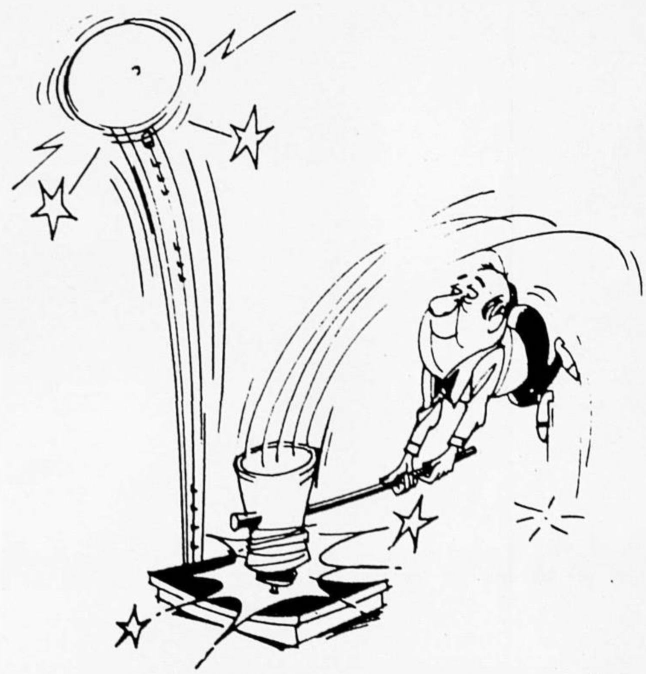
EXTENDED TASKS FOR GCSE MATHEMATICS

A series of modules to support school-based assessment



Improving Mathematical Practice And Classroom Teaching

MIDLAND EXAMINING GROUP

SHELL CENTRE FOR MATHEMATICAL EDUCATION

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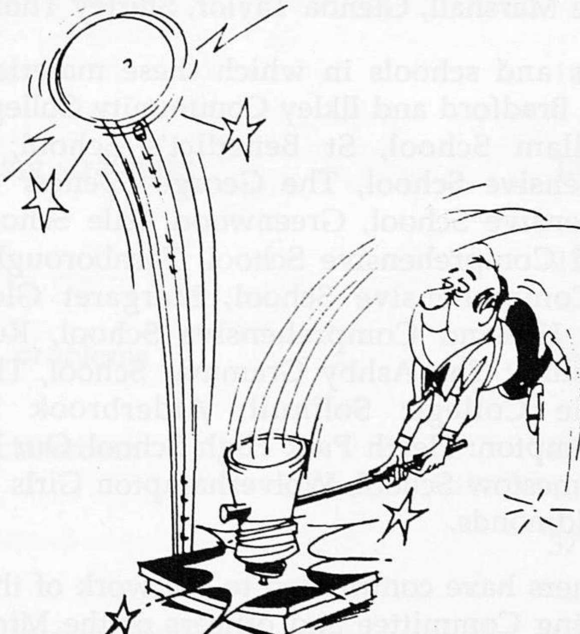
A series of modules to support school-based assessment

Improving
Mathematical
Practice
And
Classroom
Teaching



MIDLAND EXAMINING GROUP

SHELL CENTRE FOR MATHEMATICAL EDUCATION

Authors

This book is one of a series forming a support package for GCSE coursework in mathematics. It has been developed as part of a joint project by the Shell Centre for Mathematical Education and the Midland Examining Group.

The books were written by

Steve Maddern and Rita Crust

working with the Shell Centre team, including Alan Bell, Barbara Binns, Hugh Burkhardt, Rosemary Fraser, John Gillespie, Richard Phillips, Malcolm Swan and Diana Wharmby.

The project was directed by Hugh Burkhardt.

A large number of teachers and their students have contributed to this work through a continuing process of trialling and observation in their classrooms. We are grateful to them all for their help and for their comments. Among the teachers to whom we are particularly indebted for their contributions at various stages of the project are Paul Davison, Ray Downes, John Edwards, Harry Gordon, Peter Jones, Sue Marshall, Glenda Taylor, Shirley Thompson and Trevor Williamson.

The LEAs and schools in which these materials have been developed include Bradford: Bradford and Ilkley Community College; Derbyshire: Friesland School, Kirk Hallam School, St Benedict's School; Nottinghamshire: Becket RC Comprehensive School, The George Spencer Comprehensive School, Chilwell Comprehensive School, Greenwood Dale School, Fairham Community College, Haywood Comprehensive School, Farnborough Comprehensive School, Kirkby Centre Comprehensive School, Margaret Glen Bott Comprehensive School, Matthew Holland Comprehensive School, Rushcliffe Comprehensive School; Leicestershire: The Ashby Grammar School, The Burleigh Community College, Longslade College; Solihull: Alderbrook School, St Peters RC School; Wolverhampton: Heath Park High School, Our Lady and St Chad RC School, Regis School, Smestow School, Wolverhampton Girls High School; and Culford School, Bury St Edmonds.

Many others have contributed to the work of the project, notably the members of the Steering Committee and officers of the Midland Examining Group - Barbara Edmonds, Ian Evans, Geoff Gibb, Paul Lloyd, Ron McLone and Elizabeth Mills.

Jenny Payne has typed the manuscript in its development stages with help from Judith Rowlands and Mark Stocks. The final version has been prepared by Susan Hatfield.

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Long-term Development Programme

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Introductory Notes

These notes outline briefly some ways in which the long-term development programme within this IMPACT package could be used by a Head of Department, Advisory Teacher or, indeed, any other teacher.

This programme of teacher activities is intended to be flexible and to offer support to any department, or small group of teachers within a department, who may wish to review their style of mathematics teaching. An important feature of the prògramme is that there should be interaction between the teachers involved. The teacher activities offered are designed to provoke discussion, thought sharing and mutual support. This is achieved by focussing upon a single teaching/learning issue and inviting participants to share experiences of a relevant classroom activity in order to provoke discussion and reflection. It is essential that any such teacher group should have sufficient time to consider and explore the issues as they feel necessary. Although a provisional ordering of issues is suggested, it may well be beneficial to change the order according to an individual group's needs.

It is important that the teaching/learning issues under discussion should be related to the everyday classroom experiences of the group members. The programme should not be seen, merely, as a set of activities to pursue and discuss in isolation from normal teaching activities. The intention is that, through considering a variety of issues, each teacher and each group should think about how they might broaden their own teaching style, how they might introduce any desirable changes and how they could support each other in sustaining this work.

Within this book student's activities are presented inside the same type of frame as in the cluster books. Each chapter contains a teacher's activity which is presented inside a different type of frame.

The issues raised in each section of the programme should not be considered independently, but rather as facets of a new whole or aspects of a developing new teaching style. For example, when group work is under consideration, teachers ought also to be aware of previously discussed issues such as teacher lust, student autonomy, assessment and teacher roles as well as the points directly involved.

How this programme is used will depend upon the individual group or department. It works well, for example, if tackled on a two week cycle, taking one aspect of the programme as a theme for each two week period. This could then form the basis for informal, or indeed formal discussion within the group, with the teaching experience offered being tried by each teacher with at least one class during the cycle time. The teachers in a group may well decide to adopt a common approach to the teaching experience or to try a variety of alternatives between them. This is also true of different age and ability classes. The programme is not designed to put any additional pressure on teachers regarding preparation, meetings, marking, etc. It provides a long term and relatively slow process of considering and implementing change.

Teachers within a group may like to think of, and devise, a similar teaching experience for each issue based upon a lesson they would normally give within that cycle of time. They may take it in turns to devise these and therefore the workload should not be unnecessarily heavy. They ought also to consider how best they can report back to each other, or how they might keep a record of their development and considerations. They might possibly keep a diary on each issue, or simply jot down a few comments and views about their own teaching every few weeks.

Something which has previously proved popular with teachers trying this type of programme, but may not be appropriate to all groups initially, is the observing of each other's lessons. At first this can seem rather threatening and it may be a while before group members feel at ease with this. However, it is certainly true that teachers who have tried this have continued with the process, and many have gained a great deal, both in personal experience and in the feeling of being part of a team.

In summary, the most important features of the whole programme are

* Working together
* Sharing experiences
* Giving things a go
* Honesty with yourself and with each other
* A willingness to actively review your teaching methods.

