Arithmetic Test

Complete the following questions and write the answer in the space provided.

1. Add together the following vulgar fractions
   \[ \frac{3}{32}; \quad \frac{5}{8}; \quad \frac{1}{16}; \]

2. Subtract \( \frac{5}{32} \) from \( \frac{27}{64} \)

3. Add together the following decimal fractions
   \[ 1.099; \quad 0.036; \quad 0.701 \]

4. Subtract 1.987 from 11.084

5. Multiply \( \frac{8}{39} \) by 3\( \frac{1}{2} \)

6. Divide \( \frac{39}{128} \) by \( \frac{3}{8} \)

7. Multiply 4.032 by 0.75

8. Divide 2.075 by 0.2
9.

The sketch shows two holes.
Calculate the values of 'A' and 'B' dimension.

![Diagram showing two holes with dimensions]

9.

10.

Calculate the value of the dimensions marked 'X', 'Y' and 'Z' on the above template.

![Diagram with dimensions labeled X, Y, and Z]
THE SUBTRACTION SIGN - SHOWS THAT THE NUMBER BEHIND IT, IS TAKEN AWAY FROM THE NUMBER IN FRONT OF IT. THUS 12-4 MEANS THAT 4 IS TO BE SUBTRACTED FROM 12 i.e. 12-4 = 8 or \( \frac{12}{8} = 4 \)

\[
\begin{align*}
\text{SUBTRACT.} & \quad 28.764 \text{ FROM } 37.59316 \text{ or } 37.59316 - 28.764 \\
& \quad 37.59316 \\
& \quad - 28.764 \\
& \quad 8.82916
\end{align*}
\]

SOLVE. \[
9.976 - 19.863 + 11.432 + 0.375
\]
FROM BODMAS ALL ADDITIONS MUST BE DONE FIRST.
\[
\begin{align*}
\text{ie.} & \quad + 9.976 \quad \text{now } 21.783 \\
& \quad + 11.432 \quad - 19.863 \\
& \quad + 0.375 \quad \underline{1.920} \quad \text{(ANS.)} \\
& \quad 21.783
\end{align*}
\]
SOLVE THE FOLLOWING

1. \( 3.663 - 1.788 = \)
2. \( 1.003032 - 0.07063 = \)
3. \( 2.3785 - 0.6070 - 1.2375 = \)

4. \( A = 5.1875 \)
   \( 7.250 \)

5. \( 0.500 \)
   \( 2.875 \)
   \( 1.375 \)

6. \( B = 2.375 \)
   \( D/A \)
   \( A = 1.3125 \)
   \( 3.125 \)

7. \( 18 - 7 + 10 - 12 - 6 = \)

8. \( 2.125 - 8 + 200 - 24 = \)

9. \( 64 \)
   \( 18 \)
   \( B = 26 \)
   \( 10 \)

10. \( A = \)
    \( 2.742 \)
    \( 0.615 \)
    \( 0.812 \)
    \( 0.817 \)
    \( 4.904 \)
    \( 1.555 \)
    \( 0.746 \)
MULTIPLICATION. \( \times \) (TImes.)

When one number is multiplied by another the sign \( \times \) is placed between the numbers. Thus \( 6 \times 4 \) means \( 6 \) multiplied by \( 4 \) or \( 6 \times 4 \) or the product of \( 6 \) and \( 4 \).

\[ 6 \times 4 = 24 \]

The number preceding the \( \times \) sign is called the \textbf{multiplicand}.

The following \( \times \) is called the \textbf{multiplier}.

The final result is called the \textbf{product}.

Moreover since \( 6 \times 4 = 4 \times 6 \), the multiplicand & the multiplier are seen to be interchangeable.

The two numbers themselves are called \textbf{factors} of the number denoting the product.

Multiply: \( 15 \times 12 \)

\[
\begin{array}{c}
15 \\
12 \\
\hline
180
\end{array}
\]

Now \( 12.75 \times 6.7 \)

\[
\begin{array}{c}
12.75 \\
6.7 \\
\hline
89.25 \\
76.50 \\
\hline
854.25
\end{array}
\]

Count number of digits after decimal point = 3

Ignore decimal point

Refer to question for number of decimal places 3, in answer count 3 digits from right hand side & put in decimal point.
MULTIPLICATION

1. \( 90 \times 6 \)
2. \( 4.032 \times 0.75 \)
3. \( 10.375 \times 0.2 \)
4. CALCULATE THE AREAS

(a)

(b)

5. FIND THE TOTAL WEIGHT OF THIS BAR IF IT WEIGHS 2.725 LBS/IN

6. \( 97.674 \times 6.937 \)

7. IF A MAN EARNs 67.45p/HR. HOW MUCH DOES HE EARN IN 695.75 HRS
DIVISION. ÷ (divide.)

When one number is divided by another, the sign (÷) is placed between the numbers. Thus 8 ÷ 2 means 8 divided by 2 or how many times will 2 go into 8? or 2) 8.

Such division is often expressed by writing the two numbers in a fractional form, i.e. \( \frac{8}{2} \). This is the short way of writing the division 8 \( \div \) \( 8 \)

\[ \frac{2}{2} \]

The number preceding the sign of division is called the dividend, the number following it is called the divisor and the result is called the quotient.

Divide \( \frac{57}{3} \) or \( \frac{57}{3} \) or \( 3 \) \( ) \frac{57}{3} \)

\[
\begin{array}{c}
3 ) 57. \\
3 \\
27 \\
27 \\
00
\end{array}
\]

Solve \( \frac{194}{15} \)

\[
\begin{array}{c}
15 \cdot 933 \\
15 \cdot 194 \cdot 000 \\
44 \\
30 \\
140 \\
135 \\
50 \\
45 \\
50 \\
45 \\
5
\end{array}
\]

\[
\begin{array}{c}
= 1 \times 15 \\
= 2 \times 15 \\
= 9 \times 15 \\
= 3 \times 15 \\
= 3 \times 15
\end{array}
\]

It will be seen that 3 is recurring.
NOW \textsc{solve} \[ 29.63 \div 9.4 \] CORRECT TO 3 PLACES OF DECIMALS.

9.4) 29.63

IT WILL BE SEEN THAT THE DIVISOR 9.4 MUST ALWAYS BE MADE INTO A WHOLE NUMBER \( \text{i.e.} \ 9.4 \times 10 = 94 \).

94) 296.3

WE MUST NOW DO THE SAME TO THE DIVIDEND \( \text{i.e.} \ 29.63 \times 10 = 296.3 \).

\[ \begin{array}{c|c|c}
\text{3} & \text{1} & \text{5} \\
\hline
94) & 296.3 & 000 \\
\text{2} & \text{8} & \text{2} \\
\hline
& 1 & \text{4} \\
& 9 & \text{4} \\
\hline
& & 4 \text{9} \text{0} \\
& & 4 \text{7} \text{0} \\
\hline
& & 2 \text{0} \text{0} \\
& & 1 \text{8} \text{8} \\
\hline
& & 1 \text{2} \text{0} \\
& & 9 \text{4} \\
\hline
& & 2 \text{6} \\
\end{array} \]

\[ = 3 \times 94 \]
\[ = 1 \times 94 \]
\[ = 5 \times 94 \]
\[ = 2 \times 94 \]
\[ = 1 \times 94 \]

IN THIS CASE THE ANSWER CORRECT TO 3 PLACES OF DECIMALS IS. \( \text{3.152} \). IT WILL BE SEEN THAT THE LAST DIGIT (1) HAS BEEN IGNORED BECAUSE IT IS LESS THAN 5. IF THE ANSWER HAD BEEN \( \text{3.1526} \), THEN THE ANSWER CORRECT TO 3 PLACES OF DECIMALS WOULD HAVE BEEN \( \text{3.153} \), BECAUSE 6 IS GREATER THAN 5.
1. DIVIDE 64 BY 8
2. DIVIDE 81 BY 9
3. 2.075 ÷ 5
4. 6.945 ÷ 0.3
5. 74 ÷ 6.74
6. 53.984 ÷ 6.73
7. CALCULATE THE CROSS SECTIONAL AREA IF THE TOTAL VOLUME IS 175.78 ins³

8. IF THE TOTAL AREA = 273.6 ins², FIND X.

9. IF THE TOTAL VOLUME = 104.7 ins³, FIND X.

10. FIND CENTRE DISTANCE BETWEEN ADJACENT HOLES
CONVERSION OF DECIMALS INTO FRACTIONS

Take the decimal part of the number and make it into a whole number. E.g. 0.875 becomes 875 and call this the numerator. OR the denominator put down one (1) and then one nought (0) for each place of decimal. Then cancel if possible.

3. 0.875 to be converted to a fraction.

\[
0.875 = \frac{875}{1000} = \frac{7}{8}
\]

Or 0.765 = \frac{765}{1000} = \frac{153}{200}
APPENDIX 2

Some uses of Mathematics in the Aero-Engine Industry - notes and sample calculations
Some Uses of Mathematics in the Aero-Engine Industry

The complexity of an aero-engine makes it unsuitable for unskilled mass production, unlike less sophisticated equipment such as motor cars, etc.

The exceptional accuracy needed to meet guaranteed requirements for aircraft performance, weight and safety demand a very skilled labour force and a supply of numerate apprentices from local schools.

Ability in mathematics was regarded by the Company as the most important academic requirement when recruiting apprentices, C.S.E. Grade 3 in mathematics being the minimum standard acceptable, for the main craft apprenticeships.

One hundred and twenty apprentices were recruited annually to maintain a shop-floor work force of 12,000.

(There were also opportunities for entry as a mechanical or electronic engineering apprentice with A/O levels and for Undergraduate Apprenticeship for those with University Entry Qualifications.)
Illustrating the use of latches on the turbine disc and separate locking plates for securing the shrouded turbine blades.

TURBINE FAILURE

SUCH FAILURE MIGHT BE CAUSED BY INACCURACY IN MANUFACTURE.
The Need for Accuracy

Safety

Faults in aero-engines can cause disasters costing many lives and millions of pounds. Although rare, engines can fail in the turbines, as shown opposite, and these faults may result from inaccuracy in the reading of gauges, or measuring errors during manufacture and assembly.

The lower picture shows the 'fir tree' roots of turbine blades, which need precision machining to ensure the correct weight and fit. The blades are individually weighed and selectively assembled to obtain an evenly balanced blade/disc assembly. (A disc assembly spinning at 13,000 r.p.m. must be perfectly balanced to prevent stress cracking, leading to 'explosion' of the disc and a possible disaster).

Cost

The high temperatures in the engine e.g. 2,000\(^\circ\)K in the combustion chambers, require very special alloys; waste of these precious metals by poor calculations must be kept to a minimum.

A machinist making a faulty measurement or calculation can easily scrap a part which had cost several thousand pounds to reach that stage in production (material plus previous labour costs.)
MACHINING

PRECISION BORING

Figure 19-24  Bearing housing repair by fitting liner
BRIEF DESCRIPTION OF SOME OF THE SKILLED WORK AVAILABLE TO CRAFT APPRENTICES

Machining

This covers milling, turning, boring and grinding. The apprentice will need calculations involving linear and rotational speed ($\pi$, circumference, diameter, radius and r.p.m.) to set the machine r.p.m. according to the type of metal being cut.

The machinist will continually inspect his work using instruments (micrometer, depth gauge, calipers etc.) and must read them quickly and accurately. He works from an engineering drawing and may need to make additional calculations using trigonometry, Pythagoras etc.

The lower diagram shows the time tolerances sometimes demanded (to within .0005 or $\frac{1}{2}$ a thousandth of one inch). Therefore, great emphasis on the use of decimals to four places, at least, is required.

More details on this work are given in the sample calculations from the Tool-room (Appendix ).
Assembling turbo-jet engines — vertical

Torque tightening
Assembly (Fitting)

Fitters generally work in teams of two or three and assembly of one engine will take weeks rather than days. At various stages, inspection of clearances is made using measuring instruments (feeler gauges, depth gauges etc.) Inaccurate clearances could result in either vibration or a danger of fire due to friction; excessive clearances also cause loss of efficiency resulting in high fuel consumption to obtain a given power output.

The large outer casings shown left are secured by numerous bolts; the positioning of the bolt holes is critical, as is their tightening using a torquemeter (shown below). Overtightening can cause stretching and failure of the bolt, undertightening could result in a loose casing and possible disaster.
ENGINE TESTING

USE OF
BOTH MANUAL
AND
COMPUTER
DATA RECORDING

ACCURATE READING OF SCALES IS ESSENTIAL,
WITH RAPID 'ROUNDING-OFF'

MECHANICAL RIG TESTING

FUEL FLOW

41. Although the amount of fuel consumed during a given flight may vary slightly between engines of the same type, fuel flow does provide a useful indication of the satisfactory operation of the engine and of the amount of fuel being consumed during the flight. A typical system consists of a fuel flow transmitter, which is fitted into the low pressure fuel system, and an indicator, which shows the rate of fuel flow and the total fuel used in gallons, pounds or kilograms per hour (fig. 17-11). The transmitter measures the fuel flow electrically and an associated electronic unit gives a signal to the indicator proportional to the fuel flow.
Testing (Fitter/Tester)

The fitter/tester is generally a former craft apprentice employed on the rig testing of component parts or on testing complete engines on the test beds.

Apart from the installation of the component or engine, the fitter/tester must carry out the schedule of tests specified by the development engineer (a graduate/HND/HNC).

