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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 

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

by<br>JAMES GATENBY, C.Png.M.I.Mech.E.

A Master's Thesis

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

$$
\text { January } 1982
$$

Supervisor: PROPESSOR A. C. BAJPAI CARET

## 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 4 th and 5 th 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 regults extracted for those entering craft apprenticeships.

Pupila 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 wes 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.

Blographical details of intending craft apprentices vere collected and compared with the school population in general.

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

Attempts were made to relate data gathered looally 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/ were-ordinated by the Bath Project.

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 faths," Mr. Michael Packard, of Packard Fublishing 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 ond institations which have provided papers in this field.

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

Ky 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 $1970^{\prime} \mathrm{s}$, 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 Ingineering 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 CSE 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 <br> 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 learming 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 mach 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 $\mathrm{m}^{3}$.

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:

$$
\begin{aligned}
& \text { smaller class sizes (about } 20 \text { ) } \\
& \text { motivation to end unemployment } \\
& \text { more mature attitude } \\
& \text { closer linking of mathematics to trade }
\end{aligned}
$$

Poor understanding of Fnglish 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.

ShJs all norking

1. (1) Multiply 29 by 9
(2) How many eizhts in 496
(3) That number can be divided by 6 exactly 47 times
(4) Take antay 5 times from 12 times 9
2. Fill in the missing numbers:-
(1) $3,6,9,12,(), 18,21,(), 27$
(3) $\frac{1}{10} \frac{3}{10} \frac{5}{10} \frac{7}{10}$ ( ) $\frac{11}{10}$ () $\frac{15}{10}$
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) Hor many pounds in $\frac{1}{1}$ ton
(2) How many yards in 1 mile
(3) How many inches in $\frac{1}{4}$ yard
(4) How many ounces in $\frac{3}{2} \mathrm{l}$ bs
5.(1) How many sixteenths of an inch in $2 \frac{1}{2}$ inches
(2) How many 32nds of an inch in $\frac{3}{6}$ of an inch
(3) How many half inches in $24 / 16$ the of an inch
(4) Take away $7 / 16$ of an inch from $2 \frac{3}{4}$ inches
(5) Which is longer and by how much: $15 / 32$ or $\frac{1}{2}$ inch
5. (1) Change 0.125 to a vulgar fraction
(2) Change 0.0013 to a vulgar fraction
(3). Change $\frac{3}{8}$ to a decimal
(4) Change $5 / 16$ to a decimal
6. Calculate the following:
(1) $0.2+0.125$
(2.) 1 inch -0.016
(3) $0.8 \times 0.03$
(4) $0.00144 ; 0.12$
7. (1) Find area of a rectangle 24 metres long by $1 \frac{1}{2}$ metres wide
(2) Find volume of a block 7 inches lon3, 1 foot 4 inches ride, 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 $7^{\prime \prime}\left(T=3 \frac{1}{7}\right)$
(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 $4 e^{\circ}$
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 $\frac{1}{2}$ tonne
(4) How many mom 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) $1 \frac{1}{4}+\frac{1}{2}-\frac{2}{3}$
(3) $1 \frac{1}{2} \times 2 \frac{2}{5}$
(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 RAII 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.
3. Measuring with a ruler.
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.

| MEASURING EXERCISE |  |  |  |
| :--- | :--- | :--- | :--- |
| USE OF | RULE | EXERCISE NO. | 1 |
| UNITS | BLOCK <br> BLOCK <br> 2 - - MRITISH | TRAINEE |  |



|  | BLOCK 1 (IN.) |  |  | BLOCK 2 (MM.) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| LENGTH | Specified Bimension | Actual Dimension | Within Tolerance? | Specified Dimension | Actual Dimension | Within Tolerance? |
| AB | - |  | - | - |  | - |
| BC | - |  | - | $22 \pm 0.5$ |  |  |
| CD | $1{ }^{\frac{9}{32}} \pm \frac{1}{64}$ |  |  | - |  | - |
| EF | $\frac{7}{8} \pm \frac{1}{64}$ | - |  | - |  | - |
| FG | - |  | - | $33 \pm 0.5$ |  |  |
| AG | $6 \frac{1}{16} \pm \frac{1}{64}$ |  |  | $152 \pm 0 \cdot 5$ |  |  |
| AE | - |  | - | - - |  | - |
| BF | - |  | - | - |  | - |
| CE | - |  | - | - |  | - |

# Visit to E.I.T.B. Craft Training School 13.8.79 Mr. Cawthome, Fngineering Drawing Instructor and <br> 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. Cawthorme 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. $5^{2} \times 5^{3}, 4^{3}+4^{2}$.
10. Fractions, mixed numbers, improper fractions, etc.

Mr. Cawthorne felt that Imperial Units and fractions would be needed for the foreseable 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.

1. ADD TOGETHER THE FOLLOWING VULGAR fRACTIONS $3 / 32.5 / 8$. $1 / 16$
2. SUBTRACT 5/32 FROM 27/64
3.. ADD TOGETHER THE FOLLOWING DECIMAL FRACTIONS $1.099 \quad 0.036 \quad 0.701$
3. SUBTRACT 1:087 FROM 11.084
4. MULTIPLY 8/39 BẎ 34
5. DIVIDE $39 / 128$ BY 츱.
6. MULTIPLY 4.032 BY 0.75
$=$
7. $\because$ DIVIDE 2.075 BY 0.2

## METRIC SYSTEM

9. : SHOW THE ABBREVIATIONS FOR THE FOLLOWING :

10. . HOW MANY MILLIMETRES IN ONE METRE
$=$
1i. HOW MANY GRAMS IN ONE KILOGRAM $=$
11. CONVERT ONE KILOGRAM INTO LBS.
12. IF YOU DRINK EIGHT LITRES OF BEER HOW MANY PINTS WOULD YOU CONSUME
13. USE YOUR RULE TO MEASURE THIS QUESTION PAPER =
14. HOW MANY METRES IN ONE KILOMETRE . .. . =
15. IF A PIECE OF LAND WAS FOUR SQUARE KILOMETRES, WHAT WOULD ITS SIZE BE IN SQUARE MILES =
16. IF THE SPEED OF A CAR WAS 60 M.P.H. WHAT WOULD ITS SPEED BE IN K.P.H.
17. GIVE YOUR APPROXXIMATE HEIGHT AND WEIGHT IN METRIC UNITS.

HEIGHT $=$
WEIGHT =-

PUT YOUR QUALIFICATIONS BELOW.

|  |  |  |
| :---: | :---: | :---: |
| SUBJECT | G.C.E. | GRADE |

DETERMINE LETTERED
DIMENSIONS
$A=$
$B=$
$C=$
$D=$
$E=$
$F=$
$6=$
$H=$
J=
$K=$

$x=$

0 25

DETERMINE LETTER DIMENSIONS
0



BODMAS. SHOWS THE ORDER BY WHICH ANY MATHEMATICAL PROBLEM SHOULD BE SOLVED.
egg. $3(2+3)-2+3=$
IN THIS EXAMPLE THE BRACKET SHOULD BF SOLVED FIRST. ie. $(2+3)=(5)$

NOW THE MULTIPLICATION
ie. $3(5)=15$
THEN THE ADDITION; AS WILL RE SEEN WE HAVE $+158+3$ ie $15+3=18$

NOW DOING THE SUBTRACTION FART OF THE PROBLEM WE GET $18-2=16$
$\therefore 3(2+3)-2+3=$
$3(5)-2+3=$
$15-2+3=$
$18-2=16$
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 BEHIIND IT, IS TO be added to the number in front of it. Thus $4+5$ means THAT 5 IS TO BE ADDED TO 4 ie. $4+5=9$ or 4 $=\overline{9}$

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

$$
\begin{array}{r}
9.0971 \\
9.7560
\end{array}
$$

$$
0.4350
$$

$\frac{1111 \cdot 0370}{113^{2} 0^{1} \cdot 3^{8} 2^{2} 51}$

NOTE. A UNIT IN EACH VERTICAL COLUMN, READING FROM THE RIGHT HAND SIDE, IS $10 \times$ GREATER THAN A UNIT IN THE PREVIOUS COLUMN.

| 1000. | $1000 x$ | THOUSANDS |
| :---: | :--- | :--- |
| 100. | $100 x$ | HUNDREDS |
| 10. | $10 x$ | TENS |
| 1. | $1 x$ | UNITS |
| .1 | $1 \div 10$ | TENGTHS |
| .01 | $1 \div 100$ | HUNDREDTHS |
| .001 | $1 \div 1000$ | THOUSANDTHS |
| .$O O O 1$ | $1 \div 100 C D$ | TEN THIOUSANDTI |
| WRITTEN | VALUE | NAME |

DECIMAL SYSTEM.

## ADOITION

## SOLVE THE FOLLOMING

1) $7+5+10=$
3). $13+1 \cdot 750=$

5/ $131 \cdot 121+2 \cdot 8674+0 \cdot 00102+63 \cdot 2059=$
6


10


## Visit to a Large Engineering Company 26th October 1979

Personnel seen: Torks 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. Hodular 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 abilityl

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.

ENGINEERING COMPANY - CRAFT APPRENTICES ONL) [IN 1979 CSE GRADE 3 MATHEMATICS BECAME MINIMUM ACCEPTABLE ] UMBER

# VISIT TO A LARGE SCHOOL, DERBY, BY <br> REPRESENTATIVES FROM A PRECISION FNGINEERING 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 respohsible 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 embarassed 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 Imperia-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 concerm 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 <br> 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. $3.478+.005$
$=$
5
2. $2.311+5.293+.866=$ 9
3. .732-.391 $=\quad 7$
4. 2.385 - . 1354 =

14
5. $2.078 \times .128=42$
6. . $037 \times 4.290=$

39
7. $.670 \times .030=34$
8. . $276+6=39$
9. $1.120+.030=\quad 48$
10. Express $2 / 5$ as a decimal $=\quad 15$
11. Express $5 / 8$ as a decimal $=\quad 26$

## METRIC TEST

## A Large Engineering Company <br> Internal Arithmetic Tests on 80 Apprentices

```
Name ...................... Check No. ..... Date
Start
Finish
All problems on this paper are expressed in \(\mathrm{m} / \mathrm{ms}\).
```

|  |  | $\frac{\text { Number of }}{\text { Wrong Answers }}$ |
| :--- | :--- | :---: |
| 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 |

INTERNAL COMPANY REPORT ON THE TESTS
Manpormp Rencurcing
TO8

AHALYSIS OP RESULTS OP MATES TEST USED DT TOOL ROON

80 Appreaticen rece give the tact in both imperial mi metric.
a 15 achicied laes then 50; corract on at loant ono paper (9 on both).
de 12 had atudiad at CSS before foining Compare.
Thois progreas in 1 et yoar training shoued the nozmal diatribution of ability ranging ficu balor ararap (2) to ray goci (2).

11 Apprentiee achieved $100 \%$ anecess in at least one paper (one in 5 minutes).
6 studiod mathe at css.
3 sturided sathe at aCB '0' level before joining the Company.
Theip progreas in the lat yoar training ahowad a tendemcy towards nbove avorace ranging frou below average (1) to very goed (1).
superintemdent -
Works Trainting
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.

| Inches | $\frac{\text { Decimal }}{1 / 64}$ | 0.015625 |
| :---: | :---: | :---: |
| $1 / 32$ | 0.03125 | 0.3969 |
|  |  | 0.7938 |

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.

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 draving 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 angie 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. $y=92 x \sin 23^{\circ} 30^{\prime}+\left(5,5 \times \cos 23^{\circ} 30^{\prime}\right)+9,5$
(accuracy on some dimensions to 0.005 mm .)
(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 O


IT IS NECESSARY TO CALCULATE $X$ ANDY BEFORE SETTING UP FOR MACHINING.


$$
\begin{aligned}
& \operatorname{Sin} 30^{\circ}=\frac{O P P}{1.6875} \\
& \therefore \operatorname{Sin} 30^{\circ} \times 1.6875=O P P \\
& \therefore 500 \times 1.6875=O P P
\end{aligned}
$$

$$
\begin{aligned}
& \cos 30^{\circ}=\frac{A D J}{1.6875} \\
& \cos 30^{\circ} \times 1.6875=A D \\
& .866025 \times 1.6875=A i
\end{aligned}
$$

$$
\therefore O P P \quad=-8437 \quad \therefore A D J=1.4614
$$

FIND AN ADDITIONAL DIMENSION ( $x$ )



$$
\begin{aligned}
\text { DIMENSION } Y & =\text { RADIUS }-O P \\
O P & =\sqrt{12.500^{2}-2.000^{2}} \\
\therefore O P & =\sqrt{152.250} \\
\therefore O P & =12.339 \\
\therefore \text { DIMENSIONY} & =12.500-12.339 \\
& =.161 \\
\therefore x & =3.000+.161 \\
\therefore x & =3.161 \mathrm{NS}
\end{aligned}
$$

## Nomenclature

$$
11,995 \text { meant } 11.995 \mathrm{~mm}\left\{\begin{array}{l}
11,995) \text { acceptable } \\
11,992) \text { limits } \\
\text { and } 8,67, \pm 0,1
\end{array}\right.
$$

A diameter of 4 mm was written as $\varnothing 4$.
Also involved was the practice of quoting both inches and millimetres " $40 \mathrm{~m} / \mathrm{m}(1.5748)$ ".

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 5 th 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

Funt (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 meny employees merely 'get by' and iceally 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 concermed than others with the level of its applicants, whilst commercial firms have few complaints.

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

Page 33 sumarizes 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 $12 \mathscr{F}$ were willing to allow them once employees had nroved themselves to be numerate."

- "Almost all jobs involving measurement require metric units, but some $2 / 3$ of these also require Imperial Units."
. "Substantiel numbers of employers did not regard CSE 1 as equivalent to ' 0 ' level - preferred ' 0 ' grade D/E."
. "Few employers take notice of CSE grades $4 / 5$ as indicators of mathematical ability .... "

Mells (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 ouickly.
- Ability to decide whether an answer is sensible.
- Ability to estimate and also round off results.
. Knowledge and manioulation of certain fractions and their decimal equivalent.
. Understanding of tolerances.

SURVEY OF FREQUENCY OF USE: 95 FIRMS AROUND CAMBRIDGE

|  | 1ts. 75-100\% | $50-74 \%$ | $25-49 \%$ | 21 |
| :---: | :---: | :---: | :---: | :---: |
| ECT AREA | kegutar use | FREQUENT USE. | CASUAL LSE | LIITLE USE |
| number the tic | Meet whole nos. to 1000 Tables to 10 Simple mental arithmetic ( $+/-/ x / 4$ ) $+/-$ with nos. to 100 Short multiplication | Meet whole nos. $>1000$ Tables to 12 Long multiplication Short division +/- with whole nos. up to 1000 | Long division | Arithmetic with negative numbers |
| mals | +/- up to 2 d.p's | +/- up to 3 d.p!s $x / t$ up to $2 d . p^{\prime} s$ | $x / 4$ up to 3 d.p's <br> $+/-/ x / \div$ up to 4 d.p's | $+/-/ x / 4$ with $s$ d.p': Use of powers. standard form. |
| tions |  |  | Meet fractions of lorn a 10 <br> Arithetic manipulation or fractions |  |
| entages |  | 8 of an amount | * increase/decrease One quantity as a \% of another | Simple and Compound interest |
| ersicns |  | Decimal/fraction | Fraction/\% Decimal/\% |  |
| ? | . |  | Direct proportion Mixtures Scale | Inverse proportion |
| oximations |  |  | Approximations, rounding, estimation, tolerances |  |
| utation |  | Electronic calculators | Ready reckonex | rables:sq, sq. 5 t. 10 : |
| urement |  | Metric length | Length (except metric), area, capacity, weight, metric/Imp.conversion. Rate revolution Time Angles | Speed |
| uration | $\cdot$ | * | Perimeters \& areas of squares, rectangles, triangles, circles, simple compound shapes Simple plans and elevations | Surface area and volume of solids |
| noles | . | . |  | Similar triangles Pythagoras, Theorem Sin. Cos. Tas Area=lybe $\sin A$ Sine and Cosine sules |
| bra | . | - | Substitution in algebraic forumlae | Iransposition and derivation of Cormulae <br> Linear equations Simultaneous and quadratic equations |
| etry | - - |  | Co-ordinates in 2-D Constructions to bisect lines and angles and to find centre of circle | Co-ordinates in 3-0 Angle facts in polygons \& circles Construction of circumcentre of triangle |
| ability <br> and <br> istics |  |  |  | Probability Mean of data |
| osentation ata | - | - | Bar charts, histograms, St. line graphs <br> Tabulated information (matrices) Timetables | Pie charts and Pictograms |
| V | - . | +/-/x/t wi th money | Making out bills. invoices and accounts |  |

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 vere also emphasised.

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

## Employers' Selection Tests

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

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

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:-

- Government should set standards of numeracy to be achieved by all children.
- Nationwide maths tests and schools with poor record to be inspected.
- Primary teachers of mathematics to be qualified in the subject.
- Emphasis on need for standards in maths in schools and training colleges.
- Adequate numeracy to be a condition for l6+ qualifications.
- Examinations to take account of industries needs; representatives of Industry and Chambers of Commerce to help determine ' 0 ' 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 ..... $\operatorname{c}$ high school leaver unemployment is already contributing to sooial 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 govemment/ 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 govermment'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-Prent and District Steering Committee for the development of co-operation between industries and schools.

## Opinions of Local Companies

| Subject | $\%$ of firms who require proficiency |
| :---: | :---: |
| Addition and subtraction of decimals | 80 |
| MuItiplication and division of decimals | 70 |
| Percentages | 65 |
| Conversion of vulgar fractions to decimals | 60 |
| Use of 4 figure tables | 60 |
| Addition and subtraction of vulgar fractions | 60 |
| Multiplication and division of fractions | 55 |
| Transposition of formulae | 50 |
| Knowledge of Mensuration | 50 |
| Use of $\Pi$ | 50 |
| Square Roots | 30 |
| Trigonometry | 30 |

## Evidence Concerning Standards

## 1976 Evidence

Test.results published in 1976 by lir R Gilbert, training executive of Coventry Engineering Enployers' 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' requirenents after they have left school."

Mr. Gilbert did not think the increased number of applications was responsi ble 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 HMII

Coventry's chief inspector, Mix 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 Inglish task force. Mr. Sanday, however, regarded both the previous downturn and the upturn in 1980 with suspicion, questioning the sensitivity of the tests.

## EVLDEINCE PUBLISHED IN 1976




## Other Evidence Concerning Standards

In "Standards of Numeracy and Literacy in Wales," CBI Tales, 1977, (30), it was stated:
> "By 1975, however, the concern was more widespread throughout industry in Tales 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 rith $30 \%$ in 1966 using identical criteria.

Thile 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 "Luch progress is made in developing literacy and numeracy skills during the early period of apprenticeship."

Summary of Points suggested by Industrial Visits and Fmployers' Reports

- The remedial maths being taught by employers should all be covered in school.
- Both Metric and Imperial Units were widely required.
- Ingineering craftsmen were being recruited from the lower end of the mathematical ability range by some firms.
- Close relationship of maths with employment appeared to improve learning/motivation.
- The book 'Apprentice Maths' was considered by training officers to be very suitable for preparing students for the mathematics needed in craft apprenticeships.
- Standards amongst craft trainees might be improved if more girls were persuaded to apply for apprenticeships.

Chapter 2

EDUCATIONALISTS' VIEWS, RECENT MI 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 ky Head gHat, P51

## '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 inaciequate provision of remedial teaching.

## Work cards and individual learning

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

Teaching from the blackboard has become almost taboo, and now we find HuI exhorting teachers to use the very methods which had been regarded as old-fashioned. HII condemns 'repetitive practice', while parents see it as vital to children's progress, especially in learning tables.

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

## Language and Symbols

Least able have, according to HNI, 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 NFEP. were 'significantly lower in inner city areas where deprivation and poor environmental conditions will inevitably lower performence. 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 chilcren to do better in the basic skills ....'

HHiI 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 ow 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 Pesources

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 buildirgs; the Union also states that schools are blamed as 'scapegoats' for many other social probleris, including high youth unemployment, poor housing and home surroundings.

The project: 'Fifteen Thousand Hours' which monitored 1400 children through school from 11 - 15 in south-east Iondon 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 ${ }^{1}$ was illiterate or semi-literate (reading age below 10) and Vermon ${ }^{2}$ found that roughly hal $f$ 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 $1920^{\circ} \mathrm{s}$ and $1930^{\circ} \mathrm{s}$.

The N.U.T. state that in 1971 the percentage of semi-literate 15 year olds was $3.2 \%$.

1
Wall, W.D. - British Journal of Educational Psychology. 1945, No. 15 p. 28
2. Vernon, P.E. - British Joumal of Educational Psychology, 1946, No. 16 p. 149

Comparison of G.C.E. results 1964-1974

Table 1

|  | No. in <br> Comprehensives | Obtained <br> 1 | Obtained <br> 1 |
| :---: | :---: | :---: | :---: |
| 1964 | $8 \%$ | $15 \%$ | $11 \%$ |
| 1974 | $70 \%$ | $25 \%$ | $15 \%$ |

Table 2 Output of students 1966 and 1976

| Number of ' 0 ' levels or hisher grade CSE | $\%$ of age group |  |
| :---: | :---: | :---: |
|  | 1966 | 1976 |
| 0 | 58.6 | 47.4 |
| 1-2 | 8.4 | 17.0 |
| 3-4 | 6.6 | 8.7 |
| 5 or more | 18.0 | 22.4 |
| 1 or more | 33.0 | 48.1 |
| $\frac{\text { Tumber of }}{\mathrm{A}^{\prime} \text { levels }}$ |  |  |
| 1 | 2.3 | 3.0 |
| 2 | 3.2 | 4.2 |
| 3 or more | 5.6 | 8.3 |
| 1 or more | 11.1 | 15.5 |

## Table 3

|  | 1956 | 1976 |
| :--- | :--- | :--- |
| $\%$ <br> \% School leavers with: level maths or <br> equivalent |  |  |
| 'O' level English Language <br> or equivalent | $15.6 \%$ | $23.6 \%$ |

## References

3. Comprehensive Education, No. 35, Finter 1976-77/DES Statistics Vol. 111974
4. DES school leavers CSE and GCE 1976 (Vol 2)

Primary Mathematics
The HMI's survey on Primary education in Bngland (HiSO 1973) 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."

FMIs 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 of ten judge the school on the qual ity 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 mathenatics; 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 mathenatics 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 everday 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 al so needs to serve other purposes which can be understood by the pupil at the time.'
H.N.I. stated that primary teachers are not agreed on common aims and objectives. 'Some stress factual knowledge to the exclusion of other objectives; ot hers 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 inill 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 decimilisation were seen as creating more time for a broader mathematics syllabus; with understanding stressed more than 'rote' learning.
3. 12,800 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.

## TALK GIVEN TO INDUSTRIALISTS BY HEAD OF MATHS

"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 metrication 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 overthe county are discussing the

## Talk by a Head of Maths - contimued

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, ard transformation geometsy. However the circle theorems, Pythagoras' theorem and the properties of plane figures remain: ${ }^{n}$
" 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."

## Talk by a Head of Maths - continued

"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 rathemetical 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 concermed 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

Talk by a Head of Maths - continued
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.

## THE H.M.I. REPORT

"ASPECTS OH SECONDARY EDUCATION"

Summary of some of the mathematical findings

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

## Aspect

Traditional vs Modern
C.S.E. courses

Less able pupils

Number bases (eg base 8) Useful only as 'illumination' of our
Number bases (eg base 8) Useful only as 'illumination' of our tens system.

Matrices, vectors, sets, etc.

Standards in
arithmetic

## Finding

Differences have diminished. Most schools do compromise syllabus with traditional for lower ability 4 th and 5th year. Teachers' interpretation and approach more important than type of syllabus. See Table 2.

Considerable numbers of pupils follow

- courses in which there is"abstract intellectual content ..... beyond their limits."

In $60 \%$ of schools, HuI considered new courses needed for less able.

Can be of doubtful value if taught only as low level skill.

Weaknesses were hardly ever due to lack of attention to the problem -

## Aspect

Applications

Computers

Language

Mental arithmetic

Finding
not infrequently linked to difficulties from catchment area. Improvement involves more than teaching method alone."

Proper level can be achieved with both Traditional and Modern system. "Unrelieved diet of further practice on a succession of narrow techniques," not likely to solve longstanding difficulties with fractions and decimals.

Disappointing lack of realistic materials such as plans, magazines, instruction manuals. Wore linking should be made with craft and technical subjects and their equipment.

Only a minority of pupils involved, even computer terminals unused.

Not enough interchange of ideas between pupils, teachers and use of mathenatical sentences.

Not enough regular practice.

## Aspect

## Finding

| Numeracy | Should also include ability to estimate and use appropriate degree of accuracy. |
| :---: | :---: |
| Objectives | Many were too narrow, too much repetitive mechanical arithmetic without comprehension or ability to apply in fresh situations. |
| Suggestions for improvement | 1. Diagnosis of individual difficulties. <br> 2. Better appreciation of role of language and oral work. <br> 3. More use of applications from world outside. |
| Requirements of industry | "... may be a substantial problem" <br> but criticism had reinforced a number of schools in an already narrow approach in mathematics. |
| Excessive breadth | Only a problem in a small number of schools - modern syllabuses "more prone to this excess than traditional." |
| Catchment area/ social deprivation | In a few cases, "lessons proceeded in an atmosphere of resigned defeat ... most usually in schools where there were problems of social deprivation. "Solution only to be found as part of. <br> a larger programme of restoring morale." |

## Aspect

Setting and mixed ability.

Qualification of teachers.

## Finding

Only three schools had complete mixed ability across the whole range and these were criticised by $\mathrm{M} I \mathrm{I}$.

Of 3,365 teachers, $27 \%$ maths graduates, $23 \%$ not specialising in maths as lst or 2nd subjects. Between 2,500 to 4,500 of the country's teachers considered inadequate in professional/ mathematical capability. Poor presentation of work associated with poor standards of marking, but over-conscientious teachers might damage health.

## 

## 

## Pupilg' 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 $\frac{1}{5}$ th of the 384 schools. Only 24 admitted a considerable discipline problem.

Schools with a Concentration of Froblems
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 learming 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 Fathematics 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 disrruptive 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) HII 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 cormunications. There were extensive extra-curricular activities and the school had its own residential centre in Fales .

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."

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

Table 1 Examination Targets

$$
\text { Boys and Girls } \quad 384 \text { schools }
$$

| Examination Target | Year 5 |
| :---: | :---: |
| O' level | $22 \%$ |
| O/CSE | $7 \%$ |
| CSE | $53 \%$ |
| Mon-Exam | $17 \%$ |

Table 2 Kodern vs Traditional - 384 schools

| Year | Traditional | Compromise | Liodern |
| :---: | :---: | :---: | :---: |
| 1 | $29 \%$ | $43 \%$ | $35 \%$ |
| 2 | $33 \%$ | $44 \%$ | $33 \%$ |
| 3 | $36 \%$ | $43 \%$ | $34 \%$ |
| 4 | $50 \%$ | $45 \%$ | $33 \%$ |
| 5 | $53 \%$ | $43 \%$ | $31 \%$ |

(Some schools offer more than one course in a particular year so totals not l00\%.

Table 3 'Competence'.in Arithmetic

| GCE | Competent in $86 \%$ of schools |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: |
| CSE | $"$ | $"$ | $62 \%$ | $\prime \prime$ | $" 1$ |
| Non-exam | $"$ | $"$ | $37 \%$ | $"$ | $"$ |

## Table 4 Gless Size - 384 schools

| GCE | 26.5 |
| :--- | :--- |
| GCE/CSE | 27.7 |
| CSE | 25.0 |
| lixed targets | 21.1 |
| Undecided and arithmetic | 20.9 |
| Non-examination | 18.7 |

Table 5 HII's assessment of mathematical nrovision and oupils' response in 384 schools

|  |  | Kore <br> Able <br> e | Average <br> d. | Less <br> Able <br> $\%$ |
| :--- | :--- | :---: | :---: | :---: |
| Mathematical | Creditable | 17 | 10 | 9 |
| Provision | Acceptable | 68 | 64 | 44 |
|  | Unsatisfactory | 15 | 26 | 47 |
| Pupils, | Creditable | 26 | 12 | 12 |
| Response | Acceptable | 68 | 69 | 54 |
|  | Unsatisfactory | 6 | 19 | 34 |

## 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 microcomputers into schools, stated that most of this work was being undertaken by maths teachers, thus exacerbating the shortage of mathematics teachers.

Quading ( 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, of ten 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 Govermment under Mrs. Thatcher was likely to be in office at least for the beginning of the 1980 s .

Milby (Ref. 20 ) reported the Govermment's policy of retaining ' $O$ ' levels, planned to be abolished by the lest administration. They were concerned that children \#ere attempting examinations beyond their capabilities. "'O' levels and C.S.E. were designed for the most able $60 \%$..... but now they are ettempted by more than 90\%. Ir. Carlisle, the education secretary, hed arcied that 'O' level was the only exam whose standards were clearly understood and accepted by employers.

The Government wanted to recuce the number of syllabuses $\because i t h$ a 'common core' in maths, and adopt a common grading system between ' 0 ' level and C.s.E.

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

Altemetive methods of assessment would be 'profiles,' in which teachers rate character (punctuality, detemination, etc.) $\mathfrak{n} \alpha$ mastery of specific skills (e.g. ability to operate a lathe).

## SECONDMENT OH 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 youmg
people.
(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 Vermon Naths 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 spell.ing ...." "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 mathenatics 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 selfmotivation, 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 wi shed 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 intro duces 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."

## Tutor. Boys Graft and Pastoral Care

> "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.