The whole programme is designed to be an enjoyable experience. It is not intended to be a burden or chore. Some things may initially turn out disastrously, but that is not a cause for concern - the experience can be built on and is part of progress.

1 *Broadening Teaching Style*

Over the past few years many teachers have been reviewing their approach to mathematics teaching. We are often reluctant to implement change for a wide variety of reasons. Perhaps the most important factor is that we all know that things are likely to go wrong during such periods of change. This is inevitable because everything is new for both the teacher and the students. It is for this reason that it is best to try to develop our new ideas and to implement change at the same time as at least one colleague, or better still, the whole department. The most important aspects therefore are

* Give it a go
* Expect both good and bad reactions
* Accept that some things will go wrong
* Share your experiences, worries, problems and successes with at least one other colleague.

The first two case studies offered in this chapter were written by teachers who have recently reviewed and changed their teaching styles while using the 'Numeracy through Problem Solving' modules, produced by the JMB/Shell Centre Testing Strategic Skills Project; these 'boxes' provide highly supportive materials for teachers and students facing change. The backgrounds, and hence the starting points for change, of these two teachers were considerably different in relation to school type, experience and previous teaching style.

The third case study was written by a teacher who has recently broadened her teaching style while using, amongst other things, the trial materials produced for this project.

The fourth case study relates to a very different type of situation. It describes the problems in one particular college of further education and offers some solutions to those who wish to use these materials with more mature students, who may already have experienced 'failure' as measured in more traditional ways. The case study has been written by one of the project team in cooperation with the staff of the college, who worked closely with the project over a period of eighteen months.

ACTIVITY 1

Broadening Teaching Style

Discussion How do you think working on GCSE extended coursework tasks is likely to affect you in your classroom?

Activity Read the case studies provided.

Write down what appear to you to be significant factors in each case study.

Discussion Identify and discuss any common factors raised by the members of your group and the teachers in the case studies.

Case Study A

"During our first module, Design a Board Game, the pupils and I felt quite unsure of the style of working. The pupil groups initially spent their time arguing or talking about their plans for the weekend! They found it particularly difficult to make criticisms of the games beyond, 'It's boring!' or 'It's stupid!' and obviously felt very lacking in confidence.

I found it very difficult not to intervene and direct their work to begin with. It took me a while to realise that what I intended as open-ended suggestions like 'Have you thought of trying ...?' were simply interpreted by the students as 'Do this!' It was difficult to stand back and allow them to make mistakes or explore blind alleys.

I found I had to simply grit my teeth and survive the noise, arguments and apparent chaos of the first few lessons but gradually we all became much more relaxed and involved in the activities, and things settled down considerably.

The students initially complained that we were not doing 'proper maths' but as they became more involved in the modules and discovered they enjoyed doing the work the complaints became less frequent. Now after four modules I think they are beginning to see that in fact they have developed some very valuable skills through the work and that it may be of more use to them than 'proper maths.'

Using the Numeracy through Problem Solving project has had a significant impact upon my relationship with the class. I feel I know the students much better than I have ever done in an equivalent class and that in many ways they relate to me much more as a friend than as a teacher. I am sure this is because they have taken responsibility for their own learning and have had to make and live with decisions which have affected the whole class.

I have certainly discovered some talents and personal qualities in many of them which would never be revealed in a traditional maths classroom. A below average maths class has been transformed into a very impressive and interesting group of young people - or perhaps they always were?"

Case Study B

"I have been a teacher for 11 years and have always taught traditional Maths in a traditional way. When I was told that I had to use my 3rd year top set as guinea pigs in the Shell/JMB Numeracy through Problem Solving Project I was reluctant. When I looked at the Design a Board Game module my fears seemed real. My first reaction was 'What a waste of time this will be!' The mathematical content seemed minimal and way below the level of the group I was to use it with. Nevertheless I started the module.

The school I am in is in a middle/upper middle class area where most of the parents take a keen interest in their child's education, especially if their child is in the top set. You can imagine how I felt in the first week of the module when parents were telephoning the school, concerned about their child's maths course and I was finding myself having to justify a scheme which I did not believe in myself. As the module progressed I began to change my views. I realised how the module could be used as an introduction to topics which I would have taught anyway, eg, probability, shape recognition and properties, constructions and so on. The children now no longer groaned at the thought of maths homework, in fact they did a lot of work on the project outside of school.

I finally realised the full potential of the project when I returned to normal maths. Previously, I had struggled to get the children to use their own initiative and work things out for themselves. They were brilliant at learning things 'parrot fashion' but they were unable to work out how to answer questions which were slightly different to the examples shown. After the first module I decided to do Pythagoras' Theorem. I put a right angled triangle on the board with measurements and asked them to discover the theorem for themselves. After 10-15 minutes the light began to dawn and every child discovered the theorem. This was the final proof. I still felt that the mathematical content of the module was not difficult for a top set but it had taught the children to think for themselves. *I had become a complete convert.*

The children had gained the confidence they needed. They could now make mistakes and not be demoralised by them. They had realised that it was better to think and make mistakes than not to think at all. In five weeks the module had achieved what I had tried to do for months, unsuccessfully. As the other modules progressed the children and I gained in confidence with this type of work. The final proof of the value of this work was shown when other teachers commented that the children who had been involved in the first cohort coped better and were more confident with their courses than the pupils who had not had this experience. With the first cohort we only gave two classes, a top and a middle set, the experience. We were so pleased with the results and the benefits that the children gained that we have entered the whole of our third year for the second cohort, and so far all teachers concerned have been positive in their reactions towards the benefits to the pupils."

Case Study C

"My most recent teaching experience has been in Scotland where the education system has earned a reputation for employing traditional methods. When I moved to England in September 1987, I came straight into a completely different system of teaching with two fifth year and two fourth year GCSE classes requiring 40% coursework. This was undoubtedly the best way to understand the demands of the GCSE. It also made me aware of what was needed in the lower school as these fifth years had to be reminded of the strategies involved in an investigation.

Although the current fifth year had limited experience of investigations they gradually developed confidence and were certainly not lacking in ideas. I found that when beginning an investigation it was very useful to have brainstorming sessions. In this way the children were able to exchange ideas with each other. It also made them stop and think. This enabled them to establish some kind of strategy rather than rushing ahead without an overall plan. Despite this I found that the children were often not systematic enough in their approach and I had to help them to work in stages. I soon learned that I had to avoid steering the children along my own line of thinking and acquire the habit of allowing the children's own ideas to come forward. This was very stimulating as the children's ideas gave me completely new lines of thought. I also found that it was essential to do the investigations myself in order to envisage the ideas the children were likely to come up with and the problems that they would probably encounter. The role of the teacher in investigative work is that of a guide and I found I spent most of my time discussing the children's work with them and asking appropriate questions. I also acted as a resource if they did not have or had forgotten a particular skill.

I realised that it was a good idea to collect the work in from time to time to collect and write suitable comments so that I could guide the children where necessary. I found that by doing this and also by continually circulating round the class I was able to keep track of their work and also assess fairly accurately how much work was being done at home. I was at first worried that the children would not progress far enough with investigations on their own but I was pleasantly surprised at what they were able to achieve before coming to a natural end. One girl in particular went surprisingly far with Connect 4. As this was a middle band I did not expect her to come up with the formula for changing the connects and the columns and rows. She was almost there but she lacked the ability to cope with changing more than one variable. I did some work with her on this and then sent her away to look at her investigation but unfortunately she could not do it. She had gone remarkedly far but had nevertheless reached her natural end. For a teacher to learn how to deal with investigation there is no substitute for experience such as I have had in the last term. The children can be most imaginative with their ideas. The middle band, however, had difficulty in making generalisations and fully understanding the significance of what they were doing. This is the area where these particular children needed most guidance."

Case Study D

Coursework and its assessment at a College of Further Education

The Mathematics Workshop at the College operates an open learning system offering any course in mathematics anyone may want on an individualised learning basis. The workshop caters for a wide range of needs and abilities from basic numeracy to undergraduate mathematics. No formal class teaching is given but academic staff are always available to give tutorial and counselling assistance as required.

The GCSE course is organised in a series of units, each unit consisting of a booklet on one topic or group of topics. At the end of each unit the student completes an assignment. Students are able to work at their own pace and are encouraged to accept responsibility for their own learning and progress.