The testing involves the monitoring and recording of an array of dials and gauges similar to an aircraft cockpit. Usually one or two testers read the gauges, another records the readings while a fourth plots them on a graph, superimposed on expected results. Any severe departure from the predicted performance may mean extra running time and great expense.

Readings must be made rapidly to minimise fuel which is used in huge quantities on the test beds.

Maths Skills involved:-

- Accurate reading of flowmeters, pressure, temperature gauges, thrust meters etc. and familiarity with units.
- Rounding off to required accuracy.
- Neat and accurate tabulation of results and correction (multiplication or division by a fixed constant to correct to standard atmospheric conditions of temperature and pressure).
- Plotting and interpretation of straight line graphs and curves.
- Ability to input data to computer and interpret computer output.
Screw type micrometers  
(to ± .0001)

Electronic micrometer  
(to ± 0.0001 or 0.002 mm)

**COMBINATION SETS**

The combination set consists of:

1. **Rule**—Hardened and accurately graduated in 0.001 mm, 0.002 mm, and 0.005 mm.
2. **Screw Type**—Graduated in 0.001 mm, 0.002 mm, and 0.005 mm.
3. **Protractor**—Graduated to read from 0 to 180° in both directions and fitted with spirit level.

**METRIC MICROMETERS**

Reading in Hundredths of a Millimetre (0.01 mm).

Metric micrometers can be read to one hundredth of a millimetre (0.01 mm). As the screw on metric micrometers has a pitch of 0.025 mm, two revolutions of the thimble will move the spindle through 1 mm.

On the sleeve the datum line is graduated with two sets of lines—the set below the line reading in millimetres and the set above the line reading in half millimetres. (N.B. On earlier models the millimetres are graduated above the datum line with half millimetres below.)

The thimble scale is marked in 0.1 mm equal divisions, figured in lines, so that each small division on the thimble represents 0.01 of 0.1 mm, which equals 0.001 mm, 0.002 mm, etc.

To read the metric micrometer, first note the whole number of millimetre divisions on the sleeve (MAJOR divisions) then observe whether there is a half millimetre visible (MINOR divisions) and lastly read the thimble for hundredths (THIMBLE divisions), i.e. the line on the thimble coinciding with the datum line.

**Example:**

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Minor Divisions</th>
<th>Thimble Divisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 x 0.01 mm</td>
<td>0.000 mm</td>
<td>0.01 mm</td>
</tr>
</tbody>
</table>

Reading = 10.06 mm.
Inspection

While this is increasingly being undertaken by the skilled machinist etc. it is still the task of the inspector to check that finished components or assemblies conform to the limits of accuracy specified on the engineering drawing.

A range of measuring equipment is used such as micrometers, depth gauges, slip gauges, engineer's protractors etc. as shown opposite.

Often complex additional calculations must be made, similar to those described in the Appendix on the tool-room calculations i.e. Trigonometry, Pythagoras, etc.
Sample Calculations performed by a Craftsman in the Tool-Room

Second year apprentices spend time in this department gaining experience in the various skills needed to complete the mandatory E.I.T.B. modules. The work involves one-off jobs which need very accurate setting up and constant use of mathematics to calculate additional dimensions not provided on the engineering drawing. The following pages include actual calculations, typical of the standard required.

The first page overleaf shows a section of an engineering drawing, to familiarise pupils with the symbols and methods used e.g.

1. $1.000 = 1$ inch $25.4 = 25.4$ mm.

2. $40$ m/m ($1.5748$) gives the conversion m.m. to ins. often needed in setting up on an older machine. (Conversion tables are also provided).

3. $0.395$ $0.385$ This means the finished measurement must lie within the limits of $\frac{395}{1000}$ to $\frac{395}{1000}$ inches 
   i.e. a variation of $\frac{10}{1000}$ ($\frac{1}{100}$) ins. 
   is permissible without scrapping the component.

4. $\varnothing 2.000$ means a diameter of $2.000$ ins. 

5. $R.125$ means a radius of $0.125$ or $\frac{1}{8}$ ins.

The later examples show that the use of millimetres (e.g. $25.4$) is becoming the standard for the long term, but apprentices must know both systems for the foreseeable future.
### DECIMAL EQUIVALENTS

**FRACTIONS OF AN INCH EXPRESSED AS DECIMALS AND MILLIMETRES**

<table>
<thead>
<tr>
<th>Fractional inch</th>
<th>Decimal inch</th>
<th>mm.</th>
<th>Fractional inch</th>
<th>Decimal inch</th>
<th>mm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/64</td>
<td>0.015625</td>
<td>0.3969</td>
<td>3/32</td>
<td>0.09375</td>
<td>2.3813</td>
</tr>
<tr>
<td>1/32</td>
<td>0.03125</td>
<td>0.7938</td>
<td>7/32</td>
<td>0.21875</td>
<td>5.5703</td>
</tr>
<tr>
<td>1/16</td>
<td>0.0625</td>
<td>1.5875</td>
<td>9/32</td>
<td>0.28125</td>
<td>7.4688</td>
</tr>
<tr>
<td>5/64</td>
<td>0.078125</td>
<td>1.9844</td>
<td>11/32</td>
<td>0.34375</td>
<td>8.7875</td>
</tr>
<tr>
<td>3/16</td>
<td>0.125</td>
<td>3.175</td>
<td>1/8</td>
<td>0.5</td>
<td>12.7</td>
</tr>
<tr>
<td>7/64</td>
<td>0.140625</td>
<td>3.5719</td>
<td>15/64</td>
<td>0.228125</td>
<td>5.7938</td>
</tr>
<tr>
<td>1/4</td>
<td>0.25</td>
<td>6.35</td>
<td>1/4</td>
<td>0.25</td>
<td>6.35</td>
</tr>
<tr>
<td>17/64</td>
<td>0.265625</td>
<td>6.7469</td>
<td>23/64</td>
<td>0.390625</td>
<td>9.9219</td>
</tr>
<tr>
<td>5/32</td>
<td>0.3125</td>
<td>7.9375</td>
<td>29/64</td>
<td>0.453125</td>
<td>11.2094</td>
</tr>
<tr>
<td>3/16</td>
<td>0.375</td>
<td>9.525</td>
<td>1/2</td>
<td>0.5</td>
<td>12.7</td>
</tr>
<tr>
<td>5/16</td>
<td>0.4375</td>
<td>11.125</td>
<td>15/32</td>
<td>0.46875</td>
<td>11.9063</td>
</tr>
<tr>
<td>3/8</td>
<td>0.46875</td>
<td>12.5</td>
<td>21/32</td>
<td>0.515625</td>
<td>13.0969</td>
</tr>
<tr>
<td>7/16</td>
<td>0.578125</td>
<td>14.875</td>
<td>27/32</td>
<td>0.609375</td>
<td>15.4781</td>
</tr>
<tr>
<td>1/2</td>
<td>0.625</td>
<td>15.875</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conversion Tables used by Craftsmen**

(Extending to 30 pages)
DET 1-1 OFF - 851476 HE 30 WP
REMOVE SHARP EDGES.
PROBLEM 1

FIND DIMENSION 'Y' (ALL MM):

\[ Y = 145 - (35 + 35) \]
\[ = 145 - 70 \]
\[ Y = 75 \text{ mm} \]

PROBLEM 2

FIND INCLUDED ANGLE \( x^\circ \) GIVEN THAT

DIAMETER REDUCES BY 0.5260 IN 25.4 LENGTH

(0.5260 = 0.5260 mm)

REDUCTION IN RADIUS = 0.5260 \( \div \) 2

= 0.2630 mm

\[ \tan \Theta = \frac{\text{OPP}}{\text{ADJ}} \]

\[ \tan \Theta = \frac{0.2630}{25.4} \]

\[ \Theta = 0.5932 \]

\[ \therefore \text{INCLUDED ANGLE = 1.1864}^\circ = 1^\circ 11' 11" \]

N.B. IN PRACTICE 7 FIGURE LOG. TABLES OR
CALCULATOR WILL BE USED
1. Knowledge of geometry is required to establish the angles 1 and 2 of 23°30'.

2. Simple equation method to obtain "9.2 x Sin23°30'".

3. Knowledge of "BOMDAS" to complete calculation.

\[
x = 9.2 \times \sin 23°30' + [5.5 \times \cos 23°30'] + 9.5 \text{ etc.}
\]

\[
y = 9.2 \times \cos 23°30' + [20.5 \times \sin 23°30'] + 9.5 \text{ etc.}
\]
Are Apprenticeships open to males and females
Yes.

Will I be able to study for Technician qualification at College?
Yes if you have CSE grade II’s (or ‘O’ level equivalent) in Maths and a suitable science subject and English (or English based subject).

Is it possible to transfer from Craft to Technical training?
Yes, if your progress in Company and at College indicated that you would be better suited to the Technical Training Scheme you would be considered for regrade.

When would I start my training?
Apprentice intakes are in September each year.

Will I need to supply overalls?
No, the Company provide overalls and launder them each week.

What about safety shoes?
These are also provided (one free issue per year).

Are there prizes for apprentices who do well?
All apprentices are considered for prizes, awards and competitions at various stages in their training.

When should I apply?
Early in your final year at school.

To whom should I apply?
Superintendent Works Training, Mickleover Training Centre, Derby.
invited to express their preferences for the various trades and offers of apprenticeship identify the trade for which they have been selected.

Are there an equal number of vacancies for each trade?
No. The majority of the vacancies are for the machining skills, Turning, Milling and Grinding.

Will I be involved in shift work?
Yes. After the first year you may be asked to work shifts which would involve early starting and unusual finishing times. This should be borne in mind when considering travel arrangements.

What qualifications can I expect to achieve during my training?
At the end of training you will be a Skilled Engineering Craftsman. Providing you have been successful in your studies you will have obtained the following certificates:
(1) Engineering Industry Training Board Certificate of Engineering Craftsmanship.

Who pays my College fees?
The Company pay all fees for day or block release courses.

Right: Using a vertical milling machine

Use of constructions with compasses, radius, diameter circumference, areas and volumes of circle, cone, frustum, conic sections i.e. parabola, hyperbola, ellipse, for pipe joints. Use of 'nets' in fabricating shapes from flat sheetmetal.
While the foregoing covers the main areas in which craft apprentices are employed, there are other specialised skills within the Company requiring high numerical ability:

**Patternmaking**

The wood or metal pattern is used to make the mould into which molten metal is cast. Because metals contract after casting the pattern must be made oversize; the pattern-maker has a special set of measuring instruments graduated to allow for this e.g. 1.000 read from his rule may physically be 1.125 ins.

**Sheetmetal work**

In fabricating components from thin sheet, the craftsmen must use construction with compasses etc. for marking out. In addition to trigonometry, he will use areas and volumes of circles, cones, cylinders etc. and the 'net' for various shapes. An awareness of the conic sections may be involved in pipe joints.

**Electrician**

In addition to reading the scales of ammeters, voltmeters, etc. the electrician will make use of standard formulii, with substitution and changing the subject.

\[ E = I R \]

\[ \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \]
### THE INTERNATIONAL STANDARD ATMOSPHERE (I.S.A.)

<table>
<thead>
<tr>
<th>Altitude (h)</th>
<th>AMBIENT TEMPERATURE (To)</th>
<th>AMBIENT PRESSURE (Po)</th>
<th>SPEED OF SOUND (a0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>Deg. K.</td>
<td>Deg. C.</td>
<td>Deg. F.</td>
</tr>
<tr>
<td>0</td>
<td>290.13</td>
<td>-16.98</td>
<td>62.6</td>
</tr>
<tr>
<td>1,000</td>
<td>288.45</td>
<td>15.00</td>
<td>59.0</td>
</tr>
<tr>
<td>2,000</td>
<td>286.17</td>
<td>13.02</td>
<td>55.4</td>
</tr>
<tr>
<td>3,000</td>
<td>284.19</td>
<td>11.04</td>
<td>51.9</td>
</tr>
<tr>
<td>4,000</td>
<td>282.21</td>
<td>9.06</td>
<td>48.3</td>
</tr>
<tr>
<td>5,000</td>
<td>280.23</td>
<td>7.08</td>
<td>44.7</td>
</tr>
<tr>
<td>6,000</td>
<td>278.24</td>
<td>5.09</td>
<td>41.2</td>
</tr>
<tr>
<td>7,000</td>
<td>276.26</td>
<td>3.11</td>
<td>37.6</td>
</tr>
<tr>
<td>8,000</td>
<td>274.28</td>
<td>1.13</td>
<td>34.0</td>
</tr>
<tr>
<td>9,000</td>
<td>272.30</td>
<td>-0.85</td>
<td>30.5</td>
</tr>
<tr>
<td>10,000</td>
<td>270.32</td>
<td>-2.83</td>
<td>26.9</td>
</tr>
<tr>
<td></td>
<td>268.34</td>
<td>-4.81</td>
<td>23.3</td>
</tr>
</tbody>
</table>

### TECHNICAL SPECIFICATION FOR AN ENGINE

#### TAKE-OFF
- **Power**: 4,220 s.h.p., 1,235 lb. thrust
- **Total equivalent power**: 4,695 t.e.h.p.

#### REPRESENTATIVE CRUISING
- **25,000 ft., 425 m.p.h.**
  - **Power**: 2,350 s.h.p., 152 lb. thrust
  - **Total equivalent power**: 2,553 t.e.h.p.
  - **Specific fuel consumption**: 0.405 lb./hr./t.e.h.p.