## Head of Dept. of Technical Studies

"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:-


#### Abstract

"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 vould have preferred a greater amount of discipline in schools, a sentiment also given by the Union Representatives."

## Inglish 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 form 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."

## Head of Year

"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.'


#### Abstract

"This attitude helped to resolve my orm 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:-

[^0]
## Head of Upper School

This teacher noted that to avoid future loss of craftsmen from the shop floor "a relative crossmection 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 $R^{\prime} s$ 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-universityschool 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 thẹ 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."

## SURYSARY

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 ruxal 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 then 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, availa.ble 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 concemed at the continued need for Imperial Units and the use of 3rd Angle Projection contrasting with the list Angle used at many schools.

## Mathematics

Teachers appreciated the need for basic skills in Maths (and Finglish) 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 fevealed 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.
-000-


## Chapter 3

## STATISTICS OF PUPILS LEAVING A LARGE COMPREHENSSIVE SCHOOL - DESTINATIOIS AND STANDARDS IN ARITHIETIC

This chapter analyses the placement of pupils leaving the 5 th 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 vork from other projects is included, such as the SLAPONS project to standardize numeracy testing.

## ANALYSIS OF KNOWN PLACEMENT OF PUPILS ELIGIRLE TO LEAVE THE SCHOOL IN SUMEER 1978

\% of Total

1. Apprentices

$$
\text { Craft Apprentices } 50
$$

Technician Apprentices ..... 3
Draughtsmen ..... 2Total 5520\%
2. Semi-skilled Manuale.g. Machinists, Pressoperators, cutters, fettlers,painters.23
$8 \%$
3. Unskilled manuale.g. Labourers, packers,warehousemen, loaders,
window cleaners. ..... 30 ..... 11\%
4. Commercial and Secretarial
Secretaries/Typists ..... 8
Clerks ..... 19
Receptionists ..... 2
Punch Card Operators ..... 1
Total ..... 3011 $\%$
5. Service Occupations
Hairdressers ..... 4
Shop Assistants ..... 25
Police ..... 1
Firemen ..... 1
\#aitress ..... 1
Chef ..... 1Total 33$12 \%$

## B of Total

6. Sixth Form ..... 37 ..... $13 \%$
7. Colleges of Further Education ..... 25 ..... 9\%
8. 习ork Experience Program ..... 26 ..... 9\%
9. Unemployed ..... 21 ..... $7 \%$
Total Eligible
Leavers ..... 280$\underline{\underline{\square}}$
No. of boys entering craft apprenticeships .....  49
No. of boys leaving school in 1978 .. 150
of male leavers entering apprenticeships ..... 33\%
No. of girls entering craft apprenticeships .....  1
No. of girls leaving school in 1978 .. 130\% of female leavers entering craft apprenticeships$0.8 \%$


## Destinations of Pupils: Further Education

## versus Full-time Fraployment

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 heve risen, the percentage opting for further education rather than employment has actually declined slightly.

## Pupils entering employment <br> in England and Tales

|  | $1966 / 67$ | $77 / 78$ |
| :---: | :---: | ---: |
| $\oiint$ | 82 | 82.2 |
| $1000 ' \mathrm{~s}$ | 251 | 324.6 |

Puoils antering full-time
Further Education in Fngland and Wales

|  | $1966 / 67$ | $77 / 78$ |
| :---: | :---: | :---: |
|  | 18 | 17.8 |
| $1000^{\prime} \mathrm{s}$ | 55 | 70.3 |

## Mathematical Qualifications of Pupils Leaving 5th Year

 of the School in Summer 1978GRADES IN GCE/CSE MATHS OF CRAFN APPRENTICES CORPARED 汭TH WHOLE OF 5 th YEAR POPULATION


Most frequent attainment amongst craft apprentices; nonexamination

48\% of those entering craft apprenticeships obtained Grade 5ertook no examination.

IUMERACY TESTIHG 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 yart in the 'Apprentice Mathenatics' course. (This sulsequenty proved cintrasticeble.).
2. To identify those topics in basic mathematics which cause most difficulty; these would be given priority during the lunch-time course and :here necessary additional teaching material would be prepared.

## Descriotion 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:

| Maths Group | Course Followed | No. of Pupils |
| :---: | :---: | :---: |
| 1 | G.C.E. 'O' | 33* |
| 2 | G.C.P./C.S.E. | 23) |
| 3 | C.S.E. | 25 ) Potential |
| 4 | C.S.T. (Iimited | $19\left\{\begin{array}{l} \text { Craft } \\ \text { Apprentices } \end{array}\right.$ |
| 5 | " " | 18 ) |
| 6 | Non-Examination | 22 |
|  |  | 140 |
|  |  | - |

All examination courses are basically 'Tcaditional'mathematics.

* Group 1 consisted of pupils who would generally obtain ' 0 ' level grades A - C, and almost certainly no future craft apprentices.

Pilot testing showed that the weakest in Group iwould 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 ' 0 ' 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 Iimited 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' stancard in Naths 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 ERPLOYFRS' SPECIMEN ARITHAPTIC TEST
APPLIED TO 140 PUPILS REPRESWITIIG THE FHOLEOE THE 5 th PAR ABTIITY RAIGE

Table 1

| Question | Answers |  |  |
| :---: | :---: | :---: | :---: |
|  | $\mathscr{\%}$ of 5 th Year |  |  |
|  | Pight | Wrong | Not Attempted |
| $11035+77+988$ | 94 | 5 | 1 |
| $21915+201+317$ | 91 | 9 | 0 |
| 3 Find sum of 675, 209, 8885 | 79 | 7 | 14 |
| 4 1181-997 | 82 | 18 | 0 |
| 5 2141-317 | 83 | 16 | 1 |
| 6 888-799 | 91 | $8 \frac{1}{2}$ | $\frac{1}{2}$ |
| 7 Subtract 814 from 2000 | $81 \frac{1}{2}$ | 12 | $6 \frac{1}{2}$ |
| $8 \quad 113 \times 35$ | 80 | 14 | 6 |
| $9729 \times 18$ | 71 | 23 | 6 |
| $10 \quad 1417$ + 13 | 65 | 25 | 10 |
| $11 \quad 2937$ + 11 | $74 \frac{1}{4}$ | 141 | 11䨐 |
| $122.295+671+25.9$ | 65 | 27 | 8 |
| $1310.2+1.901+0.037$ | 85 | 4 | 11 |
| 14 Subtract 1.913 fromil 2.803 | $73 \frac{1}{2}$ | 141 ${ }^{\frac{1}{2}}$ | 12 |
| $151.113 \times 16$ | 69 | 18 | 13 |
| $160.002 \times 1.2$ | 53 | 31 | 16 |
| $17 \quad 48+0.4$ | 39 | 35 | 26 |
| $186416+0.15$ | 37 | 34 | 29 |
| $199 \frac{1}{8}+3 \frac{1}{2}+2 \frac{1}{4}$ | 55 | 24 | 21 |
| $202 \frac{1}{5}+1 \frac{1}{3}$ | 52 | 22 | 26 |
| 21 8年-610 | 46 | 20 | 34 |
| 22 33 ${ }^{\frac{3}{6}}$ - $2 \frac{7}{8}$ | 36 | 26 | 38 |
| 23 1 $\frac{2}{5} \times 2 \frac{1}{7}$ | 35 | 22 | 43 |
| $24 \quad 3 \frac{1}{8} \times \frac{4}{5}$ | 34 | 15 | 51 |
| $254 \frac{1}{2}+\frac{1}{2}$ | 39 | 6 | 55 |
| $26 \quad 2 \frac{1}{4}+1 \frac{3}{4}$ | 36 | 8 | 56 |
|  | Right | Wrong | Not Attempted |

\& OF 5th YEAR POPULATION NOT ACHIEVING CORRECT ANSHERS


Table 2

| Question | Mlaths Group | Correct | Incorrect | Not <br> Attempted |
| :---: | :---: | :---: | :---: | :---: |
| 1. $1035+77+988$ | GCE 1 | 33* |  | - |
|  | GCE/CSE 2 | 222 | 1 | 0 |
|  | CSE 3 | 23 | 2 | 0 |
|  | CSE 4 | 19 | 0 | 0 |
|  | CSE/TE 5 | 18 | 0 | 0 |
|  | NE 6 | 17 | 4 | 1 |
|  | ${\underset{q}{0}}_{T O T A J}$ | $\begin{gathered} 132 \\ 94 \% \end{gathered}$ | $\begin{aligned} & 7 \\ & 5 \% \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \% \end{aligned}$ |
| 2. $1915+201+317$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 221 | 2 | 0 |
|  | CSE 3 | 25 |  |  |
|  | CSE 4 | 18 | 1 | 0 |
|  | CSE/NE 5 | 17 | 1 | 0 |
|  | NE 6 | 13 | 9 | 0 |
|  | TOTAL | 127 | 13 | 0 |
|  | 8 | 91\% | $9 \%$ | 0 |
| Find the sum of 675, 209, 8885 | GCE 1 | 33 |  |  |
|  | GCE/CSE | 19 | 1 | 3 |
|  | CSE 3 | 24 | 1 | 0 |
|  | CSE 4 | 12 | 2 | 5 |
|  | CSE/NE 5 | 16 | 1 | 1 |
|  | NE 6 | 7 | 5 | 10 |
|  | TOTAL | 111 | 10 | 19 |
|  | \% | 79\% | $7 \%$ | 14\% |
| 4. 1181-997 | GCE 1 33* |  |  |  |
|  | GCE/CSE 220 |  | 3 | 0 |
|  | CSE 322 |  | 3 | 0 |
|  | CSE 416 |  | 3 | 0 |
|  | CSE/NE 515 |  | 3 | 0 |
|  | NE 6 | 9 | 13 | 0 |
|  | $\frac{\text { TOTAL }}{\%}$ | $\begin{aligned} & 115 \\ & 82 \neq \end{aligned}$ | $\begin{aligned} & 25 \\ & 18 \% \end{aligned}$ | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ |



| Question | Maths Group | Correct | Incorrect | Not Attempted |
| :---: | :---: | :---: | :---: | :---: |
| 9. $729 \times 18$ | GCE 1 | 33* |  |  |
|  | $\operatorname{GCE} / \mathrm{CSE} 2$ | 20 | 3 | 0 |
|  | CSE 3 | 19 | 6 | 0 |
|  | CSE 4 | 12 | 7 | 0 |
|  | CSE/NE 5 | 10 | 8 | 0 |
|  | NE 6 | 5 | 8 | 9 |
|  | total | 99 | 32 | 9 |
|  | $\%$ | 71\% | 23\% | 6\% |
| 10. $1417+13$ | GCE 1 | 33 |  |  |
|  | GCE/CSE 2 | 20 | 3 | 0 |
|  | CSE 3 | 18 | 7 | 0 |
|  | CSE 4 | 13 | 6 | 0 |
|  | CSE/NE 5 | 5 | 13 | 0 |
|  | IE 6 | 2 | 6 | 14 |
|  | Totas | 91 | 35 | 14 |
|  | \% | 65\% | 25\% | 10\% |
| 11. 2937 + 11 | GCE 1 | 33 |  |  |
|  | GCE/CSE 2 | 21 | 2 | 0 |
|  | .CSE 3 | 24 | 1 | 0 |
|  | CSE 4 | 14 | 5 | 0 |
|  | CSE/VE 5 | 10 | 8 | 0 |
|  | IRE 6 | 2 | 4 | 16 |
|  | totai | 104 | 20 | 16 |
|  | \% | 74\% | 14\%\% | $11 \frac{1}{2} \%$ |

12. $1.295+671+25.9$ GCE 1 33

| GCE/CSE 2 | 22 | 1 | 0 |
| :--- | :---: | :---: | :---: |
| CSE 3 | 18 | 6 | 1 |
| CSE 4 | 14 | 5 | 0 |
| CSE/NE 5 | 3 | 15 | 0 |
| NE 6 | 1 | 11 | 10 |
| TOTAL | 91 | 38 | 11 |
| $\%$ | $65 \%$ | $27 \%$ | $8 \%$ |



| Question | Maths Group | Correct | Incorrect | Not <br> Attempted |
| :---: | :---: | :---: | :---: | :---: |
| 17. $48 * 0.4$ | CCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 12 | 9 | 2 |
|  | CSE 3 | 7 | 12 | 6 |
|  | CSE 4 | 1 | 14 | 4 |
|  | CSE/VE 5 | 2 | 13 | 3 |
|  | NE 6 | 0 | 1 | 21 |
|  | TOTAL | 55 | 49 | 36 |
|  | $\%$ | 39\% | 35\% | 26\% |
| 18. $6416+0.16$ | GCE 1 | 33* |  |  |
|  | GCE./CSE 2 | 13 | 8 | 2 |
|  | CSE 3 | 5 | 14 | 6 |
|  | CSE 4 | 0 | 11 | 8 |
|  | CSE/NE 5 | 0 | 13 | 5 |
|  | TE 6 | 0 | 2 | 20 |
|  | totas | 51 | 48 | 41 |
|  | \% | 37\% | 34\% | 29.5 |
| 19. $9 \frac{1}{8}+3 \frac{1}{2}+2 \frac{1}{4}$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 20 | 2 | 1 |
|  | $\operatorname{CSE} 3$ | 18 | 5 | 2 |
|  | CSE 4 | 4 | 13 | 2 |
|  | CSE/RE 5 | 2 | 11 | 5 |
|  | HE 6 | 0 | 3 | 19 |
|  | TOTAL | 77 | 34 | 29 |
|  | $\%$ | 55\% | 24\% | 21\% |
| 20. $2 \frac{1}{5}+1 \frac{1}{3}$ | GÇE 1 | 33* |  |  |
|  | GCE/CSE 2 | 17 | 4 | 2 |
|  | $\operatorname{cse} 3$ | 16 | 5 | 4 |
|  | CSE 4 | 5 | 7 | 7 |
|  | CSE/VE 5 | 2 | 12 | 4 |
|  | NE 6 | 0 | 3 | 19 |
|  | total | 73 | 31 | 36 |
|  | \% | 52\% | 22\% | 26\% |
|  |  | CORRECT | ITCORPDCT | NOT <br> ATTEMPTED |


| Question | Daths Group | Correct | Incorrect | Not Attempted |
| :---: | :---: | :---: | :---: | :---: |
| 21. $8 \frac{1}{7}-6 \frac{1}{10}$ | GCE 1 | 33* |  |  |
|  | $\operatorname{cccs} / \mathrm{cse} 2$ | 14 | 4 | 5 |
|  | CSE 3 | 15 | 4 | 6 |
|  | CSE 4 | 0 | 9 | 10 |
|  | CSE/NE 5 | 3 | 9 | 6 |
|  | NE 6 | 0 | 2 | 20 |
|  | total | 65 | 28 | 47 |
|  | \% | 46\% | 20\% | 34\% |
| 22. $3 \frac{3}{16}-2 \frac{7}{8}$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 8 | 13 | 2 |
|  | $\operatorname{CSE} 3$ | 8 | 9 | 8 |
|  | CSE 4 | 0 | 7 | 12 |
|  | CSE/ITE 5 | 1 | 7 | 10 |
|  | NE 6 | 0 | 1 | 21 |
|  | total | 50 | 37 | 53 |
|  | $\%$ | 36; | 26\% | 38\% |
| 23. $1 \frac{2}{5} \times 2 \frac{1}{7}$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 8 | 9 | 6 |
|  | CSE 3 | 8 | 8 | 9 |
|  | CSE 4 | 0 | 6 | 13 |
|  | . CSE/NE 5 | 0 | 8 | 10 |
|  | NE 6 | 0 | 0 | 22 |
|  | total | 49 | 31 | 60 |
|  | \% | 35\% | 22; | 43\% |
| 24. $3 \frac{1}{8} \times \frac{4}{5}$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 6 | 6 | 11 |
|  | CSE 3 | 7 | 4 | 14 |
|  | CSE 4 | 1 | 4 | 14 |
|  | CSE/NE 5 | 0 | 7 | 11 |
|  | NE 6 | 0 | 0 | 22 |
|  | tomal | 47 | 21 | 72 |
|  | $\%$ | 34\% | 15\% | 51\% |
|  |  | CORRECT | IFCORRECT |  |


| Question | Maths Group | Correct | Incorrect | Not <br> Attempted |
| :---: | :---: | :---: | :---: | :---: |
| 25. $4 \frac{1}{2}+\frac{1}{2}$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 9 | 2 | 12 |
|  | CSE 3 | 9 | 2 | 14 |
|  | CSE 4 | 3 | 0 | - 16 |
|  | CSE/NE 5 | 0 | 5 | 13 |
|  | NE 6 | 0 | 0 | 22 |
|  | TOTAL | 54 | 9 | 77 |
|  | $\underset{0}{*}$ | 39\% | 6\% | 55\% |
| 26. $2 \frac{1}{4}+1 \frac{3}{4}$ | GCE 1 | 33* |  |  |
|  | GCE/CSE 2 | 7 | 4 | 12 |
|  | CSE 3 | 10 | 0 | 15 |
|  | CSE 4 | 0 | 2 | 17 |
|  | CSE/NE 5 | 0 | 5 | 13 |
|  | NE 6 | 0 | 0 | 22 |
|  | TOTAL | 50 | 11 | 79 |
|  | $\%$ | 36\% | - $8 \%$ | 56\% |
|  |  | CORRECT | IICORPTCT | $\begin{aligned} & \text { IOT } \\ & \text { ATPE:PTED } \end{aligned}$ |

Sumnary of Weaknesses

## Operation

Addition of whole numbers.

Subtraction of whole numbers.

Multiplication of whole numbers.

Division of whole numbers.

Addition using decimals.

Subtradion using decimals.

Multiplication of decimals.

Division of decimals.

Addition of
Fractions.

## Weakness

14\% of population did not know what 'find sum of' means.
'Borrowing' from 2000 caused problems.

Lack of knowledge of tables.

Inability to do long division. Missing 'O' out of 109 in quotient. Inability to write numbers in correct columns according to place value, especially when one number has no decimal point.
'Subtract 1.913 from 2.803'
was writiten as $\begin{array}{r}1.913 \\ -2.803\end{array}$
Placing of decimal point in the answer.

Conversion of divisor to whole number and adjustment of point in dividend.

Inability to convert to common denominator.

Operation Teakness
$\begin{array}{ll}\text { Subtraction of } & \text { As for addition, but al so } \\ \text { Fractions. } & \text { e.g. } 3 \frac{3}{16}-2 \frac{7}{8} \text { because } \frac{3}{16}<\frac{7}{8}\end{array}$

Multiplication and General lack of knowledge of method
Division of Fractions. i.e. conversion to improper fractions, etc.

## Variation of Mumerical Competence during Secondary School Years 1-5

Harris ( 6 ) devised a test to examine childrens' 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 sherper improvement by the boys at ell academic levels curing the 4 th end 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 deciral point, and their leck 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.)

Iindsay et al ( 21 ), devised a standardised test of basic arithmetic, the results for each individual being dram 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.


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.

## Kumeracy Testing of Apprentices

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

Some of the major weaknesses are shown below:-

| Problem | \% \#rong |
| :---: | :---: |
| $\begin{array}{r} \text { Add } 4,532 \\ 125 \\ 7,609 \\ 5,431 \\ 892 \end{array}$ |  |
|  | 66 |
| Subtract 547 <br>  139 |  |
|  | 24 |
| Subtract 4,877 from 21,342 | 34 |
| Multiply 267 6 | 44 |
| Work out $625 \times 57 \times 16$ | 75 |
| Divide 72966 | 63 |
| Divide 41,128 by 32 | 61 |
| Add $1 \frac{3}{4}$ and $2 \frac{1}{3}$ | 70 |
| Add 13.27 and 27.9 | 33 |
| Subtract 23.12 from 436.4 | 58 |
| What is $\frac{5}{6}+\frac{2}{3}$ ? | 73 |

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 $80 \%$ ).

## Surmaxy

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 Farris 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 najvely 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 àt 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 $B^{\prime} O^{\prime}$ 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 belov' 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 smell 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 most 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 ${ }_{i}$ 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 1
Analysis of Offences during each year (Boys and Girls)

| Offence | $77-78$ | $78-79$ | $79-80$ | Total <br> $77-80$ |
| :--- | :---: | :---: | :---: | :---: |
| Burglary <br> (with and <br> rithout theft) <br> Theft | 17 | 3 | 7 | 27 |
| Taking vehicle/ <br> driving <br> Criminal <br> damage | 3 | 30 | 10 | 62 |
| Indecent <br> assault | 8 | 9 | 4 | 9 |
| Handling <br> stolen goods <br> Assault/ <br> wounding <br> Insulting <br> language <br> TOTAL <br> OFFENCES | 5 | 2 | 1 | - |

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)

| Offence | (1977-1980) |  |  |
| :--- | :---: | :---: | :---: |
|  | 3rd Year | 4th Year | 5th Year |
| Theft | 14 | 24 | 24 |
| Burglary |  |  |  |
| Taking vehicle | 3 | 15 | 9 |
| /driving | 4 | - | 5 |
| Criminal damage | 1 | 4 | 12 |
| Indecent assault | 0 | 0 | 1 |
| Handing stolen | 2 | 1 | 6 |
| goods | 1 | 2 | 4 |
| Assault/wounding | 1 | 0 | 1 |
| Insulting | 0 | $\frac{46}{2}$ | $\frac{62}{2}$ |

Table 3
Analysis of Offences by Sex

| Offence | Boys | Girls |
| :--- | :---: | :---: |
| Burglary | 24 | 3 |
| Theft | 51 | 11 |
| Taking vehicle | 9 | 0 |
| Criminal damage | 15 | 2 |
| Indecent assault | 1 | 0 |
| Handling stolen goods | 9 | 0 |
| Assault | 5 | 2 |
| Insulting language | 1 | 0 |
|  | $\underline{115}$ | $\underline{18}$. |

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 casette).
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. Inlness 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 5 th 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 disrupṭive.
2. The Head of School, responsible for dealing with all disruptive pupils, considered that over $95 \%$ of all dismuptives 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 extermal 'home' (often local authority factors.

## Gary

Successive Pamily 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 pröblems 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 seekrevenge 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 tumover 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. Then aggressive, he would overtly refuse to do any work, accept any punishment or make any apology; when helpful he would vork 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 rounding 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 Tales

Bond (ref. $3^{\text {( }}$ ) 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 rithout 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 Mgland and Wales.

| Divorce | 1971 | 1977 |
| :--- | :---: | :---: |
|  | 74,000 | 129,000 |
|  | 1971 | 1977 |
| $\frac{\text { Children }}{\text { under } 16}$ of | 82,000 | 149,000 |
| divorcing |  |  |

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

## Puoils aged 14 - 16 involved in serious crime

| Male | 1957 | 25 per 1000 |
| :---: | :---: | ---: |
|  | 1978 | 78 per 1000 |
|  |  |  |
| Female | 1957 | 2.3 per 1000 |
|  | 1978 | 16 per 1000 |

## Effects of Broken Homes

Douglas (29) noted, "Broken homes are more common among the delinquent than non-delinquent boys, but it is divoree 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."

## 'ATTFMPTS BY THE SCHOOL TO ALIEVIATE

 NEGATIVE BEHAVIOURThe 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.
3. Mixed Ability Reg istration Groups.
4. Provision of Recreational and Social Facilities for 5th Year pupils.
5. Link Courses at College of F.E. and careers visits.

These changes are examined closely as they are considered central to the problem of low motivation and negative behaviour contributing tơ 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 wasppromptly 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 accomodated approximately ten pupils; these vere 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 accomodation meant that Billy was returned to be 'contained' by the school.

It was obvious that after a period in the speci al 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 darage 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 Regiatration 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, Finglish 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 chilicen 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 concientious 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 Mest 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 vould spend their spare time quietly discussing cars, motor-cycles, and music or reading magazines.

The potential apprentices displayed neither the extremes of boister ous 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 5 th 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 dariage. It was also a source of shelter for deprived pupils who were poorly fed and clothed.

## Iink 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 1970 s and making predictions for the l980s 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 menagement......... 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 unknow 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, Iondon
"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. Socie ty grows more and more divided."

At the Oxford Conference in Education at St. Catherine's College, Maden, 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 agreenent 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 mursemaid for an increasing number of problem children ..... Byebrows 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 puipils 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 intermal 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:-

- The pupil's perception of school and examinations as irrelevant to their future career e.g. destined for family business, etc.
- Problems in the home e.g. a girl brought up as a son rather than a daughter became a "fighter."
- 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 $o^{\prime}$ 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 meny 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 denrived 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 Understending and Knowledge would not be strongly felt.

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

Maslow (25) expressed these needs in the form of a pyremid, Understanding and Knowledge not being needed until others had been satisfied.

## Maslow's Hierarchy of Needs



## Attainment related to home-background

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

|  | Middle Class |  | Manuel Working <br> Class |  |
| :--- | :--- | :---: | :---: | :---: |
|  | Upper | Lower | Upper | Lover |
| Average scores <br> in Arithmetic <br> Test <br> Age 11 years | 57.18 | 54.43 | 49.86 | 47.30 |

## Mathematical Attainment Related to the Affluence of the Catchment Area

The 1980 Peport of the D.E.S. Assessment of Performence Unit ( $28^{\text {b }}$ )described tests in mathematics on 13,879 punils aged 15 years in 563 schools in Bngland, Fales and Northern Ireland.

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

|  | All pupils |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Number |  |  |  |  |
| Concepts | 64 | 71 | 64 | 56 |
| Skills | 55 | 61 | 55 | 47 |
| Applications | 45 | 52 | 44 | 37 |
| Measures |  |  |  |  |
| Unit | 55 | 61 | 55 | 47 |
| Rate and ratio | 31 | 35 | 30 | 26 |
| Mensuration | 31 | 36 | 30 | 24 |
| Al gebra |  |  |  |  |
| General | 43 | 50 | 41 | 34 |
| Traditional | - 34 | 42 | 32 | 25 |
| Modern | 32 | 39 | 30 | 25 |
| Granhical | 33 | 41 | 32 | 24 |
| Geometry |  |  |  |  |
| Descriptive | 43 | 50 | 42 | 34 |
| Modern | 27 | 34 | 26 | 19 |
| Trigonometry | 21 | 25 | 19 | 15 |
| Probability and |  |  |  |  |
| Statistics |  |  |  |  |
| Probebility Statistics | 40 38 | 48 45 | 40 37 | 30 30 |
| Statistics | 38 | 45 |  | 30 |

Without exception, for every mathematical concent 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


- < $15 \%$ Free Dinners
$\times \quad 15-30 \%$ Free Dinners
- $>30 \%$ Free Dinners

Mathematical Attainment Related to the Location of the Education Authority - Metronolitan versus Non-Metronolitan

The 1980 Report of the D.E.S. Assessment of Performence 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 Nerseyside, Greater Manchester, South Yorkshire, Mest Yorkshire, Tyne \& ツear, West Midlands and Greater London.

|  | All <br> Pupils |  | Location |  |
| :--- | :---: | :---: | :---: | :---: |
| Non-M | Met |  |  |  |
| Number |  |  |  |  |
| Concepts | 64 | 66 | 60 |  |
| Skills | 55 | 57 | 52 |  |
| Applications | 45 | 47 | 41 |  |
| Measures |  |  |  |  |
| Unit | 55 | 57 | 51 |  |
| Pate and Ratio | 31 | 33 | 29 |  |
| Mensuration | 31 | 33 | 27 |  |
| Algebra |  |  |  |  |
| General | 43 | 44 | 40 |  |
| Traditional | 34 | 36 | 30 |  |
| Modern | 32 | 34 | 28 |  |
| Graphical | 33 | 35 | 29 |  |
| Geometry |  |  |  |  |
| Descrivtive | 43 | 44 | 40 |  |
| Modern | 27 | 29 | 23 |  |
| Trisononetry | 21 | 21 | 20 |  |
| Probability and |  |  |  |  |
| Statistics |  |  |  |  |
| Probability | 40 | 43 | 36 |  |
| Statistics | 38 | 39 | 35 |  |

The results indicate that the metropoliten authorities, containing, by definition, the large industriel areas and inner city conditions, score less well on every topic than the non-metropoliten districts.

## Mathematical Ability at Secondary School <br> 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.

|  | Hean Scores |
| :--- | :---: |
| Middle Class | 48.6 |
| Manual - Uoper | 47.2 |
| - Lower | 45.7 |

## \& of Boys hoving to enter fanual Fork <br> in relation to Social Background

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

|  | \% hoping to enter manual work |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Ability at | Middl | Class | Manual |  |
| 15 | Upper | Lower | Upoer | Lower |
| 60 and over | 7 | 11 | 20 | 36 |
| 55-59 | 5 | 32 | 40 | 57 |
| 50-54 | * | 32 | 63 | 61 |
| 45-49 | * | 56 | 58 | 71 |
| 0-44 | * | 71 | 75 | 81 |


|  | \% hoping to enter the professions |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Ability <br> 15 | Middle Class <br> Upper |  | Lower | Upper |
| 60 and over | 79 | 62 | 39 | 29 |
| $55-59$ | 48 | 31 | 18 | 7 |
| $50-54$ | $*$ | 16 | 0 | 4 |

* 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.

## MIPLICATIONS FOR CRAFTT APPRFNTICES

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 problens 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 reg istration groups and recreational and social facilities for 5 th 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 patterm 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.

SURVEY OP 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, wich might have inhibited constructive criticism of teaching methods and vould 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 ovm suggestions. These were considered more likely to be original and reflecting the individual's owm outstanding impressions than obtaining their responses to a standardized set of questions.