The introduction of GCSE provided the opportunity to develop coursework. It was agreed that in 1987-88 selected groups of GCSE Mathematics students would be given a programme of assessed coursework. This programme was intended to give college staff experience in the administration and assessment of suitable coursework, to bring to light unexpected problems and to test the suitability of the chosen coursework items. It was also expected to be beneficial to those students.

It was agreed that students should be given some guidance as to the purpose and introduction of coursework. In the absence of formal lectures a video was considered to be the best option. With the advice and services of the Media Workshop a video was produced, giving guidance as to the processes involved in the presentation of coursework and taking students through an open-ended investigation emphasising the different possible routes and the formulation of a generalisation. Students were also given some guidance as to the assessment of the work. The video is intended for use by students unable to attend tutorials.

The assessment

Initially, coursework assignments were assessed using a content-based scheme, but this was replaced by an assessment scheme with three classifications

* Identification of task and selection of strodes,
* Implementation, content and accuracy,
* Interpretation and communication.

Although students are continually discussing work with teachers and with one another, incidental oral assessment proved to be difficult as a student will see many different teachers during the course. The original plan had called for brief formal interviews with students; in the event, due to lack of time and other pressures, one member of the department held informal discussions with students when they handed in their reports.

Staff training and allocation of time

It was considered that both full and part-time members of the department would benefit from some form of GCSE training. Teachers attended three two-hour sessions and were given scripts to take home to study and assess. Assessment and progress meetings were held throughout the year - three in November/December, then weekly during the Spring and Summer Terms until May. In addition, each member of the department involved spent up to 14 hours working through the coursework items and approximately 35 hours reading and assessing scripts.

Reactions and results

On the whole the coursework has been well received by students. The amount of time devoted to tasks has varied greatly, being largely dependent upon the interest and motivation of the student and pressures from other work. There were occasions when students completed a piece of work after only a few days but, as they had devoted most of their time during this period to the task, they had spent the equivalent of a student completing the work in a class over a three or four week period.

In the light of their experience the department intends to develop the scheme. The wording on some of the tasks caused difficulties. Where appropriate the language has been altered but the content of the tasks remains unaltered. The department intend to repeat the scheme and hope to develop coursework as an integral part of the course and encourage greater input from their students.

2 *Avoiding Teacher Lust*

TEACHER LUST is the desire to explain - to help students by telling them almost everything. Students so often get offered a problem and, almost hand in hand, help with solving it in one specific way. Hence, the problem is never established as something worthwhile to be explored and solved. A problem has to exist and provide a worthwhile challenge to students if they are to gain from the experience of their encounters with it.

Avoiding teacher lust is an essential feature of teacher behaviour when open-ended aspects of learning mathematics are involved. It is something that needs to be practised over a considerable period of time and it demands much conscious effort.

It is often difficult for teachers to hold back when they see students struggling with problems. However, if students are to produce their own solutions to their own problems, we need to give generally 'strategic' help and encouragement and to avoid giving hints which refer specifically to the particular problem students are tackling. Hints such as the following are to be avoided

> "Do you recognise square numbers?"
>
> "Explore it like this."
>
> "Why don't you try using 3 counters?".

ACTIVITY 2

Avoiding Teacher Lust

Discussion

How much help do you think constitutes teacher lust?

What types of help are there?

Who can help a student in need?

Classroom Activity

CENTURY.

Use the game, as offered on the student's worksheet, with at least one class. Try to monitor your own responses to students' questions.

Discussion

How did it go?

How much freedom did the students have on this problem?

What did you have to do/say?

What was common in all pairs, in all classrooms?

What was unique about their learning?

Can you suggest why?

What did you learn about their learning?

How far did you avoid teacher lust?

What do you think would have been the gains and losses from more 'lustful' interventions?

CENTURY

Have a go at this game!

You can choose any number from 1 to 10 to add to the running total of the game. Starting at zero, you and your partner take turns adding to the total and the one who gets the CENTURY (Total = 100) WINS!!!

Play the game several times to see who can score the most centuries. Discuss with your partner any ideas you have on this game and try to write about them in your own words.

Now, you and your partner use your ideas to play against another pair.

Did you win?

Sample Game

You start at zero. In turn you and your partner choose a number from 1 to 10. The number chosen is added to the running total.

The person who gets the CENTURY (Total = 100) WINS!!!

Jane	Sarah	Running Total
10		10
	9	19
8		27
	10	37
7		44
	9	53
10		63
	10	73
9		82
	10	92
8		100

JANE WINS!!!

3 *Using Problem Solving Strategies*

There is a variety of useful strategies for problem solving both within mathematics and in life in general. Different authors suggest alternative lists but the majority are based upon the four stages suggested by Polya (1945) in his book *How To Solve It.*

Understanding the problem

Devising a plan

Carrying out the plan

Looking back.

The key problem solving strategies checklist as identified in the Shell Centre 'Blue Box', *Problems with Patterns and Numbers,* is

* Try some simple cases
* Find a helpful diagram
* Organise systematically
* Spot patterns
* Use the patterns
* Find a general rule
* Explain why it works
* Check regularly.

Giving Strategic Help

When students learn how to solve problems, they need to learn how to decide what to do and when to do it. If someone always tells them what to do, they won't learn these skills for themselves. Aim to provide less and less guidance as you get further into this type of work.

Use freely any questions that make students think about the way they are tackling the problems. This type of question encourages students to organise or re-organise their own thoughts

"What have you tried?"

"Well, what do you think?"

"What are you trying to do?"

"Why are we doing this?"

"What will we do when we get this result?"

"What have you found out so far?"

"Have you seen anything that is like this in any way?"

"How can we organise this?"

"Let's draw up a table of results."

"Can you see any pattern?"

"Have you tried some simpler cases?"

"What examples should we choose?"

"How can we start?"

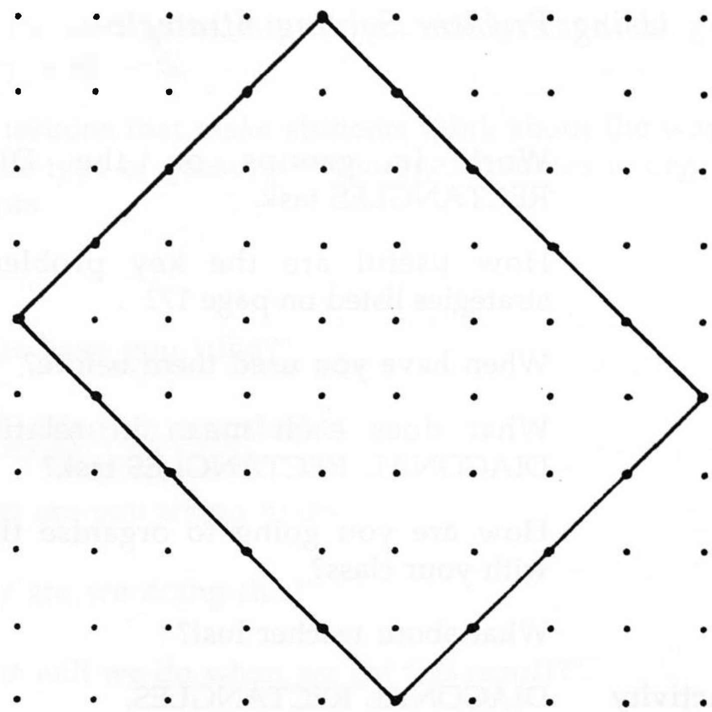
"Have you checked if that works?"

ACTIVITY 3

Using Problem Solving Strategies

Activity	Work in groups on the DIAGONAL RECTANGLES task.
Discussion	How useful are the key problem solving strategies listed on page 17?
	When have you used them before?
	What does each mean in relation to the DIAGONAL RECTANGLES task?
	How are you going to organise the problem with your class?
	What about teacher lust?
Classroom Activity	DIAGONAL RECTANGLES.
	Use the task with at least one class. Allow different groups of students to work with/without the key problem solving strategies checklist. Try to use questions similar to those listed on page 18.
Discussion	What types of student did this seem suited to?
	How did the students respond?
	How far did they get?
	What were your roles as a teacher?
	Did the problem solving strategies checklist help?
	How easy was it for you?
	What other approach might you try next time?