#### WEIGHT
- **Net dry weight**: 2,023 lb.
- **Specific weight**: 0.431 lb./t.e.h.p.

#### DIMENSIONS
- **Length to cone fitting line**: 100.25 in.
- **Height including oil cooler**: 45.75 in.
- **Width over intake fairing**: 40.5 in.

#### PROPELLER REDUCTION GEAR
- **Ratio**: 0.064 to 1
Technical Work

Transfer from Craftsmen to Technician

While much of the theoretical work in research and development is done by engineers of degree/HND level, there is encouragement for craft apprentices to transfer to technical work in areas such as service and testing.

Metric and Imperial Units etc.

A great variety of units is used, which the service engineer in particular must be familiar with (opposite page).

Also illustrated is the use of metric and imperial units.

The atmospheric data shows the need for ability with negative numbers.

Also shown is the propeller reduction gear ratio of 0.064 to 1.

<table>
<thead>
<tr>
<th>Technical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions.—Diameter 42.2 in. (107.2 cm.); length, with jet pipe, 122.0 in. (310.0 cm.); without jet pipe, 102.1 in. (259.3 cm.).</td>
</tr>
<tr>
<td>Weight.—Dry, 2,460 lb. (1,116 kg.).</td>
</tr>
<tr>
<td>Performance.—Maximum sea level static thrust, 8,000 lb. (3,629 kg.); at a specific fuel consumption of 0.955 lb/hr./lb. (0.955 kg/hr./kg.).</td>
</tr>
</tbody>
</table>

USE OF METRIC AND IMPERIAL UNITS
USE OF %
(APPORTIONING AIRFLOW)

USE OF LINE GRAPHS

VARIATION OF PARAMETERS THROUGHOUT THE ENGINE
Percentages

Shown opposite is the use of % in apportioning airflow through the engine; % is also the standard method of describing improvements in performance, especially fuel consumption. This is the overriding aircraft performance requirement, as reducing fuel used for a given power output enables more passengers to be carried.

Straight Line Graphs (and Curves)

This is the standard method for presenting information at meetings (by overhead projector) and in sales performance brochures. All students must have good knowledge of scales, best fit of lines through points, and extrapolation to predict future trends. At the research level, it is necessary to develop equations to correlate with actual data obtained from testing.

Guaranteed engine performance, as specified graphically in a brochure, is a legally binding contract and failure to meet the standards can result in large compensation payments to the airline/customer.
Therefore, given that the jet pipe—

OUTLET Area \( (A) = 651 \text{ sq. in.} \)

Pressure \( (P) = 21 \text{ lb. per sq. in. (gauge)} \)

Velocity \( (v) = 643 \text{ ft. per sec.} \)

Mass flow \( (W) = 153 \text{ lb. per sec.} \)

The thrust = \( A \times P + \frac{Wv}{g} - 14,326 \)

\[
= 651 \times 21 + \frac{153 \times 643}{32} - 14,326 \\
= 16,745 - 14,326 \\
= 2,419 \text{ lb. of thrust in a forward direction.}
\]

Propelling nozzle

19. The conditions at the inlet to the propelling nozzle are the same as the conditions at the jet pipe outlet, i.e. 16.745 lb.

Therefore, given that the propelling nozzle—

OUTLET Area \( (A) = 332 \text{ sq. in.} \)

Pressure \( (P) = 6 \text{ lb. per sq. in. (gauge)} \)

Velocity \( (v) = 1.917 \text{ ft. per sec.} \)

Mass flow \( (W) = 153 \text{ lb. per sec.} \)

The thrust = \( A \times P + \frac{Wv}{g} - 16,745 \)

\[
= 332 \times 6 + \frac{153 \times 1.917}{32} - 16,745 \\
= 11,158 - 16,745 \\
\Delta = -5,587 \text{ lb. acting in a rearward direction.}
\]

**NOTE THE NEGATIVE THRUST**
Sample Technical Calculations

Shown opposite and on the following pages are random examples of performance calculations.

The mathematical topics involved include:-

1. Area of a circle, volume flow through a cylinder.
2. Ratio (pressure and temperature).
4. Changing the subject of a formula.
5. Substitution in standard formulii.
6. Straight line graphs, reading and interpretation, (also curves).
7. Negative number (e.g. reverse thrust).
8. Velocity, force, mass flow.
9. Use of non-dimensional quantities (Variations in aircraft altitude and speed mean that the engine receives air at widely varying pressure and temperature. By expressing the important parameters non-dimensionally, e.g. pressures as ratios, the performance can be examined independent of the inlet conditions).
10. Computer input and interpretation of output (a sample is included).

The graduate (or equivalent) engineer will also need to write his/her own programs and perform 'hand calculations' to validate the computer output. These are generally performed using desk electronic calculators, including the programmable type.

The ability to estimate, particularly in 'on-site' situations is very important.
The tasks undertaken by a competent Performance Engineer involve the specification, detailed analysis and reporting of many and varied engine tests plus the design of thermodynamic cycles for advanced engines. In order to be able to perform these jobs satisfactorily, the Performance Engineer needs to have the ability to carry out a numerical and statistical analysis of test data and to be able to understand the engineering significance of the results plus a sound knowledge of the thermodynamics of gas turbines. This involves a great deal of computer running, slide rule work and graph plotting.

Finally, it is essential that, having carried out the task in question, the Performance Engineer should be capable of writing a clear and concise report.

Senior Performance Engineer
Military Engines

This description also applies to numerous other research/development departments staffed by engineers, mathematicians and physicists possessing Ph.D., Degree, HND and a few HNC.
Instruction in the Drawing Training School

cont'd ..
Designers

The designer is generally qualified to degree/HND level and produces schemes representing complete assemblies, such as a compressor or a gearbox. Complex calculations are made by hand, log tables or computer. Some designers began their careers as craft apprentices, but the usual route is by drawing office, engineering or graduate apprenticeship (leaving school with O/A levels.)

Draughtsmen

Usually qualified to ONC/HNC/City and Guilds, the draughtsman transforms design schemes into detail drawings of separate components for manufacture on the factory floor.

The tool draughtsman designs special jigs and fixtures for holding the components during machining etc. and he plans the sequence of machining operations.

The draughtsman may start as a drawing office apprentice (O levels) although many were initially craftsmen on the shop floor (leaving school with CSE).

Mathematics used in the Drawing Office

Addition, subtraction, multiplication and division (calculators or 7 figure logarithm tables).

Areas, volumes (including PI etc.) weight, density, pressure, stress, velocity, temperature, bending moments, r.p.m.

Pythagoras, Trigonometry, Ratio (Gears).

All constructions using compasses.

Projection, conic sections, ellipses etc.
Summary of Mathematical Applications

The previous pages included the use of the following mathematical skills:

1. All operations with decimals, to at least 4 places \((\frac{1}{10})\) of a thousandth of an inch.
   and to two thousandths of a millimetre \((0.002\, \text{mm.})\).
2. Conversion of fractions to decimal.
3. Use of metric and imperial units.
5. Substitution in standard formulii.
6. Trigonometry, answers in D.M.S.
7. Pythagoras' Theorem, squares and square roots.
8. Areas and volumes.
9. BODMAS, order of executing mathematical steps.
10. Estimation and rounding off.
11. Diameter, radius, circumference, rotational speed, gear ratios.
13. Conic sections, projection.
14. Reading of scales, gauges and dials.
15. Use of 7 figure logarithmic tables and/or calculator.
17. Plotting of straight line graphs, selection of scales.
18. Correction of data by scale factors.

continued ..
Additional Topics more applicable to technicians/graduates (but not exclusive of all craftsmen)

1. Interpretation of graphs, best fit, extrapolation, correlation.
2. Percentages (% increase/decrease).
3. Transposition of more complex formulii.
4. Use of volume flow rates, velocity, etc.
5. Ratios of pressure, temperature.
6. Use of non-dimensional parameters.
7. Computer input/output, some programming.
APPENDIX 5

Samples of completed questionnaire
given to 132 5th Year Pupils
These questions are for statistics only. (Your name will not be used)

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chellaston, Derby etc.)

Primary School(s) (age 5-11yrs.)

Maths Set (e.g. 5A5, 4B3)

Maths Course (O, CSE or N.Ex.)

Hobbies

Your intended career (or put 'not decided')

At what age did you decide on this career?

Reasons for choosing this career

Parent's job (leave blank if you prefer)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school life.

Please do not mention any teacher's name.

**Do NOT answer the questions below**

Final exam results in mathematics .............

Employment/Further Education .....................
METHODS OF DOING THINGS AND THIS ONLY CONFUSES PUPILS)

Those who have an obvious ability for mathematics should be encouraged, in some cases given special maths to meet their requirements. They should also be "stretched" so that they work to their full ability.

Those who are good at maths or at any subject, should be allowed to take their O-level in that subject one year early. Not only would this provide the incentive to work but it would also take some pressure of the person in the O-levels the year after.

If possible top groups should be made smaller as in the larger groups there is still a large gap in ability. Another thing is that often a pupil has just grasped a new theory when the teacher stops the whole class just to explain the theory to a few slow ones. By the end of which the original pupil is left completely baffled and has completely forgotten how to do the specific question.

Mark Farishan 4th Year
O-level pupil
These questions are for statistics only. (Your name will not be used) NAME Richard T..............
FORM AS.................

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chellaston, Derby etc.)
Shelton Lock

Primary School(s) (age 5-11yrs.) attended
Boulton Primary
Shelton Infants Primary

Maths Set (e.g. 5A5, 4B3)
4B1

Maths Course (O, CSE or N.Ex.)
'O'

Hobbies

Your intended career (or put 'not decided')

At what age did you decide on this career?

15

Reasons for choosing this career

I think I would enjoy this type of work.

Parent's job (leave blank if you prefer)

Assistant Foreman (British Rail)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school life.

I think that maths could be improved by adding a little variety. The only thing I was taught were the basic £4-

When I made the step from Primary to Secondary I found that as I had only been doing the basics for the past P.T.O

(b) Secondary School

I am satisfied with the way Maths is taught in Secondary School.

Do NOT answer the questions below

Final examination result in mathematics

Employment/Further Education
years a lot of time was wasted on doing things that we could each
agree that a good base in any subject is essential but I feel that
Primary school as one only did the same things day after day one
boring. If we had been tested more at this level by the intro-
in of new branches of maths then time would not have been wasted
Secondary school.

Think things like simple algebra and some of the simpler mathematical
would be taught at this stage so I think that they could only be
to pupils and also the earlier you start something in your life the
you have to become good at it.
These questions are for statistics only. (Your name will not be used)

NAME: Gary Simcox
FORM: 31

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chellaston, Derby etc.)

Primary School(s) (age 5-11yrs.) attended

Maths Set (e.g. 5A5, 4B3)

Maths Course (O, CSE or N.Ex.)

Hobbies

Your intended career (or put 'not decided')

At what age did you decide on this career?

Reasons for choosing this career

Parent's job (leave blank if you prefer)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school life.

Please do not mention any teacher's name.

I think that they should have stricter discipline and I think the more time should be spent on the subject that they are taking.

Do NOT answer the questions below teachers who are not

Final examinations result in mathematics

Employment/Further Education

CONTINUED OVERSIDE
the teacher should look as though they are interested in the subject. Also you get teachers who are very strict and some that are very soft and this is wrong because if the strict person is too strict he or she will probably be too scared to do the work and so in the end they will be not interested in the lesson. If you had a soft teacher at the beginning of school life and you found out that he was not interested, the children in the class will just take advantage of it and so in the end the class will just feel about it so no more work will be done until another lesson starts. So what I am saying is that when it is the children's first day at school the teacher should be strict but fair so that the class knows that the teacher will do something about it if the children do not feel about it. Also I think that the teachers should spend more time on one subject so that the children will be able to understand on what the teacher is talking about. So this leads on to another one where a teacher is explaining how to do a very hard sum and you get some stupid kid who says "I don't know what he's doin', and this holds up the class as they try to work. Also, free with the method where a teacher says right, you can sit by a girl because this makes the girls get on together because then you have more mates to speak to and then you will find that the class will get good examination results, so that is another method. Also if the children are not exactly the punishment I think is either extra homework or probably extra lines probably 200 hundred to start with. Also I think that Mall's classes should have two teachers because if one teacher is explain to one person with him in a better sense than another.
UNIVERSITY OF LOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chellaston, Derby etc.)

Shelton Lock

Shelton Juniors

3A1

0

Sport, TV, Collecting

baddies and programmes

Not Decided

Parent's job (leave blank if you prefer)

works at BOC (dad)

Secretary for Western Texas (mum)

(a) Primary School

The basics should be taught more clearly and homework should be set in order to practice the basics.

(b) Secondary School

Complicated maths should be explained better and each piece of work should be talked about and discussed.

Do NOT answer the questions below

Final examina-' result in mathematics

Employment/Further Education
UNIVERSITY OF LOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)
NAME: Steven Wood
FORM: 5O

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chellaston, Derby etc.)

Primary School(a) (age 5-11yrs.) attended

Maths Set (e.g. 5A5, 4E3)

Maths Course (C, CSE or H.Ex.)

Hobbies

Your intended career (or put 'not decided')

At what age did you decide on this career?

Reasons for choosing this career

Parent's job (leave blank if you prefer)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school life.
Please do NOT mention any teacher's name.

Aston-on-Trend

Aston Primary school

5B2

CSE

Archery, shooting, modelling, electronics

Draughtsman, Technician

I wanted to do something along this line

Self-employed builder

(a) Primary School

In some primary schools, pupils have few qualifications and in some cases new teachers should be recruited or retrained.