## Definitions

Rural (R): $\quad$| 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.
'O' LEVEL PUPILS

| Fupil Ref. No. | Sex | Home Area Type | Parental Occupation |  | rupil's <br> Intended Career | Age When Decided |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Father | Mother |  |  |
| 1 | F | R | Nursing Asst. | - | College | 15 |
| 2 | F | S | Lecturer | Lab Technician | Teaching | 14 |
| 3 | M | S | - | - | - | - |
| 4 | F | U | - | - | - | - |
| 5 | M | S | - | - | Designer | 15 |
| 6 | $F$ | S | - | - | - | - |
| 7 | F. | U | - | - | Secretary | 16 |
| 8 | M | U | Retired Mngineer | - | Apprentice Mlectrician | 15 |
| 9 | $F$ | S | Rolls-Royce | - | SRN | 5 |
| 10 | F | R | Nurse | - | Dental Nurse | 16 |
| 11 | F | S | Driller | Shop Asst. | R.A.F. | 15 |
| 12 | F | U | - | - | Banking/ Accounts | - |
| 13 | F | S | - | - | Window Dresser | 16 |
| 14 | M | R | Nurse | - | R.A.F. | - |
| 15 | M | S | Post Office | Nurse | - | - |
| 16 | M | U | Builder | Clerk | Apprentice Electrician | 11 |
| 17 | M | J | Foreman (RR) | - | Apprentice Fingineer | 13 |
| 18 | M | S | Manufacturing Supervisor. | - | Apprentice Technician | 15 |
| 19 | M | U | R.R. | Shop Asst. | Bakery | 15 |
| 20 | F | U | - | - | - | - |
| 21 | F | U | B. R. | Typist | Kennel liaid | 14 |
| 22 | M | R | B.R. Examiner | S.R.N. | Craft App. | 15 |
| 23 | M | R | Lecturer | - | Computers | 15 |
| 24 | M | S | Accountant | - | Legal Adviser | - 15 |
| 25 | M | R | Farmer | - | Chartered Surveyor | 15 |

10' LEVEU EUUILS - continued

| Pupil Ref. No. | Sex | Home Area Type | Farental Occupation |  | Fupil's Intended Career | Age :7hen Decided |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Father | Mother |  |  |
| 26 | F | S | Rolls-Royce | School Ancillary Staff | Nurse .. | 14 |
| 27 | M | S | Stress Analyst | - - | P.E.Teacher | - |
| 28 | M | S | fachine Operator | - | Accountancy | 14 |
| 29 | M | R | - | - | Apprentice Electrician | 15 |
| 30 | F | S | Coppersmith | Dinner Supervisor | - | - |
| 31 | F | S | Foreman R.R. | - | Teaching | 11 |
| 32 | M | S | Engineer | - | - | - |
| 33 | F | S | - | - | Clerical/ Secretary | 15 |
| 34 | M | S | Production | - | Transport Lanager | 11 |
| 35 | M | S | Radiographer | - | Computer <br> Erogrammer | 15 |
| 36 | M | S | Builder (S/E) | - | Apprentice Eattern I:aker | 14 |
| 37 | L | U | Dept. Head | - | - | - |
| 38 | F | S | Desi Ener"R.R. | Narket Research | Banking | 15 |
| 39 | F | R | Foreman Joiner | - | Doctor | 7 |
| 40 | F | S | Fire Service | - | $\begin{aligned} & \text { Bank/ } \\ & \text { Interpreter } \end{aligned}$ | 14 |
| 41 | F | S | Weeh. Engr. | - | Teaching | - |
| 42 | M | U | Concrete Technician | - | Computers | 15 |
| 43 | M | S | - | - | - . | - |
| 44 | F | S | Plumber | - .. | - | - |
| 45 | F | ర | Labourer | - | Teacher | 13 |
| 46 | M | S | Computer Operator | - | Journalist | 13 |
| 47 | F | R | Chartered Burveyor | - | - | - |
| 48 | M | R | Sales Contracts R.R. | - | $\begin{aligned} & \text { Racing } \\ & \text { Correspondent } \end{aligned}$ | 12 |

C.S.E. PUPILS

| Pupil Ref. No. | Sex | Home Area Type | Parental Occupation |  | Pupil's Intended Career | Age When Decided |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Father | Mother |  |  |
| 49 | F | S | Damp Froofer | - | Typist | 15 |
| 50 | F | U | - | - | Forestry | 15 |
| 51 | F | R | Farmer | - | Clerk | 15 |
| 52 | F | U | Technical Iibrarian R.R. | Cleaning Supervisor | Secretary | 14 |
| 53 | F | U | Sprayer/ <br> Driller | - | S/H Typist | 14 |
| 54 | F | U | - | - | Telephonist | 14 |
| 55 | M | U | - | - | Craft App. | 14 |
| 56 | F | S | Fitter | Nurse | Hairdresser | 15 |
| 57 | M | U | - | - | Law | 15 |
| 58 | $F$ | S | B.R. | - | Clerk | 15 |
| 59 | M | U | H.G.V. Driver | - | Retail <br> Manager | 15 |
| 60 | F | U | Clerk | Secretary | Army | 11 |
| 61 | M | S | - | - | - | - |
| 62 | M | U | - | - | Craft App. | - |
| 63 | it | S | Storekeeper B.R. | - | Craft App. | 15 |
| 64 | M | R | $\left\lvert\, \begin{aligned} & \text { Planning } \\ & \text { Controller R. } \end{aligned}\right.$ | - | Craft App. | 16 |
| 65 | M | U | Instructor B.R. | Barmaid | Craft App. | 15 |
| 66 | M | S | Machinist (Turner | - | Banking | 14 |
| 67 | M | U | - | Cleaner PR. | Craft App. | 16 |
| 68 | F | S | - | - | Police | 10 |
| 69 | F | S | Senior Tech. Officer | Assistant Manager | Clerical | 12 |
| 70 | F | S | Froject Controller | Telephonist | Police | 8 |
| 71 | F | S | Training <br> Officer | Nurse | - | - |
| 72 | F | U | Security Officer R.R. | - | Nursery Nurse | 13 |
| 73 | M | U | Vehicle <br> Builder | - | Apprentice Flumber | 15 |


| Fupil Ref. No. | Sex | Home Area Type | Parental Occupation |  | Pupil's Intended Career | $\begin{gathered} \text { Age } \\ \text { Deciden } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Father | Mother |  |  |
|  |  |  |  |  |  |  |
| 74 | M | U | - | - | - | - |
| 75 | F | U | HGV Driver | Cook | Physiotherapist | 15 |
| 76 | 近 | 5 | - | - | Diesel Viechanic App. | - |
| 77 | M | R | Builder S/E | - | Apprentice <br> Draughtsman/ <br> Technician | 14 |
| 78 | F | R | Greengrocer | Secretary | Secretary | 14 |
| 79 | F | U | Sheet Netal Worker | Office Cleaner | Hairdressing | - |
| 80 | M | U | Accountant | Fost Mistress | App. Instrument Mechanic | 16 |
| 81 | M | S | - | - | Teacher | - |
| 82 | F | U | Machinist | Nurse | - | - |
| 83 | F | U | Stress <br> Superintendent | - | Hairdressing | 14 |
| 84 | F | U | - | - | - | - |
| 85 | M | U | Strander | - | Craft Apprentice | 15 |
| 86 | M | U | - | - | - | - |
| 87 | $F$ | U | Bus Driver | Bakery Worker | Army Catering | 13 |
| 88 | F | U | - | Canteen Asst. | Hairdressing | 14 |
| 89 | $F$ | U | Welder | - | Secretary | 14 |
| 90 | M | U | Service Engr. | - | Craft App. | 15 |
| 91 | F | U | - | - | Secretary | 15 |
| 92 | F | U | - | - | - | - |
| 93 | M | U | Machine Shop Foreman | - | Apprentice Welder | 14 |
| 94 | M | U | R.R. | - | Craft App. | 15 |
| 95 | F | U | - | - | - | - |
| 96 | M | U | Foreman | - | App. <br> Electrician | 1.5 |


| Pupil Ref. No. | Sex | Home Area Type | Parental Occupation |  | Fupil's Intended Career | Age Then Decided |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Father | Mother |  |  |
| 97 | F | U | Mechanic | Cleaner | Shop Asst. | 14 |
| 98 | M | S | Plumbing Estimator. | Hages Clerk | App. <br> Hechanic | 13 |
| 99 | $F$ | U | Machine Operator | - | S/H Tyoist | 13 |
| 100 | $F$ | U | B.R. | - | Art Sollege | 13 |
| 101 | F | U | Machinist | - | Secretary | 12 |
| 102 | F | U | Long Distance Lorry Driver | Shop Asst. | Secretary | 15 |
| 103 | F | S | - | - | Secretary | 15 |
| 104 | M | U | - | Sal eswoman | Nightclub Manager | 15 |
| 105 | M | S | - | - | Craft App. | 15 |
| 106 | M | U | Laundry <br> Worker | Bakery <br> Worker | - | - |
| 107 | $F$ | S | Trimmer (B.R. | Sewing hachinist | Clerk | 14 |
| 108 | F | 5 | Foreman | Head Clerk | S/H Typist (THRAT | 14 |
| 109 | F | U | Area Manager | Dinner Lady | - | - |


| Fupil Ref. No. | Sex | Home Area Type | Parental Occupation |  | Fupil's Intended Career | $\begin{gathered} \text { Age } \\ \text { When } \\ \text { Decided } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Father | Mother |  |  |
| 110 | F | U | Builder (S/E) | - | Copy Typist | 14 |
| 111 | F | U | Foundry Forker | Market Stall Asst. | Shop Asst./ Hairdresser | 14 |
| 112 | F | U | R.R. | Nurse | Catering | 15 |
| 113 | F | U | Woodmachinist | Home Help | Hairdressing | 15 |
| 114 | F | U | Cable Joiner | - | Clerk | 15 |
| 115 | M | U | - | - | App. Pattern Naker | 13 |
| 116 | M | R | - | - | Working with farm machinery | 13 |
| 117 | M | U | Fitter | - | App. <br> Technician | 14 |
| 118 | M | U | - | - | - | - |
| 119 | M | R | Work <br> Inspector | Secretary | Craft App. | 14 |
| 120 | F | U | Sand Blaster | - | Factory Tork | 16 |
| 121 | M | U | Grinder | Cleaner R.R. | Army or Baker | 14 |
| 122 | M | U | Warehouseman | Home Help | Driver's Mate | 15 |
| 123 | M | U | B. R. | Co-op | Craft App. | 14 |
| 124 | M | U | Building Torker | - | Army or Machinist | 9/16 |
| 125 | F | S | Taxi Driver | Infirmary | - | - |
| 126 | F | U | Bricklayer | - | Factory <br> Worker | 15 |
| 127 | M | U | R.R. | R.R. | App. Car Mechanic | 14 |
| 128 | M | U | Car Fark Attendant | - | App. Car Mechanic | 14 |
| 129 | M | U | R.R. | - | Cycle Worker | 13 |
| 130 | M | U | British Celanese | - | App. <br> Mechanic | 14 |
| 131 | M | U | R.R. | - | App. <br> Joiner | 16 |
| 132 | F | U | Unemployed | Factory Worter | Secretary | 12 |

## Father's Cccupation (All Pupils)

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

| A. | Professional/ Hanagerial | e.g. | Lecturer, Accountant, Surveyor, Manager, Designer. |
| :---: | :---: | :---: | :---: |
| B. | Technical, Supervisory. | e.g. | Foreman, Farmer, liurse, 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.

|  | O' | CSE | C/N. Ex | Total |
| :--- | :---: | :---: | :---: | :---: |
| Frofessionaz | 9 | 6 | 0 | 15 |
| Technical, |  |  |  | $17 \%$ |
| Supervisory | 12 | 7 | 1 | 20 |
| Manual |  |  |  | $23 \%$ |
|  |  | 25 | 14 | 52 |

It can be seen that of the 34 ' 0 ' 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 Tyoes within Each Course

|  | Rural | Suburban | Urban | Total |
| :--- | :---: | :---: | :---: | :---: |
| $\% 0^{\prime}$ | 10 | 26 | 12 | 48 |
| $\%$ | 21 | 54 | 25 | 100 |
| CSE | 4 | 17 | 40 | 61 |
| $\%$ | $6 \frac{1}{2}$ | 28 | $65 \frac{1}{2}$ | 100 |
| C/N.Ex | 2 | 1 | 20 | 23 |
| $\%$ | 9 | 4 | 87 |  |
| TUTAL | 16 | 44 | 72 | 132 |
| $\%$ of Total | 12 | 33 | 55 | 100 |

## Distribution of Pupils to Courses from Each Area Type

| Area | '0' | CSE | C/N.Ex | Total |
| :--- | :---: | :---: | :---: | :---: |
| Mural | 10 | 4 | 2 | 16 |
| $\%$ | $62 \frac{1}{2}$ | 25 | $12 \frac{1}{2}$ | 100 |
| Suburban | 26 | 17 | 1 | 44 |
| $\%$ | 59 | 39 | 2 | 100 |
| Urban | 12 | 40 | 20 | 72 |
| $\%$ | 17 | 55 | 28 | 100 |
| TOTAL | 48 | 61 | 23 | 132 |
| $\%$ of total | 36 | 46 | 18 | 100 |

## Analysis of Home Area Types wi thin each Course



## Distribution of Pupils to Courses

from each Area Type


Urban Pupils



Key

$$
\begin{aligned}
& 0=0 \text { level } \\
& C=C S E
\end{aligned}
$$

C/N.EX $=$ Limited
Grade CSE or non-examination
' O' LEVEL PUPILS

| Fupil Ref No. | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Primary | Secondary |
| 1 | F | - | - |
| 2 | F | liake more interesting, improve understanding. | Provide good teachers, have same one, not 3 . |
| 3 | M | Emphasise basics, prepare for secondary. | - |
| 4 | F | Varied subjects, emphasise importance. | - |
| 5 | 15 | - | Regular tests. |
| 6 | F | - | More apparatus, monthly tests instead of one final exam. |
| 7 | $F$ | More basic maths | Omit things not needed later e.g. algebra. |
| 8 | Mi | Better Scope (?) | Nore specified lesson (?) |
| 9 | F | Make it interesting | Explain so that people understand, keep interest. |
| 10 | $F$ | - | More interesting, useful for later life. |
| 11 | F | - - | Practical work, relate maths to careers. |
| 12 | F | More interest | Same teacher, not 3 . |
| 13 | F | More interest | Same teacher, avoid different methods. |
| 14 | M | Teach tables, basics, long division. | More help for those not understanding. |
| 15 | M | More basics, tables, decimals, more time. | More time, better teaching, explanation. |
| 16 | M | liake more active, a game, not sitting down. | Make it practical, what you need to know. |
| 17 | M | Don't rush, plenty of practife, make it fun. | Don't rush, teach in stages. |
| 18 | M | Give certificates, prizes for reaching standards. | Keep same teacher, print out year's revision notes for pupils. |
| 19 | M | Better facilities | Better facilities |


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

10. LEVES PUPILS - continued

| Pupil Ref. No. | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Primary | Secondary |
| 39 | F | More emphasis on maths, replace French by more maths. | Apply to everyday things, allow some ihysics to 'creep into this.' |
| 40 | F | Make sure of basics. | - |
| 41 | F | Wake maths fun to learn | Relate to jobs, stress need as a oualification, strict discipline. |
| 42 | M | Use colours, shapes, relate to surrounding events. | 'Go out' and show <br> practical examples instead <br> of books all the time. |
| 43 | M | - | - |
| 44 | F | - | Same teacher for final 2 or 3 years. |
| 45 | $F$ | Younger: number games, songs for enjoyment. Older: more pupil involvement. | More individual attention. |
| 46 | M | - | - |
| 47 | F | Everyday applications, larger objects than 'cakes.' | Individual attention, more teachers to a class. Show problems e.g. cars, using models. |
| 48 | H | - | - |

CSE FUPILS

| Fupil <br> Ref. No. | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Prinary | Secondary |
| 49 | F | - | - |
| 50 | $F$ | Learn the basics | - |
| 51 | F | Learn basics when you are young. | Hiss out things e.g. trigonometry, as not needed for interview. |
| 52 | F | Learn tables, weekly tests. | More basic maths. |
| 53 | F | Hore strict teachers. | - |
| 54 | $F$ | More advanced vork, then senior work 'wouldn't be so hard.' | Have only one teacher, less different ways of solving a problem. |
| 55 | M | Let pupils mork at ovm pace. | As primary. |
| 56 | F | Kore teaching aids. | Niake everyone understand thoroughly; monthly tests. |
| 57 | M | Have a shop, learn to give change. | Explain more fully, omit irrelevant material. |
| 58 | $F$ | - . |  |
| 59 | M | Learn harder maths. | Stricter teachers. |
| 60 | F | Keep it simple and interesting. | Concentrate on basics: special classes for those who want to do trig and geometry for jobs. |
| 61 | M | - | Maths Club, get rid of topics not used in a job. |
| 62 | [1 | Hore homework. | Stricter teachers to make pupils listen and learn. |
| 63 | M | More advanced maths. | Make maths more interesting explain better. |
| 64 | M | More discipline | More discipline, learm basic facts. Same teacher throughout secondary. |


| Pupil Ref. No. | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Primary | Secondary |
| 65 | M | More basic ari thmetic | Maths not needed in future so less maths. |
| 66 | M | Harder 'sums' | Strictness, less noise. |
| 67 | M | - | Less maths topics that won't be needed later. |
| 68 | F | No changes to teaching, only smaller classes. | Smaller classes. |
| 69 | F | Reduce 'new maths', concentrate on basic ari thmetic for sound basics. | Gradual introduction of new topics e.g. algebra. More time on each topic. Personal revision sheets. |
| 70 | $F$ | More time on maths instead of games and dance. Concentrate on basics. | More attention to necessary work e.g. logs, multiplication, rather than sets and binary numbers. |
| 71 | F | Liore basic maths, better books. | Go slover, more explanation. |
| 72 | F | Cut out useless maths e.g. binary | Cut out unnecessary maths, more explanation, better teachers. |
| 73 | M | - |  |
| 74 | M | More interesting, use rewards. | Rewards, variety, use of computers, calculators to prevent boredom. |
| 75 | F | Already good. | Two courses (a) one for those needing algebra etc. in futare, (b) simpler one with just the basics. |
| 76 | M | - |  |
| 77 | M | Older unqualified teachers need replacing or retraining. | Introduce 'Apprentice Maths earlier. Leave out things like sets. |
| 78 | F | Better understanding of very basic maths. | Keep lessons varied and interesting. |
| . 79 | F | - | Same teacher. |


| Pupil Ref. No . | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Primary | Secondary |
| 80 | M | Start secondary maths in 3rd Year | Apply more; harder maths. |
| 81 | M | Find the best text book and use for all pupils. Concentrate on liaths/English. | - |
| 82 | F | - | - |
| 83 | F | Make sure of tables as these are basis of all maths. | More interesting and make sure everyone understands. |
| 84 | F | Extend to applications of maths in surroundings. | Relate to science subjects. More individual attention. |
| 85 | M | Liore basic maths. | Teach the basics. |
| 86 | M | More time on maths, strict teachers. | - |
| 87 | M | - | Explain more so we can understand |
| 88 | F | Basic maths, addition, subtraction, multiplication. | More maths used in works (industry) |
| 89 | $F$ | - | - |
| 90 | M | 'Decent' teachers, friendlier atmosphere, easier maths. | As primary: friendly teachers, 'take a joke', teach with interest. |
| 91 | F | Make them more interested in their work, include games. | Do tests likely for a job or college. |
| 92 | F | Games to help with numbers | Video about jobs and maths needed. |
| 93 | M | Better Pacilities. | Better facilities. |
| 94 | M | " " | " $\quad$ |
| 95 | F | Teacher more strict. | Explain more. |
| 96 | M | - | Special courses at college. |
| 97 | F | Stricter teachers. | - |


| Fupil |  | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
| No. |  | Primary | Secondary |
| 98 | M | Start early, really learn basics as foundation. | Concentrate on things needed for life. |
| 99 | F | Hore examples, e.g. cutting a cake. | Make pupils understand, make pupils write on the board. |
| 100 | F | - | Explain more until pupils understand. One teacher spends more time telling pupils off. |
| 101 | F | - |  |
| 102 | F | Learn basic maths when young. | I can't understand trigonometry, so perhaps go to basic maths. |
| 103 | F | Little games to help vi th maths. | Work on their orm, but ask for help if needed. Fimphasise importance of passing maths. |
| 104 | 运 | Better tools, use shapes and relate to world around. | One teacher not different one every tern. |
| 105 | Mif | A lot of homework. | Learn the right maths that will be needed. |
| 106 | H | Do the things for Secondary. Tests to show weaknesses. | Work from books at ovn speed. |
| 107 | F | Games with numbers on the board to make interesting. Better books and allow to help each other. | Keep pupils quiet. .Those who don't want to work, put them in a class of their own. |
| 108 | F | Make lessons interesting and varied. | As for primary. |
| 109 | $F$ | - | Stick to one teacher. |


| Fupil <br> Ref. <br> No. | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Frimary | Secondary |
| 110 | F | - | More attention towards the pupils. |
| 111 | $F$ | Explain the work more. | More attention, give pupils confidence in their work and to ask for help with problems. |
| 112 | $F$ | Teachers should learn more about liaths and English. | More teachers and give more attention. |
| 113 | F | Pupils should learn more about naths than any other subject. | More teachers. |
| 114 | F | Explain more slowly so that you understand. | Hore teachers and go over things twice if you don't understand. |
| 115 | M | More maths lessons. Fore time spent on blackboard work. | - |
| 116 | M | - | - |
| 117 | Mi | Better teaching. | Better teaching. |
| 118 | M | - | - |
| 119 | M | Learn harder things earlier. | - |
| 120 | F | Taught to sit and listen. | Very strict teacher. |
| 121 | M | More lessons, up-to -date books. | As primary. |
| 122 | M | Make it interesting. | Decent teachers. |
| 123 | M | - | Smaller class size. |
| 124 | M | Möre interesting; homework in 4 th and 5 th year. | More interesting. |
| 125 | F | More interesting. | Allow pupils to drink coffee, tea, smoke, and they might get on better. |

NON-FXAMLNATLOM/L1LITTED GRADE CSE - continued

| $\begin{aligned} & \text { Pupil } \\ & \text { Ref. } \\ & \text { No. } \end{aligned}$ | Sex | Suggestions from Fupils |  |
| :---: | :---: | :---: | :---: |
|  |  | Primary | Secondary |
| 126 | F | Better books. | As primary |
| 127 | M | - | - |
| 128 | M | Diake it more interesting: work at their ovm pace. | - |
| 129 | M | - | - |
| 130 | M | - | Better teachers |
| 131 | HI | Make it interesting. | Better teachers |
| 132 | $\cdots$ | " | Go everyday |

## PRIMARY SCHOOL MATHER:ATICS

Retrospective Suggestions for Improvement from 5th Year Pupils

| Suggestions/Mords Used by Fupils | No. of Fupils making suggestions |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | '0' | CSE | C/N.Ex | Total |
| A. MOTLVATLONAL |  |  |  |  |
| More interesting, more games, activity, fun, songs. | 9 | 11 | 6 | 26 |
| Offer prizes, rewards. | 1 | 1 | 0 | 2 |
| Apply maths to real world. | 3 | 4 | - | 7 |
| B. TEACHING MATHODS |  |  |  |  |
| Emphasize basic skills, tables, $x,+,+,-$ | 8 | 13 | 0 | 21 |
| Prepare for secondary, more advanced maths. | 6 | 7 | 1 | 14 |
| Less rushing, work at ovm pace. | 1 | 1 | 2 | 4 |
| Less playing, stricter. | 1 | 5 | 5 | 11 |
| Set homework. | 0 | 2 | 0 | 2 |
| Improve explanations, understanding, 'better' teachers. | 1 | 4 | 4 | 9 |
| Omit binary, new maths. | 0 | 2 | 0 | 2 |
| C. PDUCATIONAL EROVISLON |  |  |  |  |
| Better facilities, books, equipment, teaching aids. | 1 | 5 | $I$ | 7 |
| More time for maths relative to other subjects e.g. French/Dance/Drama. | 2 | 2 | 2 | 6 |
| Smaller classes. | 0 | 1 | 0 | 1 |
| D. System already good. | 1 | 2 | 0 | 3 |

## Suggestions for Improvement by 5th Year Pupils

> No. of Pupils
> making suggestions

| More interest, games, |
| :--- | :--- |
| fun, enjoyment. |
| Emphasis of basic |
| skills, tables. |
| More preparation for |
| Secondary. |
| Stricter discipline, |
| less playing. |
| Better explanations, |
| understanding. |
| More applications. |
| Better books, equipment. |
| More time rel ative to |
| other subjects. |
| Mork at own pace, not |
| mush. |
| System already good. |
| Offer prizes, rewards: |
| Set homework. |
| Omit 'new' maths, e.g. |
| binary. |
| Smaller classes. |

Suggestions for Improvement by 5th Year Pupils

| Suggestions/एords Used | No. of Fupils making suggestions |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | '0' | CSE | C/N.Ex | Total |
| Keep the same teacher/ methods. | 6 | 5 | 0 | 11 |
| Regular tests. | 2 | 2 | 0 | 4 |
| Concentrate only on maths needed later in real life, omit sets, binary, algebra, trigonometry. | 10 | 16 | - | 26 |
| Practical work with equipment, calculators, computers. | 5 | 1 | 0 | 6 |
| Hore basic maths. | 0 | 3 | 0 | 3 |
| Make it more interesting. | 3 | 4 | 1 | 8 |
| More help with understanding, individual attention, better explanation. | 9 | 14 | 9 | 32 |
| Work at owm pace, more time. | 3 | 2 | 0 | 5 |
| Stricter teachers, less noise. | 1 | 4 | 1 | 6 |
| Print revision notes. | 1 | 0 | 0 | 1 |
| More freedom e.g. smoking, tea, coffee. | 0 | - | 1 | 1 |
| Improved attendance. | 0 | - | 1 | 1 |

## SECONDARY SCHOOL WIATHFSATICS

## Suggestions for Improvement by 5th Year Fupils

No. of Pupils making suggestions


| Pupil Ref No. | Home Area | Father's Occupation | Hobbies | Naths Course |
| :---: | :---: | :---: | :---: | :---: |
| 8 | U | Retired Engineer | Football | '0' |
| 16 | U | Builder | M/cycles, 玵ectronics | $10 \cdot$ |
| 17 | U | Foreman R.R. | Sports, Reading | '0' |
| 18 | S | Manufacturing Supervisor | Football, Electronics, Chess | '0' |
| 22 | R | B.R. Examiner | Sports, Astronomy, Chess | '0' |
| 29 | R | - | Scouts, Reading | '0' |
| 36 | S | Builder (S/E | Modelling, Sport, Art | - $0^{\prime}$ |
| 55 | U | - | Sport, Gardening | CSE |
| 62 | U | - | Football, Snooker | CSE |
| 63 | S | Storekeeper | Cycle Ryding, TableTennis | CSE |
| 64 | R | $\begin{array}{\|l} \text { Planning } \\ \text { Controller R.R. } \end{array}$ | Model Railways, Boating | CSE |
| 65 | U | Instructor B.R. | Athletics, Football, Cricket | CSE |
| 67 | U | - • | All sports | CSE |
| 73 | U | Vehicle Builder | Football, Fusic | CSE |
| 76 | S | - | Buses | CSE |
| 77 | R | Builder S/E | Guns, Modelling, Electronics | CSE |
| 80 | U | Accountant | Sport | CSE |
| 85 | U | Strander | Table-Tennis | CSE |
| 90 | U | Service Rngr. | Motor-cycles, Shooting, Fishing | CSE |
| 93 | U | Machine Foreman | Motor-cycles, Tabletennis | CSE |
| 94 | U | R.R. | Fishing, Shooting, Ornothology | CSE |
| 96 | U | Foreman | ```Modelling, Football, Badminton,``` | CSE |
| 98 | S | Plumbing Estimator | Motor cycles | CSE |
| 105 | S | - | Motor cycles | CSE |

BLOGRALHICAL DETALLS - cont'd
32 ASPIRLITG APPREMTICES

| Pupil Ref. No. | Home Area | Father's Occupation | Hobbies | - Maths Course |
| :---: | :---: | :---: | :---: | :---: |
| 115 | U | - | Discos, Music, Bikes Reading | C/N.Ex |
| 117 | U | Fitter | Discos, Table-tennis, Bikes | C/IN.Ex |
| 119 | R | Work Inspector | Fishing, Sailing, Talking | C/N.Ex |
| 123 | U | B.R. | Modelling | C/N.Ex |
| 127 | U | R.R. | Football | N.Ex |
| 128 | U | Car Park Attendant | $t$ Football, Skating | N.Ex |
| 130 | U | British Celanese | Building Ingines | N. Ex |
| 131 | U | R.R. | Motor-cycles | N.Ex |

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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 Fngineer' was assumed to be a skilled occupation.) 'Retired Engineer' is not included as this might, in practice, have been professional, technical or skilled.

| Professional; Managerial <br> (i.e. manufacturing <br> supervisor, planning controller, <br> accountant) |  |  |
| :--- | ---: | ---: |
| Technical, supervi sory | 3 | $15 \%$ |
| Minual | 5 | $25 \%$ |
|  | $\underline{12}$ | $\underline{20}$ |
|  |  |  |
|  |  |  |



20 Aspiring Apprentices

## 32 ASPIRIIVG APERENTICES (ALL MALE)

SUGGESTIONS FOR LHFROVITG HATHMATICS

| Iupil Ref. No. | Maths Course | Primary | Secondary |
| :---: | :---: | :---: | :---: |
| 8 | '0' | Better scope (?) | Nore specified lesson (?) |
| 16 | - ${ }^{\prime}$ | Make more active, a game, not sitting down. | Wake it practical, what you need to know. |
| 17 | '0' | Don't rush, plenty of practise, make it flun. | Don't rush, teach in stages. |
| 18 | '0' | Give certificates, prizes for reaching standards. | Keep same teacher, print out year's revision notes. |
| 22 | '0' | More basics | Less maths that won't be needed later. |
| 29 | - 0 | - | - |
| 36 | - 0 | Frepare for secondary school, schools 'combine' | Concentrate on maths for later in life and not wander. |
| 55 | CSE | Let pupils work at their own pace. | As primary |
| 62 | CSE | More homework. | Stricter teachers to make pupils listen and learn. |
| 63 | $\operatorname{CSE}$ | Hore advanced maths. | Wake maths more interesting, explain better. |
| 64 | $\operatorname{CSE}$ | More discipline | More discipline. Learn basic facts. Same teacher |
| 65 | GSE | Riore basic arithmetic. | liaths not needed in <br> future, so less maths. |
| 67 | CSE | - | Less maths topics not needed later. |
| 73 | CSE | - | - |
| 76 | CSE | - - | - |
| 77 | CSE | Older unqualified teachers need replacing or retraining. | Introduce 'Apprentice Maths' earlier. Leave out things like 'sets.' |
| 80 | CSE | Start secondary maths in 3rd yr. | Apply more; harder maths. |

## 32 ASPIRIIIG APPRENTTICES

SUGGESTION: FOR IRPROVING RATHEAATICS - continued

| Pupil <br> Ref. <br> No. | Maths Course | Primary | Secondary |
| :---: | :---: | :---: | :---: |
| 85 | CsE | More basic maths. | Teach the basics. |
| 90 | CSE | 'Decent teachers', friendlier atmosphere, easier maths. | Friendly teachers, 'take a joke', teach with interest. |
| 93 | CSE | Better facilities. | Better facilities. |
| 94 | CSE | " | " $\quad$ |
| 96 | CSE | " " | Special courses at college |
| 98 | CSE | Start early, really learm basics as foundation. | Concentrate on things needed for life. |
| 105 | CSE | A lot of homework. | Iearn the right maths that will be needed. |
| 115 | C/N.Ex | hore maths lessons. More time spent on blackboard work. | - |
| 117 | C/N.Ex | Better teaching. | Better teaching. |
| 119. | C/N.Ex | Learn harder things earlier. | - |
| 123 | C/N. Ex | - | Smaller class size. |
| 127 | C/T.Ex | - |  |
| 128 | C/N.Ex | Make it more interesting, work at their own pace. |  |
| 130 | C/N.Ex | - | Better teachers |
| 131 | C/N.Ex | Make it interesting. | Better teachers. |

Home Area Type and Maths Course for the 32 Aspiring Apprentices

| Home Area Type |  |  | Total |
| :---: | :---: | :---: | :---: |
| Rural | Suburban | Urban |  |
| 5 | 6 | 21 | 32 |
| $15 \frac{1}{2} \%$ | $19 \%$ | $65 \frac{1}{2} \%$ | $100 \%$ |



Home Area Type
32 Aspiring Apprentices

| Maths Course |  | Tofal |  |
| :---: | :--- | :---: | :---: |
| $\cdot 0^{\prime}$ | CSE |  |  |
| 7 | 17 | 8 | 32 |
| $22 \%$ | $53 \%$ | $25 \%$ | $100 \%$ |



Maths Course
32 Aspiring Apprentices

## SUMIARY

## 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 ' $C$ ' 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 nathematical 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 $55 \xi_{\text {of }}$ of the sample but provided only 25 d of the ' 0 ' level candidates, while providing $87 \%$ of the non-examination/CSE classes.
- The suburban children represented only $33{ }^{6}$ of the sample but provided $54 \%$ of the ' $C$ ' level candidates.
- Rural children provided only $12 \%$ of the sample but $21 \%$ of the ' 0 ' level pupils.
- The proportions on the CSE course roughly reflected those in the whole sample.