DIAGONAL RECTANGLES



We will call this shape a '4 x 5 diagonal rectangle'.

(One edge is 4 diagonal units long, and the other is 5 diagonal units long.)

(i) Count the number of dots inside the 4 x 5 rectangle.

(ii) How many dots will lie inside a 9 x 10 diagonal rectangle?

(iii) How about a 99 x 100 diagonal rectangle?

(iv) Explain carefully how you obtained your answer to (iii).

(v) How many dots will lie inside an n x (n+1) diagonal rectangle?

Investigate The Problem

4 *Looking At Lessons*

Here, we are very much concerned with the teacher's various roles during lessons and the ways in which they may differ when problem solving or investigative work is the main classroom focus.

It is extremely useful to observe other teachers in action, and to compare their styles with your own when using particular tasks. Most teachers who have tried it, claim to enjoy it and wish that these opportunities were less rare. However, if you want to get more than general impressions from looking at other people's teaching, it is helpful to have some structure - some simple 'pegs' - to hang your observations on. They will also make you more aware of what you are doing. In order to provide one possible structure, let us consider the following framework for analysis

explaining

managing

task setting

counselling

being a fellow student

acting as a resource

These six *roles* give us a simple framework for looking at the teacher's activity.

In the vast majority of mathematics lessons, the roles of manager, explainer and task setter appear to dominate. However, if students are to become skilled in independent problem solving and investigation, the teacher needs to spend a greater proportion of the time counselling, working with them (being a fellow student) or just being there for consultation (acting as a resource). Equally it is valuable for reinforcing students' understanding to get *them* explaining, and also task setting - *role shifting* and *role sharing* seem to promote high level learning.

ACTIVITY 4

Looking At Lessons

Discussion

Which of the six teacher roles identified do you use regularly?

Which roles do you feel you need to develop?

Are there any roles you choose not to adopt?

Classroom Activity

DIAGONALS OF A POLYGON

Try the above activity with at least one class, using the Teacher's Notes. Monitor your activities using the Observing Teacher Activity sheet.

On the Observing Teacher Activity sheet you should note the time when you change activity, the number of students with whom you interact, the role you adopt and any other factors you think are important.

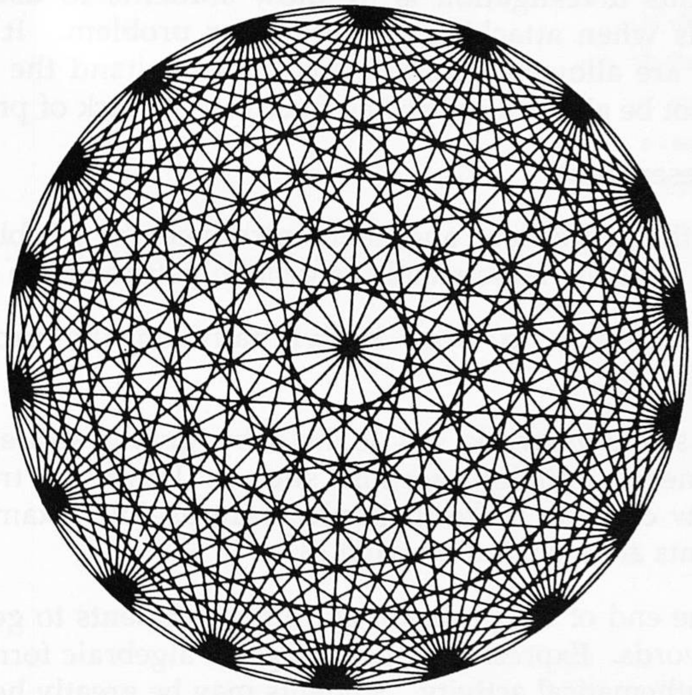
Discussion

Compare your observations with those of your colleagues.

Which roles predominate?

Are you surprised by your findings?

DIAGONALS OF A POLYGON



This diagram has been drawn by connecting each of the eighteen vertices to every other vertex.

A straight line joining one vertex to another non-adjacent vertex is called a **diagonal.**

How many diagonals are there?

Investigate The Problem

DIAGONALS OF A POLYGON

The aim of this investigation is to allow students to use the specific strategic skills when attacking an unfamiliar problem. It is important that students are allowed time to come to understand the problem, but they should not be allowed to become frustrated by lack of progress.

Suggested presentation

1. Distribute the worksheet and then introduce the problem orally to ensure that students understand the general nature of the task.

2. Invite the students to work individually on the problem before forming pairs etc.

3. While the students work, try to help by giving strategic help and encouragement. Initially questions such as 'Have you tried a simpler case?' 'How can you make it simpler?' are useful. Examples of other strategic hints are included on page 18.

4. Towards the end of the problem, encourage students to generalise their results in words. Expressing a pattern as an algebraic formula is a very difficult mathematical activity. Students may be greatly helped towards it if they are encouraged to write down and explain their rules in words, as an intermediate step, rather than to attempting to translate the patterns directly into algebra. It is easy to underestimate just how difficult this is. For some students it may even be counter-productive to pursue the notion of expressing their verbal generalisation in algebraic form.

5. Emphasise the importance of checking that the rule works in every case. Take the opportunity to show that a variety of rules work and can be developed into equivalent algebraic expressions.

6. A suitable conclusion to the lesson may be to discuss how useful the students found the strategies, and also if they have discovered any new ones which could be added to the list. For example, a student may discover the strategy of generating further cases from simpler cases rather than by starting afresh each time.

OBSERVING TEACHER ACTIVITY

TEACHER ROLES

E - Explaining

M - Managing

T - Task setting

C - Counselling

F - Being a fellow student

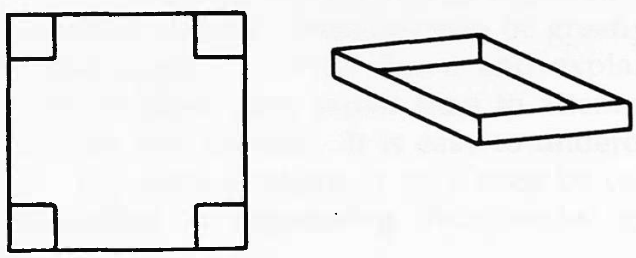
R - Acting as a resource

Time	No of students	Role	Notes

5 *Working With Open Problems*

By tradition, the majority of problems offered in the mathematics classroom are relatively closed and routine. It is a very different type of experience to handle a truly open-ended problem which can be interpreted in a variety of ways and which involve several possible solutions.

For example, students might be asked to find the volume of an open box made by cutting squares of a specified size from the corners of a square sheet of paper and folding as in the diagram below.



Working in a more open way, students might be asked to find what size squares cut from the corners would produce a box of maximum volume.

Further discussion relating to 'open' problem solving is contained in The Teacher's Guide.

The Shell Centre 'Blue Box', *Problems with Patterns and Numbers,* contains many problems of an 'open' type, together with teacher support material concerning their use in the classroom.

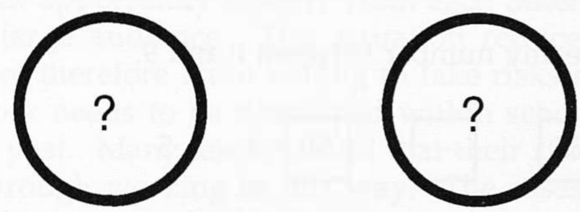
ACTIVITY 5

Working With Open Problems

Activity

Try this task for yourselves.

Here we have 2 discs, each with a single number on both sides.



The discs are tossed into the air and when the numbers on the upper faces are added together we can obtain the following totals: 13, 11, 10 and 8. What are the numbers on each face?

Discussion

How far is this an open task?

Think of other tasks that are more and less open.

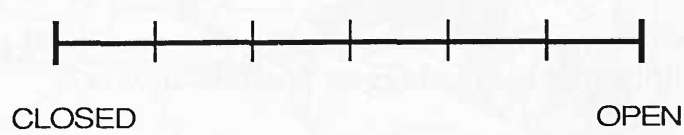
Classroom Activity

Try one of the OPEN PROBLEMS with at least one group of students.

Discussion

How did you cope with this type of work?

Where do these problems fit on the closed/open scale?



Who decides how this should be extended? Could it be used over a period of about twelve to fifteen hours work as an extended task for GCSE coursework?