(b) Secondary School

Introduction of apprentice maths at an earlier age.

Concentration on specific things such as sets (there should be left out of the syllabus)

Do NOT answer the questions below

Final examinations result in mathematics: GRADE J

Employment/Further Education: FORM
UNIVERSITY OF LOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chellaston, Derby etc.)

Primary School(s) (age 5-11yrs.) attended

Maths Set (e.g. 5A5, 4B3)

Maths Course (O, CSE or N.Ex.)

Hobbies

Your intended career (or put 'not decided')

At what age did you decide on this career?

Reasons for choosing this career

Parent's job (leave blank if you prefer)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school life. Please do not mention any teacher's name.

(a) Primary School

(b) Secondary School

Do NOT answer the questions below

Final examination: result in mathematics N.E.X.

Employment/Further Education FURNITURE TRADE?
UNIVERSITY OF LOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)

NAME DAVID BLYTHE
FORM S.H

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chelleston, Derby etc.)

Primary School(s) (age 5-11yrs.) attended

Maths Set (e.g. 5A5, 4B3)

Maths Course (O, CSE or N.Ex.)

Hobbies

Your intended career (or put 'not decided')

At what age did you decide on this career?

Reasons for choosing this career

Parent's job (leave blank if you prefer)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school life. Please do not mention any teacher's name.

(a) Primary School

(b) Secondary School

Do NOT answer the questions below Not so many kids in the classes.

Final examinations result in mathematics

Employment/Further Education
APPENDIX 4

Samples of Numeracy Tests
for pupils of varying abilities,
and destinations after Year 5
1. 1035 [Craft Apprentice] 11.3 x
   87
   .98
   9.88
   2000 ans /
   36
   390
   565
   3955 ans /

2. 1915
   201
   131.7
   243.3 ans /

3. 8885
   209
   6.75
   9769 ans /

4. 2181
   994
   784 ans /

5. 2131
   31.7
   1824 ans /

6. 888
   799
   89 ans /

7. 2880
   814
   1186 ans /

8. 729
   18
   7290
   5832
   13122 ans /

9. 109 ans /

10. 13 1417
    13
    117
    117
    000

11. 267 ans
    267
    2937
    22
    48
    66
    77
    77
    00

12. 671
    25.9
    1295
    698.195 ans
23.13 x 24

2

1915
201
317
2433

3

8885
209
675
9769
ans 9769

4

984
997
184

5

814
317
1824
799
089

6

2008
814
1186

7

113
36
565
3390
3955
CANDIDATE

SELECTED BY ARMY

WEAKNESS IN MATHS

THOUGH DISPLAYING ABILITY

SPORT, CAVING, "OUTWARD

OND", D.O.F. E. AWARD.

EXCELLENT CHARACTER

AND 100% ATTENDANCE

1. \[
\begin{align*}
35 & \times 30 = 1050 \\
157 & \times 6 = 942 \\
156 & \times 5 = 780
\end{align*}
\]

2. \[
\begin{align*}
814 & \div 7 = 116 \ldots 2
\end{align*}
\]

3. \[
\begin{align*}
675 & \div 209 = 3.214
\end{align*}
\]

4. \[
\begin{align*}
997 & \div 184 = 5.417
\end{align*}
\]

5. \[
\begin{align*}
174 & \div 1824 = 0.0952
\end{align*}
\]

6. \[
\begin{align*}
899 & \div 0.89 = 1000
\end{align*}
\]
NON-EXAMINATION

'Remedial' Maths, Yet
Obtained interview for
Craft Apprenticeship

3.41 - 3.11 = 0.3
6) 888 - 799
365
887
2937 ÷ 11 = 117

\[ \begin{align*}
\text{Q7} & : 1.295 + 671 + 25 = 627.01 \\
\text{Q8} & : 10.2 + 1.401 + 0.037 = 11.721 \quad \text{X} \\
\text{Q9} & : 16142 \\
\text{Q10} & : 4.2114 \\
\text{Q11} & : 1214 \times \quad \text{X} \\
\text{Q12} & : 12 \times \quad \text{X} \\
\text{Q13} & : 112 \\
\text{Q14} & : 3 \frac{3}{8} \times \quad \text{X} \\
\text{Q15} & : 14 \frac{2}{7} \times \quad \text{X} \\
\text{Q16} & : 5 \frac{3}{8} \quad \text{X} \\
\text{Q20} & : 3 \frac{4}{8} \\
\text{Q21} & : 3 \frac{4}{11} \quad \text{X} \\
\text{Q22} & : 3 \frac{5}{12} \quad \text{X} \\
\end{align*} \]
APPENDIX 5

Samples of Work from 'Apprentice Maths' for pupils of varying abilities
\[
\frac{1}{2} " = 0.5"
\]
\[
\frac{3}{16} " = 0.1875" \quad \text{so the } \frac{5}{16} " \text{ dia. bar would be used.}
\]
\[
\frac{3}{8} " = 0.625"
\]
\[
\frac{1}{16} " = 0.0625"
\]
\[
\frac{3}{4} " = 0.75"
\]

How far would the cutting tool have to be fed in to produce the required size? i.e. what is the distance \(X\)?

\[
D = 0.625
\]

\[
X = \frac{D - 0.610}{2}
\]

\[
= \frac{0.625 - 0.610}{2}
\]

\[
= \frac{0.015}{2}
\]

\[
= 0.0075"
\]

Calculate (a) \(x\) and (b) \(y\) using Pythagorean theorem.
To find the length AB follow the same procedure as to find x on previous page.

I know use pe to find y

\[ x^2 = 11 \]
\[ y^2 = 2.11 \]
\[ x^2 = 12 \]
\[ x = \frac{3.555}{1.1175} \]
\[ y = \frac{11}{12} \]

The following sketch shows details of a groove in a pulley for a see belt drive. Calculate x.

HELP NEEDED TO FORM A. Using the measurements and angles given on the diagram done I have worked out a separate diagram making a triangle with this triangle find the length of c. The opposite side is the same so did to c's together and subtract then from 20cm.
A component is designed as shown below. However, all the machinery and tools to produce this part are calibrated in metric units. Sketch component giving dimensions in mm correct to two decimal places.

3·75" dia

\(1" = 25·40 \text{ mm}\)

\[
\begin{array}{c|c|c}
25·40 & 13·375 & 13·375 \\
3·125 & 25·400 & 12·780 \\
12·700 & 00·000 & 12·780 \\
25·400 & 00·000 & 00·000 \\
16·200 & 45·000 & \\
19·369 & 000 & \\
3·125" = 79·37 \text{ mm}
\end{array}
\]
<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>=</td>
<td>88.90 mm</td>
<td>1.625</td>
<td>=</td>
<td>143.55 mm</td>
<td></td>
</tr>
<tr>
<td>3.50</td>
<td>2.54</td>
<td>1400</td>
<td>7.625</td>
<td>2.540</td>
<td>305000</td>
<td>381500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>112500</td>
<td></td>
<td></td>
<td>15250000</td>
<td>14361500</td>
</tr>
<tr>
<td>8.3900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.313</td>
<td>2.313 = 58.85 mm</td>
<td>3.750</td>
<td>3.750 = 95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.540</td>
<td></td>
<td>92520</td>
<td>1254</td>
<td>1500</td>
<td>15000</td>
<td>95250</td>
</tr>
<tr>
<td></td>
<td>1166500</td>
<td>4328000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59.8500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.125</td>
<td>8.125 = 206.38 mm</td>
<td>2.540</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>325000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4562500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1625000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20637500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A man is asked to produce a bar of 0.610 dia. In metal store, the materials available are:

\[
\begin{align*}
\frac{1}{2} \text{ dia} & \quad \frac{9}{16} \\
\frac{5}{8} & \quad 1.77\text{ inc} \\
0.625 & \quad 0.6875 \\
0.75 &
\end{align*}
\]

Which bar will he choose if he is to waste the least amount of material when machining Diameter D.

With \( \frac{5}{8} \), he will waste less.

How far will the cutting tool have to be wound to produce the required size? I.e. What is distance x (D is the diameter of the bar chosen).

\[
D - 0.610 = 0.625 = 0.15.
\]
1. Use the theorem of pythagoras to calculate:

\[ x \approx 6.2 \]
When tapping a hole (putting a thread inside) a hole must first be drilled before the thread can be cut.

The tapping drill sizes for Whitworth threads can be calculated using the formula:

\[ T = D - 1.1328 \times P \]

Where:
- \( D \) = diameter of thread in inches
- \( P \) = pitch of thread in inches
- \( T \) = tapping drill diameter in inches

Calculated \( T \) when \( D = \frac{3}{8} \), \( P = 0.0625 \).

Answer correct to 3 decimal places.

\[ T = D - 1.1328 \times P \]

\[ T = \frac{3}{8} - 1.1328 \times 0.0625 \]

\[ = 0.375 - 1.1328 \times 0.0625 \]

\[ = 0.375 - 0.0708 \]

\[ = 0.3042 \]

\[ = 0.375 \]

\[ = 0.0708 \]

\[ = 3.33 \]

\[ = 11328 \]

\[ \times 0.0625 \]

\[ = 566.4 \]

\[ = 22656.0 \]

\[ = 67968.0 \]

\[ = 0.0708000 \]
\[ N = \frac{1000 \text{ S}}{\pi D} \]
\[ = \frac{1000 \text{ S}}{3.142 \times 35.5} \]
\[ = 70000 \]
\[ = \frac{70000}{3.142 \times 35.5} \]
\[ = 627.9 \]

\[ = \frac{1000 \times 70}{3.142 \times 35.5} \]
\[ = \frac{70000}{3.142 \times 35.5} \]
\[ = \frac{70000}{111.541} \]
\[ = 627.9 \]

\[ = \frac{1000 \times 70}{3.142 \times 98} \]
\[ = \frac{40000}{307.916} \]
\[ = 129.9 \]

\[ = \frac{3.142 \times 70}{\pi} \]
\[ = \frac{215.36}{307.916} \]
\[ = 0.698 \]

\[ = \frac{40000}{307.916} \]
\[ = 129.9 \]
The formula connecting 
rev/min and cutting speed 
is \( N = \frac{1000 \times S}{\pi D} \)

Where \( N \) = rev/min of 
spindle 
\( S \) = Cutting speed 
in m/min 
\( D \) = cutter 
diameter 
in mm 
\( \pi \) = A constant 

\[ 7\text{ in.2} \]

\[ 374 \]

**Calculate \( N \) when \( (a) \) \( S = 50 \text{ m/min}, D = 54 \text{ mm} \)**

**Formula** \( N = \frac{1000 \times S}{\pi D} \)

\[ N = \frac{1000 \times 50}{\pi \times 54} \approx 169.68 \]

**Calculate \( N \) when \( (b) \) \( S = 70 \text{ m/min}, D = 35.5 \text{ mm} \)**

**Formula** \( N = \frac{1000 \times S}{\pi D} \)

\[ N = \frac{1000 \times 70}{\pi \times 35.5} \approx 111.54 \]

\[ 111.54 \times 70000 \]

\[ 70000 \]
Maths

Homework - 5-2-80

Height x Area of Cross-section = Volume of prism

44 mm

D = 20 mm \[ R = 10 \]
D = 10 mm \[ r = 5 \]

\[ \pi (R^2 - r^2) \times 44 \]
\[ \pi (100 - 25) \times 44 \]
\[ \pi (75) \times 44 \]

9.426 000
2.199 400
1.571 000

Volume of prism = 9.426 000
9.426 000
10 368 600

Area of rectangle = 120 \times 40 = \boxed{4800}

Area of circle = \[ \pi \times r^2 \times 2 \]

\[ = 3.142 \times 900 \]

Area of circle = 2827.8 \[ 3.142 \]

Area of rectangle - Area of \[ \frac{1}{2} \] circle = \boxed{3386.1}

Volume of Prism = \boxed{270888}
\[ H^2 = x^2 + y^2 \]
\[ x^2 = 6 \]
\[ H^2 - y^2 = x^2 \]
\[ (6^2 - 5.2^2) = x^2 \]
\[ (36 - 27.04) = x^2 \]
\[ (8.96) = x^2 \]
\[ \sqrt{8.96} = x^2 \]
\[ \sqrt{8.96} = 2.99 \]
\[ \therefore 2.99 = x \]

\[ 6 + (2.99 \times 2) = D \]
\[ 6 + 5.98 = D \]
\[ 11.98 = D \]
\[ \frac{4 \text{ L shape}}{2} = \frac{(11.98) + 6 \times 5.2}{2} \]
\[ 8.99 \times 5.2 \]
\[ = 9.3496 \]
\[ \frac{9.3496}{2} = 4.6748 \]
\[ 9.35 \]
\[ \frac{2.17}{654.5} \]

Volume of prism = \(654.5 \text{ cm}^3\).
APPENDIX 6

Reports by pupils, teachers, employers, etc.

on the text 'Apprentice Maths'
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name ...Long Powell...

Occupation ...Pupil
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

1. For revision for C.S.E examinations and basics.

2. They are easy to read and with the help of the diagrams enable a better understanding of the topic.

3. They are very helpful as they certify just how much of a certain topic you know and how much you must revise, in which regard to what depth in order to fully understand the topic.