## 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 ( $8 \%$ ).

## SURMARY

## 32 Aspiring Apprentices

- The intending apprentices were mainly the sons of fathers engaged in similar work, i.e. industrial manual.
- The majority were following a full CSE 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 mere 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 mocelling 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以aths.'
- The potential craft apprentices represented approximately $50 \%$ of the male population in the school; when the boys who entered engineering/science after the 6 th 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 REPRESEHTING THE WHOLE ABILITY RANGE

Following the questionnaire given to 1325 th Year pupils, it was decided to question the children more closely about their experiences in school mathematics, and the interviews were recorded on casette.

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 ' 0 ' 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 lanch-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 ${ }^{\text {Findridge }} 1$ - 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 Naths' 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 Mindridge (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."
":That about mixed ability?"
"The clever ones help the weak."
"Have you ever been stopped from working?" "Yes, you always get the occasional idiot" "rhe 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 stack."

Renneth 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 mathods 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 alvays 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."
" F hat do you think of the 5 th Year Centre (Recreationaly " "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 smacks - it's a good place."
"What about the teachers?"
"They are more 'with it,' with having older pupils. You can undefstand 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."
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## Graham Prime - 5th Year CSE/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 its 'we don't need anyone' or 'we want ' 0 ' 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 vith 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 text book?".
"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." "Yeople move desks, fighting, arguing; in the end he gets fed up and gives up." "Feople who want to learn have got no chance."
"irhat's the answer?"
"Stricter teachers, those who don't want to learn, put them on their own and let them do what they wan $t$.
"?hat 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."

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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. "That 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."
"Mhat has been the biggest factor damaging your maths?"
"Not knowing tables and missing time at school."
"How many teachers have you had for 4 th year maths?" WIV have had nine, one all the time for one of the lessons, but in all we have had nine" (in $1 \frac{1}{2}$ terms).
"How has that affected your lessons?"
"We have had different mathods and different ways. It's been up and down. This one we have got now is very nice, he setsit 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.?
"iimat are twelve sevens?"
"60"
"Have you al ways struggled in maths"
"Yes, right from the primary school"
"hhat 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 Finglish, and messing around doesn't get you anywhere."
"Then did you realise that.?"
"This morning."
"If you leamed to do long multiplication, e.g. $15 \times 37$
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."
"Fould films showing the use of maths help in the 3rd year ?"
"Yes."

Steven, 4th year non-examination maths
"inat are nine sevens?"
"Don't know"
"io 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. liy 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."
"Hould regular practice help?"
"Yes, in dinner hours and breaks."
"Have you thought about a job?"
"No, not yet."
"Have your teachers always hel ped 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."
"ihat was primary school like?"
"The classës 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."

Mark 4th Year '0' Level
Exceptionaliy able and hardworking. Anthusiastic parental support
"I vant to take 'A' levels and a degree in liaths". "Have you never been interested in engineering or computing?" "I like to work things out myself, not use a machine."
"That 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."
"Fould it help to show these applications to other pupils?" "Yes, a lot of people think engineering is for nonexamination 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 '0' 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."
"Thy 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." rofe 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 Midilands 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."
":hat methods did the good teachers use?"
"They spent more time on explaining and going round putting you right."
"That causes you most trouble in maths?"
"Fractions." "Te just rushed through the work."
"Explanations were too quick. I gave up."
"inhat 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."

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"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 mith tables, all the way through?"
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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.'

Hichael 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 $3 r d$ Year '0' 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."
"7as 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."
"inhat about Comprehensives?"
"They are alright, maybe teachers aren't strict enough now and again, but otherwise its 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."

Alan $\because$ (continued)
"That 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."

Gary . 3rd Year (Probable CSE)
Exceptionally well-motivated and hardworking.
"I want to be a chef in the merchant navy. Hy parents told me to go to the Sea Cadets to keep me off the streets." "Fhy 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."
"that 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 thro:T rubbers at your head."
"Is that ridespread?"
"Yes, you come to learn, not to mess about."
"what about primary school?"
"Very good for maths and English, but not much else."

Gary: "Teachers explain a thing twice and someone at the back keeps saying they don't understand. There's no time left to ¥ork.

Alan: $\quad$ 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 ouite resularly. I go to extra lessons on a Sunday in French and German, because I get personal attention, unlike school."

Gary: "Peachers 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 cormer of the room and show it to the pupils when they came in."
"Do you learn if you talk while you work?"
Alen: "Yes, it helps to compare wori with a friend to correct mistakes."

Gary:

Al an : "Classical studies is a waste of time."
"Fhat is most usefur at school?".
Alan \& Gary: "Miaths."
Alan: Maths is used in physics, chemistry, engineering and technical drawing."

Discussion with Gary \& Alan (continued)

Gary:

Alan:
"Attendance at school is bad because people think it is boring. Most are present when it is football and sport, not English and biaths." "What about careers lessons?"
"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."

Jeannine . - 5th Year CSE (but '0' 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, its 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 séven."
"That do you think of comprehensives?"
"I prefer the grammar school system, but at $13+$ for late developers."
"ihy not comprehensives?"
"There are some very disruptive elements in the classes. There is a world of "difference between the ' 0 ' level and the CSF classes."
"That 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 concemed 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."

Jeannine - continued
"What about teaching methods?"
"Ny 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 ' 0 ' levels in other subjects."

Sheridan - 5th Year CSE 'Average', Weak understanding Taking some ' $O^{\prime}$ 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 4 th 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 honework 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."
"That chances would you nake 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 accountents."

## 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: $\quad$ ge go into little groups bosed on intelligence." "What about mixed ability lessons?"

Jeannine: "It was awful, nobody worked. The weaker ones pulled the brighter ones dom. We had to weit for the others to catch up - they picked my breins 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 kno\%. That dicn't happen when we vere 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 ' 0 ' level group most of us are quite well off."

Jeannine: "'hen asked in our 'C' level geography group, all but two came from Chellaston (a residential village/suburb.)

Tayne. - '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."
"ihat would have made you work hard?"
"Teacher being stricter."
"\#ere many people working hard?"
"Yes, most, but there's always some who drag the rest do:m." "ihen did you realise you needed to work?"
"At the end of the 3rd year."
":that made you work harder?"
"When you start writing for jobs it dawns 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."
":ihy are you interested in plumbing?"
"Ey uncle has his own business and he is never out oif 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, its 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 conld nork from it without a teacher."

Tayne - 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."


Neil. - 5th Year '0' 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 wie th 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." "iny have you always rorked 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 rell 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."

Neil - 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 leam to work with all sorts of people. I prefer it to a school like Radley in the television Tublic School series."
$\frac{\text { Andrew }}{\text { capable }} \quad-4$ th Year ' 0 ' Level, very hardworking and
"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."
"That 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 cuite 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 lst and 2nd year."

Richard 4th Year ' 0 ' Level, conscientious and very capable.
"Have you decided on a career yet?"
"No, not yet; I hope to stay on at school or college." "ihnat points are there for school sixth form versus collese of further education?"
"At school, I would carry on wi thout 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?"
"Pairly 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."
"That about secondary school maths?"
"Fider variety of topics in maths, a bit harder but it got better."
"That 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. Then we went into sets all that stopped. Now if you should be doing well and aren't, your firiends egg you on to do better."

## Discussion between four '0' level boys

- Mark .. , Richard 5 , Richard T , Andrew

Bark: $\quad$ Four years work in the primary school could have been done in $1 \frac{1}{2}$, 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 $\mathrm{T}: ~$ "We did games everyday, we made two cinefilms, that's all we did."

Mark: $\quad$ Games were alright but it was $2 \frac{1}{2}$ days a week. If you behaved well, he'd say 'we'll do games this aftermoon'".
"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: $\quad$ I don't think you are, there's a limit to what you can take in."

Mark: $\quad$ 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."

Discussion - continued

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 '0' level if they want to. The teacher couldn't control them, although she tried." (This was the top 3 rd 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?"

Lark:

Richard S:

Mark:
"Yhat do you think of the 5 th 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: $\quad$ I find maths interesting."
Richard T: "Teachers and self-motivation. Parents shouldn't push you too much because relationships become strained."

Mark: "rressures from the outside world, the job situation and the will to get on."
"Whet are the differences between the people in the top and bottom sets?"

Mark: "Feople 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."
"Yhat 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: $\quad$ 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.
liark: "Also origins. Very few Jamaicans in the top set. Jamaicans think 'why bother?'"

Discussion - continued

Andrew: $\quad$ 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."

Discussion between three 5th Year ' 0 ' level gri rls:
Deborah , Penelope - good 'O' level
Lesley : - average ' 0 ' level

All three intended to enter the 6 th 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."
"ihat pressures are there to work hard?"
Deborah: "Depends on the people you go around vith." Lesley: :'Rivalry with friends, be bigger than them".
"What pressures are there not to work hard?"
Deborah: Feople 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 3 5th 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 vhen 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: "Feople who do mork hard don't influence the others. "If they don't work and don't get told off then you don't bother either."

Lesley: $\quad$ You're on your own if you start working."
"inat about regular tests?"
Penelope: "Yes, it's a good idea in all subjects, it makes you learn."
"Is there too much homevork?"
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."

## Discussion between 3 5th year girls - 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?" AII: "Yes."
"Have you thought of a career in Bngineering?" All: NNo."

Deborah: "He don't know if we'd like it, you almays 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."
"That about primary school, how were you taught?"
Deborah: "णe 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."
"ilas 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 noyal 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 Baths?'
"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."
"That maths topics have you mainly used it for?"
"Trigonometry and volumes."
"That 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 Bnglish."
"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."

Andrew - continued
"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 liaths' 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 Naths teacher and then this book can be used to advance on the basics."
"Generally, winat 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."
"ihat was primary school like in Yorkshire?"
"You could do anything you wanted, you weren't supervised." "Vas it good?"
"No, you weren't learning enything, just passing time away, doing things that weren't important."
"llere you unhapoy about it?"
"Yes, if you said anything they answered your question and you never heard anymore about it."
":7as Secondary School an improvement?"
"Yes, a lot better, classes reasonable size and teachers not all that bad".
"That about Comprehensives?"
"I think the gramnar 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

Andrew. - continued
still be the grammar schools instead of having to wait for people of less ability."
"What about learming multiplication tables?"
"liy mun 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."
"That changes would you make?"
"Smaller classes, stricter teachers, closer pupil/teacher relationship."
"Yhat about the Haths 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."

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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 lov ability CSE group (limited grade). Basically sensible and hardworking, but occasionally districted.
"Hov do you feel you've been taucht?"
"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 (lst and 2nd Year.)"

Nayan , 5th Year 'Average CSE'

Nayan had travelled widely, after leaving Uganda, and had been to school in Leeds, York and Derby.
"Mhat 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."
":as 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 iifferent, there it was quite easy." "What would you change in School Miaths?"
"Less pupils in a class; not vary it in different schools." "Yhat were Leeds and York Schools like?"
"In Leeds it was pretty easy."
"\#as it strict enough?"
"No."
"reople 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."

Nayan .. - 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?"
"Wy parents taught me some Indian and some African, but
I learn't English from Nursery School."
"Have you found some books difficult?"
"Yes."
"Do you think Comprehensive Schools mork 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 $2 \frac{1}{2}$ days a veek"), 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 (gemes, visits, etc.) end 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 cosire rule as having no apparent applications in their lives and, unlike some methematics 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 <br> USE OF 'APPRENTICE MATHS' IN SCHOOL: THE <br> 'apprentice maths' CLUB and other evaitations.

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 ' 0 ' 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 ' 0 ' level to remedial.

## The 'Aporentice 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 suprly teachers, several of thom 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: - .... 3 SHOOL

## 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 rlaths" produced by the University of Loughborough (CAMES, 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 5 th 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.P. grade l) went immediately to the practical applications.

## 5th Year Potential Apprentices

## Performance on Specimen Test 1



|  |  | $\begin{aligned} & N \\ & \underset{\sim}{x} \\ & \sim \\ & \sim \\ & \dot{O} \\ & \dot{\circ} \end{aligned}$ | + $\dot{+}$ + + + + | $\bullet$ <br> $\vdots$ <br> $\dot{0}$ <br> + <br> $\vdots$ <br>  | $\begin{gathered} + \\ + \\ + \\ \text { + } \\ + \\ + \\ +-1 \infty \end{gathered}$ | $\begin{gathered} -\lim \\ \stackrel{+}{+} \\ -\ln _{N} \end{gathered}$ | $\begin{gathered} -10 \\ -1 \\ -12 \\ -\infty \end{gathered}$ |  | $\begin{gathered} \underset{\sim}{-N} \\ \times \\ N \end{gathered}$ | $\begin{gathered} +i n \\ x \\ x-100 \\ m \end{gathered}$ |  | $\begin{aligned} & \text { 蚞 } \\ & + \\ & \text { + } \end{aligned}$ | ¢ O O H + + |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Bryan H. | $\checkmark$ | $\checkmark$ | $\times$ | $x$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\times$ | $\checkmark$ | ? | ? | ? | 20 |
| Colin I. | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\times$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | 1 | $\checkmark$ |  |
| Tayne F. | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $x$ | ? | ? | $?$ | 19 |
| Kalmajit B. | $\checkmark$ | $\checkmark$ | $\times$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\times$ | $x$ | $x$ | $\checkmark$ | $\checkmark$ | $\times$ | 20 |
| John H. | $x$ | $\times$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | x | $\checkmark$ | $x$ | $x$ | $x$ | $\checkmark$ | $\checkmark$ | 19 |
| Kenneth W. | $\times$ | $\checkmark$ | ? | $?$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | - | ? | ? | $?$ | 7 | 16 |
| Steven H. | $\checkmark$ | $x$ | x | $\times$ | $\checkmark$ | $\checkmark$ | ? | ? | ? | ? | ? | ? | 12 |
| Steven R. | $\checkmark$ | $\times$ | $\checkmark$ | $\checkmark$ | 7 | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | 24 |
| Peter H. | $\checkmark$ | $\checkmark$ | $x$ | $x$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $x$ | $\times$ | $\checkmark$ | $x$ | $\times$ | 18 |
| John D. | $\checkmark$ | $\checkmark$ | $\times$ | $\times$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $x$ | $x$ | $x$ | x | $x$ | 16 |
| Lorma P. | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\times$ | x | $x$ | x | $x$ | $x$ | $\checkmark$ | $\checkmark$ | 19 |
| Dameon C. | $\checkmark$ |  | $\checkmark$ | $x$ | $\checkmark$ | $\checkmark$ | ? | ? | ? | ? | ? | ? | 16 |
| David W. | $\checkmark$ | $\checkmark$ | $x$ | $\cdot x$ | $\times$ | $\checkmark$ | $\checkmark$ | $x$ | $x$ | $x$ | + | ? | 18 |
| Stephen C. | $\checkmark$ | $\checkmark$ | $x$ | $x$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $x$ | $x$ | $\times$ | $\checkmark$ | 21 |
| Nayan K. | $\checkmark$ | $\checkmark$ | $x$ | ? | $x$ | $x$ | ? | ? | ? | ? | ? | ? | 13 |
| Carl R. | $?$ | ? | ? | ? | ? | 7 | $?$ | ? | ? | ? | ? | 2 | 9 |
| Rana A. | 7 | $x$ | $\times$ | $x$ | ? | X | $x$ | x | $\times$ | $x$ | $\checkmark$ | $\times$ | 15 |
| Michael B. | ? | ? | ? | ? | ? | ? | ? | 7 | ? | ? | ? | 2 | 7 |
| Roy W. | $\checkmark$ | $\checkmark$ | $x$ | ? | $x$ | $x$ | $x$ | ? | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\times$ | 19 |
| Paul D. | $\checkmark$ | $\checkmark$ | $x$ | $x$ | $\checkmark$ | $\checkmark$ | $x$ | $\times$ | $\checkmark$ | $x$ | ? | ? | 18 |
| Gary B. | $x$ | $\checkmark$ | $x$ | $x$ | $\times$ | $\times$ | ? | $\checkmark$ | ? | ? | ? | ? | 13 |
| Peter R. | $\checkmark$ | $x$ | $x$ | $x$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $x$ | $\times$ | $x$ | $x$ | ? | 14 |
| Number not Correct | 5 | 8 | 16 | 17 | 8 | 8 | 11 | 17 | 17 | 17 | 15 | 17 |  |


|  | 5th Year Report |  |  | Job obtained | CS |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | *E | м\% | Comment |  | F/C. | A |
| -0. Level |  |  |  |  |  |  |
| Tim H. | c | 18 | Poor basics | C.A. B.R. | D/E | 3 |
| Gary H. | c | 42 | Conscientious, lacks confidence | C.A. Cel. | C | 1 |
| Full CSE |  |  |  |  |  |  |
| Bryan H. | B | 49 | Hard worker | C.A. ? | 3 | 4 |
| Colin | B | 71 | Able, determined | C.A. Elec. | 1 | 1 |
| Wayne | C | 51 | Quiet, steady | C.A. Build. | 4 | 3 |
| Kamaljit | c | 50 | Enthusiastic | $\begin{aligned} & 2 \text { C.A.s } \\ & \text { offered, } \\ & \text { R-R + B.R. } \end{aligned}$ | 2 | 2 |
| John H. | B | 72 | Able, interested | C.A. Elec. | 1 | 1 |
| Kenneth | C | 56 | Polite, reliable | C.A. R-R. | 4 | 2 |
| Steven H. | c | 66 | Able, too easygoing. | C.A. Chemical Engr. | 3 | 2 |
| Steven R. | C | 63 | Able, well-behaved | 6 th Form | 2 | 1 |
| Peter H. | B | 52 | Enthusiastic | C.A. R-R. | 2 | 4 |
| John D. | C | 50 | Quiet, sensible | 6th Form | 3 | 4 |
| Lorna | A | 61 | Excellent attitude | 6th Form | 2 | 3 |
| Dameon | C | 44 | Feak, tries hard | C. of F.E. | 4 | 4 |
| David W. | C | 38 | Quiet | C.A. R-R | 5 | 5 |
| Stephen C. | D | 39 | Poor attitude, under-achiever | C.A. B.R. | 4 | 4 |
| Nayan | C | 45 | Willing, but weak | 6th Form | 3 | 4 |
| Roy | C | 51 | Quiet, popular | C.A. Foundry | 3 | 3 |
| Paul D. | C | 49 | Enthusiastic | C.A. R.R | 4 | 4 |
| Gary B. | C | 32 | Tries hard, weak | C.A. B.R. | 4 | 4 |
| Andrew A. | B | 43 | Determined, hardworking. | 6th Form | 3 | 4 |
| Peter R. | C | 52 | Poor attitude and attendance | C.A. B.R. | 3 | 3 |
| Stewart C. | D | 29 | Eastly distracted | Auto-Spares | 4/5 | 5 |
| Shaun M. | D | 37 | Wastes time | C.A. International Combustion | 4/5 | 5 |

[^1]B.R. =British Rail

Cel. = Celanese
C. of F.E. = College of Further Education

|  | 5th Year Report |  |  | Job obtained | CSE |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | * ${ }^{\text {E }}$ | M\% | Comment |  | F/C. | ${ }^{\text {A }}$ |
| $\frac{\text { Limited }}{\text { Grade CSE }}$ |  |  |  |  |  |  |
| Carl R. | B | 44 | Reliable, cooperative | C.A. Foundry | 4/5 | 4 |
| Graham P. | C | 30 | $\begin{aligned} & \text { Pleasant, willing } \\ & \text { but distracted } \\ & \text { easily. } \end{aligned}$ | C.A. Building | 4/5 | 5 |
| Richard E. | C | Abs | Reliable but weak | Butcher | 4/5 | 5 |
| David T. | B | 35 | Easily distracted | $\begin{aligned} & \text { C.A. Build- } \\ & \text { ing. } \end{aligned}$ | 4/5 | 5 |
| Gary G. | B | 46 | Sensible, tries hard. | C.A. Electrical | 4/5 | 4 |
| Andrew | B | 41 | Domestic problems, willing and wellbehaved | C.A. B.R. | 4/5 | U |
| Genevieve | c | 29 | Weak at basics | C. of F.E. | 4/5 | 5 |
| Steven I. | - | 44 | Lacked maturity, poor concentration | C.A. B.R. | 4/5 | 4 |
| $\frac{\text { Non- }}{\text { Examination }}$ |  |  |  |  |  |  |
| Michael B. | D | 66 | Weak, wastes time | 6th Form | N.Ex. | - |

## Key

C.A. = Craft Apprentice
B.R. $=$ British Rail
*E = Effort M = Mock

$$
\begin{aligned}
& \text { R-R }= \text { Rolls-Royce } \\
& \text { C. of F.E. }= \text { College of } \\
& \text { Further } \\
& \text { Fducation }
\end{aligned}
$$

$\mathrm{F} / \mathrm{C}=$ Porecast
$A=$ 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 <br> 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, wellbehaved 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 liaths 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 freouent 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 suppily. Graham wented to enter the building trade as a craft apprentice; his father was a self-employed builder but wanted his son to start off with anotier firm.

Graham's father liked 'Apprentice Naths' and helped Graham with it at night.

Graham was unlikely to have done any maths homework in the 4 th or 5 th year - unfortonately he was influenced by the badly behaved pupils around him. His attendance at the liaths 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 aporenticeships.

## 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 4 th and 5 th 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 show exceptional application to work against. difficult circumstances in the botton set.

Carl was motivated by an ambition to join the Navy, but was unsuccessful and changed his ambition to printing.

Carl did about one honework per week in the 5th year. He had great difficulty in obtaining enployment.

## Loma

Extremely harčworking and conscientious. Above average CSE cancidate through effort, not ability.

Two honeworks per week regularly done.
Intended to join the army and used 'Apprentice Eaths' to revise for CSE - relied very heavily on the book in preference to others.

## Pryan

Intenced to becone a diesel mechanic; very quiet and hardworking - a steady 'plodder'. Average CSE candidate.

Regularly and conscientiously did two honeworks per week throughout 4th and 5th year. 7ent on rorks visit to engineering works; surprised at noise, smell and poor behaviour of some employees.

Bryan attended the maths club regularly and borroved '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 canàiate 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 honework was erratic and did not reflect his ability.
Surprisingly he very quickly obtained a craft apprenticeship with the lerge 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.

## Gaxy H.

An ' 0 ' 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, kut came once to borrow 'Apprentice Maths' to revise for on 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 hiw own successful plumbing business.

Attended Maths Club well and worked from 'Apprentice Maths' at home.

Obtained a craft apprenticeship at a large building firm.

Carl (haths 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 '0' level, considered he needed more time on arithmetic :ith frequent 'refresher courses.'

Paul and Peter (weak CSE/Ion-exam. 4th Year,) thought they covered too many topics and wanted more time on 'useful topics'. They would have liked the 4 th and 5th Year to be spent on Naths needed for a job.

Genevieve wanted help with the steps in long division, even with practice from 'Apprentice $1:$ aths' she coulon't remember the sequence.

Colin and Steven R. (CSE Set 2), asked to borrow 'Apprentice Waths' for revision for CSE 'Wock' exams. They worked from the section on circles.

Colin, Steven R. and Wayne said they vould have liked a CSE course based exclusively on 'Apprentice liaths' and Wayne said he wished he had started on the book in Year 3.

Lorna had kept a copy of 'Apprentice lifaths' 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).

## RERK 1

Attendance 19. There was no meeting for the Londay 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 'selfexplanatory, 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 casette.

Eryan (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 vords 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 knovm what 'find the sum of' meant, but was otherwise sound on basic arithmetic. Steven went straight on to the practicel 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 ('O' level 26) Gary had no problems with basic arithmetic so was told to choose some work which interested him. He wor'sed through the questions on gears (ratio), which he did correctly and found interesting.

Gary hoped to become a Technician Apprentice. (Brentually accepted a craft apprenticeship.)

Kamaliit (20) couldn't do $3 \frac{3}{10}-2 \frac{7}{8}$. Read the book and understood the correct method.

Lorna (19) corrected her wealnesses on the four operations with fractions (which only needed revision) and went on to the chapter on estimation.

Lorma hoped to join the army and saw the work as useful revision for CSS. She coped with nos. 1 - 5 on the self-assessment test but could not do 6 - 10 so worked through the text.

Mavan (13) learnt to cope with $48+0.4$ on his own, but would have preferred $\frac{27.95}{1.3}$ to al so be written as
$27.95+1.3$ as he was initially confused. (i'his 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 exceptionaily hard-working !o' level pupil) Used Apprentice Raths to supplement his ' 0 ' level exercises on logarithms. Found Exercise 11 fairly easy but worth doing, al though struggled with $\left(\frac{1}{0.00765}\right)^{2}$.

A large group of 5 th year pupils joined, being concerned at their lessons with non-specialist and supply teachers. The time was spent on the basic maths test.

The 4th year evening group, all very weak, with scores of less than half on the basic test wanted help with fractions. The pupils said they had done the work before but had not had enough practice, were rushed on to the next topic too quickly before the work had 'sunk in'. Paul had, in his test, made 'subtract 814 from 2000' into 8140 .
-2000

Ian had missed out the 0 when multiplying by a number in the tens column.

The 5th year \#ednesday 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 jourmeys 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


Carl - very weak CSE/N.Ex hoping to obtein an apprenticeship in the Ferchant Navy. Tanted help with fractions. Thought the method of drawing boxes useful.

David - weak CSE couldn't see how to do $\frac{1}{3} \times 5$, kut read the correct method himself from 'Apprentice Naths.'

The able 5 th 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 :rork appropriate to a diesel mechanic and was given the section on gears to do.

The general interest and notivation after three weeks was high and the pupils were continuing to work steadily on their own.

Eight pupils asked for copies of thetext 'Apprentice Maths' to use for the long weekend.


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 liaths'. The boys worked through Bxercise 7.

Simon ( $0 / \mathrm{CSE}$ ) 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.
lieyan (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 149) so worked through the text and practice exercises.

David (18) felt he needed to practice decimal frections 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 vere 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 vithdrawal unit was firmly convinced of the value of the vork 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 rould 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 Baths;' initially drawing $2 \frac{1}{5}$ as $1 \frac{1}{5}$, but eventually learnt and understood the technique as a result of drawing.