OPEN PROBLEMS

1. $\boxed{A}$ $\boxed{B}$ $\boxed{C}$ = 5

A. Choose any number between 0 and 99.

B. Choose +, -, x, ÷.

C. Choose any number between 0 and 9.

eg $\boxed{55}$ $\boxed{-}$ $\boxed{50}$ = 5

How many different ways can you get the result 5?

2. Take any number between 10 and 20.

Split the number into three parts.

eg, 17 = 11 + 4 + 2

Now multiply the three parts together.

11 x 4 x 2 = ______

What's the answer?

How can you split the number so that your final product (the answer to the multiplication) is the biggest possible answer?

6 *Group Work In The Classroom*

Students often benefit from working in small groups of about two to four. In this type of situation they have an opportunity to learn from each other and to explain their own ideas without a large audience. This situation reduces the threat of personal failure. Students are therefore more willing to take risks and experiment with ideas. This type of work needs to be developed within schools a great deal more than it has been in the past. Many teachers find that their students gain both academically and socially through working in this way. The assessment of work completed by individuals who have worked within a group is a difficult task for any teacher. Any such assessment is complex and should take account of other individuals in the group. The assessment needs to include observation and discussion. It needs to take into account factors such as a student's ability to respond to direct questions, discuss mathematical ideas and explain mathematical arguments.

ACTIVITY 6

Group Work In The Classroom

Discussion

What skills do you think group work can develop?

How can we organise group work in the classroom?

What types of problems are best suited to group work?

How can we actually assess what each student has achieved?

Classroom Activity

ORGANISING A LEAGUE

In groups of about two to four let students tackle the Organising a League task in any way they wish. Try to observe how different groups tackle the problem and how individuals behave in each group. Once you have set the task try to act solely as an observer. If there is time at the end, allow the groups to walk around and look at each other's solutions.

Discussion

What problems did you encounter in dealing with this type of work?

Did it go the way you thought it would?

Were there any advantages for the students in tackling this task in groups?

Do you think this style of work has anything to offer to the more traditional areas of mathematical content?

ORGANISING A LEAGUE

There are six schools in the area:

Aston	(A)
Beauchamp	(B)
Coalville	(C)
Didsbury	(D)
Elham	(E)
Fenton	(F)

You are to organise a mixed basketball league. The following facts must be taken into account when organising the league.

a) Schools *play each other once.*

b) Fixtures can only be arranged on Thursdays.

c) All matches must be played during the period January 1 to February 28.

d) All matches must be played in term time. (You are provided with a calendar giving details of the holidays (■) for each school. Dates marked with a cross (X) indicate that the school has a prior non-league fixture on that particular day.)

On the answer sheets provided

1) Work out the total number of games which need to be played.

2) Make a list of the games which need to be played.

3) Use the calendars provided to arrange a list of fixtures on the table provided. Refer to each school by the first letter of their name ie, Aston v Beauchamp becomes A v B.

The fixtures to be played on 19 February have already been filled in.

4) Write out a fixture list for Didsbury, showing clearly the schools to be played and the dates.

Answer Sheet 1

Name(s) ....

1. **Total number of games to be played**

2. **List of games to be played**

Answer Sheet 2

Name(s) ....

3. Fixture List

Date	*Fixture*
Jan 1	H O L I D A Y
8	
15	
22	
29	
Feb 5	
12	H O L I D A Y
19	A v C D v E
26	

4. Fixture List for Didsbury School

ASTON

CALENDAR

	JANUARY	FEBRUARY	MARCH	APRIL
S	. 4 11 18 25 ..	1 8 15 22	1 8 15 22 29 ..	. 5 12 19 26 ..
M	. 5 12 19 26 ..	2 9 [redacted] 23	2 9 16 23 [redacted] ..	. 6 13 20 27 ..
T	. 6 13 20 27 ..	3 10 [redacted] 24	3 10 17 24 [redacted] ..	. 7 14 21 28 ..
W	. 7 14 21 28 ..	4 11 [redacted] 25	4 11 18 25	1 8 15 22 29 ..
T	[redacted] X 15 22 29 ..	5 [redacted] 19 X	5 12 X X	2 9 16 23 30 ..
F	[redacted] 9 16 23 30 ..	7 [redacted] 20 27	6 13 20 27	3 10 17 24 .. ..
S	3 10 17 24 31 ..	6 14 21 28	7 14 21 28	4 11 18 25 .. ..

	MAY	JUNE	JULY	AUGUST
S	. 3 10 17 24 31	. 7 14 21 28 ..	. 5 12 19 26 ..	. 2 9 16 23 30
M	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..	. 3 10 17 24 31
T	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..	. 4 11 18 25 ..
W	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 ..	. 5 12 19 26 ..
T	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..	. 6 13 20 27 ..
F	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..	. 7 14 21 28 ..
S	2 9 16 23 30 ..	6 13 20 27	4 11 18 25	1 8 15 22 29 ..

	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
S	. 6 13 20 27 ..	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..
M	. 7 14 21 28 ..	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..
T	1 8 15 22 29 ..	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 .
W	2 9 16 23 30 ..	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..
T	3 10 17 24	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..
F	4 11 18 25	2 9 16 23 30 ..	6 13 20 27	4 11 18 25 .. ..
S	5 12 19 26	3 10 17 24 31 ..	7 14 21 28	5 12 19 26 .. ..

BEAUCHAMP

CALENDAR

	JANUARY	FEBRUARY	MARCH	APRIL
S	. 4 11 18 25 ..	1 8 15 22	1 8 15 22 29 ..	. 5 12 19 26 ..
M	. 5 12 19 26 ..	2 9 [redacted] 23	2 9 16 23 30 ..	. 6 13 20 27 ..
T	. 6 13 20 27 ..	3 10 [redacted] 24	3 10 17 24 31 ..	. 7 14 21 28 ..
W	. 7 14 21 28 ..	4 11 [redacted] 25	4 11 18 25	1 8 15 22 29 ..
T	[redacted] X 15 22 29 ..	5 [redacted] [redacted] 26	5 12 19 26	2 9 16 23 30 ..
F	[redacted] 9 16 23 30 ..	7 [redacted] 20 27	6 13 20 27	3 10 17 24 .. ..
S	3 10 17 24 31 ..	6 14 21 28	7 14 21 28	4 11 18 25 .. ..

	MAY	JUNE	JULY	AUGUST
S	. 3 10 17 24 31	. 7 14 21 28 ..	. 5 12 19 26 ..	. 2 9 16 23 30
M	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..	. 3 10 17 24 31
T	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..	. 4 11 18 25 ..
W	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 ..	. 5 12 19 26 ..
T	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..	. 6 13 20 27 ..
F	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..	. 7 14 21 28 ..
S	2 9 16 23 30 ..	6 13 20 27	4 11 18 25	1 8 15 22 29 ..

	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
S	. 6 13 20 27 ..	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..
M	. 7 14 21 28 ..	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..
T	1 8 15 22 29 ..	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 .
W	2 9 16 23 30 ..	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..
T	3 10 17 24	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..
F	4 11 18 25	2 9 16 23 30 ..	6 13 20 27	4 11 18 25 .. ..
S	5 12 19 26	3 10 17 24 31 ..	7 14 21 28	5 12 19 26 .. ..