4. I think that 5-10 questions are enough to certify whether you know a subject or not and when the first few questions are easy and they get harder, as they do in this book, they show you just how much you have revised and learnt the work. If you get all of the questions right it is guaranteed that you fully know the topic and have understood it all.

5. The practical applications were alright though I tended to stay more with the practice exercises when I couldn't do the self-assessment tests.
6. I think that the book could do with some explanations of transformation graphs and their gradients and specific gravity and density.

7. For comparison I used 'Mathematics Three' which like 'Apprenticeship Maths' go into much detail of a topic. Unfortunately in 'Mathematics Three' if you find you a lot of the questions in the first few exercises wrong and have to revise them through the help of the book, it appears to be a long tedious way for you are confronted by a page of solid writing. whereas in 'Apprenticeship Maths' there is not so much writing and the explanation is helped by examples and diagrams.

8. I can't really improve the book only by adding a few more subjects and topics and a few more specimen papers.

9. I found 'Apprenticeship Maths' very helpful and hope I have learnt enough to succeed in my nearing examinations.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name ........................................ (Colin Brown)

Occupation .................................
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview,
   CSE examination or apprenticeship theory work)
2. The quality of the explanations (are they easy to read and understand?)
3. The self-assessment tests - are they helpful?
4. The exercises (the quantity of questions and level of difficulty.)
5. The practical applications (are they helpful, interesting?)
6. The scope of the book (should any extra topics be included or any omitted?)
7. Please make any comparisons with other CSE/basic maths text books.
8. Any suggestions for improving the book.
9. Any other comments.

1. Revision of Mathematics
2. The quality of explanation is excellent because no-one else needs to explain it.
3. The self-assessment tests show the parts where revision is needed.
4. The exercises start easy and provided you've read the passage on the exercise you should be able to do the more difficult ones.
5. Practical Applications Exercises are exercises which are most probable to encounter when doing an apprenticeship.
6. Key tables should be included to make it a more complete book.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name: K. Wundridge

Occupation: Pupil

(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

I am using the book at the moment to help me pass my apprenticeship maths test for a job and I am pleased to say it helped me pass.

The book is very different in the explanation because they give you a test at the beginning of each section and if you can pass it you can leave the section but if you don't you can go through all the different examples and practice.
3. The self-assessment tests are helpful in the way that they tell you whether you can go on with the next section.

4. The exercises are helpful because they put all the different ways of doing the sums into different exercises, e.g., fractions, instead of putting multiplication and subtraction in one exercise they will have four separate exercises.

5. The practical applications are good because it shows you will crop up in the actual job and you will recognize it instead of just remembering some “rules” in a book.

6. There are enough topics in the book to cope with every aspect of craft and scaffolding and that is all we need.

7. They are much better than other books because normal books tend to teach you a “novel fashion” you don’t have to do what they do, but with this book they do an example and the thinking is left up to you.

8. There are no suggestions for improving the book, obviously the authors have sat down and thought about the book and it would be wrong to criticize them. Beside they have done a good job.

9. I would just like to thank the authors and it has helped me a lot and probably got me a job. I would like to see this book introduced into the class and not just an exercise book for extra work.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name MARK EARNSHAW

Occupation 9TH YEAR O-LEVEL STUDENT.
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

(1) I used the book for revision purposes and further practising of theories, etc.

(2) I found the explanations generally well set out with explicit, easy to understand diagrams. One particularly good point was that they weren't cluttered up with useless dimensions, axes and chords etc which have nothing to do with that particular question.
I didn't do many self-assessment tests but the few that I did I found very helpful - a good measure of exactly what I knew and what I had to revise more thoroughly.

In the exercises I thought the quantity was ample but the quality fairly poor and monotonous. I found that in some areas (e.g. logarithms) there were too many questions about one area (e.g. turn numbers into logs and vice versa) not only did I think that after a while they were boring but I also think on the whole many of the questions were quite easy and some of the space, instead of repetition of say addition of logarithms, should have been devoted more adventurous equations.

I found the practical applications very helpful indeed and although I sometimes understood the topic, without the idea of the application, I still found them very useful in clarifying certain points.
I thought that the book was very well planned with an excellent variety of subjects. These subjects were well explained. Although, as I have said before, I would have liked to have seen the inclusion of a few more testing questions.

At the moment I am studying for my O-levels and I am using a mathematics three by L. Harwood. Clarice. I have been using the apprentice maths book as supplementary work and it has served that purpose very well. However, I found the apprentice maths book as good if not in some cases better than our present text book simply because of the excellent explanations which were given specifically and not "decorated" with fancy phrases. I'm not saying this book ought to replace our text book as some areas are irrelevant (e.g. construction) to most pupils, unless they desire to become an apprentice, but I sincerely feel that it should be used at times in conjunction with our present text book.

Apart from some slightly more advanced maths I can't think of anything that would improve the book. It has, in my opinion,
I think the book is a real eye-opener to the work that an apprentice has to do. It surprised me... and I'm sure that some students must have a nasty shock when they discover the amount of maths needed for engineering. I must admit I thought an apprenticeship was an easy back way out. If you're unsuccessful at school and like getting your hands oily!

One thing I think would be a good idea would be to introduce this book at third year level when pupils are taking option choices. I think this would show the third years what was needed for an apprenticeship, provide an incentive to work and prevent disappointment when they find the after messing about in lessons they require that subject for apprenticeship. The only problem would be that the standard might be a little too high. But once again I think it would just put the temptation off.
John Hall

Electrician:

One of Apprentice maths books.

I have used this book for trigonometry because I could not determine which sign of trig. to use, eg tan, cos, sin, but now I have used the book I find it easy. It helped me by taking an example and putting it into an imaginable situation. The book also takes an example shows you easy ways to do it. They call it the Apprentice maths book because all the problems included in the book could be needed when you go in for your apprenticeship.

General Maths

I think I've been taught reasonably through my primary school and some of the secondary school until I was put into an ordinary level teaching group which I found to hard to cope with and I started to fall behind a bit, after a few months I was so far behind, that I was moved to a lower group. This group I am in know is just about right for pace and stretchers. He mind a bit which is good I think.
Some teachers don't teach you anything because they cannot gain the attention of the pupils because they are not strict enough or interesting, but on the other hand some teachers are too strict and do not allow you to talk among friends and if you are caught you get sent out which means you lose vital education. I suggest that more practical test should be brought into what lessons such as making given solids accurately using trig and Pythagoras etc.

John Hall, 5th pupil.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name ........................................

Occupation ........................................
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview,
   CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and
   understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included
   or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

(1) The book is very read for revision from and
    reference to.

(2) The explanations are easy to read and
    very easy to understand.

3) These tests are helpful to check a firm cut
   what you are not as read at.

4) There are plenty of questions but I have not
   encountered one which I cannot do.

5) The practical applications are interesting.
and helpful.

4. I have not studied this book through or so I can not give an accurate answer, but I have read the scene the book covers and:

5) This book is far better than any other we both at explaining problems and their answers. The examples are easier to follow.

8) I do not think the book can be improved much more.

9. My only comment concerns the course itself. The course should have been started at an earlier time. I think it should have been started at the beginning of the 6th year.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name: WAYNE FEARN

Occupation: (e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:

1. Actual use of the book and the situation:
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

1. I found the book very useful especially before I went to interviews. The night and morning before I went I had a good look at the book. This helped me a lot especially at the Gas Board Test.

2. The explanations are very easy to read and simple to understand.

3. Yes. They save a lot of time doing things which you already know.

4. The exercises are not easy but they are...
not ever so hard. One good idea in the book
the practical exercises. They show how and where eh
matches are needed and should be used.
5. As I have said above they help a lot
6. I cannot think of any things what need added
or any what should be taken out
7. The book far excells any other C.S.E. ex-
ination book.
3. -
9. -
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name: Simon Robinson

Occupation: (e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:

1. Actual use of the book and the situation: (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

1. Extra help with Trigonometry.

2. The explanations were clear and precise are straight forward and do not waffle.

3. The self-assessment tests are not particularly helpful as a pupil could tell how well he/she is doing in a subject from the exercises.

4. The number of questions was about right but they were too easy.

5. The practical applications are interesting and would come in be good practice for
anyone doing engineering.

6 The scope of the book is good but I think that common fractions and decimal fractions should be put under the same head.

7 This book is very good. This book is no clearer than my text book Mathematics by Clarke which misses out steps jumps around and in places is very obscure. My text book will for example give the method that you could use if you already knew how to do the equation (see quadratic equations p. 13-7) but decided to find a new way to do it. The appendix maths on the other hand shows clear concise ways to solve the equation.

8 I am not in a position to suggest changes in the book as I believe it is the employer's job to do that. 

© 1980
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name Andrew Ashworth

Pupil

Occupation ........................................
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview,
   CSE examination or apprenticeship theory work)
2. The quality of the explanations (are they easy to read and
   understand?)
3. The self-assessment tests - are they helpful?
4. The exercises (the quantity of questions and level of difficulty.)
5. The practical applications (are they helpful, interesting?)
6. The scope of the book (should any extra topics be included
   or any omitted?)
7. Please make any comparisons with other CSE/basic maths text
   books.
8. Any suggestions for improving the book.
9. Any other comments.

1) revision for exams at school and at home
2) Quality of book in excellent explanations are clear to understand and plenty to learn from
3) Very helpful then you don't waste time reviewing a section that you know.
4) The quantity of questions are very good and the degree of difficulty is good, as the harder the more you learn
5) The book is helpful and interesting as the diagrams are clear and it is a pleasant book to work from.

6) No topics - su The only topic to be omitted should be the modern maths, as modern maths such as sets are no good to anybody while if they were not included in the syllabus other important topics could be taught.

7) The book compared with other textbooks is excellent as the diagrams and examples are plentiful.

8) —

9) Excellent book to work from.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name

Occupation (e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:- (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)
2. The quality of the explanations (are they easy to read and understand?)
3. The self-assessment tests - are they helpful?
4. The exercises (the quantity of questions and level of difficulty.)
5. The practical applications (are they helpful, interesting?)
6. The scope of the book (should any extra topics be included or any omitted?)
7. Please make any comparisons with other CSE/basic maths text books.
8. Any suggestions for improving the book.
9. Any other comments.

Revision

1. Yes, they are.
2. Yes, because you don't have to go through the exercise for nothing.
3. Not really. Difficult because the extra examples look difficult.
4. Yes, the book is really good and interesting because it is not too easy and not too hard.
5. None.

7. In other basic maths books there are either too many examples so you get bored reading them or too few that you don't understand the question.
EVALUATION OF THE BOOK 'APPRENTICE MATHS'

NAME: MR J. BASSETT
OCCUPATION: EDUCATION INSTRUCTOR, LONG EATON SKILLCENTRE

1. Revision of basic arithmetic plus geometry, trigonometry and algebra where appropriate for engineering, electrical and building trades courses in M.S.C. T.S.D. Skillcentre.

2. They are easy to read and understand.

3. Very helpful.

4. Adequate.

5. Helpful and interesting.

6. Adequate.

7. Compares well with existing Skillcentre text books.

8. I feel that the description of parts of a circle, i.e. circumference, diameter, radius are required by the student before reaching Chapter 11. Suggest inclusion of same at Pages 15/19.

Ref: Page 14. Suggest inclusion of explanation that \( \frac{1}{4} \) is the same as \( \frac{1}{4} \div \frac{2}{3} \)

9. I consider that 'Apprentice Maths' brings to fruition very well the intentions stated in the preface.

J. Bassett ICIII
Education Section
19 May 1980
Dear Mr. Gatenby,

Thank you for your letter of 12th May 1980. I apologise for not replying earlier but I have just returned to work today after being on leave.

Enclosed herewith is the observations of the book submitted by Mr. J. Bassett, Education Instructor.

I have discussed with Mr. Bassett the general content of the book and he is of the opinion that he has found it to be useful in taking various examples from it for use in the classroom situation.

As you are aware that our Education Instructors have guide lines in presenting revision applicable to mathematics we think it covers in a simple and explicit form problems which are encountered by apprentices in the work situation.

Please do not hesitate to contact me if you wish to visit the Skillcentre for further discussion with our Education Instructors.

Yours sincerely,

[Signature]

W. Gordon
Deputy Manager
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name ..........................................................
Occupation SOFTWARE TRAINING
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)
2. The quality of the explanations (are they easy to read and understand?)
3. The self-assessment tests - are they helpful?
4. The exercises (the quantity of questions and level of difficulty.)
5. The practical applications (are they helpful, interesting?)
6. The scope of the book (should any extra topics be included or any omitted?)
7. Please make any comparisons with other CSE/basic maths text books.
8. Any suggestions for improving the book.
9. Any other comments.

This book has been used as a teaching aid for Craft Apprentices who are experiencing difficulty with calculations in the workshop or maths at the College of Further Education.

It has been used as an aid to enable the apprentice to overcome his own difficulties. I cannot comment on the value of the various sections of the book, other than to say, its comprehensive cover has catered for all our problems and the success achieved led us to purchase a second copy when the other was temporarily mislaid.

The apprentices who have used the book speak very highly of it.

Please continue on the other side if necessary.
Dear Mr. Gatenby,

Looking through my correspondence, I find a point in your last letter which I haven't responded to, namely a review of "Apprentice Mattis".

The quick answer is that I'm not in a position to review the book myself because I just don't have dealings with youngsters in my work - all my lads are graduates or mature draughtsmen. Because of the rather odd way BR is organised I can't suggest a colleague either. But perhaps you've found what you want elsewhere.