By showing Andrew the 3 examples given, egg.

$$
4 \frac{2}{5}=\frac{(4 \times 5)+2}{5}=\frac{22}{5} \text {, Andrew was able }
$$

to understand the method and practised Exercise 3 with the intermediate step


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 in th the intermediate stenos in the calculation, had enabled this remedial boy to cope with hither to 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.
lihen pointed out to the boys that, perhaps, i:aths should be interesting for its own sake, Steven and Daneon 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 aná Colin bought their own copies and would be revising from them.

Interview with a tyoical 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 <br> father) repairing, cleaning oicycle. |
| :--- | :--- |
| Trade sought: $\quad$ | Sheetmetal/coppersmith, stimulated <br> by school metalwork. |
| First Interview: $:$ | Thought it was easy going. Too <br> 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 Finglish and less on 'Cuest' 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/intermal 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 opm copies.

## Use of 'Apprentice Maths' during Normal Lessons

As part of their normal syllabus, a 3rd year haths 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

$$
\nabla=\text { (area of cross-section) } x \text { length and }
$$

there were no diagrams.
This was inadequate for all but the most able pupils and in the past it had been necessary to moke up examples showing the different types of prism.
'Apprentice Maths' provided m 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 showm 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 $\pi\left(R^{2}-r^{2}\right) \times l$

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, Pobert, sho 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 unfemiliar situations, so frequently advocated by HEI.

The work appealed to most of the 60 pupils who attempted it, not just boys interested in engineering vork.

## PERC ENTAGES

Before attempting compound interest as part of their 3rd year syllabus, a group of future ' $C$ ' level and CSE pupils needed to revise percentages.

## Self-Assessment Tests

The self-assessment test, o. 149, was given to the whole class. Virtually all coped with q. 1-5 (fractions to ${ }^{\circ}$ ) and a. 6-10 (decimals to $\%$ ) but only 2 could do q. 11 - 15 ( $\%$ to fractions) and only 9 were able to do q. 16 - 20 (店 to decimals.)

This gave a clear indication of the weaknesses of the class and therefore they were given (after the explenetion 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 mork 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 $13 \frac{1}{8} \%$ to 13.125 while others, like Alan, wrote it straight down. Robert, Paul and Alen 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.

## Percentages - continued

## Response to Homework

Practice Exercise 4 was completed successfully by over' $90 \%$ of the class, with the exceotion of 3 pupils still having trouble with steps like changing $1 / 8$ to .125 . Nost pupils got all 15 questions right and cleimed to have found the level correct.

The three more-able boys who did the practical epplications as far as question 8 were also successful and said tiey 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 'Aporentice Waths' inth a 4th Year CSE Group

This was a particularly restless group, who were having difficulty with standard form. The explenation on p .57 was given end practice.exercises 7 - 9 were done.

These were far more comprehensive than the few exemples in the usual CSE text and occupied this difficult class well for a double lesson. The level and grading of the examples :rere exactly right, taking as a criterion the way the class worked continually without becoming restless, bored or siving up in frustration.

## 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 0 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:-

## Covered in 'Aporentice I..aths'

1. $13578+2$
2. $3995 \div 17$
3. $1 \frac{1}{5} \times 3 \frac{2}{3}$
4. $1 \frac{2}{3}+2 \frac{3}{4}$
5. $100-28.73$
6. $28.73 \times 100$
7. $28.73 \div 100$
8. $5.2 \times 8.6$
9. $47+4.7+0.47+0.047$
10. $\frac{0.8 \times 7 \times 1.5}{2.1 \times 4}$
11. Convert $\frac{2}{5}, \frac{3}{7}$ and $1 \frac{5}{2}$ to decimals.

Pages 46 and 47
Pages 46 and 47
Pages 1 - 3, 5, 11
Pages 9 and 10
Pages 26, 27, 37, 38 but not 099.91

Pages 29, 30
Pages 29, 30.
Page 41
Page 37
Page 48

Pages 30, 31.

## Attendance at 'Aporentice 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 (l0+), especially considering the proximity to Christmas.

The book had then been used by pupils from ' 0 ' level to remedial; there was some evidence that parts of the text were too easy for ' 0 ' 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 ovm, but without boredom.

Pupils (such as Lorna) with no interest in Fingineering, 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 HITH PUPILS OF ALL ABILITIES USING PRACTICAL APPLICATION QUESTIONS FROM 'APPRETITICE 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 nornal 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.

## Obiectives

- 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 renuired by firms visited locally, to determine the calibre of pupil able to cooe with this work.
- To compare the standard of those puopils able to do this :ork 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 reauired 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 GKADING SYSTEM

EQUIVALSNCE OF GCE 'O' LEVEL AND CSE


No grade equivalence outside of shaded band
'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 0 level.
> 75\% of all 16 year olds obtain at least one graded result.

SOUKCE: "EXAMS BRIEF" ( ) A SCHOOL EXAMTNATIONS GU」DE FOR EHLHOYERS - SCHOOLS COUNCIL/UBI.

## Categories of Pupil

## Good '0' 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 ony interest in engineering as a career.

## Teak '0' Level

This boy seemed bright verbally, but made many mistakes with basic concepts; probably nlaced in this group because of ability in other subjects.

Rejected the advice to enter for both GCE and CSE examinations, wanting ' 0 ' level or nothing - peer group pressure?

## CSE Pubils

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 $\because$. . .ost 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)

## Iimited Grade CSE/Non-Examination - The Domain of those vith 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 obtaineble 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 \#elfare Officer. A 'disruptive' transferred from Leicestershire was subseguently 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-snecialist suonly teachers.

At the beginning of year 5, they were there ore dispirited and lacking in motivation, al though still well-behaved and regular attenders.

Tilliam, whose parents were West Indian, and Kem 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 rether 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 Edintrurgh'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 meens "Two hundred million and four"

$$
\begin{aligned}
& 4 \times 4 \times 4=52 \\
& 1,8,27,64,-- \text { ("No idea") }
\end{aligned}
$$

$9 \times 8$ was computed by adding nine 8 's which had been tabulated.
(Philip was subsequently rejected for a career as a chef in the Navy: "Youre 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 yerr 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 stendards.'

## Comparison of Attendances at Maths Lessons

 for GCE Raths Set 1 and Limited Grade CST/Non-Examination Set 7


Week No.
1st Sentember - 5th December 1980

Key

- GCE (Set 1) Tuesday and Wednesday
$\Delta$ L.G./Non-exam (Set 7) Monday and Friday
N.B. Sets I-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 $N=\frac{1000 s}{\pi D}$, find $N$ for given values of $S, D$ and $\pi$

## 10' Level punils

The two very good '0' level pupils had no trouble with this problem, using logarithms for the division. The third weaker ' 0 ' level boy cancelled $\frac{\frac{500}{500 \times 50}}{\frac{54 \times 3.142}{27}}$, unlike the other boys who saw that it was easier to treat 1000 x 50 as 50,000 . The weaker boy was also happy to write 500 x $50=2500$ and obtain the wrong final answer.

## CSE Pupils

Chris, a very keen ' 0 '/CSE pupil (probable double entry) performed the substitutions correctly, but failed on 50000 by long division as follows:169.668

$$
169.668 / \frac{.0033933}{5000}
$$

Andrew, an 'average' CSE pupil, wrote $\frac{1000 \times 50}{3.142 \times 54}$ but could go no farther.

Iinda, used a calculetor and obtained the correct answers.
Brian used logarithms and obtained incorrect answers because of incorrect characteristics.

## ?uestion A (continued)

## Limited Grade CSB pupils

Milliam and Fong were unable to understend the question. Every sten 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 $40,000 \times 40$ and obtained 40,000 as follows:-

$$
\begin{array}{r}
40,000 \\
\quad \times 40 \\
\hline 00,000 \\
40,000 \\
\hline 40,000
\end{array}
$$

Place value, etc.
Fong and William vere asked to multiply $1000 \times 50$ and made several guesses, including 5,000 and 5 million.
(In a later exercise, Philip wrote 20004 as 'Tyo hundred million end 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).

## Cuestion B

Convert dimensions in inches to mm. p. 45 in 'Apprentice Maths'

It was given that $I^{\prime \prime}=25.40 \mathrm{~mm}$, and the diagram was to be redrawn with 8 dimensions e.g. $13.375^{\prime \prime}$ converted to mm . end corrected to 3 decimal places.
'0' 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 $13.375 \times 25.40$ as follows:-

| 13 | .375 | 25.400 |  |
| ---: | ---: | ---: | ---: |
| 25 | .400 | 13.375 |  |
| 00 | 000 | 127000 | etc. |
| 000 | 000 | 1778000 |  |
| 450 | 000 | 00 |  |

Simon then durew 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). Buentually 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 aiagram contained the obvious inconsistencies shown below.


Failure to recognise ridiculous answers (place value).

## Calculators

Andrew used a calculator and obtained the correct enswers - it is probable that he would not have done so mell by long multiolication.

Linda also obtained the correct answers with a calculetor when experience would suggest that she would have made mistakes in lof multiplication.

## Iimited Grade CSE

William, Fong and Philip, although given that $I^{\prime \prime}=25.40 \mathrm{~mm}$. were unable to start the ouestion.

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 diemeter
(convert fractions to decimals, compare relative sizes p. 34, 'Apprentice Maths').

A man is asked to produce a bar of $0.610^{\prime \prime}$ dia. In the metal store, the materials available are:-

$$
\frac{1}{2} " \text { dia., } \frac{9}{16} \text { dia., } \frac{5}{8}^{\prime \prime} \text { dia., } \frac{11}{16} \text { dia., } \frac{3}{4} \text { " dia. }
$$

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).


## 10' Level Funils

Mark and Richard had no problem with this question and were able to see that the tool only moves .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 .

## C.SE 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 $D-0610=0625=0.15$
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 showm 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 $0.625-0.610=0.015^{\prime \prime}$ 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 explenation.

Pong and William both needed explanations to convert the frections to cecimsls. Both were able to do the short division but Fong struggled with

$$
1 6 \longdiv { 9 . 5 } \stackrel { 0 . 5 } { 9 . 0 0 } \text { Fong carried } 1 \text { not } 10 .
$$

## PIACE VALUE

Meither 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 rritten as 0.750.

Meither 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 wes a bit too hard' for them, but they did ask to continue with the progrem of work on practical applications.


Use the Theorem of Pythagoras to calculate:
(a) $x$
(b) $y$

## -0' 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 $x$

This was the only question to trouble Mark, who made a basic error in using 18 mm . as the length $A B$.


Richard used the suggested triangle and obtained the correct answer.

Simon used $40^{\circ}$ instead of $20^{\circ}$ 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 cheracteristics.

Chris made the unusual mistake of using logs to add two numbers.

Tim struggled to form the triangle,initially used sine instead of tengent and instead of subtracting $2 \times 5.848$ from 20, his working was as follows:-

$$
\begin{array}{r}
20.000 \\
-\quad 5.848 \\
\hline 14.152 \\
-\quad 5.848 \\
\hline 8.304
\end{array}
$$

## Iimited Grade CSE

This auestion was obviously well beyond the ability of Pilliam, Fong and Philip.

## CSE Puoils

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 reguired 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:-

$$
\begin{aligned}
\mathrm{x}^{2}= & 3.1^{2} \times 2.0^{2} \\
& 9.61 \times 4.0 \\
& 38.44 \\
= & 6.2
\end{aligned}
$$

Failure imnediately after a successful solution to a similar problem.

Jill, Tim, Chris needed some help to form the reauired 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 logari thms mace 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 ' 0 ' level or the CSE pupils.

## Limited Grade CSE

Tilliam and Fong were both unable to start this cuestion. Fong couldn't remember how to change $\frac{7}{8}$ to a decimal, although he had cone 5 examples, including $\frac{5}{8}$, in the previous week.

Meither 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. +2 caused Fong great difficulty and many attemots were needed to get . 6875 including

and
POOR KNOFLEDGE OF TABLES

## Some of the Pupils' Comments on the Work

## Very Good '0' 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 Eythagoras 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 troe 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."

## CSE 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 $55.78 \mathrm{~mm} . \pm 0.05$. Then we have to find the largest and the shortest length the bar can be. Thereas in normal classwork we just get numbers not diagrems and reel live problems.
"People could say the engineering work is harder but I found it easier to understend then 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 difficuit 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."

## Iimited 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 sajd "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: "Ny 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 al though quite cavable 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 orm.

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 :ork was shown to some of the 4th year boys, who were surprised at the high standard of maths used in industry.
liark, 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.

T:ro CSE boys, Lexoy 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 concerm if typical of the rest of the pupils.

Similerly, Mark and Richard appeared to have 'vritten off' engineering or never considered, being totally unaware of its mathematical content and seeing it basically as a lowly, practical, non-academic occupation.

## EVALUATION OP 'APPRFYTIICE EATHS'

## Motivation from Practical Applications

The training superintendent and a shilled craftsman from Rolls-Royce brought sample calculations and engineering dravings, specially prepared for the 'Apprentice lifaths' club.

These vere 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, IOA, etc. he could not select the correct trig. ratio for a particular situation.

This problem is covered very adequately in 'Apprentice Haths' and John borrowed a copy to work through. \%ithin a week he returned with eigit sides of work and claimed he had overcome his difficulties. (A senple of John's work in overcoming his problem is shown as shown in the Appendices.)

Thile John had been provided with two other text books for his CSE course, he had been unable to read and understand this major 0/CSE topic. . His work from 'Apprentice faths' was totally self-taught, it was correct and included practical applications, not simple repetitive examples.

After struggling on the 4 th 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, al though entered for ' 0 ' level, made frenuent mistakes in basic processes such as long multiplication.

The CSE pupils, in general, showed competence to carry out the processes, such as trigonometry and Eythagoras, once the nroblem had been reduced to a simple triancle.

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 logari thms, fractions, trigonometry or Pythagoras' Theorem - all topics used in engineering at craft level.

In theory, Fong, Philip or Tilliam 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 scone 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 nepr ' 0 ' level standard, and it was noted that craft apprentices specialising in electronics ond instrument fitting often had grade 1 CSE or 'O' level.

For heavier work in the locomotive and carriage workshops, British Rail were apparently setisfied 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) Annlying trigonometry and Pythagoras in situations where the appropriate triangle must be identified.
(b) Amount a cutting tool moves is helf 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 ' 0 ' 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, mach words as "real", "live", "Mature," "achievement", "clear diagrams", appering 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.

Tilliam and Fong, the two very week 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 draughtsmen 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 remediel help in English and Meths obtained an interview for a craft apprenticeship. This boy had a score of 1 out of 26 on the 'Aporentice 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 renge 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 of ten 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 maller classes. The 'average' pupils containing the potential craft apprentices are perhans 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 '0' Level Pupil Hark 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 ' 0 ' 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 Findridge

5th Year CSE pupil who obtained a craft apprenticeship. in engineéring.
"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 vill 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 aathors. 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.

- lir. J. Gatenby, The . School, , Derby.

19th Kay 1980.

Dear Mr. Gatenby,

Kenneth has now obtained employment as an apprentice engine fitter at Rolls-Royce Ltd., Derby.

Until last year we pere very concemed about Kenneth's general progress until he started the 'Apprentice laths' 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 textbook 'Apprentice maths' regularly in his spare time at home.

We believe this work helped Kenneth to improve his mathematics and also to obtain on apprenticeship.

Yours faithfully,


## 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 CSS 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 4 th year.

## Tayne 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 '0' 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 exans. 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 pleasent 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 harci."

## Lorma Powell

5th Year CSE intending to join the Army

Lorma 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 品ployers' Tests l - 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 hov much you must revise, in which area and to what depth to fully understend 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.
"Vell laid out pages, not too much on a page, clear and concise explenations. 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 i. 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 dra:ring
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 leaming techniques in abstraction."

Mr. Kinsey
Head of Wathematics, Queen Elizabeth's Gramar 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 chartging 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/Netalwork

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 decinal 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 learming 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 selfassessment 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. Halfoenny

Chartered Engineer, involved vith 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 <br> words and clear diagrams, but others |
| :--- | :--- |
|  | e.g. division of fractions are just stated." |

## 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 Forkshop 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. T. Gordon,
Deputy Kanager, Skill Centre, Iong Eaton.
"The 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 york situation."

The Education Instructor "has found it to be useful in taking various examples from it for use in the classroom situation."

## Mr. J. Dassett

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 $\frac{\frac{1}{4}}{2 / 3}$ is the same as $\frac{1}{4}+2 / 3$."
9. "I consider that 'Apprentice Maths' brings to fruition very well the intentions stated in the preface."

Mr J Gatenby
30 Chestnut Grove
Etwall
Derby

## 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 $6+\frac{2+4-3}{8}$ was confusing, but the presentation was otherwise excellent.

White noted the inclusi on of Imperial and Wetric Units, and stated that they had tried to make students 'think Metric.'

As noted by the pupils in Figlend, 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' <br> RELLATIVE TO THE MOST TRADITIONAL CSE SYLLABUS OFFERED BY EAST MLDLANDS <br> REGLONAL EXAM $\perp$ NATLONS BOARD (Used by the Test School)

## 1980 Syllabus ('Full' CSE) $\quad \frac{\text { Coverage in }}{\text { Aporentice Maths' }}$

## Paper 1 ( $30 \%$ of marks)

Four operations with number, money S.I. units, decimals.

Prime and composite numbers.
Fractions, conversion to decimals and vice versa.

Approximations, estimates and rounding off.

Squares and square roots leading to whole numbers $<20$.

Graphical representation of data, graphs, pie charts, etc., mode, mean etc.

Percentages, applications.
Ratio and proportion.
Speed, distance and time.
Number patterms, sequences.
Use of letters to represent numbers, simple formulae.

Symmetry, properties of common figures, plane and solid.

Covered.
Not covered.

Covered.

Covered.

Covered.

Not covered.
Covered.
Covered.
Not covered.
Not covered.

Covered.
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 then 10.

The index laws. Standard form (A $\times 10^{n}$ ).

Length, area, volumie, 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 Fnglish 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
'Aporentice Maths'

Not covered.

Covered.
All covered except kite.

Not covered.
Directed numbers, covered, mappings, relations, not covered.

Covered.
Simple equations covered, simultaneous and inequations not covered.

Not covered.
Covered.
${ }_{0}^{C 8 v e r e d}$ (as angles $0^{8}-360^{\circ}$ ).

Not covered.
Covered.
Not covered.

Not covered.
Covered.

| 1980 Syllabus | Coverage in Apprentice Maths |
| :---: | :---: |
| Properties of triangle, parallelogram, trapezium and kite. | All covered except kite. |
| Similarity and congruence. | Not covered. |
| Pythagoras Theorem. | Covered. |
| Sine, cosine and tangent. | Covered. |
| Probability. | Not covered. |
| Simple interest, Hire Purchase. | Not covered. |
| Travel graphs. | Mot covered. |
| Change of units, foreign currency. | Covered Metric <br> Imperial <br> Not currency. |

## 1980 SylI abus

Paper 3 Option A (40\% of marks) Traditional

Trig. ${ }^{\text {fatios, }}$ sine, cosine, $\tan .0^{\circ}-180^{\circ}$. These + Pythagoras applied to 3 dimensions.

Sine and cosine rules.
Factors of algebraic expressions (grouping and quadratics)

Simultaneous equations.
Quadratic equations (graph and algebraic).

Re-arrangement of formulae (Transposition.

Similar and congruent triangles, intersecting chord, secent, tangent. Not covered.

Ratio of areas, volumes of similar figures.

Mensuration of cone, sphere, pyramid, sector. Mensuration of annulus.
$y=m x+c$, gradient of a line.
Properties of the circle, its parts.

Angle properties, cyclic quadrilateral etc.

Constructions: perpendiculars, division of lines, triangles, inscribed, circumscribed circle.

Locii in 2 and 3 dimensions.

Coverage in
'Apprentice Maths'

Angles $>90^{\circ}$ not covered. 3 dimensions not covered.

Not covered.

Covered.
Not covered.

Not covered.

Covered.

Not covered.

Not covered. Covered.

Not covered.

Covered.

Not covered.

All covered.
Not covered.

## Suminary

There were approximately 53 topics on the CSE syllabus of which 25 were covered thoroughly in 'Apprentice Kaths.'

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 meny intending apprentices and they suggested a course based on this text book.

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.

## Chapter 10

SULPARY AHD COICLUSIONS, RECOMMDATIONS
AMP SUGGESTIONS FOR EUTURE RESRARCH

> SESTION A - EVALJATION OF 'APPRWITICE BATHS'

## 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 unrelis.ble calculator by logarithms, the ability to abol.y trigonometry and Fythagoras' Theorem, (and thereforesquares 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 toyics 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 York 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 matcining 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."
"Fe 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 mathenatics 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 end the top boy in the 5th year commented on "the excellent explanations given specifically, not 'decorated' vith fancy phrases" after comparison with the school text book. (This boy later achieved $8^{\prime} 0$ ' levels and even he was concerned about language used in text books, so there are obvious implications for pupils of average ability and below.)
liark 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."

Wark and several other able punils also commented that the quite challenging applications altered their previously
lov opinion of engineering, "I thought an aperenticeship 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 Waths, ' Por calculations on his motor-cycle engine, and finally credited the book with helping to secure an apprenticeship:-

> "I vould 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 rithout help - the material was written with such clarity that further explanations were unnecessary:-

Simon: "The explanations were clear and precise and straishtforward and do not 'maffle.'"
"ly text book ........ misses out steps and in places is very obscure."

Hann (31) noted that '0' 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."

Tayne liked the practical applications, "They show you hom and where the maths are needed. The book far exceeds any other CSE book."

```
Practical Applications
Some comments included:-
lark: "bringing a mature asnect into the theorens and proving that theories such as Pythagoras are useful and so ought to be lermt." .
Richard: "I preferred this type of maths ..... :here the question could be linked to a situation in work."
Chris: "In normal lessons we just get numbers not diagrems and real live problems."
Jillian: "Mith the help of a clear diegram seems easier to understand."
Tilliam: "You can see what it's for."
```

The overwhelming enthusiasm and positive responses to "Apprentice Laths" convinced the author that there is a great benefit to be gained from introducing this material into school. The text highlighted the gulf between that schools provide and what many pupils feel they need. Although potential cra.ft 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 comiented on the ease with which they could read and understand 'Apprentice Naths' 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 ..." Thonas F. White (39) noted, "Friting style - excellent very clear and understandable ....., their presentations are the best I have seen in any text ...... I would recomend it to my teachers without reservation ......."

## Recomendations

1. The good experience :rith 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 locàlly. 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. 0
4. Potential craft apprentices still form the largest group of pupils in many schools; teachers should recognise their "customers" desire for vocationallyorientated 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 on acaतemic problem-solving discipline. Hathematics is required as a tool, including use in school science and other subjects, but problem solving, games, etc. must also be incluced 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 villing to give their oninions, 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 हoing 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 ( $\approx 35 \%$ ), decimal multiplication $(\approx 50 \%)$, etc. and operations with fractions ( $\approx 50 \%$ ).

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 deciced to investigate incividual differences in the children.

It was found that the ' 0 ' 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 suburben children from the school's catchment area. '0' 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.

FHI have recently produced some evidence relating matheratical 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 icentify 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 morkload 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) Eore emphasis on teacher-training was given to coping with "inner city" pupilsi.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.
\#ork 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 consicer implementing changes.


## Suggestions for Further Research

It was repeatedly suzgested by 5 th year pupils that 'Apprentice haths' 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 compeny and more work is needed to encourage girls to enter ergineering.

The style and format of this material was successful, and it is suggested that the same approach, including selfassessment 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 semple 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 backsround 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 fron the "real" worlc. Of course, the author aporeciates the problens of or enanisation which this :ork places on the teacher.

The poor control of some teachers referred to by the children in this research was often wi th probationary or non-snecieljst mathematics teachers. Other experienced staff mey be fully stretched and unable to zive the supnort necessery 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 then in the schools in prosperous suburben and mural areas. Research on turnover of mathematics teachers and reasons for their movins is suggested. Lany 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; FHI noted that this can cause ill-health, and instruction should be given in less rigorous, but effective methods of merking and e.ssessment.

## The Futare

The :ide variety of syllabuses, methods and philosophies of mathematics teaching suggests the need for a dialogue between schools, employers, parents and pupils to decide oroad 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, FacGregor (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 stendards of living ..... ve have to export ....." nr. Hacaresor :ondered, "if there mas difficulty in maintaining our position because ve are technologically illiterate ..... Wose responsibility is this? It must be the responsibility of those who are in tio education system from wich we sprins."

In 1931 the problems of the inner cities and unempioyment amongst school leavers have attracted much publicity. ITew 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 permenent employment, must maintain and improve their standards in numeracy and it is felt that the material contained in 'Apprentice laths ${ }^{r}$ would most adequately form the basis for any courses in mathematics at Colleges of Eurther Education or other training establishments:

It is hoped that the work cone in this project in eveluating 'Apprentice Naths' will enable the reader to aporeciate 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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## APPETDDIX 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 l4th 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 trairees 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.

## BITB Arithmetic Test

NAME ......................... CLOCK No. .... GROUP

Complete the following questions and vrite the answer in the space provided.

## Answers

1. Add together the following vulgar fractions

$$
3 / 32 ; \quad 5 / 8 ; \quad 1 / 16 ;
$$

2. Subtract $5 / 32$ from $27 / 64$ $\qquad$
3. Add together the following decimal fractions
1.099; 0.036; 0.701
4. Subtract 1.987 from 11.084
5. Multiply $8 / 39$ by $3 \frac{1}{4}$ $\qquad$
6. Divide $39 / 128$ by $3 / 8$
7. Multiply 4.032 by 0.75
8. Divide 2.075 by 0.2
9. 


10.


Calculate the value of the dimensions maxked ' $\%$ ', ' $Y$ ' and 'Z' on the above template.




THE SUBTRACTION SIGN - SHOWS THAT THE NUMBER BEHIND IT, IS TAKEN AWAY PROV THE NUMBER IN FRONT OF $1 T$. THUS $12-\angle$ iviEANS THAT 4 is TO BE SUBTRACTED FROM 12 ie. $12-4=8$ or 12

$$
=\frac{4}{8}
$$

SUBTRACT 28.764 FROM 37.59316 or $3759316-28.764$

$$
\begin{array}{r}
-37.59316 \\
-28.76 .4 \\
\hline 8.82916 \\
\hline
\end{array}
$$

SOLVE. $\quad 9.976-19.863+11.432+0.375$
FROM BODMAS ALL ADDITIONS MUST BE DONE FIRST.

$$
\text { ie. } \begin{array}{rr}
+9.975 \\
+11.432 \\
+\quad 0.375 & \text { now } 21.783 \\
\hline 21.783 & -19.863 \\
\hline
\end{array}
$$

SOLVE THE FOLLOWING

1. $3.863-1.788=$
2. $1003032-0.07063=$
3. $2 \cdot 3785-0 \cdot 6070-1 \cdot 2375=$
4. 


5.

6.

7. $18-7+10-12-6=$
8. $2-125-8+200-24=$
9.


## MULTIPLICATION. X (TIMES.)

WHEN ONE NIJMBER IS MULTIPLIED BY ANOTHER THE SIGN $(x)$ 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.

$$
\text { ie. } 6 \times 4=24
$$

THE NUMBER PRECEEDING THE $(x)$ SIGN is CALLED THE MULTIPLICANT. " " FOLLOWING ." " " " .. " MULTIPLIER.
THE FINAL RESULT IS CALLED THE PRODUCT. MOREOVER SINCE $6 \times 4=4 \times 6$. THE MULTIPLICANT \& THE MULTIPLIER ARE SEEN TO BE INTERCHANGEABLE.

THE TWO NUMEERS THEMSELVES ARE CALLED FACTORS OF THE NUMBER DENOTING THE PRODUCT.
MULTIPLY. $15 \times 12$

| 15 |
| ---: |
| $\times 12$ |
| 30 |
| 150 |
| 180 |

Now $12.75 \times 6.7$

| $\begin{gathered} 12.75 \\ 6.7 \\ \hline \end{gathered}$ | $\cdots$ | COUNT NUMBER OF DIGITS AFTER DECIMAL POINT • $=3$ |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{r} 89^{5} 2^{3} 5 \\ 765^{3} 00 \\ \hline \end{array}$ |  | IGNORE DECIMAL POINT |  |  |  |  |  |  |
| 85.425 |  | REFER TO QUESTION FOR NUMBER OF |  |  |  |  |  |  |
|  |  | DECIMAL* PLACES 3. IN ANSWER CCUNT |  |  |  |  |  |  |
|  |  | 3 DIGITS FROM RIGHT HAND SIDE |  |  |  |  |  |  |
|  |  | PUT IN DECIMAL PCINT. |  |  |  |  |  |  |

MULTIPIGATION

1. $90 \times 6$
2. $10 \cdot 375 \times 0 \cdot 2$
3. $4.032 \times 0.75$
4. CALCHLATE THE AREAS
(a)

5. FIND THE TOTAL WEIEHT OF THIS BAR IF IT WJOHS 2.785 LES/IN

6. $97.674 \times 6.937$

7: IF AMAN EASNS 67.45 / HIP. HOW MUCH DOES HE EARN IN 695.75 HRS

DIVISION. - (DIVIDE.)
WHEN ONE NUVGER IS DMIDED BY ANOTHER, THE SIGN(:) IS PLACED BETYEEN THE EUMBERS. THUS $8 \div 2$ MEANS 8
DIVIDED BY 2 OR HOW MANY TIMES WILL 2 GO INTO 8 ? OR $2 \longdiv { 8 }$
SUCH DIVISION IS OFTEN EXPRESSED BY WRITING THE TWO NUMBERS IN A FRACTIONAL FORM, ie. $\frac{8}{2}$. THIS IS THE SHORT YHAY OF WRITING THE DIVISION $\underset{\frac{8}{2}}{\stackrel{8}{-}} \frac{8}{2}$
the number preceeding the sign of division is called
THE DIVIDEND, THE NUMBER FOLIOWING IT IS CALLED THE DIVISOR AND THE RESULT IS CALLED THE QUOTIENT.
DIVIDE $57 \div 3$ OR $\frac { 5 7 } { 3 } \cdot O R \quad 3 \longdiv { 5 7 }$
$3 \longdiv { 1 9 }$
SOLVE $194 \div 15$
$\begin{array}{r}\frac{3}{27} \\ \hline 27 \\ \hline 00\end{array}$
$1 5 \longdiv { 1 9 4 . 0 0 0 }$

| $\frac{15}{44}$ | $=1 \times 15$ |
| :--- | :--- |
| $\frac{30}{140}$ | $=2 \times 15$ |
| $\frac{135}{50}$ | $=9 \times 15$ |
| $\frac{45}{50}$ | $=3 \times 15$ |
| $\frac{45}{5}$ | $=3 \times 15$ |

it will be seen that 3 is recurring.