COALVILLE

CALENDAR

	JANUARY	FEBRUARY	MARCH	APRIL
S	. 4 11 18 25 ..	1 8 15 22	1 8 15 22 29 ..	. 5 12 19 26 ..
M	. 5 12 19 26 ..	2 9 [redacted] 23	2 9 16 23 30 ..	. 6 13 20 27 ..
T	. 6 13 20 27 ..	3 10 [redacted] 24	3 10 17 24 31 ..	. 7 14 21 28 ..
W	. 7 14 21 28 ..	4 11 [redacted] 25	4 11 18 25	1 8 15 22 29 ..
T	[redacted] 8 15 22 29 ..	5 [redacted] 19 26	5 12 19 26	2 9 16 23 30 ..
F	[redacted] 9 16 23 30 ..	7 [redacted] 20 27	6 13 20 27	3 10 17 24 .. ..
S	3 10 17 24 31 ..	6 14 21 28	7 14 21 28	4 11 18 25 .. ..
	MAY	**JUNE**	**JULY**	**AUGUST**
S	. 3 10 17 24 31	. 7 14 21 28 ..	. 5 12 19 26 ..	. 2 9 16 23 30
M	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..	. 3 10 17 24 31
T	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..	. 4 11 18 25 ..
W	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 ..	. 5 12 19 26 ..
T	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..	. 6 13 20 27 ..
F	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..	. 7 14 21 28 ..
S	2 9 16 23 30 ..	6 13 20 27	4 11 18 25	1 8 15 22 29 ..
	SEPTEMBER	**OCTOBER**	**NOVEMBER**	**DECEMBER**
S	. 6 13 20 27 ..	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..
M	. 7 14 21 28 ..	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..
T	1 8 15 22 29 ..	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 ..
W	2 9 16 23 30 ..	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..
T	3 10 17 24	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..
F	4 11 18 25	2 9 16 23 30 ..	6 13 20 27	4 11 18 25 .. ..
S	5 12 19 26	3 10 17 24 31 ..	7 14 21 28	5 12 19 26 .. ..

DIDSBURY

CALENDAR

	JANUARY	FEBRUARY	MARCH	APRIL
S	. 4 11 18 25 ..	1 8 15 22	1 8 15 22 29 ..	. 5 12 19 26 ..
M	. 5 12 19 26 ..	2 9 [redacted] 23	2 9 16 23 30 ..	. 6 13 20 27 ..
T	. 6 13 20 27 ..	3 10 [redacted] 24	3 10 17 24 31 ..	. 7 14 21 28 ..
W	. 7 14 21 28 ..	4 11 [redacted] 25	4 11 18 25	1 8 15 22 29 ..
T	[redacted] 8 [redacted] 22 29 ..	5 [redacted] 19 26	5 12 19 26	2 9 16 23 30 ..
F	[redacted] 9 16 23 30 ..	7 [redacted] 20 27	6 13 20 27	3 10 17 24 .. ..
S	3 10 17 24 31 ..	6 14 21 28	7 14 21 28	4 11 18 25 .. ..
	MAY	**JUNE**	**JULY**	**AUGUST**
S	. 3 10 17 24 31	. 7 14 21 28 ..	. 5 12 19 26 ..	. 2 9 16 23 30
M	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..	. 3 10 17 24 31
T	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..	. 4 11 18 25 ..
W	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 ..	. 5 12 19 26 ..
T	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..	. 6 13 20 27 ..
F	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..	. 7 14 21 28 ..
S	2 9 16 23 30 ..	6 13 20 27	4 11 18 25	1 8 15 22 29 ..
	SEPTEMBER	**OCTOBER**	**NOVEMBER**	**DECEMBER**
S	. 6 13 20 27 ..	. 4 11 18 25 ..	1 8 15 22 29 ..	. 6 13 20 27 ..
M	. 7 14 21 28 ..	. 5 12 19 26 ..	2 9 16 23 30 ..	. 7 14 21 28 ..
T	1 8 15 22 29 ..	. 6 13 20 27 ..	3 10 17 24	1 8 15 22 29 .
W	2 9 16 23 30 ..	. 7 14 21 28 ..	4 11 18 25	2 9 16 23 30 ..
T	3 10 17 24	1 8 15 22 29 ..	5 12 19 26	3 10 17 24 31 ..
F	4 11 18 25	2 9 16 23 30 ..	6 13 20 27	4 11 18 25 .. ..
S	5 12 19 26	3 10 17 24 31 ..	7 14 21 28	5 12 19 26 .. ..

ELHAM

CALENDAR

	JANUARY	FEBRUARY	MARCH	APRIL
S	. 4 11 18 25 . .	1 8 15 22	1 8 15 22 29 . .	. 5 12 19 26 . .
M	. 5 12 19 26 . .	2 9 [redacted] 23	2 9 16 23 30 . .	. 6 13 20 27 . .
T	. 6 13 20 27 . .	3 10 [redacted] 24	3 10 17 24 31 . .	. 7 14 21 28 . .
W	. 7 14 21 28 . .	4 11 [redacted] 25	4 11 18 25	1 8 15 22 29 . .
T	[redacted] X X 22 29 . .	5 [redacted] 19 26	5 12 19 26	2 9 16 23 30 . .
F	[redacted] 9 16 23 30 . .	7 [redacted] 20 27	6 13 20 27	3 10 17 24 . . . .
S	3 10 17 24 31 . .	6 14 21 28	7 14 21 28	4 11 18 25 . . . .

	MAY	JUNE	JULY	AUGUST
S	. 3 10 17 24 31	. 7 14 21 28 . .	. 5 12 19 26 . .	. 2 9 16 23 30
M	. 4 11 18 25 . .	1 8 15 22 29 . .	. 6 13 20 27 . .	. 3 10 17 24 31
T	. 5 12 19 26 . .	2 9 16 23 30 . .	. 7 14 21 28 . .	. 4 11 18 25 . .
W	. 6 13 20 27 . .	3 10 17 24	1 8 15 22 29 . .	. 5 12 19 26 . .
T	. 7 14 21 28 . .	4 11 18 25	2 9 16 23 30 . .	. 6 13 20 27 . .
F	1 8 15 22 29 . .	5 12 19 26	3 10 17 24 31 . .	. 7 14 21 28 . .
S	2 9 16 23 30 . .	6 13 20 27	4 11 18 25	1 8 15 22 29 . .

	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
S	. 6 13 20 27 . .	. 4 11 18 25 . .	1 8 15 22 29 . .	. 6 13 20 27 . .
M	. 7 14 21 28 . .	. 5 12 19 26 . .	2 9 16 23 30 . .	. 7 14 21 28 . .
T	1 8 15 22 29 . .	. 6 13 20 27 . .	3 10 17 24	1 8 15 22 29 .
W	2 9 16 23 30 . .	. 7 14 21 28 . .	4 11 18 25	2 9 16 23 30 . .
T	3 10 17 24	1 8 15 22 29 . .	5 12 19 26	3 10 17 24 31 . .
F	4 11 18 25	2 9 16 23 30 . .	6 13 20 27	4 11 18 25 . . . .
S	5 12 19 26	3 10 17 24 31 . .	7 14 21 28	5 12 19 26 . . . .

FENTON

CALENDAR

	JANUARY	FEBRUARY	MARCH	APRIL
S	. 4 11 18 25 . .	1 8 15 22	1 8 15 22 29 . .	. 5 12 19 26 . .
M	. 5 12 19 26 . .	2 9 [redacted] 23	2 9 16 23 30 . .	. 6 13 20 27 . .
T	. 6 13 20 27 . .	3 10 [redacted] 24	3 10 17 24 31 . .	. 7 14 21 28 . .
W	. 7 14 21 28 . .	4 11 [redacted] 25	4 11 18 25	1 8 15 22 29 . .
T	[redacted] 8 15 22 29 . .	X [redacted] 26	5 12 19 26	2 9 16 23 30 . .
F	[redacted] 9 16 23 30 . .	7 [redacted] 20 27	6 13 20 27	3 10 17 24 . . . .
S	3 10 17 24 31 . .	6 14 21 28	7 14 21 28	4 11 18 25 . . . .

	MAY	JUNE	JULY	AUGUST
S	. 3 10 17 24 31	. 7 14 21 28 . .	. 5 12 19 26 . .	. 2 9 16 23 30
M	. 4 11 18 25 . .	1 8 15 22 29 . .	. 6 13 20 27 . .	. 3 10 17 24 31
T	. 5 12 19 26 . .	2 9 16 23 30 . .	. 7 14 21 28 . .	. 4 11 18 25 . .
W	. 6 13 20 27 . .	3 10 17 24	1 8 15 22 29 . .	. 5 12 19 26 . .
T	. 7 14 21 28 . .	4 11 18 25	2 9 16 23 30 . .	. 6 13 20 27 . .
F	1 8 15 22 29 . .	5 12 19 26	3 10 17 24 31 . .	. 7 14 21 28 . .
S	2 9 16 23 30 . .	6 13 20 27	4 11 18 25	1 8 15 22 29 . .