Meanwhile I've shown the book to a number of people in industry & teachers of mattis, and I find
their remarks show a lot about their backgrounds.

Here are some specimens: —

Remark

Teacher:

Some operations are well explained in words & clear diagrams, but others e.g. division of fractions, are just stated.

Teacher:

Is 0.649" a realistic degree of precision?

Is long division still needed, except as a quick approx. to check calculator?

Do people still use logarithms?

Engineer:

Fluent mix of units is expected still. Surely engineering is all metric?

I have only ever used S.I. (abroad) & I'm sure you'll never see C.g. type pressures in Pa, 0 p.s.i. or kgf/cm² (Ug)

Teacher & Engineer:

A child will need a teacher or mentor to bridge the coursework of presentation of most topics.

Everyone: Well done! Yours sincerely

David Halfpenny
In general the book was found most helpful in the Engineering Science course run in the school. Its main use being in remedial help for lower ability pupils and as an aid to help pupils when in difficulty, or when they have specific difficulties for example Brackets and decimal points.

The main areas of the book found most useful were the following: Algebra p.109, Areas, Volumes, Squares and Square roots, Powers and indices. I actually based a lesson on Volume using the book, which proved to be very successful as an aid to learning the principles and calculations involved.

The feedback from individual pupils who used the book when in difficulty was excellent, with a high success rate in overcoming these problems and difficulties. The self-assessment tests in the book are an excellent idea, and help give more confidence to pupils using the book.

In general I think this book is an excellent aid to pupils taking Engineering Science and fills a need for pupils and teachers as a refresher in maths relevant to a technical subject.

Suggestions for improvement are:
1) A more specific/detailed contents table
2) An index at end of the book
c) Inclusion of more practical applica...

K Cullen
ENGINEERING SCIENCE TEACHER
THE MERRILL SCHOOL
DERBY.

Footnote

The plant ecology is inverse proportion
with the examples on fuller's and giving
I found very helpful and could be extensible.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name: MR. K. WHITE

Occupation: Teacher

(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.
1. Teaching of fractions - revision of C.S.E topics. Revision for interview for British Rail.

2. Explanations are exceptionally well laid out, easy to follow and understand.

3. If one follows each chapter, then the self-assessment tests are very useful as they give a good indication of how you have understood the work.

4. See question 2.

5. For those pupils who are actually involved in apprentice mathematic, the practical applications are helpful and interesting.


7. Obviously this book as a C.S.E text book is inadequate, there are not enough topics covered. If the book's scope was broadened to
. encompass a more comprehensive range of material than the simple explicit fundamentals would make this an excellent C.S.E. handbook.

8. As an apprentice maths book no:
But as a C.S.E. book - see 7 above.

9. None.
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name: R.F. Jenkins (Mr.)

Occupation: Teacher

(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:

1. Actual use of the book and the situation:—
   (e.g. revision of multiplication of fractions for interview, CSE examination or apprenticeship theory work)
2. The quality of the explanations (are they easy to read and understand?)
3. The self-assessment tests — are they helpful?
4. The exercises (the quantity of questions and level of difficulty.)
5. The practical applications (are they helpful, interesting?)
6. The scope of the book (should any extra topics be included or any omitted?)
7. Please make any comparisons with other CSE/basic maths text books.
8. Any suggestions for improving the book.
9. Any other comments.

I CSE revision + Technical Drawing source book.

I Well laid out pages, not too much on each page. Clear and concise explanations. Most useful having worked examples and then a fair amount of questions for the children.

Explanations are the teachers role not the using for books to attempt at great length, as some do, especially as we are largely...
dealing with less able children to whom lengthy verbage is a waste of time.

3. As we use diagnostic maths tests, I already knew what the children can and 'can't' do, so when I knew that most of the children couldn't do any of the assessment questions (i.e. fractions) I used the assessment test after covering the work in the book. My pupils were not capable of using the tests in the manner way required for self-assessment.

4. The number and level of difficulty of the questions was about right. I used the book initially, and then backed this up with individual sheets to satisfy individual areas of difficulty. A section in the book for this.

5. These satisfy a long felt need. Not having a technical background it was difficult for me to think up examples. Some of the more technical examples were rather hard to understand if one has not had an engineering background.
Out of the CSE Mathematics syllabus, there are certain things not covered in your book. I appreciate your book is not aimed at this syllabus specifically. Perhaps aspects of:

- graphs
- distance/time conversion, etc.
- money
- costing, salaries, bills, H/P
- averages
- compound, simple interest
- scale drawing
- metric

would be useful to cover.

Could you write a book for CSE Mathematics using your present format as every other books aimed to cover CSE Mathematics is unsuitable for the less able due to the crammed presentation, too much explanation, too few examples, too expensive.

I find SMP books too cramped, unhelpful, good ideas are too small and, examples are too few.

I would like a non-answer book.

(implication for assessment tasks.)
Overall, the book is a useful bridge between theory and practical application in that my less able pupils see why they must learn certain skills, rather than learning technique in abstraction.
Dear Mr Galley, Thank you for your letter. I regret I did not get your book as I could not afford to buy it out of my school allowance.

Yours sincerely,

[Signature]

[Name, Head of Department]
EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name ............. U. While MA (Oxon).

Occupation .......... Teacher .................
(e.g. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:-
   (e.g. revision of multiplication of fractions for interview,
   CSE examination or apprenticeship theory work)

2. The quality of the explanations (are they easy to read and
   understand?)

3. The self-assessment tests - are they helpful?

4. The exercises (the quantity of questions and level of difficulty.)

5. The practical applications (are they helpful, interesting?)

6. The scope of the book (should any extra topics be included
   or any omitted?)

7. Please make any comparisons with other CSE/basic maths text books.

8. Any suggestions for improving the book.

9. Any other comments.

Potential uses seem to be as outlined in the Preface of the book. It
is certainly be used for revision purposes by either CSE or theory
jobs, although it obviously only covers some areas of CSE work. I would
imagine it would be difficult to find a better book for use by
apprentices to give them a good basic knowledge.

1. The explanations and worked examples are very good, certainly a
   great improvement on most basic text books.

2. They seem to have value either to encourage a student who
   has done well or as an indication that further effort is
   required. They also make it possible to take short cuts - this is
   work which is already adequately understood.
4. These seem to be ample exercises. Some of them do seem to be a bit difficult, especially at the end of chapters, but no more than an apprentice would presumably have to cope with.

5. From limited experience of his needs of engineering I would imagine them to be very helpful indeed. The diagrams are commendable for their clarity.

6. Some work on changing units and expressing e.g. 3m in cm and perhaps be useful. I'm sure Ted has a better idea of the needs of apprentices than I have. At first involved my algebra was included, but the exercises at this end made that clearer.

7. There are many CSE text books, but it is very difficult to find one which contains good explanations as well as sufficient exercises - there tends to be one or the other, but not both. I have not seen any CSE text which could be used by a pupil on his own as well as this one could be, although its usage is clearly limited to certain areas of most CSE syllabuses.

8. Possibly a few more worked examples for the practical applications exercise, which some pupils may find off-putting perhaps...
Mr R Bond
Mathematics Department
Burleigh Community College
Thorpe Hill
LOUGHBOROUGH
Leicestershire

Dear Rod

Please excuse the delay in contacting you after your request about the Burleigh Maths Course and the use of your book.

Having been in contact with some of the apprentices at the Training Centre the following information was obtained:

1. Approximately 14 boys purchased the book as an aid to the course.
2. Two young men were advised by myself to obtain a copy. (This action was a result of the test sheets sent to me after the course.)

As far as my own comments are concerned, I feel that the book is useful to the boys especially in the early stages of the transition from school to work.

I have suggested that the first year Training Centre obtains a copy to use as a aid when problems occur.

Hoping this information will be of use.

Yours sincerely

D V Bushell
Training Officer
Dear Mr. Pond,

I have been using Apprentice Maths for some time now with a group of men in a Basic Maths class and have found it to be very versatile.

It is a good revision book for those men who have had some Maths background, but have not used their maths for some years. They find that they can work from the text on their own with some help when needed.

I have also found the text and examples of methods to be very useful for the less able men, who have found the examples easy to follow and helpful to use either to refresh or re-inforce class teaching.

The problems which are set in each section are relevant and easily applied to everyday life and therefore appeal to the slightly older student.

I have been pleased to recommend Apprentice Maths to many other teachers working with similar groups.

Yours faithfully,

[Signature]

Father At: Gacree Prison - Home Office Problems Re Advertising
We Can't Mention Where She Teaches
Mr. R.M. Bond,
11 Langdale Avenue,
Loughborough,
Leics.

Dear Rod,

Many thanks for the complimentary copy of "Apprentice Maths".

I find it a most comprehensive volume, pitched at the right level and with a stimulating approach to the subject. It also provides the missing dimension to school mathematics - purpose.

I sincerely hope it will be used to good effect in the workshops as well as the classroom.

Proud to have been associated with the project and wish the publication every success.

Yours sincerely

T. Pawley
Training Manager
TO: JUDY GREEN- Engineering Technology Editor  
John Wiley & Sons  

FROM: THOMAS F. WHITE- Math Coordinator K-14  
Quincy Public Schools  

SUBJECT: Review of "Apprentice Maths" - Bajpai/Bond Text  
Packard Publishing LTD. - 1979 - for American adoption  

DATE: MARCH 18, 1980  

Observations by Chapters  

1. Preface - Should be "Americanized"  
2. Book Binding - Should be hard cover  
3. Notes for Student and Teacher are excellent  
4. Imperial system = Standard English Measures  

Chapter 1 - Fractions  

1. Confusing when they drop the + sign from ex(s) 2 & 3 i.e.  
   \[
   \frac{2 + 4}{8} - \frac{3}{8} \text{ instead of } \frac{6 + 2 + 4}{8} - \frac{3}{8} \]  
   otherwise an excellent presentation.  
2. Page 13 practice exercise - Pounds to Dollars  
3. Division of fractions - inversion? - This does not follow well  
   their fine examples of multiplication of fractions. Should  
   they have used their rectangles and squares to gain a better  
   understanding of the division function?  
4. Exclude Union acronyms - miscellaneous example - this should  
   continue throughout text.  

Chapter 2 - Decimals  

1. Would their 2.9 decimals be confusing to our pupils who are  
   used to 2.9? (Note decimal at the bottom for us - they reverse  
   the use - 2.9 is multiplication and 2.9 is the decimal)  
2. We use "Computer's Rule" for rounding off numbers - See"Math  
   Dictionary"- James and James by Van Nostrand - 1963. They  
   round 5 and over to next (page 32) higher - Drop off any less  
   than 5. We teach to round a 5 to even number i.e. .025 is .02;  
   .035 is .04.  
3. + and - signs to right of problem - may or may not cause problems  
   for our students - Teachers could very well explain this if given  
   warning.  
4. Money (page 43 and 44)  
5. Conversion of Metric to Imperial (English) - We have tried to  
   avoid this - having pupils "Think Metric." It may well be  
   necessary to teach conversion until adoption is complete???
Review of "Apprentice Maths" cont'd -2-

Chapter 3 - Approximation - Estimation
1. "Computer's Rule" again

Chapter 4 - Simple Indices and Numbers in Standard Form
1. Again difference of decimal vs. multiplication i.e. x.x as opposed to 1.3 - Would a N.B. - Clarification for this TEXT???
2. I personally like how they handle the Laws of Exponents (Indices)
3. a) Scientific Notation = Standard Form
   b) Standard Form = Ordinary Form
   c) Exponential Form = Scientific Notations

   a) what we call $1.03 \times 10^2 = 103$
   b) what they call above
   c) two expressions sometimes we use for each other confusion???

Chapter 5 - Logs
1. Money page 78 and 79
2. Problems on page 78 and 79 use logs of numbers between 0 and 1 before it is taught on page 80 and 81

Chapter 6 - Area
1. Trapezium is our Trapezoid
2. Money pages 100-105

Chapter 7 - Algebra
1. Use of double symbols could confuse i.e. + $2 - + 3$ some of our texts have this double use but lift the opposition sign and keep the operation sign in the middle. i.e. $+2 - +3$
2. Time sign differential page 109 - ours is colon(;) Theirs is 5.00PM= 5:00PM and 9.00 AM = 9:00AM
3. Money page 117, 127 and 130, 131

Chapter 8 - Ratio/Proportion
1. Money page 138-140 and 142

Chapter 9 - Percentages
1. Money pages 152-157
1. Table of Contents - The Total is inclusive but I have suggested between Chapter 10 and Chapter 11 review that perhaps the Chapter order would be better if it ran 1, 2, 3, 6, 8, 9, 4, 5, 7, 11, 10, 12, 13, 14, 15. Nothing to add or delete - but if we were to use Tables for squares/square roots - a section for this perhaps included with "logs."

2. Writing style - excellent - very clear and understandable - The examples are good and sufficient. In many, many cases their presentations are the best I have seen in any text. Some of their methods I have incorporated in my methods and techniques of teaching.

3. I worked various problems and exercises by random selection - Found no errors in doing this type of work. In my Chapter review I have cited things which are different from our style here in America - no errors per se.

4. See my Chapter Reviews.

5. This could be done with minimal changes I have noted in Chapter Review for Preface, Money, Time, Trapezium, Decimal/Multiplication Symbolism, Standard Form and Scientific Notation, etc. None for Machinery or devices.