NOV 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 ie $9.4 \times 10=94$.
$9 4 \longdiv { 2 9 6 . 3 }$. WE MUST NOW DO THE SAME TO THE DIVIDEND ie $29.63 \times 10=296.3$.
$\therefore$ WE PUT THE CALCULATION DOWN IN THE FOLLOWING MANE

$$
\begin{aligned}
& 9 4 \longdiv { 2 9 0 \cdot 3 0 0 0 } \\
& 282 \\
& \begin{array}{r}
143 \\
94 \\
\hline 490
\end{array} \\
& 470 \\
& 200 \\
& \frac{188}{120} \\
& \frac{94}{26} \\
& \equiv 3 \times 94 \\
& =1 \times 94 \\
& \equiv 5 \times 94 \\
& =2 \times 94 \\
& =1 \times 94
\end{aligned}
$$

IN THIS CASE THE ANSWER CORRECT TO 3 PLACES OF DECMMALS IS. 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 3.1526. THEN THE ANSWER CORRECT TO 3 . PLACES OF DECIMALS WOULD HAVE BEEN 3.153, BECAUSE 6 is GREATER THAN 5.

1. DIVIDE 64 BY 8
2. $2 \cdot 075 \div 5$
3. $6 \cdot 945 \div 0 \cdot 3$
4. $74 \div 6 \cdot 74$
5. $53.984 \div 6.73$
6. CALCULATE THE CROSS SECTIONAL AREA IF THE TOTAL VOLUME IS $175.78 \mathrm{iris}^{3}$.

7. IF THE TOTAL $A R E A=273.6$ ins $^{2}$. FIND $X$.

8. IF THE TOTAL VOLUME $=104 \cdot 7 \mathrm{ins}{ }^{3}$. FIND $X$.

9. FIND CENTRE DISTANCE BETWEEN ADJACENT HOLES


CONVERSION OF DECIMALS INTO FRACTIONS
take the decimal part of the number and make it into a 'HOLE NUMBER EGG. O. 875 BECOMES 875 AND CALL THIS THE NUMERAL OR THE DENOMINATOR PUT DOWN ONE (I) AND THEN ONE NOUGHT (O) OR EACH PLACE OF DECIMAL. THEN CANCEL IF POSSIBLE.
;. 0.875 TO BE CONVERTED TO A FRACTION.

$$
0.875=\frac{875}{1000}=\frac{7}{8}
$$

OR O. $765=\frac{765}{1000}=\frac{153}{200}$

## APPMPDIX 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, weicht 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.F. 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).


SUCH FAILURE MIGHT BE CAUSED BY<br>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. $2,000^{\circ} \mathrm{K}$ 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 (Apprendix ).


T40911
Assembling turbo-jet engines - vertical

$T 41022$
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 (show below). Overtightening can cause stretching and failure of the bolt, undertightening could result in a loose casing and possible disaster.


ALTERNATIVE
FRICTION THIMBLE CAP

[^2]

USE OF
BOTH HANUAL
and
COMPUTER
DATA RECORDIT

## ACCUPATE RHADLING OF SCALZS $1 S$ ESSELTLAL,

WITH RAPID 'ROUNDING-OH'F'


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 kilogrammes 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/HID/HNC).

The testing involves the monitoring and recording of an array of dials and gauges similar to an aircraft cock-pit. 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 S:-ills involved:-

- Accurate reading of flovmeters, 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 $\pm .0001$ )

MICRO 2000 ELECTRONIC DIGITAL MICROMETER


The Micro 2000 is the latest development in hand held orecision measuring instruments. Te is the first ever hand electronie digital micrometer that is somplecely self contared. Of robust construction. the solid state electronits are orosected by stamiess steet and rough acetal copolymer casing and powered by its own re-
chargeable power pack. A purpose buit regharging unt is supolied chargeable power pack. A Durpose buit resharging unt is susolied
with the micrometer and boith are concained in an injection with the micrometer and boith are consained in an in!ection moulded plastic case.
The Micro 2000 is designed for use in quality assurance, in stan. dards rooms, laboratories. on the shop loor and whereve: arecise measurement and comparison are requited.
Two models are avaitable with 2 capacity range of 0.25 mm or is to $\mathbf{t}$ inch each with illummaced 5 figise digital read out. Accuracy is to $=2$ microns $(0.002 \mathrm{~mm})$ or to -0.0001 theh wish the imperia madel. The urique constant force spindle slosure ensures con another.

The dicital display is automatically set to rero mmediately the unit is swisthed on. At the souch of a turron. instant tero ses is abreined against 2 efeference stancord ato therefore wies the Mcro 2000 selicalibrating ant anatecied is near. Tite $A$-es components to be accurately meas reatiny nytareg in ine reat components to be accurately meas rrea and netiseg in :he read
out display as a plus or minus variacion.

Electronic micrometer
(to $\pm 0.0001$ or 0.002 mm )

## COMBINATION SETS

the combination set consists of:
(1) RULE-HARDENED AND ACCURATELY GRADUATED IN 300 mm .450 mm AND 600 mm LENGTHS.

BLE:
'ME. - Millimetres and hall mallimecres both sides.
'ME' - One side in half millime:res and 32nds of an inch.
(2) SQUARE HEAD-DROP FORGED STEEL.
(CONTAINING SPIRIT LEVEL AND SCRIBER)
(3) CENTRE HEAD-DROP FCRGED STEEL.
(4) PROTRACTOR HEAD-GRADUATED TO READ FROM $0-180^{\circ}$ IN BOTH DIRECTIONS AND FITTED WITH SPIRIT LEVEL.


TYPICAL APPLICATIONS



Fig. 2

METRIC MICROMETERS
Reading in Hundredths of a Millimetre ( 001 mm .)
Metric micrometers can be read to one hundredth of a millimetra ( 0.01 mm. ). As che screw on merric micromecers has a Disch of $\frac{1}{1} \mathrm{~mm}$. so two revolutions of the shimble will move the spindle through I mm.
On the sleeve the datum line is graduated with iwo sets of lines-the set below the line reading in milhmetres and she set above the line reading halr millimeres.
N.B. On earler ith half millimires belowis graduated above the datum line with half millimetres below.)

The thimble seale is marked in filty equal divisions, figured in fives, so that each small division on the ihimble represents $1 / 50$ of mm . which equals $1 / 100 \mathrm{~mm}$. ( 001 mm .)


## Inspection

While this is increasingly reing 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 showm 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.


14 Dimensional inspection of a compressor dise

## 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 m engineering drawing, to faniliarise pupils with the symbols and methods used e.g.

1. $1.000=1$ inch $25,4=25.4 \mathrm{~mm}$.
2. $40 \mathrm{~m} / \mathrm{m}(1.5748)$ gives the conversion m.m. to ins. often needed in setting up on an older machine. (Conversion tables are also provided).
3. . 395 This means the finished measurement must .385 lie vithin the limits of $\frac{385}{1000}$ to $\frac{395}{1000}$ inches
i.e. a variation of $\frac{10}{1000}\left(\frac{1}{100}\right)$ ins.
is permissible wi thout scrapping the component.
4. $\varnothing 2.000$ means a diameter of 2.000 ins.
5. R. 125 means a radius of .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

| Fractional inch | $\begin{aligned} & \text { Decimal } \\ & \text { inci } \end{aligned}$ | mm. | Fractional inch | $\begin{aligned} & \text { Decima! } \\ & \text { inch } \end{aligned}$ | mm . |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1/64 | 0.015625 | 0.3969 | 33/64 | 0.515625 | 13.0969 |
| 1/32 | 0.03125 | 0.7938 | 17/32 | 0.53125 | 13.4938 |
| 3/64 | 0.046875 | 1-1906 | 35/64 | 0.546875 | 13.8906 |
| 1/16 | 0.0625 | 1.5875 | 9/16 | 0.5625 | 14.2875 |
| $5 / 64$ | 0.078125 | 1.9844 | 37/64 | 0.578125 | 14.6844 |
| $3 / 32$ | 0.09375 | $2 \cdot 3813$ | 19/32 | 0.59375 | 15.0813 |
| 7/64 | 0.109375 | 2.7781 | 39/64 | 0.609375 | 15.4781 |
| 1/8 | 0.125 | 3.475 | 5/8 | 0.625 | 15.875 |
| $9 / 64$ | 0.140625 | 3.5719 | 41/64 | 0.640625 | 16.2719 |
| 5/32 | 0.15625 | $3 \cdot 9688$ | 21/32 | 0.65625 | 16.6688 |
| 11/64 | 0.471875 | 4.3656 | 43/64 | 0.671875 | 17.0656 |
| 3/16 | 0.1875 | 4.7625 | 11/16 | 0.6875 | 17.4625 |
| 13/64 | 0.203125 | $5 \cdot 1594$ | 45/64 | 0.703125 | 17.8594 |
| 7/32 | 0.21875 | 5.5563 5.953 | 23/32 | 0.71875 | 18.2563 |
| 15/64 | 0.234375 | 5.9531 | 47/64 | 0.734375 | 18.6537 |
| $1 / 4$ | 0.25 | 6.35 | 3/4 | 0.75 | 19.05 |
| 17/64 | 0.265625 | 6.7469 | 49/64 | 0.765625 | 19.4469 |
| 9/32 | 0.28125 | 7.1438 7.5486 | 25/32 | 0.78125 | 19.8438 |
| 19/64 | 0.296875 | 7.5406 | $51 / 64$ | 0.796875 | 20.2406 |
| 5/16 | 0.3125 | 7.9375 8.334 | $13 / 16$ | 0.8125 | 20.6375 |
| 21/64 | 0.328125 | 8.3344 | 53/64 | 0.828125 | 21.0344 |
| 11/32 | 0.34375 | 8.7313 0.1281 | 27/32 | 0.84375 | 21.4313 |
| 23/64 | $0.359375$ | $9 \cdot 1281$ | 55/64 | $0.859375$ | $21.8281$ |
|  | $0.375$ | $9.525$ | 7/88 | $0.875$ | $22 \cdot 225$ |
| 25/64 | 0.390625 | 9.9219 10.3188 | 57/64 | $0.890625$ | 22.6219 |
| $13 / 32$ | 0.40625 | 10.3188 10.7156 | 29/32 | 0.90625 0.921875 | 23.0188 23.4156 |
| 27/64 | $0.421875$ | $10.7156$ | $59 / 64$ $15 / 16$ | $\begin{aligned} & 0.921875 \\ & 0.9375 \end{aligned}$ | $\begin{aligned} & 23.4156 \\ & 23.8125 \end{aligned}$ |
| 7/16 | $0.4375$ | $11 \cdot 1125$ | 15/16 | $0.9375$ | $23 \cdot 8125$ |
| 29/64 | 0.453125 | 11.5094 | 61/64 | 0.953125 | 24.2094 |
| 15/32 | 0.46875 | 11.9063 | 31/32 | 0.96875 | 24.6063 |
| 31/64 | 0.484375 | 12.3031 | 63/64 | 0.984375 | 25.0031 |
| 1/2 | 0.5 | $12 \cdot 7$ | 1 | 1 | 25.4 |

Conversion Tables used by Craftsmen
(extending to 30 pages)

METHOD OF DIMENSIONING


DEP I- I OFF - BS 1476 - HE 30 WP
REMOVE SHARP EDGES.

PROBLEM (1) ADDITION AND SUBTRACTION
PROBLEM (2) USE OF DIAMETER RADIUS AND TANGENT
TO CALCULATE AN ANGLE IN D.M.S.
ALL DIMENSIONS IN MM.

'ROBLEM (1) FIND DIMENSION 'Y' (ALL MM):-

$$
\begin{aligned}
y & =145-(35+35) \\
& =145-70 \\
\therefore y & =75 \mathrm{~mm}
\end{aligned}
$$

Problem (2) Find included angle $x^{\circ}$ given that DIAMETER REDUCES BY 0,5260 in 25,4 LENGTH

$$
(0,5260=0.5260 \mathrm{~mm})
$$

REDUCTION IN PADUS $=0.5260 \div 2$


$$
\begin{aligned}
T_{A N} \theta=\frac{O P P}{A D J} & =\frac{0.2630}{25.4} \\
\therefore \theta & =0.5932^{\circ}
\end{aligned}
$$

$$
\therefore \text { INCLUDED ANGLE }=1.1864^{\circ}=1^{\circ} 11^{\prime} 11^{\prime \prime}
$$

NB. IN PRACTICE 7 FIGURE LOG. TABLES OR CALCULATOR WILL BE USED

HARDER APPLICATIONS OF IRTGONOTMETRY
(1) KNOWLEDGE OF GEOMETRY IS REQUIRED TO ESTABLISH THE ANGLES (1) $\$(2)$ OF $23^{\circ} 30^{\circ}$.
(2) SIMPLE EQUATION METHOD TO OBTAIN" $92 \times \sin 23^{\circ} 30^{\prime \prime}$
(3) KNOWLEDGE OF "BOMDAS" TO COMPLETE CALCULATION


* order of OPERATIONS BRACKETS -OF' \&MULTIPLICATIOA Division ADDITION subtraction

$$
\begin{aligned}
& x=92 \times \sin 23^{\circ} 30^{\prime}+\left[5,5 \times \cos 23^{\circ} 30^{\prime}\right]+9,5 \text { etc. } \\
& y=92 \times \cos 23^{\circ} 30^{\prime}+\left[20,5 \times \sin 23^{\circ} 30^{\circ}\right]+9,5 \text { etc. }
\end{aligned}
$$

## Entryqualifeations

Appicationsare tivitedrom those whose homes axe withifeeasyd daly Grave of Derby whoexpecto obtain good gradeCSE (or equivalent) ${ }^{3}$ Mathsand Engishor Science and who wish totranto becomeskinedsTumers Milers,

Ginders, Sheetmetal worker, Coppersmiths, instrmemt Méchanics, Maintenance Fiters, Maintenance Electricians, Fitter Testers, Welders, Rattemnakers MoulderCoremakers

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 Istart 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.

Above: Discussing a turning problem
Below: Fitting


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.

Right: Using a vertical milling machine

A demonstration on the sheetmetal section

## What qualifications can I expect to achieve during my training? <br> 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: <br> (1) Engineering Industry Training Board Certificate of Engineering Craftsmanship. City and Guilds Mechanical Engineering Craft Studies Certificate Parts I. II and III OR Technical Education Council-Technician Certificate.

## Who pays my College fees?

 The Company pay all fees for day or block release courses.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 'netṣ' in fabricating ohapes 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 patterm-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 wi th compasses etc. for marking out. In adaition 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.

$$
\text { e.g. } \begin{aligned}
E & =I R \\
\frac{1}{R} & =\frac{1}{r_{1}}+\frac{1}{r_{2}}+\frac{1}{r_{3}}
\end{aligned}
$$

## UNITS USED IN TECHNICAL WORK

THE INTERNATIONAL
STANDARD ATMOSPHERE (I.S.A.)

| altitude <br> (h) |  | AMBIENT TEMPERATURE (To) |  |  | AMBIENT PRESSURE (Po) |  | SPEED OF SOUND (ao) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Feet | Metres | Deg. K. | Deg. $C$. | Deg. F. | Ib./sq. in. | millibars | ft./sec. | knots | m.'sec. |
| -1,000 | -304.8 | 290.13 | +16.98 | 62.6 | 15.24 | 1050.4 | 1120.3 | 663.3 | 341.5 |
| 0 | 0 | 288.15 | 15.00 | 59.0 | 14.69 | 1013.2 | 1116.6 | 661.1 | 340.3 |
| $+1,000$ | $+304.8$ | 286.17 | 13.02 | 55.4 | 14.17 | 977.1 | 1112.6 | 658.8 | 339.1 |
| 2,000 | 609.6 | 284.19 | 11.04 | 51.9 | 13.66 | 942.1 | 1108.7 | 656.5 | 337.9 |
| 3,000 | 914.4 | 282.21 | 9.06 | 48.3 | 13.17 | 908.1 | 1104.9 | 654.2 | 336.8 |
| 4,000 | 1219.2 | 280.23 | 7.08 | 44.7 | 12.69 | 875.1 | 1100.9 | 651.9 | 335.6 |
| 5,000 | 1524.0 | 278.24 | 5.09 | 41.2 | 12.23 | 843.0 | 1097.1 | 649.6 | 334.4 |
| 6,000 | 1828.8 | 276.26 | 3.11 | 37.6 | 11.78 | 811.9 | 1093.2 | 647.8 | 333.2 |
| 7,000 | 2133.6 | 274.28 | 1.13 | 34.0 | 11.34 | 781.8 | 1089.3 | 644.9 | 332.0 |
| 8,000 | 2438.4 | 272.30 | -0.85 | 30.5 | 10.92 | 752.6 | 1085.3 | 642.6 | 330.8 |
| 9,000 | 2743.2 | 270.32 | -2.83 | 26.9 | 10.51 | 724.3 | 1081.4 | 640.3 | 329.6 |
| 10,000 | 3048.0 | 268.34 | -4.81 | 23.3 | 10.11 | 696.8 | 1077.4 | 637.9 | 328.4 |

## TECHNICAL SPECIFICATION FUR AN ENGIFE

## TAKE-OFF

Power .. .. 4,220 s.h.p., 1,235 lb. thrust
Total equivalent power .. .. 4,695 t.e.h.p.

## REPRESENTATIVE CRUISING <br> 25,000 ft., 425 m.p.h.

Powंer .. .. 2,350 s.h.p., 152 lb. thrust

Total equivalent power .. . . 2,553 t.e.h.p.

Specific fuel consumption . . $0.405 \mathrm{lb} . / \mathrm{hr} . / \mathrm{t} . \mathrm{e} . \mathrm{h} . \mathrm{p}$.

## WEIGHT

Net dry weight .. . . . . 2,023 lb.
Specific weight .. .. $0.431 \mathrm{lb} . / \mathrm{t} . \mathrm{e} . \mathrm{h} . \mathrm{p}$.

## DIMENSIONS

Length to cone fitting tine .. $100 \cdot 25 \mathrm{in}$.
Height including oil cooler :. $\mathbf{4 5} .75 \mathrm{in}$.
Width over intake fairing .. $\mathbf{4 0 . 5} \mathrm{in}$.

PROPELLER REDUCTION GEAR
Ratio .. .. .. .. 0.064 to I

## 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, whic $h$ 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 .

## Technical Data

Dimensions.-Diameter 42.2 in. (107.2 cm ): length. with jet pipe, 122.0 in. $(310.0 \mathrm{~cm}$.$) ; without jet pipe, 102.1 \mathrm{in}$. (259.3 cm.).

Weight.-Dry, 2,460 lb. ( 1.116 kg )
Performance.-Maximum sea level static thrust. 8.000 lb . $(3.629 \mathrm{~kg}$.); at a specific fuel consumption of $0.955 \mathrm{lb} . / \mathrm{hr} . / \mathrm{lb}$. 0.955 kg./hr./kg.).

## USE OH \&

(APPORTION」NG AIRHLOW)


USE OF LINE GRAPHS

$1 \quad$ Deg C. Fe/sec. Lb/O in.


## 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.

LONG RANGE TRANSPORT AIRCRAFT EFFECT OF $10 \%$ IMPROVEMENT IN S.F.C.


Therefore, given that the jet pipe-
OUTLET Area $\quad(A)=651$ sq. in.
Pressure $\quad(P)=21 \mathrm{lb}$. per sq. in. (gauge)
Velocity $\quad(\mathrm{v})=643 \mathrm{ft}$. per sec.
Mass flow $(W)=153 \mathrm{lb}$. per sec.
The thrust $=\mathrm{A} \times \mathrm{P}+\frac{\mathrm{Wv}}{\mathrm{g}}-14,326$
$=651 \times 21+\frac{153 \times 643}{32}-14,326$
$=16,745-14,326$
$=2,419 \mathrm{lb}$. 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 $\quad(A)=332$ sq. in.
Pressure $\quad(P)=6 \mathrm{lb}$. per sq. in. (gauge)
Velocity $\quad(\mathrm{v})=1.917 \mathrm{ft}$. per sec.
Mass flow $(W)=153 \mathrm{lb}$. per sec.
The thrust $=A \times P \div \frac{W v}{g}-16,745$

$$
=332 \times 6+\frac{153 \times 1,917}{32}-16,745
$$

$$
=11,158-16,745
$$

* $=-5,587 \mathrm{lb}$. acting in a rearward direction.


## 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, voiume flow through a cylinder.
2. Ratio (pressure and temperature).
3. Square roots.
4. Changing the subject of a formula.
5. Substitution in standard formulii.
6. Straight line graphs, reading and interpretation, (al so 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 țemperature. 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.

## PERHORMANCE - ENG」NEER

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 al so anplies to numerous other research/development departments staffed by engineers, mathematicians and physicists possessing Ph.D., Degree, HND and a few HNC.

## DRAWING OHFTCES

(DESIGNERS AND DRAUGHTSAEN)


Instruction in the Drawing Training School

## 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 0/A levels.)

## Draughtsmen



Usually qualified to ONC/HYC/City and Guilds, the draughtsman transforms design. schemes into detail drawings of separate components for manufacture on the factoryfloor. The tool draughtsman designs special jigs and fixtures for holding the components during machining etc. and he plans the sequence of machining operations.

The draughtsnen may start as a draving 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,
$\rightarrow$ stress, velocity, temperature, bending moments, r.p.m.
$\therefore$ P̀ythagoras, Trigonometry, Ratio (Gears).
All constructions using compasses.
Projection, conic sections, ellipses etc.

## Sumnary 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 mm.$)$
2. Conversion of fractions to decimal.
3. Use of metric and imperial units.
4. Menipulation of simple equations.
5. Substitution in standard formulii.
6. Trigonometry, answers in D.M.S.
7. Pythagoras' Theorem, squares and square roots.
8. Areas and volumes.
9. BOMDAS, order of̂ executing mathematical steps.
10. Estimation and rounding off.
11. Diameter, radius, circumference, rotational speed, gear ratios.
12. Constructions using compasses, nets.
13. Conic sections, projection.
14. Reading of sceles, gauges and dials.
15. Use of 7 figure logarithmic tables and/or calculator.
16. Negative numbers.
17. Plotting of straight line graphs, selection of scales.
18. Correction of data by scale factors.

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 programing.

## APPMDIX 3

Samples of completed cuestionnaire given to 1325 th Year Pupils

ENTERED C. OF. FURTHER EDUCATION UNIVERSITY OH LOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)

HAME MARK. $\in$
FORM ... 4 H

Please use a blue or black pen.
please continue over the page if necessary

Home District (egg. Allenton, Chellaston, Derby etc.)


Primary School (s) (age 5-1 lyra.)
MeADow FARM PRMAKY | SHELIOW
Math Set (eeg. 5A5, 4B3) ...AAA!......

Maths Course ( 0, CSE or N. Ex.)
Hobbies

## LISTENING 70 ROCK.. MUSIC MESSING ABOUT

Your intended career (or put
'not decided')
ACCOUNTANCY ORACTURIAL ....13./!14....
At what age did you decide on this career?

Reasons for choosing this career

.ALL. SPORTS CAMPING M....! !....e. OR.........WOKK GOOD AT IT. GOOD WAGES.AMO..SGCUY!TY...

Parent's job (leave blank if you prefer)

Please suggest ways of improving pupil's learning in maths throughout his/her whole school ide.
Please do not mention any teacher's name.

PRINCIPAL SCIENTIFIC OFFICE (a) Primary School

STREAMINGS AT AN EARLY AGE MORE PRESSURE PLACED ON PUPILS PO WORK TO THEIR FULL ABILITY WIDER SELECTION OF TEXT BOOKS IE. NOT ONE SET MATHEMATKS COURSE
(b) Secondary School
"WEEDING" OUT THE TROUBLEMA OR THOSE WHO STOP OTHERS FROM WORKING. WHOLE SECONDARY SCHOOL TACHE THROUGHOUT THE Do NOT answer the questions below
Final examinats: $:$ result in mathematics
Employment/Further Education

METHODS. OF DOING. THINGS Pup ILs)

THOSE WHO HAVE AN OBVIOUS ABILITY FOR MATHMMATKS SHOULD BE ENOCOURAGED, IN SOME CASES GIVEN SPECIAL MATHIS TO MEET THEIR REQUIREMENTS. THEY SHOULD ALSO AE"STRETCHED" SO. THAT THEY WORK TO THEIR FULL AGILITY

THOSE WHO ARE GOOD AT MATHS, OR AT ANY SUBJECT, SHOULD BE ALLOWED TO TAKE THEIR O-LELKL IN THAT SURUECT ONE YEAR EARLY. NOT ONLY WOULD THIS PROVIDE THE INCENTIVE TO WORK BÜT IT WOULD ALSO TAKE some pRessure of the peRSOn IN HiE O-LEVELS THE YEAR AFRIT.

IF POSSIBLE TOP GROUPS SHOULD
BE MADE SMALLER AS IN THE LARGER GROUPS THERE IS STILL A LARGE GAP IN ABILITY. ANOTHER THUG 15 HAT OFTEN A PUPIL HAS JUST GRASPED A NEW THEORY WHEN THE TEACHER STOPS AH WHOLE CLASS OUST TO EXPLAIN THE. THEORY TO A FEW SLOW ONES BY THE END OF WHICH THE ORIGINAL PUPIL IS LEFT COMPLETELEY BAFFLED AND HAS COMPLETZLEY FORGOTTEN HOW TO TO THE SPECIFIC Question.

Monk anshan 47H var

These questions are for statistics only. (Your name will not be used)

HAME Richatel. T
FORM .AS.

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE L $F^{\prime}$ NECESSARY

Home District (egg. Allenton, Chellaston, Derby etc.)

Primary School (s) (age 5-1 lyre.) attended

Maths Set (e.g. 5A5, 4B3)
Maths Course ( 0, 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.

Shalt L. ck
Boult ru Primary
Sinhtrork Piman
4.4!
...O.
Brchuntro. Cocked, Morlilling AFV's

15
 - ㄱ. wo.

Acsintent Fore (British Rail)
(a) Primary School

I think that minims coned be improved
by addling is little init, The only tim
 5 secondary I pound dice for the posies for the pity

## (b) Secondary School

I am satisfied with it way matt I is tonight in secanchury Schools.

Do NOT answer the questions below

## Final examinatitis result in mathematics

Employment/Pur the Education
oped with at Primary level
agree that a good bose in any subject is essential int I fee
i Primary school as me only did the acme ting day after dang one
, Welhargic. If we had bean tested more at this laurel by te int
on of new hrametios of maths them tire would rot have hern wooster
Seconding school.
ti's thingy like simple alogitra and sane of the simpler ratteration
s crude he Tangles of ti stage, in I thick that thy conley on dy he
$r$ ts pupils cone also the cantier you start somelting in your if the yon have ts become good at it.

UNIVERSITY OF IOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)
name Gary Sumo
роги .3L..............
Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (e.g. Allenton, Chelleston, Derby etc.)

Primary School (a) (age 5-11 yrs.) attended

Maths Set (egg. 5A5, 4B3).
Maths Course ( 0, 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/wier whole school life. Please do not mention any teacher's name.
. Shelton . Lock.......
.Shelton Work........
. 3 Al......
Short I. V, Fishing.
. Collecting. Stiver an.....
Chef. in Mo Morshort Nay
.Il. years. of age

.Bidthyor(dad. Spestatay (mo
1 (b) prime that thou sods have stricter disupplise and 1 think He more time should be seen on the sabtioct hat hey are on the subisact H
 more stricter in the class nowadays ito iden in the class just do nt care because yurt. Do NOT answer the questions below teachers ate are not Final examina+s, result in mathematics ..........
Enpln:-mt/Further Education
continued overside
the teacher shod look as theaph they interested in the sulkiest. Also you get teachers ito very strict and some that are very seat and this orang because if the strict fosson is too strict the s will poddy will be too scored to do the rand so in the and they will be nduniencodrain eosin. If you had a soft teactor of the beggining of schod lie e and you pond at that he was nat erred the chider in the class will jat taheardata and 50 in the and the class will just pod anat $s 0$ no more look will be dene until andter in stats. So what lam saying is tho when it ma chithions First day at school the teach should stich but fair so Hat the class knows that the cher will do something erect it if the childe it to fool cabot Also ithint that the reactors old spend moe time on ore subject so that the ten will lo able vo understand on what the char is talking chat so this lands on to sorrdt. e and thor is when a header is explaining how do a soy hard sum you get some stupidicte the and who says" I doit knew what ta do, ord this hods op the class as they try to worth. Pto jere with the method where a teaghtar says right - you can sit boy pith bseoowse this makes the ss get on trogettar because than you have none your mater to pack ho and then you will find 5 the doss will gets good exomidion resale - $s$ that is andter method. Also if the children are salty the puritment I think is enter extra haman erolachly extralinos probity 200 hounded to $t$ tact = coth. Also lihink that Masts classes stand se tho teactars because if one teactar is ext

UNIVERSITY OH LOUGHBOROUGH SURVEY

These questions are for statistics only. (Your name will not be used)
name Paul Musthalos
porn .. 3 ...........
Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (egg. Allenton, Chellaston, Derby etc.)