	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
S	. 6 13 20 27 . .	. 4 11 18 25 . .	1 8 15 22 29 . .	. 6 13 20 27 . .
M	. 7 14 21 28 . .	. 5 12 19 26 . .	2 9 16 23 30 . .	. 7 14 21 28 . .
T	1 8 15 22 29 . .	. 6 13 20 27 . .	3 10 17 24	1 8 15 22 29 .
W	2 9 16 23 30 . .	. 7 14 21 28 . .	4 11 18 25	2 9 16 23 30 . .
T	3 10 17 24	1 8 15 22 29 . .	5 12 19 26	3 10 17 24 31 . .
F	4 11 18 25	2 9 16 23 30 . .	6 13 20 27	4 11 18 25 . . . .
S	5 12 19 26	3 10 17 24 31 . .	7 14 21 28	5 12 19 26 . . . .

7 Coping With Chaos

Sometimes it is not a comfortable situation for a teacher to stand back and allow students to have more freedom in the classroom. Real enthusiasm often leads to excitement, noise and movement, causing the teacher to feel that everything is out of control. It takes a lot of courage and effort to allow 'controlled chaos' to take place in your classroom.

The term 'chaos' is used here to refer to the excitement and lively activity which often accompanies working in the ways suggested using these materials: we do not use the term in the strict dictionary sense to denote complete disorder or anarchy.

There are times when students become so interested in their problems and discoveries, that a greater volume of noise and more movement may occur in the classroom.

This section of the IMPACT programme is designed to enable each individual teacher to discover an appropriate balance between the classroom environment they wish to achieve and the one which may arise when new types of mathematical activities are introduced for the first time. For some teachers and some students, this will be breaking new ground. It is a matter of discovering how to maintain your usual control while allowing more freedom of activity and enthusiastic discussion.

ACTIVITY 7

Coping With Chaos

Discussion

Do you think we need to let go of the reins?

Will chaos always occur?

What do you feel is the limit?

When is a class in control?

Classroom Activity

PIG

Use the game as outlined on the sheet. It is probably best if you play, or at least start, a demonstration game with the whole class. This could be teacher versus all the students, or half the class versus the rest.

Allow students time to play the game and give it serious consideration. Try to let student enthusiasm and excitement for the game take over, as much as possible. See what happens.

Discussion

How did it go?

Do you think certain things happened just because it was a game or for other reasons?

Do you feel you need to explain a change in teaching approach to your students?

What do you think were the most worthwhile features of your lesson?

PIG

A dice game for two or more players.

The aim of the game is to be the first player to score over 100. You will need 2 dice and a piece of paper to score on.

When it is your turn, roll both dice. If you score a six with either dice (or both) your score is zero for that turn and you must pass the dice on to the next player. If neither of your two numbers is a six then add the two numbers together. You must now make a decision, either you record this total as your score for this turn and pass the dice on to the next player, or you roll the two dice again. On this second throw, the same rules apply, if neither number is a six then the two numbers showing are added to your score for the turn so far. However, if either number, or both, is a six, then your score for the turn is immediately set to zero, and your turn is over. So long as you do not roll a six you may continue rolling the two dice and adding to your score for the turn. The winner is the first player to reach a total score of 100.

Play the game a few times against your friends, either in pairs or small groups.

Keep your score carefully. For example

SCORES ON DICE	SCORE FOR TURN	TOTAL FOR GAME
(4 + 2)(1 + 5)(4 + 3)(6 + 4)	0	0
(3 + 5)	8	8
(4 + 4)(1 + 3)	12	20
(6 + 5)	0	20
(4 + 1)(2 + 2)(3 + 4)(5 + 2)	23	43

Can you suggest any ways to improve your chances of winning? This is called a STRATEGY.

Does your strategy make sure that you never lose?

Write down your ideas on the game.

8 Practical Approaches To Real Problems

One of the long term aims of the new approaches to teaching mathematics is the development of personal skills which ensure that students are able to tackle whole real tasks with confidence. In the past, mathematics teaching has, in general, failed to achieve this aim for a variety of reasons

* We have failed to offer whole problems but, instead, mere fragments of a whole

* Often the problems offered have not been real to our students

* We have failed to inspire confidence.

For the majority of people, mathematics is often at its most powerful when it relates to a practical task and is readily applicable to real life problem solving. For example, planning a kitchen refit would probably involve data collection, the cutting out of scaled pieces, the consideration of alternative solutions and decision making. These are important mathematical and social skills when solving real problems of this type.

The Shell Centre do-it-yourself in-service pack, *Handling Real Problem Solving In The Classroom,* contains a video and printed materials which are designed to promote working in this way. This in-service pack which is linked particularly to the *Be a Paper Engineer* module of the *Numeracy through Problem Solving* materials, contains some interesting students' classroom materials as well as teacher activities based upon the video.

ACTIVITY 8

Practical Approaches To Real Problems

Activity	In groups, work through the ADVERTISING LAYOUT task.
Discussion	Can you suggest other problems which could be included under this category?
	Do you think mathematics teaching should consider whole problems of this nature?
	Do you feel social skills are relevant to our subject?
	How do you think you could assess the outcomes of this task?
Classroom Activity	Let students tackle the ADVERTISING LAYOUT task. You will need to provide each group with an A3 size sheet on which to lay out their advertisements.
	Again, try to avoid teacher lust and observe your own role as a teacher in the classroom.
Discussion	Do you think this was a useful task?
	What were the difficulties you experienced as the teacher?
	What do you think your students learned?
	How could your department organise this type of work?
	Assess your students' work, using either your own assessment framework or the one provided on the next page.

ADVERTISING LAYOUT

This task involves students in selecting and arranging advertisements to provide the maximum income possible. The practical in method aspect of this task enables all students to attempt the task but many do not read the instructions carefully and do not, therefore, take into account all the constraints. Whilst most provide an income, very few provide a maximum income.

	Marks allocated
LAYOUT (irrespective of income)	
• Adverts do not overlap margin	1
• Adverts do not overlap one another	1
• No single spaces large enough to place any of the unused adverts	1
• No additional advert can be fitted in, even with rearrangement	2
INCOME	
• Correctly calculated income generated by chosen layout	1
• Correct layout that generates at least £1770	2
• - at least £1870	+2
TOTAL	10

ADVERTISING LAYOUT

An important source of income for newspapers comes from advertising.

* Sheets 2-5 show the advertisements which are to appear in a particular issue of an evening paper.

* Sheets 6-8 give the fee charged for each of these advertisements.

* The large A3 sheet is the page on which the adverts are to appear.

  On your A3 sheet draw a rectangle 22 cm x 33 cm and lay out your advertisements within this space.

  However, there is not enough space for all the advertisements to appear.

* The Personal and Commercial advertisements are given on page 2 (Garages for Sale, Musical for Sale, Musical Wanted and Home Services), if included, they must appear together in the same column.

YOUR TASK is to decide which adverts to include, to give the greatest income, and the layout of the advertisements page.

When you have decided upon the layout, stick the advertisements in place and write down the total income gained on sheet 9. This sheet should be attached to your layout sheet.

Advertising Layout continued : sheet 2

• HALIFAX RLFC 19, ST HELENS 18 •

MAY SALE • MAY SALE • MAY SALE • MAY

CONGRATULATIONS HALIFAX R.L.F.C.