6. a) Self assessment tests - excellent and an excellent idea.  
b) Practice exercises - plenty of them and they are variable enough to be good for students.  
c) Practical applications exercises - good and plenty (not candy) to challenge all students from all vocations  
d) Miscellaneous exercises - A real challenge for the better students - could be used for only the better pupils or used later in their training for revision.  
e) Miscellaneous multiple-choice questions - good over all review - or final exam for a full course in this text.  
f) Specimens selection tests - all good progress tests as student progress through the text.

Yes the exercise material is sufficiently technical for beginning students - first year introductory pupils. No changes except as noted in Chapter Review.

7. Yes - all answers should be available to the student - This has always been my feeling - the working of the material - How they do the solving - The important part of learning and correcting - not the answers.

8. Just the minimal changes I have listed in the Chapter Review and Questions 1, 4 and 5 above. I would feel the book would be outstanding and should catch on in our Market.
D. The placement of decimal point in the text could possibly be confusing because traditional American texts use a different format. Example: 2.34 vs 2·34. Other terms and/or symbols used in the text that may need defining: extensive use of e.g., . . . , (+ve), (-ve).

7. Yes I do like the idea of including answers to all the exercises at the end of the book.

8. Taking all aspects of the book into account, it would be my estimation that 20% of the book would have to be changed in order to produce a U.S. book.

9. Yes I do feel that the text would be appropriate for courses at the levels indicated because the text is well written, has good examples, and allows students with previous math background to work at a pace that is comfortable to them.

10. I cannot comment as to which U.S. text this book would be competitive with because I am not familiar with any of the texts listed in your letter.

11. I feel that the Bajpai/Bond text would be a more than adequate text for use in the U.S. market if the appropriate changes were made.

If you have any further need for comment from me or would like to ask any questions directly of me, please feel free to contact me.

Sincerely yours,

Duane M. Cowing
Dean of Academic Affairs

DMC/vm
"Education and Employment"

METRICATION

One of the most troublesome questions in recent years has been metrification. This has obvious relevance to syllabi. Should they include both Imperial and metric measures? The general opinion among Chambers is that they should. But there is a contrary view. The arguments can best be set out by quoting typical comments from two Chambers.

1. The Case for Teaching Both Measures -
   the Calderdale Chamber of Commerce and Industry:

   "There will be machinery in use in various industries in this country for very many years to come which will have been manufactured according to Imperial measurements and employees working with such machinery will find it essential to be familiar with the imperial system."

2. The Case for Pressing Ahead with Metrification -
   the Birmingham Chamber of Industry and Commerce:

   "The Education Committee has agreed that there is a case to be made for urging the Government to set a deadline for the introduction of metrification, as a serious consequence of the delay is that valuable time is being wasted in schools through teaching the Imperial system alongside the metric system. Certainly we have specific evidence that in this area schools have had to re-introduce the Imperial system into the maths curriculum. The Principal of one such school has gone on record as saying that 'valuable teaching hours are being spent on what should be by now an obsolete system'.

   "We note that some Chambers are taking the line that there is a need to teach both systems side by side. As schools have a responsibility to equip pupils to meet the realities of working life, it is undoubtedly the case that at present pupils should have a thorough knowledge of both systems. Our Committee is approaching the same problem from a different angle and saying that the Government should be urged to press ahead with the metrification programme without delay, so that duplication of this nature will become unnecessary in the near future."
1. It has been necessary to produce programmes of work for all our training courses. The programmes themselves having the following common core themes.

   a) facility with numbers
      10, 100's, 1000's
      simple addition - subtraction

   b) Reading a rule.
      Fractions.
      \( \frac{1}{64}, \frac{1}{32}, \frac{1}{16}, \frac{1}{8}, \frac{1}{4} \)
      Conversion of fractions to decimals.
      \( \frac{1}{8} \) to 0.125 \( \frac{1}{4} \) to 0.25 \( \frac{1}{2} \) to 0.5.
      Conversion of decimals to fractions (as above).

   c) Simple division

   d) Knowledge of percentages

   e) Measurement of:-
      Length, weight, area, capacity, volume, time, temperature

   f) Basic competence.
      Automatic response to multiplication tables

   g) Mental arithmetic.

2. Many factual examples can be given to demonstrate that industry and many young people entering industry suffer because of the lack of basic arithmetical ability.

3. Trainees are not dismissed because of their lack of basic arithmetical ability, they are recruited and numeracy is then part of the training programme. (If industry dismissed those who lack numeracy, there would be very few young people in work.)
SURVEY CARRIED OUT BY THE TYNE AND WEAR CHAMBER OF COMMERCE.

Question 1: applicants for employment being unsuitable owing to a lack of basic mathematical skills.

Question 2: apprentices/trainees failing to complete their course owing to a lack of basic mathematical requirements.

<table>
<thead>
<tr>
<th>Firm</th>
<th>Answer to Q1</th>
<th>Answer to Q2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yes, with some applicants for apprenticeship.</td>
<td>No. This must be ascertained on interview. Training is too costly to risk failure due to academic inability. This highlights the importance of acceptable exam results.</td>
</tr>
<tr>
<td>B</td>
<td>Selection method screens out applicants without the necessary skills.</td>
<td>No evidence to suggest this. Our experience suggests that the problem has been greatly exaggerated.</td>
</tr>
<tr>
<td>C</td>
<td>Of 12 applicants aged 16-17 for Lab. Assistant, only one even knew what a percentage was!</td>
<td>No.</td>
</tr>
<tr>
<td>D</td>
<td>Yes. All those with mathematical ability already &quot;creamed&quot; off to Polytechnics, etc.</td>
<td>Applies in some cases.</td>
</tr>
<tr>
<td>E</td>
<td>No. Those requiring maths skills suitably qualified.</td>
<td>No. Selection technique ensures trainees have necessary maths qualifications.</td>
</tr>
<tr>
<td>F</td>
<td>Yes. In certain cases this has happened.</td>
<td>No. We only recruit apprentices/trainees who have achieved the necessary qualifications one of which is mathematics. (Usually at GCE 'O' level).</td>
</tr>
<tr>
<td>G</td>
<td>No. I suspect we might meet this problem if numbers of applicants for positions precluded strict screening at initial letter stage.</td>
<td>No. Occasionally an apprentice has difficulty with academic areas of study but no failures to date.</td>
</tr>
</tbody>
</table>
H No. General standard of education tends to be unimpressive.

I Yes.

J No.

K Yes. Many cannot even read and write with reasonable accuracy.

L No. Only clerical staff with GCE 'O' Level maths considered.

M Yes. But not an abnormal increase over say the last ten years.

N Yes.

O Yes. They also have difficulty with spelling and grammar.

P Yes. Careful interviewing prevents this. However their methods of solving problems leave much to be desired.

Q Yes. Recently interviewed 50 applicants for Junior Clerk job, simple arithmetic test (3 addition, 3 subtraction), test completed incorrectly by more than half.

Yes. We have had occasions to transfer trainees to lower grade courses at Tech. owing to inadequate maths.

Yes. Young people do have problems in understanding basic arithmetic as applied to office and manufacturing activities.

Yes. We do not employ those who will obviously fail.

No. Selection methods tend to prevent this happening.

Yes. As in I.

Yes. No.
STATEMENT TO NEWPORT AND GWENT CHAMBER OF COMMERCE BY A MAJOR EMPLOYER

1. We have established our own programme for teaching basic mathematics in our Training Centre where we train apprentices and junior operatives.

All our apprentices and junior operatives undergo this basic mathematics training which has been in operation since 1967.

2. Since 1974/75 we have found that 50 per cent of those applying for places as apprentices have been below acceptance level in basic mathematics. Records have been kept since 1967 and these indicate a progressive deterioration in standards as illustrated by the data given below:

Results of Arithmetic Tests given to Applicants for Apprenticeships

<table>
<thead>
<tr>
<th>Age at entry - 16 years</th>
<th>Maximum score obtainable - 50</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Group 'A' (40-50 score)</th>
<th>Group 'B' (30-39 score)</th>
<th>Group 'C' (20-29 score)</th>
<th>Not up to Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of Total Tested</td>
<td>% of Total Tested</td>
<td>% of Total Tested</td>
<td>% of Total Tested</td>
</tr>
<tr>
<td>1967</td>
<td>4.00</td>
<td>13.33</td>
<td>53.33</td>
<td>29.34</td>
</tr>
<tr>
<td>1972</td>
<td>-</td>
<td>8.26</td>
<td>54.13</td>
<td>37.61</td>
</tr>
<tr>
<td>1977</td>
<td>-</td>
<td>1.63</td>
<td>37.96</td>
<td>60.41</td>
</tr>
</tbody>
</table>

3. Technicians would be recruited from Groups A and B, and Electricians and Mechanics from Group C as a general rule.

We would recruit apprentices for lower grades and operatives from those who failed to make the grade on the mathematical test.

In addition, we also recruit accountancy and metallurgical trainees at the age of 18 and these sit the same mathematical test but we would expect them to fall into Group A.

4. We have no evidence of any apprentices/trainees failing to complete their course owing to lack of basic mathematical skills which would confirm the soundness of our preliminary training and selection procedures.
5. For some years our Training Department has established very close links with local schools and colleges and we participate actively in career evenings. Joint courses are organised, school staff members visit our Training Centre and our staff also make regular visits to the schools concerned. This enables the schools to become acquainted with our particular needs and encourages them to establish meaningful training programmes as part of the school curriculum.

Progress in some instances is slow but mention should be made of the excellent co-operation being given by Lliswerry School, Hartridge School and Fairwater School, Cwmbran.

As the result of close co-operation, Fairwater School are now including workshop mathematics as part of their CSE/O level Course thereby providing a much more practical approach. This co-operation also extends into the science field with members of our Electrical Steels Research Department participating.

6. Strenuous efforts are being made to encourage all schools in the area to follow the Fairwater example so that education can meet the needs of industry. Schools have in the past tended to concentrate on the bright mathematical students to the detriment of at least 70 per cent of the pupils who will eventually be seeking jobs in industry and commerce.
STATEMENT TO THE RUGBY AND DISTRICT CHAMBER OF COMMERCE BY A MAJOR EMPLOYER

1. Within our 'In-plant' training programme we teach:-

   a) Technician Apprentices - the application and development of mathematics to relevant industrial subjects. We also integrate with the East Warwickshire College of Further Education on Block Release, where, within the framework of TEC Courses, a fuller and more general teaching of relevant mathematics is an integral part of the course.

   b) Craft Apprentices - a similar situation to Technicians but with more emphasis on basic arithmetical manipulation.

   c) Student Apprentices - in co-operation with EWCFE the initial three weeks of the apprenticeship is devoted to the interpretation and application of 'A' level maths to industrial subjects.

2. Approximately 20 per cent of applicants fail to meet our entry standard as a result of sitting our entrance test. The entrance test comprises two papers - a Mechanical Arithmetic Test and a General Ability Test, one hour each.

   The main reasons for failure are a lack of basic arithmetical perception and inability to use simple numerate skills. We believe that a contributory reason for this is the structuring of the subject in the education system. This prevents consolidation by repetition of previously learned exercises and concentrates instead on the teaching of progressively more complex mathematics to the disadvantage not only of the slow learner but also the bright pupil who tends to relegate arithmetical functions to his or her mental backwaters.

3. Due to the aforementioned selection and training process none of our trainees fail to complete their courses but some may have difficulty in achieving their full potential.
### ANALYSIS OF QUESTIONNAIRE SENT TO MEMBERS OF THE CROYDON CHAMBER OF COMMERCE AND INDUSTRY

112 replies

<table>
<thead>
<tr>
<th>Actual findings</th>
<th>Percentages of 112</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Do you employ school leavers who do not possess 'O' level or CSE Grades I, 2, 3?</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>63</td>
</tr>
<tr>
<td>No</td>
<td>47</td>
</tr>
<tr>
<td>Sometimes</td>
<td>1</td>
</tr>
<tr>
<td>n/a</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>2.</strong> Overall do you employ</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 20 persons?</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>20-50</td>
</tr>
<tr>
<td>50-100</td>
</tr>
<tr>
<td>over 100</td>
</tr>
<tr>
<td>n/a</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3.</strong> Do you set prospective employees a mathematical or arithmetical test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Sometimes</td>
</tr>
<tr>
<td>n/a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>4.</strong> Do you attach significance to a prospective employee holding a CSE Grade 4, 5, 6 in mathematics?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Sometimes</td>
</tr>
<tr>
<td>n/a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>5.</strong> Do you disregard CSE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>n/a</td>
</tr>
</tbody>
</table>
6. If it were proposed to introduce a 16+ school leaving certificate in mathematics, indicating the course followed, the level of achievement with actual examples of completed work and comments on attitude and attendance, when assessing an applicant would this be

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More helpful than CSE grades 4, 5 or 6?</td>
<td>43.75%</td>
</tr>
<tr>
<td>as helpful as CSE grades 4, 5 or 6?</td>
<td>6.25%</td>
</tr>
<tr>
<td>less helpful than CSE grades 4, 5 or 6?</td>
<td>2.68%</td>
</tr>
<tr>
<td>n/a</td>
<td>47.32%</td>
</tr>
</tbody>
</table>

7. Do you have any objective evidence about arithmetical standards of school leavers?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>29</td>
<td>25.89%</td>
</tr>
<tr>
<td>No</td>
<td>36</td>
<td>38.39%</td>
</tr>
<tr>
<td>n/a</td>
<td>47</td>
<td>43.79%</td>
</tr>
</tbody>
</table>

8. If your answer to question 7 was 'Yes', does this evidence suggest that arithmetical standards have

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risen</td>
<td>0</td>
<td>.0%</td>
</tr>
<tr>
<td>Remained the same</td>
<td>2</td>
<td>6.89%</td>
</tr>
<tr>
<td>Fallen</td>
<td>27</td>
<td>93.10%</td>
</tr>
</tbody>
</table>

Analysis of the 63 replies of those who answered 'Yes' to Question 1 are as follows - i.e. who employ school leavers without 'O' level/CSE grades 1, 2 or 3.