Primary School (s) (age 5-1lyrs.) attended

Maths Set (eeg. 5A5, 4B3)
Maths Course ( 0, CSE or N.Ex.)
Hobbles

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 nome.
...Shelton..Lock......
Shelton. Juniors..
...........
O......... 1 Collecting
.bedders and programmes
..not...Decided....
.............
.......................................................................
. Secretary. for U. ester. Taxis (mum
(a) Primary School

The basics should be taught more clearly and homework should be set in order to practice the basic
(b) Secondary school

Complicated maths should be explained better and each piece of work should
Do NOT answer the questions below be talked about and discusse Final examinate:- result in mathematics ..........
Pmpln-wntinurther Education

## Jiilvens TY OH LOOGHBOROUGH SURVEY

Thcsa neeacions are for statistice only. (Your nare will not be used)
mane .Sterom nliceden..
PORM ..... 50.

Please uas a blue or black pen.

HEASE COMMINE OVER THE PAGE If NECESSARY

Home Jifitrict (e.g. Alleaton, Chellaston, Deroy etc.)

Primary Scinool (a) (ase 5-11yra.) attended

Haths Set (e.E. 5A5, AB3)
シ̈ths Cowse ( $0, \mathrm{CSE}$ or ii. Ex.)
Tubbles

"aot decided'
ft what are tia you Eecide on this carter?

Reasuna for choceine this career
$\because$ Ent's joi (leave inank if -ou prefer)
 rapil's leaming in maths Groughout his $i=6$ finole 30:001 lifさ.
llease do zot mention any teacher's nane.

To NOT andaci the diesilons below

Aston-an-Trent
.hton Drimary.ashod .............
...C.SE......
Arpuen dheteng, ....
.Draugh?mand.Tednouso.
..thongion do scmenting dumg Enime love selfermeloued buedern...
(a) Primary School

In some thrimary scheo suchap atern. Ely teguhery oat
ven, have hew accelficcetions veay, have few gucelfictetions condo in some casep pion
shend liter unciculice teachey
(b) Seconderà school
atec ecentiction of aciprentise maths


Tinal exminn...... susult in mathematics .GRADE.J..
-uployment/Furtier Education
6TM. FORM

## UNIVERSITY OH 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 (egg. Allenton, Chellaston, Derby etc.)
Primary School (s) (age 5-1lyrs.) attended

Maths Set (egg. 5A5, 4B3)
Maths Course ( $0, \operatorname{CSE}$ 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.

Astran:on-T.Tprot....... .Aston w:onn...Truct...... ....5月5....
...SSE.....
 crafterpperetime.s.mis. ...14.
 Methut..ur? work chepetior
.. S. 0 rsthaty
(a) Primary School lower hort ur hines eorkges.
(b) Secondary School

Do NOT answer the questions below
Final examinats: result in mathematics . N. EX. Emplownint/Further Education FURNTTURE. . TRDD.E

These questions are for statistics only. (Your name will not be used)
 PORK .. .....SHAH

Please use a blue or black pen.

PLEASE CONTINUE OVER THE PAGE IF NECESSARY

Home District (egg. Allenton, Chellaston, Derby etc.)

Primary School (s) (age 5-1lyre.) attended

Maths Set (ce. 5A5, 4B3)
Maths Course ( 0, CSE or N. Ex.)
Hobbies

Your intenaid career (or put 'not decided')

At what age did you decide on this career?

Reasons fer choosing this career

Paint'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 nome.

## (b) Secondary School



Do NOT answer the questions below

CS E...
Mol! ..........
 ........!4.....
 . . Bart. . . . \&. . . . .
B. $R_{1}$. . . .COOP: 1

## APPTHDIX 4

Samples of Numeracy Tests for pupils of varying abilities, and destinations after Year 5

John CSE GRADE I


5 2'iki
11.

$$
\begin{aligned}
& 11 \sqrt{2937} \text { ans } \\
& \frac{22}{47^{\prime} 3}
\end{aligned}
$$

6 | 3888 |
| :--- |
| 799 |
| 89 |



7 $\begin{array}{r}\dot{2} 8^{9} 0^{4} 0^{\circ} \\ \frac{814}{1186} \mathrm{ans} \\ \hline\end{array}$
12.

$$
\begin{aligned}
& 671 \\
& 25.9 \\
& 1.295 \\
& \hline 698.195 \\
& \hline
\end{aligned}
$$

cuns
$2313 / 5 \times 2 v_{7}$

$5)^{123}$


6728840

$$
\frac{814}{1186}
$$

$$
\begin{aligned}
& 8,113 \\
& \frac{35}{565} \\
& \begin{array}{l}
3390 \\
\hline 3955 \\
\hline
\end{array} .
\end{aligned}
$$

81 CANDIDATE

JECTED BY ARMY WEAKNESS IN MATHS HOUGH DISPlaying abILITY SPORT, CAVING, OUTWARD IND', D.DF. E. AWARD. eXCELLENT CHARACTER (D) $100 \%$ aTTENDANCE
$3)$

$$
\begin{aligned}
& 675 \\
& 204 \\
& \frac{885}{9769}=9
\end{aligned}
$$

4) $0{ }^{\prime \prime} x^{\prime \prime} 1$

$$
\frac{\frac{997}{0184}}{1.184}
$$

5) ${ }^{2} 11_{4}^{3} 1$

$$
\frac{317}{1824}=1824
$$

6) $7_{8}^{\prime \prime} 8$

$$
\frac{799}{089}=\frac{086}{1}
$$

13) 

$$
\begin{aligned}
& 10 \cdot 200 \\
& 1 \cdot 901 \\
& \frac{0.037}{12 \cdot 138}=12.138
\end{aligned}
$$

$$
\begin{aligned}
& \text { 8) } \begin{array}{l}
113 \\
\frac{35}{565} \\
\frac{3390}{3955} \\
9.179
\end{array}=3955
\end{aligned}
$$

9) 729

$$
\begin{aligned}
& \frac{18}{5832} \\
& \frac{5290}{2122}=12122
\end{aligned}
$$

$$
\frac{814}{1186}=\frac{1186}{1}
$$

10) $1 3 \longdiv { 1 4 1 7 \% } = 0 1 0 8$

$$
1111 \frac{0268}{2937}=2937
$$

121

$$
\begin{array}{r}
1.295 \\
0671 \\
\frac{25,900}{26.866}=
\end{array} \div
$$

3) 10.200

NON-EXAMINATION
'REMEDIAL' MATHS, YET

- obíained interview for CRAFT APPRENTICESHIP
(7) $=3455 *$

(12)

$$
\begin{aligned}
& \text { (2) } 1.295+671+25.9=62141 X \\
& 10.2+1.901+0.037=1224.138
\end{aligned}
$$

(5) 16142
(5) 62114
(6) $12141 x$
(24) $3 \frac{5}{12} x$
(11) 1421
(74) 1214

$$
3 \frac{4}{8}
$$

((2)) $3 \frac{2}{8} x$
(21) $14 \frac{2}{17}$
(2) $5 \frac{3}{13}$

K


## APPETDIX 5

Samples of Work from 'Apprentice
Maths' for pupils of varying abilities

$$
\begin{aligned}
& 1 / 2^{\prime \prime}=0.5^{\prime \prime} \\
& 9 / 16^{\prime \prime}=0.5625 \\
& 5 / 8^{\prime \prime}=0.625^{\prime \prime} \\
& 11 / 16^{\prime \prime}=0.6875^{\prime \prime} \\
& 3 / 4^{\prime \prime}=0.75^{\prime \prime}
\end{aligned}
$$

$\therefore$ the $5 / /$ "gabar would

How far would the cutting to l have
to be fed in to produce the required size? ie. what is the distance $x$ ?


$$
D=0.625
$$

$$
\begin{aligned}
X & =\frac{D-0.610}{2} \\
& =\frac{0.625-0.610}{2} \\
& =\frac{0.015}{2} \\
& =0.0075
\end{aligned}
$$

Calculate (a) $x$ and (b) y: using pythagoras theorem.

PTo

GOOD CSE BOY
n
vineery Tofund the lengit A．B
Jollow the sama procedure
as $t$ fand $x$ on pravicus
pase．

$$
\begin{aligned}
& \text { FE - } \quad 5:=0 \\
& \pm 2 \ldots \\
& F \underline{E}=1 .
\end{aligned}
$$

I know use pe to find $y$

$$
\begin{aligned}
& x=21^{2}-:^{2} \\
& y^{2}=201+(1) \\
& x^{2}=0: \\
& \text { ソッ・小ろ可 } \\
& \text { ここ=: }
\end{aligned}
$$



6．The followny sholch shows detach of a grove in a pullyy for a cee bell drue．Colculate $x$ ．


HELP INEEDED．TO


Llong the measuremests ant anjes gewn in the deaqum abver I have cuerted cut a soparde duggion matring a treangle．Whtt the lieangle fand the longth of＇＇＇． the apposcte sude is the sane no had for＇c＇＇s together and subtract than from 202m，

$$
\begin{aligned}
& \operatorname{Tan} 20^{\circ}=\frac{c}{18} \\
& 0.36+0=\frac{c}{18}
\end{aligned}
$$



A component is designed as shown below-
Howeier, all the macheiery and tools to produce this part are calibrated in metric units. Scotch component giving dunintions in min correct tee the decimal places

$3.750^{\circ} d i a$

$$
\left(i^{4}=25.40 \mathrm{~mm}\right)
$$

$$
\begin{array}{r}
2540 \\
\frac{3.165}{2.100} \\
3070 \\
25: 5000 \\
162000= \\
\hline 14.36900 \\
3.125^{4}=70.37 \mathrm{~mm}
\end{array}
$$

13.375
25.400
000000
$\therefore 00.1200$
450.000

$$
\begin{aligned}
& 45 \cdot 400 \\
& \frac{13.375}{120.2000} \\
& 19.780 .375^{2}=234.73 \\
& 0.00
\end{aligned}
$$


49.370

$$
2 \cdot 313 \quad 2 \cdot 3 i 3^{\prime \prime}=58 \cdot 55 \text { :mim }
$$

$$
\frac{3540}{0000}
$$

$$
92520
$$

$$
1166500
$$

$$
4628000
$$

$$
58: \$ 5020
$$

$$
\begin{aligned}
& 8 \cdot 125^{\circ} \quad 8 \cdot 125^{\prime \prime}=206.38 \mathrm{~mm} \\
& \times 25 \cdot 40 \\
& \frac{2000}{3250200} \\
& 4562500 \\
& 16250000 \\
& 20,6,37500
\end{aligned}
$$

$$
\begin{aligned}
& D_{A} A=95.25 \text { mm ..... } \\
& \text { _.....206.38 } \\
& 3 \cdot 5^{\prime \prime}=88.90 \mathrm{~mm} \\
& 1.625^{4}=143.68 \mathrm{~mm} \\
& 3.50 \\
& \frac{25.4}{14^{2} 00} \\
& 17^{2} 500 \\
& \frac{70000}{88900}
\end{aligned}
$$

VERY WEAK OLCSE GIRL

A man is. asked to produce a bar of 0.610 dis In metal store, the moderials available are:

| $\frac{1}{2}$ bia | $\frac{9}{16}$ | $\frac{5}{8}$ | $\frac{11}{16}$ | $\frac{3}{4}$. |
| :--- | :--- | :--- | :--- | :--- |
| .5 | $1.77^{\text {nc }}$ | 0.625 | 06575 | 0.75 |

Which bar will he chose if he is to waste the boat amount of material when machining Diameter 1 .
with $\frac{5}{8}$ he will waste less.

How for will the cutting tool have to be vend to produce the required. size? le what is distance $x$ ( Dis the cliemeter of the bur chosen.


1. ase the theorm of pythragnas to calu


$$
\begin{array}{r}
y^{2} 1.1^{2}+3.1^{2}= \\
10.82=y^{2} \\
\sqrt{10.82}=4 \\
3.29=y \\
\\
x^{2}=3.1^{2} \times 2 . \\
9.61 \times 4.0 \\
38.44 \\
x=6.2 .
\end{array}
$$

$\xrightarrow{\text { LIMITED GRADE/N.EX. }} \begin{aligned} & \begin{array}{c}\text { RECENT } \\ \text { CHINESE) BOY } \\ \text { ARRIVAL }\end{array}\end{aligned}$
$12-80$.
When tapping a hall (putting a thread inside) - hale must purist be drilled before pu e the theiad care ag in e cut.


The tapping drill sizes for Whitwonth threads can be Calculated using the formula o $T=D \equiv 1.1328 P$

Where:
$D=$ diameter of thecae in inches
$P=$ pitch of thread in inches.
$T=$ tapping dill diameter in inches
Calculated $T$ when $D=\frac{38^{\prime \prime}}{}{ }^{\prime \prime} P=0.0625^{\prime \prime}$.
Answer correct to 3 dec. places.

$$
\begin{aligned}
& T=D-1.1328 p \\
& T=\frac{3}{8}-1.1322 \times 0.0625 \text { change } \frac{3}{2} \text { to fuactina } \\
& =0.375-1.1328 \times 0.0625 \\
& =0.375-.0708 \\
& =333 \\
& \begin{array}{r}
0.375 \\
8 \longdiv { 3 . 3 0 6 4 0 }
\end{array} \\
& 11328 \\
& \begin{array}{rr}
61 & \times 00625 \\
.0708 & \begin{array}{r}
56610 \\
0.375
\end{array} \\
\hline 332650 \\
& 6796400 \\
& 00.080000
\end{array}
\end{aligned}
$$

$$
\begin{aligned}
& N=\frac{1000}{\pi D} \\
& =\frac{1000 \mathrm{~s}}{\pi \times D} \\
& \text { (2) }=\frac{1000 \times 70}{3.142 \times 35.5} \\
& 3.142
\end{aligned}
$$

$$
\begin{aligned}
& =\frac{70000}{3.142 \times 35.5} \\
& \begin{array}{r}
=\frac{70.000}{964.370} \\
111.5410 .
\end{array} \\
& =\frac{70000}{3 \cdot 142 \times 35.5} \\
& =\frac{70000}{111.541} \\
& -627.9
\end{aligned}
$$

(3)

$$
\begin{aligned}
& =\frac{1000 \times 40}{3.142 \times 98} \\
& =\frac{40000}{307.916} \\
& =129.9
\end{aligned}
$$

$$
\begin{aligned}
& 129.9 \\
& =\frac{4.48}{5.48} \\
& \frac{211}{211}
\end{aligned}
$$

N (roo/min)
1.


The formula conacting $\mathrm{ra} / \mathrm{min}$ and cutting spacd

$$
\text { is } N=\frac{\operatorname{vec} s}{\pi D}
$$

Wher $N=$ ravimin of sp:ndla
$S$ = Culting spond in m/mo
$D=$ aron cuiter dianss in mm

$$
\begin{aligned}
\pi= & A \text { constant } \\
& 3 \mathrm{int} 2
\end{aligned}
$$

Calcuitate $N$ then (a) $S=50 \mathrm{~m} / \mathrm{min}, D=54 \mathrm{~mm}$
sisec.


$$
N=0.0033933
$$

worting an different shate DEC. POINTS.
DIVISION.

Cotaitate No when (b) $S=70 \mathrm{~m} / \mathrm{min}, D=35.5 \mathrm{~mm}$
ines

$$
\begin{aligned}
& \text { Formia } N=\frac{1000 s}{\pi D} \quad N=\frac{1000 \times 70}{\pi \times 355} \quad N=\frac{70000}{111.541} \\
& 1 1 1 . 5 4 1 \longdiv { 0 . 0 0 1 5 9 3 4 } \\
& N=0 . \infty 01593 n \\
& \text { DEC. POINT. } \\
& \text { DIVISION. }
\end{aligned}
$$

BEST 3RD YEAR
Robert Yomenson 3RI-3J
Maths
Homework - 5-2-80
(9)


Height $\times$ Area of Cross - Section $=$ Volume of prism 44 mm :

0


Volume of prism $=$ oren of coss-section $x$

Area of rectangle $=120 \times 40=4800$ 40. Area if circle $=\pi r^{2} 2:$ 4800
$\frac{10}{0}$

$$
\begin{aligned}
& =3-42 \times 900 \\
& =3-142 \times 900 \\
& \text { Area of cycle }=2827.8 \therefore 3.142 \\
& 2 \longdiv { 1 4 1 3 . 9 } \\
& \begin{array}{r}
28278000
\end{array} \\
& 48^{\circ} 0^{\circ} \\
& \int \frac{1413 \cdot c}{3386 \cdot}
\end{aligned}
$$



$$
H^{2}=x^{2}+y^{2}
$$

$$
\begin{array}{r}
5-2 \\
5 \cdot 2 \\
2600 \\
104 \\
\hline 2704
\end{array}
$$

$\begin{array}{lll}x^{2}-6 & 36.00 \\ H^{2}-y^{2}=x^{2} & & 27.04 \\ \left(6^{2}-5 \cdot 2^{2}\right)=x^{2} & 8.96\end{array}$
$(36-21.04)=x^{2}$
( 8.96 ) $=x^{2}$
$\sqrt[2]{8.96}=x^{8}$
$\begin{array}{rlr}\therefore \sqrt[2]{8.96} & =2.99 & \frac{2}{5.98} \\ \therefore 2.49 & =x . & \end{array}$
$\begin{array}{rlr}\therefore \sqrt{8.96} & =2.99 & \frac{12}{5.98} \\ \therefore 2.99 & =x .\end{array}$
2.99

$$
\begin{array}{r}
6+(2.99 \times 2)=D \\
\quad 6+5.98=D \\
11.98=D \\
\dot{y}_{\text {rapesion }}=\frac{(11.98)+6}{2} \times 5.2
\end{array}
$$

$$
17.98
$$

$2 M_{\text {rapesion }}=2\left[\frac{17.98}{2} \times 5.2\right]=93.5$

$$
=\Rightarrow=93.5
$$

$$
\begin{array}{r}
93.5 \\
237 \\
654.5
\end{array}
$$

Value of presm $=6.54 .5 \mathrm{~cm}^{3}$.

## APPMRDIX 6

Reports by pupils, teachers, employers, etc. on the text 'Aporentice Maths'

EVALUATION OF THE BOOK "APPRENTICE MATHS"
Name ... horns.. Auth bl..........
occupation ...Pupil...................
(egg. pupil, teacher, student, training officer etc.)

Please comment on the book under the following headings:-

1. Actual use of the book and the situation:(egg. 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.
10. For revision for C.S.E examinations and basics:
11. This y are easy to neal and with the help if the dicuigrows encible a better widerstaniehing of the topic
12. They are very hipotul as thees certify joist how mich if a iericuin topic you know and how much you must revise, in which rrealand to wheat depth in order to fully undsistiond the topic.:
13. I thick that 5-10 questions are enough to cariffy whether you know a subject or not and when the first jew questions are ecusy and they, get harder, as they do in this bork, they show you just how much you have revised and liount the weak. If you gat ail of the equations, right it is apvaianted that gur fully knows the topi and have uirderstasd it ail
14. The practical applications were alight thotigh I tended to stevie more witt He practise exercises when I couldin't do the ciff-ouseient lasts
15. I think that the beok could do sor rith some expernations of Tirrizes gropho and their gradients and specific Grevity cind donsity
16. For compaizoon itilezd 'matteratics Thee' this like 'Apprenteciactip maths go into much ietail of a topie. Untortimedich in "Mcittranctecs Thues' if you find you a st of the questions in te frist fos exuercizos. wrions and heve to revise them through its help of be back, it appicin to be a long techious wuy for yen are contunted by a page of oodit -reting
$=$ where as in 'Appresticesthip maths' there is not so inch writing ond $\forall$. explanetion is helped by excunples anel ticigionno.
17. I con't sally improve $\forall \mathrm{H}$ boote anly by aikling a few more suifjects arel topies and a fow inore specumen papers.
18. Ifeund 'Apprenticestip Meiths' viry helptel and hape 1 have liamt enought to succaed in my rearing eximenections.
-..

EVALUATION OP THE BOOK "APPRENTICE MATHS"


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.
10. Revision of Matharistios
11. The quality of explanation is excellent beccuac no-ine else needs to explain it.
12. The self assessment teats sher the ports where eussesiment teviskin is needed. 4. The exercises start easy curd providraly yeunve reck the pessiage on the exarch to ye yo i shoridid bo s. The to do the more difficult scans.
escercises which Appliketions Exccercuse are when dang an apprentice rises probable to erocounter
13. Lergtables should be enclueded to if nice it an mure cinuilete boride.

EVALUATION OF THE BOOK "APPRENTICE MATHS"
Name $:$ O.....dndge........
(egg. 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.)
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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 an waving the boots at the inowent to he Ip e pass winy arpentishig math test Dor in sib \& I am pleased to say it helped me poss. Ti bootes s very different in the explanation ecemse thy give you a test it the keginng it el section and if you com pass it you con lewes sechon, but - - you don't you cir go trough The explaming of the arithmathe in so es easy d ill the different escomplses are given.
(3) The pelf-assemment tests re e help haul io th way that thy tell you wheat you can go on on work through 16 section.
(4) The exercises are helphat because they put al the different ways of doing il sums ir differ eocerciss e.g. Coaction in instead op putties multiplier $=$ will have four seperate exercises one exercise by (5) T6 practical aplications ane geod because il drawings thy show you will crop up in th actua job cns yer will recognise it $\Rightarrow$ instead of post remembering some iglims" it in boob.
o. There are enough topics is the book fill to cope wilt every inspect of Craft Appentichiges ind Hat is all we weed.
O) Thy are much better then ot tr bodes boo normal bootes tend to tench you "parrot fashion you do whit lily do, but with this book thy to in escomple and the thunterng is. Left up te you
( There are wo suggestions for improving the te obviously th authors have sat down and itiought :bort th book and it would be wrong to crit "Hew. besarde ty hasa done a good job
(9) I would jest like to thank. He cuthours.
it It has helped me a lot ind vertu got we a job. I would. like to see the book in trodveed into the class and wot yo

EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name MARK EARNSHAW
Occupation . $47 H$. YEAR. OLEVEL STUDENT.
(egg. 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) IUSED THE BOOK FOR REVISION PUKPOSES AND FURTHER PRACTISING OF THEORIES, $\in T$.
(2) I FOUND THE EXPLANATIONS GERORALLY WELL SET OUT LITH EXPLICIT, EASY TO UNDERSTAND DIAGRAMS. ONE PARTCULARLY GOOD POINT WAS THAT THEY WERENT CLUTTERED UP WITH USELESS DImerosions, ADIS AND CHOROS ER WHICH HAVENOTHING P DO WITH THAT PARTICULAR QUESTION.
(3) I DIPN'T DO MANUY SELFASSESSMENT TESTS BUI THE FEW THAT I DIDI FOUND VERY HELPFUL - A GOOD MEASURE OF EXACTLY WHAT I KNEW + WHf I HAD TO REVS MORE THOROUGHLY.
(4) In THE ExERCISES I THOUGHT THE QUANTITY WAS AMPLE BUT THE QUALITY FATLY POOR AWD MOROOTONOUS. I FOUND THAT In SOME AREAS (EGG. LOGARITHMS) THERE WERE TWO MARTY QUESTIONS ABOUT ONE AREA (E.GTUR NUMBERS INTO LOGS AND VICE VERSAJNOT ONLY DID I THINK THAT AFTER A WHILE THEY WERE BORING BUT / ALSO THINK ON TH WHOLE MANY OF THE QUESTING WERE QUITE EASY AND SOME OF THE SPACE, INSTEAD OF REPETITION OF SAY ADDITION OH LOGARITHMS, SHOULD HAVE BEEN DEVOTED MORE ADVENTUROUS EQUATIONS.
(5) I FOUND THE PRACTICAL APPLICATIONS UKR HELPFUL INDEED AND ALTHOUGH I SOMETI UNDERSTOOD THE TOPIC, WITHOUT THE WEES OF THE APPLCATION; I STILL FOUND THEM VERY USEFUL IN CLARIFYING CERTAIN POINTS.
(6) THOUGHT THAT THE BOOK WAS VERY WELL PLANNED WITH AN EXCELLENT VARETY OF SUBJECTS. THESE ... SUBJECTS WERE WELL EXPLAINED ALTHOUGH, AS I HAVE. SAID. BEFORE, I WOULD HAVE: WKED TO HAVE. SEEN THE INCLUSION OF A FEW. MORE TESTING QUESTIONS.
(7) AT THE MOMENT. I AM STIDYING FOR My. O-LEVELS. ANDI AM USING A MATHEMATICS THREE BY. L. HARWOON ClARICE. I HAVE BEEN USING THE APPRENTKE . MATHS BOOK AS SUPPLEMENTHR WORK ATP IT HAS SERVED. THAT PURPOSE VERY WELL. HOWEVER, I FOUND THE APPRENTICE MATHS BOOK AS GOON IF NOT IN SOME $\therefore$ CASES. BETTER THAN OUR PRESENT...TEDET BOOK SIMPLY BECAUSE GE THE ... EXCELLENT... EXPLANATIONS WHICH.... WERE. GIVEN. SPECIFICALLY ANA NOT. "DECORATED" WITH FANCY PHRASES. II NOT... SAYING THIS... BOOK OUGHT. TO. REPLACE... OUR TEXT BOOK AS SOME AREAS. ARE. IRRGEVENT: (EGG. CONOSTRUCTOWS D . MOST. PUPILS...UNLESS... THEY DESIRE TO BECOME AN APPRENTICE, BUT: SINDCEKLY FEEL THAT IT SHOULD DE USER AT TIMES IN CONJUNCTION WITH OUR PRESENT TaCT BOOK.
(8) APART - FROM - BOME SLIGHTLY MORG MOUANOCE MATHS 1 - CANT THINK OF ANYTHING THAT WOULD IMPROVE THE BOON IT HAS, IN MY. OPINION,

BEEN WELL PLANNED AND SET OU COVERS. ALL ASPECT NEEDED FORA GOOD KNOWLOGE OF MATH AND 10OMLD-BE A DEFINTE BOOST FOR
(9) ANYONE SURV ING ESE S. OR O-LEV

ITHINK...THE BOOK. IS A. REAL EYE - OPENER TO THE WORK THAT A APPRENTICE HAS TO DO. IT SUPBISEL ME AND IT SURE THAT SOME STUDENTS MUST HAVE A NASTY SHOCK . WHEN THEY DISCOVER IT AMOUNT OF MATHIS NEEDED. FOR ENGINEERING APPRENTICE. I MUST AD I I THOUGHT AN APPRENTKESHIP WAS AN EASY BACK WAY OUT. IF YOU W UNSUCCESFU. AT SCHOOL AND. LIKED GETTING YOUR HANDS OILY!

ONE HING I THINK WO BE A GOOD IPEA wOULD BETO INTRODUCE THIS BOOK AT THIRD YEA LEVEL WHEN PUPILS ARE TAKING OPTION. CHOICES.I. THINK THIS WO U SHOW ... THE.. THE YEARS WHAT. WAS NEED ED - FOR AN APPRENTICESHIP, PRC AN INCENTIVE TO LORIE AND PREVENT DISSAPOINTMEN WHEN THEY FIND THU AFTER MESSING ABOUT IN LESSONS They REQuire that subject For APPRENTICESH1P. THe ONLY PROBLEN W BE THAT THE STANDARD MIGHT T A LITRE TOO HIGH. BUT ONCE AGAIN I THINK IT WOULD JUST PU

John . Hall.

Electrician:
Use of Apprentice maths books.
I have used this book for trigonometry because. I could not. determine which sign of trig. to use eg tan, cosisin, but now I have vied the book I find it ecisy. it helped me by taking an example and putting it into an imegoinable situation. the book also takes an example shows you aa by says. to do it. They call it He Apprentice. matts book because all the problems included in He beck could be needed .........en you go in for your - apprenticeship.-

General malls
1 think lis beentought racsonably through my primary school and some of te secondary school. until. I weis put into an ordinary level tending grasp which, I found to hand to cope With and I started to fall behind a bit, after a. few montlis... l. was se for behind. That I. was moved to a lases group. This group. I a... in know is just about right for pace curd. stretchers He wind a bit which is goad, I think.

Sone teachers dont teach you amy because they carnot gain-... the alton of the pupils because they ara not strict enoegh or intereshing but on He other hand some teachers are toe strict and do not allow you talk amoing friends and if you...con caught you get spit out erich, you lose vile education. I suggest tore practical test should be br into maths lessons such as meth given solids accurately using trig and pythagaras act.

John Hall 5 yr pupil.

EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name
Steven Neater?
occupation .... Pcrupur.
(egg. 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 bechis very creed bor reunion from and reference to.
(2) The explanations are easy to read and very leary tocenderstand
3.) These teds are help hel bo ind catt wencet yea are net- coco al:
4) There ara nleply of onyestuons bed I have not encecontered one which $I$ cannoldo.
(5) The practices apluicahons are interesterna
and helical
4. I have not studied this bot through ca To I can not give con accunale answer. bet I ware feand the scene the beoh covers aduonical
$\rightarrow$ This boot is far better than any other we bot at esiplaining moblems.and their answer The tocamnlesare easier to toll a
3) I do not thing the boot can be improved riuch more.
4. My only comment concems the coupe, its. self The coarse scald hare been started at an edith time, I Limb it should hare been starteo no tie beeping of the lith year.

EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name $\qquad$
Occupation . PUPIL......................
(egg. 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.
10. I found she book very useful especially before I went to interviews. The night ind morning if fore I went I had a godel look at che book. This helped me a lore especially at she lias Boniel Tess
11. The explanations ire very easy 50 read and simple so understand.
12. Yes. They save a lot of tine doing things which fou alreachy know.
13. The exercises are not cases bis they ane
not everso hard. One good 8 idea in the bock the practical exercisin. Ihiy ahow how and whire ith inatith ive needid and Socld bie usid.
14. As I have saici absve chery thilp a tiot
15. I canner chink f any things shate need adde or cony that should be fakin ouv
16. The beck fear exeallos any ocher C.S.E. exc inction bock.
17. —
Q. -

EVALUATION OF THE BOOK "APPRENTICE MATHS"
Name . Simon .Robinson..........
Occupation
(egg. pupil, teacher,

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 Treganometry.
2 The explanations were dear and presiese are strait forernard and do not waffle.
3 The selfartes mint tests are not particularly helpful as a pupil could tell howell how well he/she is doing in a subject from the exercises.
4 The number of questions was
5 the practical aplicationsave interesting and would come in be geod practice for
anyone doing engineng.
6 The scope oftlu book is geed but 1 think that common fractions and Decimal fractions shored be putunaler the same hooch
7 Fits beak bi very go "his book is clearer than my text book "Mabhanvaties the by Clarke which misses out steps jumps around and in places is very obscure. My Est took ill for example give the method that you could use if you already knew how to 20 the equation (see quadratic equations $\mathcal{P}_{1}$ 13) but deciciol io find a new way to do it. Mu apprenien maths on the rather bevel elvers? clear conses ways to solve the equation.
8 lam not in a pogethor to suggest shan in the book as 1 belive it' is the employed job to do that
(c) 1980

EVALUATION OF THE BOOK "APPRENTICE MATHS"

occupation PupiL
(egg. 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) reizsion for exanis at school and at home
2) Quality of bock in excellent explanations are clear to understand and plenty to kern from
3) Very helpful then you don't waste time reizteing a section that you know.
4 The quantitif if questions are very good and the degree af diftuclty is goad, as the harder the the snore you learn
4) The book is helphut and interesting as the diag are clear and is a pleasant book to workfien
5) No topics si The only topic to be onmited should be the modern maths. As mordern math such as sets are no good to anybody whit
Tit they were not included in the syllables other important topics could be taught
7 The book compared with otherlext books is excellent as the dhagrans and excmuplis are plea ul.

8 $\qquad$
9 Excellent book to work Prem.

## EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name NAy. en. . Rhetoric
Occupation. PK P\%.
(egg. 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?) or any omitted?)
6. Please make any comparisons with other CSE/basic maths text books.
7. Any suggestions for improving the book.
8. Any other comments.

1, Revision.
2, yes, thin ane.
3, yes, Beanuse yon dent have is goa through the exercise for nothing.
4, wot really dessicut because the examples help wet.
5, yes, the berk is becpioi we and intesiang because its not ion cask and not to hard.
4, sone.
TIn er bask meths burks there are etcher oe many exarppies
 so you dent understand the question.

Manpower Services Commission, Training Services Division, Tilsthorpe Road, Long Baton, Nottingham NG10 3HH

EVALUATION OF THE BOOK 'APPRENTICE MATES'
DAME: liR J. 3ASSEMT
OCCUPATION: EDUCATION IISTRUUTOR, LONG EATON SKILICETRE

1. Revision of basic arithmetic plus geometry, trizonometry and al zebra 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. Selpful and interesting.
6. Adequate.
7. Compares well with existing Skilleentre 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 13/19.

Ref: Page 14. Suggest inclusion of explanation that $\frac{\frac{1}{4}}{2 / 3}$ is the same as $\frac{1}{4} \div 2 / 3$
9. I consider that 'Apprentice Matis'Brings to fruition very well the intentions stated in the preface.

J. Basset IOIII

Education Section
19 May 1980

## Training Services Agency

SXILLCEATRE Wilsthorpe Road

Ir J. Gatenby
30 Chestnut Grove Btwall
Derby

Our ref
WG/MG/Lon/80
2 June 1930

Dear iif Gatenby
Thank you for your letter of 12 th ihay 1980. I apologise for not replying earlier but I have just returned to work today after being on leave.

Inclosed heremith is the observations of the book submitted by :ir J. Bassett, Education Instructor.

I have discussed with Hr 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 a:rare 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

'7. Gordon Deputy Manager


$$
22 \cdot 5 \cdot 80 .
$$

## EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name J.M. SMITH
Occupation SupT. AriRQUTCE RRTINING
(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 interfew, 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 applicationa (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.

Tris book has been used as a teaching aid for Crart ipprentices who are experiencing dinficulty with calculations in the wor'shop or naths at the Coilege of rurther Education.
It inas reen used as an aid to enable the apprentice to overcone his own difiicuities. I cannot coumert on the value of the various sections of the coon, otier than to say, its comprenensive cover nas catered for all our problems ard the success achieved led us to purchase a second copy when the other was temporarily misiaid.

The apprentices who have used the book speak very highly of it.

Please continue on the other side if necessary


92 Darky Abbey Dune Derby
8 Aport 80
Dear Mr. Gateruby,
Lading through my correspondence, I find a point in your last letter which I haren't responded to, namely a review of "Apprentice Mattes".

The anick answer is that I'm not in a position to review the book myself because I just don't have dealings witt youngsters in my work ~ all my lads are graduates or mature draughtsmen Because of the natter odd way $B R$ is organised I can't suggest a colleague either. But perhaps you've famed what you naut elsewhere.

Meanwhile I've shown the book to a number of people in industry \& Rachers of matts, and I find
their remarks. show a Cot about their bachgrounds.

Here are same specimens:
Remark
$\Rightarrow$ Teacher: ny comment reply.

Sone operations are nell explained in wands \& clear diagrams, but otters erg. diusion of fiadions, are just stated.
Teacher:
Is $0.64 \mathrm{~g}^{\prime \prime}$ a realistic degree of precision?
Is long division still needed, except, What do yon as a amish approx. to check calculator? ? $\left\{\begin{array}{l}\text { when your } \\ \text { calculator has } \\ \text { flushed }\end{array}\right.$
Do people stir use logarithms? calculator has
Engineer:
Fluent mix of mints is expected still. used s.I. (a abroad) \& Inv
BUT yowl never si tyre prossimes in Pa - O $p . s, i \quad \approx \mathrm{kgf} / \mathrm{cm}^{2}\left(u_{g}\right.$
Teacher \& Engineer:
A chill mil need a teacher or mentor to bridge the concise of presentation of most topics.
Ereyone: Well done!
yous sincerely
Dand Halfpenny

Mr. Cullen. Teacher of Engineeting Seiznce/Berabierk 392 Former evapt appentive and sizilld inafliman.
PPRENTICE MATHS EvALUATION.

In general the book was found most helpful $n$ the Enijineeming Deverice course run in the schoal. Its min we heivy in nemedial help, for cowen alirlity pupils and as an cind to help pupils when in difficultion on when they howe speifir differcultion fin escample Bractum and decimal points.

The main areas of tte loach 9 found mast usefull were the foitcoun, Algetra P.109, Aneas, Vialumes. Bquantes and square roits, Poumen and inchcis. I acturatly lased a Lesan on Valume usin the loak, which proved to he veng successful as an aid to leanning the prineiptis and colculatios invilued. The feedlrack from wodivichal pupit, who used the lozik when in difficull was escellent, with a high sucoess rite in orencomin these prolioms and difficultio. The self assessment testi in the look ane an erecellent idea, and help gine mone confirdence to pupid using the loak.

In general os thinh thai lratz is on escellent aid to pupib, takuig Enijuncenn Daince and filts a need for pupich and teachens as a neforesher in maths nelerzant to a lechnuical rutjert.

Ruggestimin fro improvement ane:
a) mane specifir/ditrided conterti talile

1) An index at end if the Lorik.
c) Inclusin of mone proctical applic $K$ Cullen.
Engineering Science Teacher.
the Merrill Schoul DERBY.

Footnote
Ihe stont sectin on 9inverss propentin with the vessomples on fulleirs and gecum 9 found veny helpful and conld 9 feall esplinded.

## EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name . MR... K...! $1 / 1$ TE.
occupation .....Tens ce t.
(egg. pupil, teacher, student, training officer etc.)
Please comment on the book under the following headings:-

1. Actual use of the book and the situation:(egg. 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
3. The self-assessment tests - are they helpful?
4. The exercises (the quantity of questions and level of difficulty.)
5. The practical application a (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.
10. Teaching of fractions - revision of C.S.E topics. Revision for interview for British Rail.
11. Eeplomations are exceptionally well laid. ont, easy to follow and understand.
12. If one follows each chapter, then the seef-arsersment lasts are very useful as they give a good indication e of Rove your have understood the work.
13. See question 2 .
5.. Tor those pupils who are actually involved in apprentice mathematics the practical applications are Delplul: and interesting.
14. Quite adequate as an apprentice maths Lext-book.
15. Obviously, this book as a e.s.E text book, is inadequate, there are not enough topics covered.' If the books scope. was broadened to.
encompass a more comprehensive range of material then the single explicit' fundamentals would rake this in excellent e.s.E. handbook.
16. As an apprentice maths; book no: but. as a CSE book -see 7 above.
17. Nome.

EVALUATION OF THE BOOK "APPRENTICE MATHS"

Name R.F. Jentingern...... Mr). occupation ....T.ersches.......... (egg. 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?)
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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.

V CSE. revision treihnical Drawing source book.
Well laid out pages not too much on each page. Clear and concise explanations. Mast useful having voted. examples and then a Fiver amount of questions for the children. - Explanations are to teachers rive not the Thing for books to attempt at great length, as some do, especially as we ape largely
dealing with less atbe childfen to whorre lengthy verbage is a waste of time.
(3)

Os we use diagnotic maltrs tosts I alrendy tnow what to childian can and cant do., so whan f. knew thut nat of tho childien couldet cos any of tho assessriant questions [ie Fraction]. I' used the asessmant lest ofter covening to work in to book. illy porils were not capatle of using tho tests in tho matute way requirod for self ossessriant.
(4) The nuriber and. level fy deffavity of the question wios about right. Is used tho book witcally, and thon backed this up weth undurdeal strats to settisty indiuvderal areers of diffrilty. a secteon in tho book for hiis?
(5) These satisfy a lomg fert nood. Nol-habing a trechnial bactgroend it duas diffiult forne to Whirk up examps. semey the mose cechnical exampler usore rattor hard to undortitid, y one har not had an engieering back groind.
(6)(7) whth - $C 5 E$.... anthratic, there are certecin thurgs on he syingois not covefed in ypert bo... boit whinst is apprecinte your bootris sot ouriod at tris sfllabis sreofrciolly rraigbe asports of

- grapis - distana/tinse, onverzen, fic.
- Money - costring, selarizs bills, itp visurarico.
- Qvieragos.
- Comprad, sumpe vitacosk
- Esalr dravina
- inctive mondits.
uncide be usefiol to cover.
Coud you winis a bode for cise anchrnctis ving your present fermat os evary otlor ldserias aviiod' for cSE chathenatics is maritabe for tho bss atbe clueto carined prosortiotion, teomen explanation ten few excamplos,
 geod idear are too crampal whting is. Noo singul, cend - exariples afse 100 fice.

3) Protuce a non anvujer beok.
... ( $\because$ unpluation for assesment tostrs)
(9) Overall the books a useful bridge. baton theory t practical application in that mr loss able per soc why the i most boom contemn stills., rather Gan Gowning. Lechniau in ... obstruction.


En Bon Espoyr

QUEEN ELIZABETH'S GRAMMAR SCHOOL
ASHBOURNE DERBYSHIRE DEG $1 E P$
TELEPHONE 3685/6/7
HEADMASTER: J. BROCKLEHURST, MA. (CANTAB) 10* tare 1980 .

Dear $M=$ Cratuby. Shareyou on your letter. I
regret $F$ and not sase you book as $F$ could not offend to buy it out of ing school allowance


EVALUATION OF THE BOOR "APPRENTICE MATHS"

occupation ....tache................ (egg. 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 bork. It can ceiturny be seed for recisim purposes fo extine CSE ar tests fujibs, although it obviably only lives some abas of CSE work. I amide imagine it mood be diffenit to find a better book fo use by cyprentices to give them a good basic knowledge.
2. The explanation and worked examples we very good, cetminly a great improvement on most maths textbooks.
3. They seem to hove value eike to encourage a student who has. drive well or as am. indication that further efforts are required. They also woke it possible to take shout cuts - hus ant work which is aready aclequatey understood.
4. Thate seim to be ample exerciies Sone ci) than do sean to be a bic chffrcult, especially at the end of chapies, but Ho inve than an appentics hould presumably hare tocupe untin.
5. Fum limited experience of the neeas of enginecring I wolld imagine treen to be vey helptul indend. The diagrams are ceruinendcike for their clarity:
6. Sonnciverk an changing units and expoessing e.g. 3min cin coned peitais be wactul. I'm swe Kod has a better iclea of tre reeas of apperitices thon 1 have. At first inandied ung algebra wies imeluded, but the exeraies at the and made that cleaer.
7. Theiace many CSE test books, but it is very cliftemer to finid, one ulvich containg goved explanatias as ell al sufficient execases stere tends to be ira or the cther, but not both. I have wir Siin ding CSE text whin cild be wed by a pupil on his inn as wed as this one canta be, altroigh its asage is ctriondy iimitial to certain creas of unost CSE sylleruses.
8. Possibly affin nure novked -exauples for the practical applicatias exeraice. which sone pupils may find cHputting ferihes

Requtiered Offkey
P.O. Box No. 18, Falcon Works,

Loughborough, Leicestershire LE 11 i HI

Telephone Loughborough (0509) 63131 Telex 341091
Telegrams Brush Loughboro Telex

Extension 357

Your ref
Our ref DVB/TMC
Date: 2 October 1 !ns

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 -uggested that tho first year Training Centre obtains a copy to use as a 1 when problems oct ut,

Hoping this information will be of use.
Yours sincerely


## D V Bushel

Training Officer

## The Rectory

## Markfield

Leicester
LE OWE

Dear Mr. Bond,
I have been using Apprentice laths for some time now with a group o:
men in a Basic Maths class and have found it to be fiery versatile.
It is a good revision book for those men who have had some laths
hackarcund, hut have not used the ir maths for some years, They first tit. then


I: : wo also found the tex. nd examples of methods to be very: : setup fir the less a. le men, who have roust the examples easy ic follow and hel: fut to wis either to refresh or reinforce lass teaching.

The problems which are set in each section are relevant and easily arils? so everyday life and therefore appeal to the slightly older student.
 moving faith similar groups.
Ours faithfully,
Kilo hint-

Mr. R.M. Bond. 11 Langdale Avenue, Loughborough. Leics.

Your Ref
Oit Rnf TP/RLC

Date 23rd September 1980
Telephone
Contact
Exi

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 classrom.

Proud to have been associated with the project and wish the publication every success.

Yours sjncerely
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.
$6 \frac{2+4-3}{8}$ instead of $6+\frac{2+4-3}{8}$ 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 1.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 "Appreñtice 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 a 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 sometines 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 sumbols could confuse 1.e. $+2-+3$ some of our texts have this double use but lift the opposifion 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 $=5: 00 \mathrm{PM}$ 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 pages152-157
2. 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."
3. Writing style - excellent - very clear and understandable - The examples are good and sufficient. In many, many cases theic presentaions are the best I have seen in any text. Some of their methods I have incorporated in my methods and techniques of teaching.
4. I worked various problems and excercises 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.
5. See my Chapter Reviews.
6. This could be done with minimal changes I have noted in Chapter Review for Preface, Money, Time, Trapezium, Decimal/Multiplication Bymbolism, Standard Form and Scientific Notation, etc. None for Machinery or devices.
7. 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 excercises - good and plenty (not candy.) to challenge all students from all vocations
d) Miscellaneous examples - 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 ase 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.
8. 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.
9. Just the uinimal changes $I$ have listed in the Chbpter Review and Questions 1, 4 and 5 above. I would feel the book would be outstandine and should catch on in our Market.

Ms. Judy Green
Page 2
March 21, 1980
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.,. $\therefore$ (tve), (-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.


Duane M. Gowing
Dean of Academic Affairs
DMG/vm

## APPENDIX 7

"Education and Mmployment"
Report by the Association
of British Chembers of Commerce, 1972.

## METRICATION

One of the most troublesome questions in recent years has been metrication. 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 Metrication 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 metrication, 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 metrication programme without delay, so that duplication of this nature will become unnecessary in the near future."

## MANAGER.

(The Walsall Chamber runs an Engineering and Training Centre).

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
$10,100^{\prime} \mathrm{s}, 1000^{\prime} \mathrm{s}$
simple addition - subtraction
b) Reading a rule.

Fractions.
$1 / 64,1 / 32,1 / 16,1 / 8,1 / 4$.
Conversion of fractions to decimals.
$1 / 8$ to $0.125 \quad 1 / 4$ to $0.25 \quad 1 / 2$ 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.

Firm Answer to Q1
A Yes, with some applicants for apprenticeship.

B Selection method screens out applicants without the necessary skills.

C Of 12 applicants aged 16-17 for Lab.Assistant, only one even knew what a percentage was!

D Yes. All those with mathematical ability. already "creamed" off to Polytechnics, etc.

E No. Those requiring maths skills suitably qualified.

F Yes. In certain cases this has happened.

G No. I suspect we might meet this problem if numbers of applicants for positions precluded strict screening at initial letter stage.

Answer to Q2
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.

No evidence to suggest this. Our experience suggests that the problem has been greatly exaggerated.

No.

Applies in some cases.

No. Selection technique ensures trainees have necessary maths qualifications.

No. We only recruit apprentices/trainees who have achieved the necessary qualifications one of which is mathematics. (Usually at GCE ' 0 ' level).

No. Occasionally an apprentice has difficulty with academic areas of study but no failures to date:

H No. General standard of education tends to be unimpressive.

I Yes.

J No.
$K \quad$ 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.

0 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.

No.
No. We do not employ those who will obviously fail.

No. Selection methods tend to prevent this happening.

Yes. As in 1.

No.
都

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
Age at entry - 16 years
Maximum score obtainable - 50

| Year | Group ' A ' (40-50 score) | $\begin{gathered} \text { Group 'B' } \\ (30-39 \text { score }) \end{gathered}$ | $\begin{gathered} \text { Group 'C' } \\ (20-29 \text { score }) \end{gathered}$ | Not up to Standard |
| :---: | :---: | :---: | :---: | :---: |
|  | \% of Total Tested | \% of Total Tested | \% of Total Tested | \% of Total Tested |
| 1967 | 4.00 | 13.33 | 53.33 | 29.34 |
| 1972 | - | 8.26 | 54.13 | 37.61 |
| 1977 | - | 1.63 | 37.96 | 60.41 |

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 out 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.

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

## Actual findings Percentages of 112.

1. Do you employ school leavers who do not possess ' 0 ' level or CSE Grades 1, 2, 3?

| Yes | 63 | $56.2 .5 \%$ |
| :--- | ---: | ---: |
| No | 47 | $42.07 \%$ |
| Sometimes | 1 | $0.89 \%$ |
| n/a | 1 | $0.89 \%$ |

2. Overall do you employ

| less than 20 | persons? | 30 | $26.78 \%$ |  |
| :--- | :---: | ---: | ---: | ---: |
| $20-50$ | $"$ | $?$ | 32 | $28.57 \%$ |
| $50-100$ | $"$ | $?$ | 6 | $5.36 \%$ |
| over 100 | $"$ | $?$ | 43 | $38.40 \%$ |
| n/a |  |  | 1 | $0.89 \%$ |

3. Do you set prospective employees a mathematical or arithmetical test?

| Yes | 21 | $18.79 \%$ |
| :--- | ---: | ---: |
| No | 85 | $75.09 \%$ |
| Sometimes | 1 | $0.89 \%$ |
| n/a | 5 | $4.46 \%$ |

4. Do you attach significance to a prospective employee holding a CSE Grade 4, 5, 6 in mathematics?

| Yes | 51 | $45.53 \%$ |
| :--- | ---: | ---: |
| No | 52 | $46.43 \%$ |
| Sometimes | 7 | $6.25 \%$ |
| n/a | 2 | $1.28 \%$ |

5. Do you disregard CSE?

| Yes | 15 | $13.39 \%$ |
| :--- | :--- | :--- |
| No | 48 | $42.85 \%$ |
| n/a | 49 | $43.75 \%$ |

6. If it were proposed to introduce a l6t 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 $6 ?$ | 49 | $43.75 \%$ |
| :--- | :--- | :--- |
| as helpful as  <br> CSE grades 4,5 or $6 ?$ 7 |  |  |
| less helpful than $6.25 \%$ <br> CSE grades 4,5 or $6 ?$ 3 |  |  |
| n/a | 53 | $2.68 \%$ |

7. Do you have any objective evidence about arithmetical standards of school leavers?

| Yes | 29 |  |
| :--- | :--- | :--- |
| No | 36 |  |
| n/a | 47 |  |

8. If your answer to question 7 was 'Yes', does this evidence suggest that arithmetical standards have

| risen | 0 | $.0 \%$ |
| :--- | ---: | ---: |
| remained the same | 2 | $6.89 \%$ |
| fallen | 27 | $93.10 \%$ |

Analysis of the 63 replies of those who answered 'Yes' to Question 1 are as follows - i.e. who employ school leavers without ' 0 ' level/CSE grades 1,2 or 3.

Actual Findings
Percentages of 63
5A. Do you disregard CSE?

| Yes | 17 | $26.98 \%$ |  |
| :--- | ---: | ---: | ---: |
| No | 41 | $65.07 \%$ |  |
| Sometimes | 1 | $1.58 \%$ |  |
| n/a | 4 |  | $6.30 \%$ |

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 corments on attitude and attendance, when assessing an applicant, would this be
more helpful than
CSE grades 4,5 or 6 ? $42 \quad 66.66 \%$
as helpful as
CSE grades 4,5 or $6 ? 8$ 8 12.69\%
less helpful than
CSE grades 4, 5 or 6 ? 3 . $4.76 \%$
n/a $10 \quad 15.87 \%$
7A. Do you have any objective evidence about arithoetical standards of schocl 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 | $57.14 \%$ |



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 $8 \times 7$ ?" 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) '0' 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."

Aprrentice Maihs Lome Powell

$1 \frac{1}{3}+\frac{1}{8}=\frac{8+3}{24}=\underline{\underline{11}}$
2. $\frac{1}{16}+\frac{1}{2} \cdot-\frac{1}{32}=\frac{2+16-1}{-32}=\underline{\underline{\frac{17}{32}}}$
3. $1 \frac{1}{4}+3 \frac{1}{5}=4 \frac{5+4}{20}=4 \frac{9}{20}$
4. $1 \frac{2}{3}+1 \frac{1}{5}=2 \frac{10+3}{15}=\underline{\frac{13}{15}}$
s. $3 \frac{1}{2}-2 \frac{5}{16}=\frac{8-5}{16}=\frac{-3}{16}$

6: $2 \frac{1}{4}+3 \frac{1}{2}-1 \frac{1}{3}=4 \frac{3+6-4}{12}=4 \frac{5}{12}$
$7 \quad 7 \frac{1}{5}-3 \frac{1}{4}+2=6 \frac{4-5}{20}=6 \frac{9-1}{20}=\frac{14}{20}$
$86 \frac{1}{8}+2 \frac{1}{16}-3 \frac{13}{32}=5 \frac{14+2 \cdot-13}{32}$
$=5-7=4 \frac{25}{32}$
$1 \frac{1}{3} \times \frac{1}{4}=\frac{4+3}{12}=\frac{11}{12}$
19. $9 \frac{1}{8}+3 \frac{1}{2}+2 \frac{1}{4}$

$$
\begin{aligned}
& 8+32+24 \\
& 14+\frac{1+2+2}{8}=14 \frac{7}{8}
\end{aligned}
$$

20. $2 \frac{1}{5}+1 \frac{1}{3}$

$$
\frac{2 \frac{1}{5}+1 \frac{1}{3}}{3+5}=-\frac{815}{15}
$$

21: $8 \frac{1}{7}-6 \div 10$

$$
2 \frac{10+7}{70}=2 \frac{17}{70} \times
$$

22. $3 \frac{7}{16}-2 \frac{7}{5}$

$$
\begin{aligned}
& 1 \cdot \frac{3+14}{16}=1 \frac{17}{16}=2 \frac{1}{16}= \\
& \frac{7^{5} \times \frac{15^{3}}{7}}{5}=3 \\
& 24 \begin{array}{l}
3^{\frac{1}{8}} \times \frac{4}{5} \\
\frac{25}{8_{2}^{\prime}} \times \frac{-4}{8} \\
2
\end{array}
\end{aligned}
$$

$231 \frac{2}{5} \times 2 \frac{1}{7}$

1) 16.8

2) 191.3 $\qquad$ 3) 6.15
b)
3) 2.00000
4) $40 \times 100=40007.2000 \times 0.01=20$. 20
5) $100 \times 20=2000 \times 9) 2000 \div 40=0.080 \times$
q)

$$
\begin{gathered}
\text { a) } c=f 64 \times x \\
f 128=64 \times x \\
.6100 \\
25 \times 128^{16}=x \\
.16 ; \\
200=x
\end{gathered}
$$

Ans $=200$ diells can be. puchoured
c) $C=\{64 \times x$

$$
\begin{aligned}
& \begin{array}{c}
100 \\
f 84 \cdot 48=6^{16} k \times x
\end{array} \\
& \frac{5 \cdot 28}{2-24}+0_{25} \\
& 25 \times 84 \text { - 大i }=x \\
& 168 x \\
& 132=x
\end{aligned}
$$

Ano $=132$ dills can be purctazed

$$
\begin{aligned}
& \text { b) } c=k 64+x x \\
& f 32=6^{16^{100}} \times x \\
& \begin{array}{c}
25 \times 3 \frac{2}{2}=x^{100} \\
16
\end{array} \\
& 50=x
\end{aligned}
$$

Ano: 50 duelle san bu Du-heu-st

$$
\begin{gathered}
\text { d) } c=\{64 \times x \\
100 \\
f 40.32=604 \times x \\
25 \times 40-32=x \\
162 x \\
63=x
\end{gathered}
$$

$A_{n o}=63$ diells con $b:$ puchored

$$
\begin{gathered}
\text { e) } C=\$ 64 \times x \\
100 \\
\$ 49.92=6^{15} 4 \times x \\
25 \times 4.92 .100 .25 \\
16 \times 2 \ldots
\end{gathered}
$$

Ans $=78$ diello can be purchazed


Proactive $8 \times 2$

1


$$
\begin{aligned}
& \sin A=\text { opp }=2=1 \\
& \text { hyp }
\end{aligned}
$$

$\sin A=12^{\circ} 26^{\top}$
2

$$
\text { Tm } \tan B=\text { opp }=1.0 .25
$$

B)
$\ldots 4 \mathrm{~m} \ldots-\tan B=60^{\circ} 39^{\prime}$

Chup 7 Self Aseasement Test 1

1) $+2++3=+2+3=+5(2)+2-+3=+2-3=-1$
2) $-2++3=-2+3=+1 / 4)-2--5=-2+5=+3$
5): $-1-+1=-1-1=-2 \Omega 6)+6--2=+6+2=+8$
3) $-5++4=-5+4=-1 / 8)-3 x-2=+6$
4) $-1 x+12=-12$
5) $-3 \div+1=-3$
$\left.\frac{12}{12} \cdot 11\right)+6 \div+2=+3$
6) $-10 \div-5=+2$

Solf Aseessmant Teat
1). $3 a+2 a+5 a=10 a$
2) $3 x-2 y+2 x+5 y=3 x+2 x-2 y+5 y=5 x+3 y$
3) $z+7 z-2 q+z=9 z-2 q$
4) $p^{2}+2 p-p+4 p^{2}=5 p p^{2}+p$
5) $8 a^{2}-2 a+14 a-a^{2}=12 a+7 a^{2}$
6) $6 a b+7 b a+6 b=13 b a+6 b$
7) $8 x y-9 y+10 y x=18 x y-9 y$
8) $16 x^{3}-14 x^{2}+9 x^{3}-x^{2}=23 x^{3}-15 x^{2}$

$$
\begin{aligned}
& \text { 5. } \begin{array}{l}
75 \\
\pi d
\end{array} 360 \\
& x=75 \times 360 \\
& x=13500 \\
& 157 \\
& x=86^{\circ} \\
& \text { 6) } \frac{21 "}{\pi d} \sim 360 \\
& x=21 \times 360 \\
& 3.42 \times 12 \\
& x=630 \\
& 3.142 \\
& x=210^{\circ} \text {. } \\
& \text { 7: } 70 \times \pi d \\
& \text { 8) } 210^{-} \times \pi d \\
& 70 \times 3.142 \times 50 \\
& 210 \times 3142 \times 28 \\
& \text { 7. } \left.\quad \begin{array}{ll}
760 \\
360
\end{array}\right) \\
& 1099
\end{aligned}
$$

$$
\begin{aligned}
& \begin{array}{l}
36 \\
\text { Chap II SAT 2 }
\end{array} \\
& \text { 3. } A=\pi r^{2} \\
& A=3.142=9.5^{2} \\
& \text { 4) } A=\pi r^{2} \\
& A=3.142 \times 2.25^{2} \\
& A=3.142 \times 90 \\
& A=3.142 \times 5 \\
& A=282780 \text {. } \\
& x=77 \mathrm{~mm}
\end{aligned}
$$


[^0]:    "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."

[^1]:    C.A. $=$ Craft Apprentice
    $\mathrm{R}-\mathrm{R}=$ Rolls-Royce
    Elec. = Electronics

[^2]:    THE DFI TM GAUGE