<table>
<thead>
<tr>
<th>Actual Findings</th>
<th>Percentages of 63</th>
</tr>
</thead>
<tbody>
<tr>
<td>5A. Do you disregard CSE?</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>17</td>
</tr>
<tr>
<td>No</td>
<td>41</td>
</tr>
<tr>
<td>Sometimes</td>
<td>1</td>
</tr>
<tr>
<td>n/a</td>
<td>4</td>
</tr>
</tbody>
</table>
6A. If it were proposed to introduce a school leaving certificate in mathematics, indicating the course followed, the level of achievement with actual examples of completed work and comments on attitude and attendance, when assessing an applicant, would this be more helpful than CSE grades 4, 5 or 6? 42 66.66%
as helpful as CSE grades 4, 5 or 6? 8 12.69%
less helpful than CSE grades 4, 5 or 6? 3 4.76%
n/a 10 15.87%

7A. Do you have any objective evidence about arithmetical standards of school leavers?

Yes 25 39.68%
No 33 52.38%
n/a 5 7.94%

8A. If your answer to question 7A was 'Yes' does this evidence suggest that arithmetical standards have risen? 0 0%
remained the same 2 3.17%
fallen 25 39.68%
n/a 36 57.14%
OPINION OF LOCAL COMPANIES (% AGE)

Addition & Subtraction of decimals to four places

Multiplication and division of decimals to four or more places

Percentages to one decimal place

Conversion of vulgar fractions (down to 1/64) to decimals and vice-versa

Use of reference tables

Addition and subtraction of vulgar fractions down to 1/64

Multiplication and division of fractions

Transposition of simple Formulae

A knowledge of mensuration – area of plane and solid figures, chords, segments and sectors

Use of π as a constant

Use of four figure log tables

Use of square root

Trigonometrical Calculation, Pythagoras, sine, cosine and tangent ratios

Metric / Imperial

3rd angle projection drawing

Use of slide rules and calculators

Addition and subtraction of angles (degrees and mins)

The results of a survey showing demand for defined mathematical skills. Source: Burton upon Trent and District Steering Committee for the development of co-operation between industries and schools.
COMMENTS MADE AT MEETINGS OF EMPLOYERS AND TEACHERS SUPPLIED BY THE SOUTH EAST HAMPSHIRE CHAMBER OF COMMERCE AND INDUSTRY.

1. A visitor to a school received an explanation of Fletcher mathematics which involved pupils looking at patterned paper and colouring in different areas thus learning to look at problems from different viewpoints. An apparently bright pupil who had produced some very "interesting" work was asked "What is 8 x 7?" Answer from teacher "Oh - she has a sort of blockage as far as tables are concerned." (Collapse of visitor).

2. Teacher - "If employers really needed us to improve pupils' numeracy we could do it in a crash course lasting a few weeks - no problem."

3. Teacher - "Do they (the employers) think we try to prevent pupils from learning their mathematics?"

4. Teacher - "We really are beaten sometimes. What we teach just does not sink in. We wish we knew the answer."

5. Employer - "No (modern maths) 'O' level or CSE passes give us any guidance as to whether a pupil can add, subtract, multiply or divide."

6. Teacher - "In any event employers are worrying about the wrong things. Industry's problems are to do with people and their ability to work together - not problems of numeracy."

7. Employer: "Some mathematics teachers have no understanding of the relevance of their mathematics teaching to subsequent employment, and have no opinion as to whether it should be relevant."

8. Teacher: "Employers criticise modern mathematics. How many of them know the content of any modern maths curriculum?"(!)

9. Employer - "Modern mathematics may be exciting and challenging to the brighter pupil. To the average or below average pupil it represents confusion, is clearly irrelevant and produces a sense of failure."

10. Teacher - "We keep on giving them (the employers) the explanations - but they keep on asking the same questions - we are wasting our time."

11. Employer - "We keep on asking the same questions but they (the teachers) keep on avoiding the issue. We are wasting our time."
Apprentice Maths

Lorna Powell

Mr. Grutamby
1. \( \frac{1}{3} + \frac{1}{8} = \frac{8 + 3}{24} = \frac{11}{24} \)

2. \( \frac{1}{16} + \frac{1}{2} \cdot - \frac{1}{32} = \frac{2 + 16 - 1}{32} = \frac{17}{32} \)

3. \( \frac{1}{4} + 3 \cdot \frac{1}{5} = \frac{1}{4} \cdot \frac{5 + 4}{20} = \frac{1}{4} \cdot \frac{9}{20} \)

4. \( \frac{2}{3} + \frac{1}{5} = \frac{2}{3} \cdot \frac{10 + 3}{15} = \frac{2}{3} \cdot \frac{13}{15} \)

5. \( 3 \frac{1}{2} - 2 \frac{5}{16} = 1 \cdot \frac{8 - 5}{16} = 1 \cdot \frac{3}{16} \)

6. \( 2 \frac{1}{4} + 3 \frac{1}{2} - 1 \frac{1}{3} = 4 \cdot \frac{3 + 6 - 4}{12} = 4 \cdot \frac{5}{12} \)

7. \( 7 \frac{1}{5} - 3 \frac{1}{4} + 2 = 6 \cdot \frac{4 + 5}{20} = 6 \cdot \frac{9 + 15}{20} \)

8. \( 6 \frac{1}{8} + 2 \frac{1}{16} - 3 \frac{13}{32} = 5 \frac{6 + 2 + 13}{32} = 5 \frac{19}{32} \)

9. \( \frac{1}{3} \cdot \frac{1}{4} = \frac{4 \cdot 3}{12} = \frac{11}{12} \)
23rd November

19. \[9\frac{1}{8} + 3\frac{1}{2} + 2\frac{1}{4} = 14 \frac{7}{8}\]

20. \[2\frac{1}{3} + 1\frac{1}{3} = 3 \frac{2}{9}\]

21. \[8\frac{1}{4} - 6\frac{1}{10} = 2 \frac{11}{20}\]

22. \[3\frac{3}{16} - 2\frac{5}{8} = 1 \frac{11}{16} = 2 \frac{1}{16}\]

23. \[1\frac{2}{5} \times 2\frac{1}{9} = \frac{7}{5} \times \frac{19}{9} = \frac{3}{1}\]

24. \[3\frac{1}{8} \times 5\frac{1}{3} = \frac{23}{8} \times \frac{16}{3} = 2 \frac{1}{2}\]

Approximation & Estimation

1) 16.8 \approx 191.3 \approx 6.75
2) 0.0031 \approx 0.0000
3) 20000
4) 100 \times 20 = 2000
5) 2000 \div 0.01 = 200000
6) 9.65 \div 99.5 \approx 10 \div 10 = 0.01
5. (a) \( C = \frac{\$64}{100} \times x \)
    \[ \frac{128}{64} = \frac{64}{x} \]
    \[ 2.5 \times 64 = x \]
    \[ 16x \]
    \[ 200 = x \]

   **Ans.** 200 dollars can be purchased.

(b) \( C = \frac{\$32}{100} \times x \)
    \[ \frac{32}{64} = \frac{64}{x} \]
    \[ 25 \times 3.2 = x \]
    \[ 16 \]
    \[ 50 = x \]

   **Ans.** 50 dollars can be purchased.

(c) \( C = \frac{\$64}{100} \times x \)
    \[ \frac{64}{84.48} = \frac{84.48}{x} \]
    \[ 25 \times 64.8 = x \]
    \[ 16x \]
    \[ 138 = x \]

   **Ans.** 132 dollars can be purchased.

(d) \( C = \frac{\$64}{100} \times x \)
    \[ \frac{40.32}{64} = \frac{64}{x} \]
    \[ 25 \times 40.32 = x \]
    \[ 16x \]
    \[ 63 = x \]

   **Ans.** 63 dollars can be purchased.

(e) \( C = \frac{\$64}{100} \times x \)
    \[ \frac{49.92}{64} = \frac{64}{x} \]
    \[ 25 \times 49.92 = x \]
    \[ 16x \]
    \[ 78 = x \]

   **Ans.** 78 dollars can be purchased.
### Table

<table>
<thead>
<tr>
<th>Angle</th>
</tr>
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<tbody>
<tr>
<td>50° 21'</td>
</tr>
<tr>
<td>30°</td>
</tr>
<tr>
<td>60°</td>
</tr>
<tr>
<td>16° 13'</td>
</tr>
<tr>
<td>18° 58'</td>
</tr>
<tr>
<td>82° 57'</td>
</tr>
<tr>
<td>21° 14'</td>
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<tr>
<td>33° 42'</td>
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<tr>
<td>38° 42'</td>
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<tr>
<td>64° 42'</td>
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<tr>
<td>71° 18'</td>
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<tr>
<td>41° 50'</td>
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<td>59° 30'</td>
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<tr>
<td>89° 42'</td>
</tr>
<tr>
<td>4°</td>
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<tr>
<td>87° 22'</td>
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<tr>
<td>3° 42'</td>
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</table>

<table>
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<tr>
<th>Sine</th>
<th>Cosine</th>
<th>Tangent</th>
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<tbody>
<tr>
<td>0.7736</td>
<td>0.6336</td>
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<tr>
<td>0.5000</td>
<td>0.8660</td>
<td>0.5774</td>
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<td>0.0647</td>
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</tbody>
</table>

### Practice Exercise 2

1. \[ \sin A = \frac{\text{opp}}{\text{hyp}} = \frac{2}{3} = 0.333 \]
   
   2 cm N \[ \begin{array}{c|c} \text{opp} & 1 \\ \text{hyp} & 3 \end{array} \]
   
   \[ \frac{2 \text{ cm N}}{1 : 0} \]

2. \[ \tan B = \frac{\text{opp}}{\text{adj}} = \frac{1}{4} = 0.25 \]
   
   \[ 1 \text{ m} \]

   \[ 4 \text{ m} \]

   \[ \tan B = 60° 39' \]
Chap 7  Self Assessment Test 1

1) \( 2 + 3 = 2 + 3 = 5 \sqrt{2} \)  
2) \( -2 + 3 = -2 + 3 = -1 \)  
3) \( 2 + 3 = -2 + 3 = 1 \)  
4) \( -2 - 5 = -2 + 5 = 3 \)  
5) \( 1 - 1 = 1 - 1 = -2 \)  
6) \( 6 - 2 = 6 + 2 = 8 \)  
7) \( -5 + 4 = -5 + 4 = -1 \)  
8) \( -3x - 2 = 6 \)  
9) \( -1 + 12 = -12 \)  
10) \( -3 + 1 = -3 \)  
11) \( 6 + 2 = 3 \)  
12) \( -10 - 5 = 2 \)  

Self Assessment Test

1) \( 3a + 2a + 5a = 10a \)  
2) \( 3x - 2y + 2x + 5y = 3x + 2x - 2y + 5y = 5x + 3y \)  
3) \( z + 7z = 2q = 9z - 2q \)  
4) \( p^2 + 2p - p + 4p^2 = 7p^2 \)  
5) \( 8a^2 - 2a + 14a - a^2 = 12a + 7a^2 \)  
6) \( 6ab + 7ba + 6b = 13ba + 6b \)  
7) \( 8xy - 9y + 10yx = 18xy - 9y \)  
8) \( 16x^3 - 14x^2 + 9x - x = 2 \)  
9) \( 16x^3 - 14x^2 + 9x - x = 2 \)  
10) \( 15x^3 \)
5. \(75 \times 360 \\text{ m} \times 3.14159 = \approx 7271.69 \text{ m}^2\) \\
\[x = 75 \times 360 \times 3.14159\]
\[x = 75 \times 360 \times 3.14159\]
\[x = 17560\]
\[x = 57^\circ\]
\[x = 86^\circ\]

6. \(21 \times 360 \\text{ m} \times 3.14159 = \approx 2718.46 \text{ m}^2\) \\
\[x = 21 \times 360 \times 3.14159\]
\[x = 21 \times 360 \times 3.14159\]
\[x = 630\]
\[x = 210^\circ\]

7. \(70 \times 360 \\text{ m} \times 3.14159 = \approx 7950.81 \text{ m}^2\) \\
\[x = 70 \times 360 \times 3.14159\]
\[x = 70 \times 360 \times 3.14159\]
\[x = 157\]
\[x = 36\]

\[x = 301 \text{ mm}\]

\[x = 77 \text{ mm}\]

8. \(210 \times 360 \\text{ m} \times 3.14159 = \approx 2452.82 \text{ m}^2\) \\
\[x = 210 \times 360 \times 3.14159\]
\[x = 210 \times 360 \times 3.14159\]
\[x = 73^\circ\]

9. \(\theta \times 360 \\text{ m} \times 3.14159 = \approx 8598.28 \text{ m}^2\) \\
\[\theta \times 360 \times 3.14159\]
\[\theta \times 360 \times 3.14159\]
\[\theta \times 360 \times 3.14159\]
\[\theta \times 360 \times 3.14159\]
\[\theta \times 360 \times 3.14159\]

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