Celebrate the Challenge Cup with us

Come on down and see the staggering price reductions in our Challenge Cup

MAY SALE

Specially reduced prices off every type of *Electrical and Gas Appliance*

See our incredible display from the finest manufacturers in Europe, some of our German Bosch and Bauknecht appliances almost ½ price

— — — IT'S ON NOW — — —

DISHWASHERS

Hoover Crystaljet £199.99
Philips 12 place setting, latest model.....................£179.99
Bauknecht Decor panel, model GSF1150...............£229.99
Bosch S710 Top Delux model, one only £319.99

AUTOMATIC WASHERS

Philips deluxe 800 spin, reduced to £189.99
Bauknecht 1200 spin deluxe WA858, down to £314.99
Bendix 1000 Spin de luxe model 71258...........£229.99
Philips 1200 Spin £269.99

Big Savings on Hoover 1100 spin washer dryer £279.99

Fridge Freezers prices reduced, big price savings on *Microwaves, Fridges, Freezers, Chest Freezers, Built-in Appliances, Slot-in Cookers, Gas Cookers, Tumble Dryers etc*

WE STOCK EVERY TYPE OF MAJOR APPLIANCE AT OUR LOWEST PRICES

★ COME AND LOOK – SEEING IS BELIEVING ★

WE SPECIALISE IN DOMESTIC APPLIANCES AND CONSTANTLY SEARCH THE COUNTRY FOR TOP BRAND MAKES TO SELL AT PRICES FAR BELOW THOSE OF OUR COMPETITORS

THIS IS ONLY A SAMPLE OF THE LARGEST DISPLAY IN CALDERDALE

WE GUARANTEE TO SAVE YOU MONEY

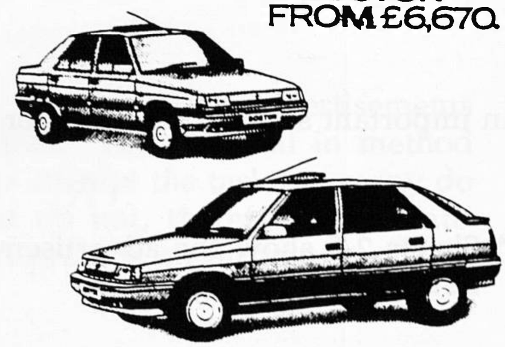
FREE DELIVERY TO ALL CALDERDALE
FULL INSTALLATION SERVICE
FULL GUARANTEES, 5-YEAR COVER AVAILABLE
WE STOCK PERFECT AND MAKERS SECONDS

DIRECT DISCOUNTS

14 POWELL STREET, HALIFAX. TEL 68937

• MAY SALE • MAY SALE • MAY SALE •

THE NEW RENAULT BOSTON FROM £6,670.



In addition to this impressive list of standard features, every single special edition Renault 9 and Renault 11 Boston comes complete with a powerful Blaupunkt digital stereo.

- Colour co-ordinated bodywork.
- Special white or supergloss metallic silver paintwork.
- Britax tilting glass sunhatch.
- Louisiane sport steering wheel.
- A choice of two engines, five gears and two models.
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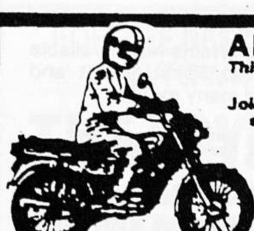

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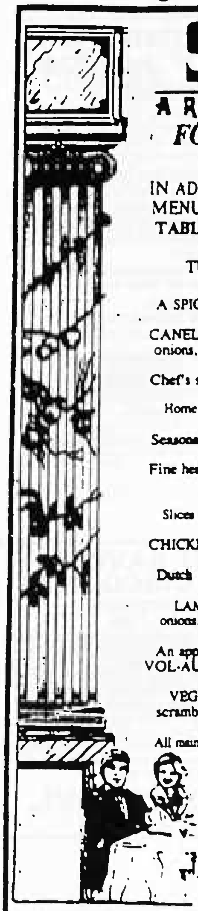
Advertising Layout continued : sheet 5



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LAMB KIDNEYS, sauted with chippolata sausages, onions, mushrooms in red wine sauce, served on a side of savoury rice
An approx. 8oz TROUT fried in butter with fine herbs
VOL-AU-VENT filled with strips of veal and ham cooked with mushroom sauce
VEGETARIAN MAIN DISH, tomatoes filled with scrambled egg, spinach and chives, served on a bed of savoury rice
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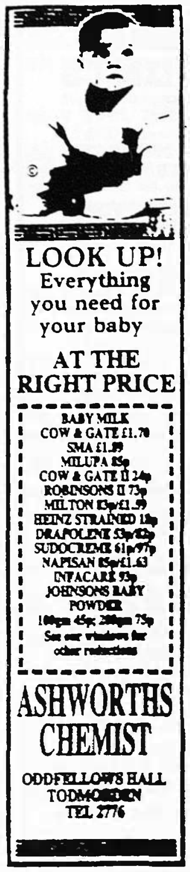

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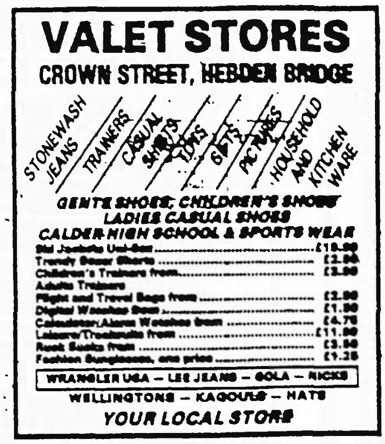

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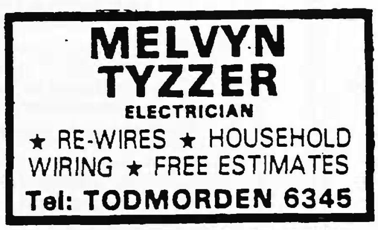

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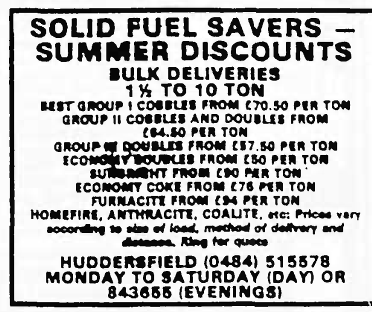

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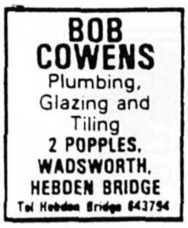

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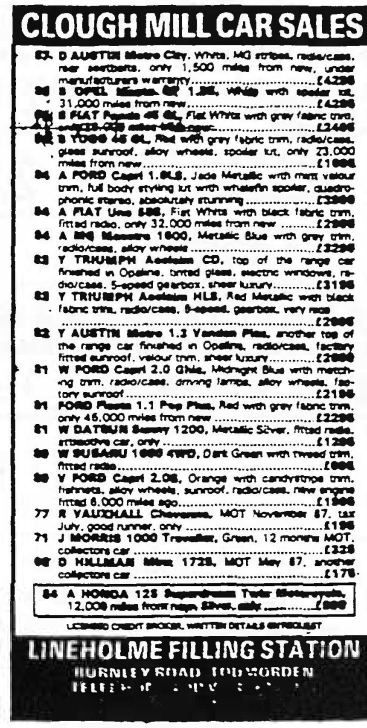

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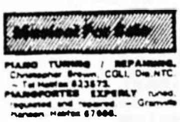

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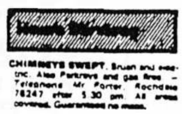

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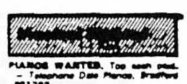

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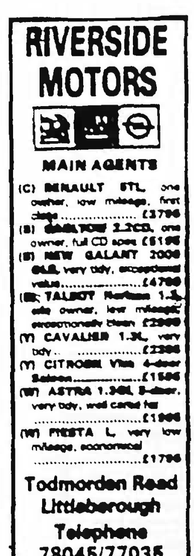

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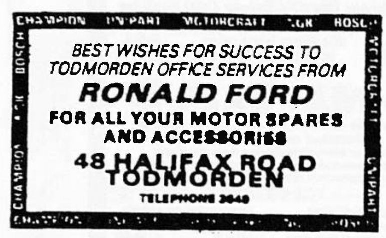

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THE ADVERTISER

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Estimated income ....

9 *Handling Discussion In The Classroom*

There are many ways of organising discussion in a mathematics classroom. One particularly nice model is the 1–>2–>4–>8–> report back approach. Each student spends a short time formulating her own ideas on a particular problem before forming a pair, then a group of four and eventually a larger group of about eight. The intention is that, at each stage of the process, discussion continues until all students within each group reach agreement. The final stage is a class reporting back session, when a representative from each large group briefly explains the agreed ideas of their group. A more detailed account, relating also to the purposes of discussion, is contained in The Teacher's Guide.

The Shell Centre 'Red Box', *The Language of Functions and Graphs,* contains a wealth of material designed to promote discussion activity in the classroom.

ACTIVITY 9

Handling Discussion In The Classroom

Activity In groups, try the GOLF SHOT followed by the WHICH SPORT? tasks.

Discussion How do you think you should organise your classroom for discussion activities?

Does your classroom layout make this easy or difficult?

Classroom Activity GOLF SHOT and WHICH SPORT?

Use the GOLF SHOT followed by WHICH SPORT? activities with at least one class, following the 1->2->4->8->report back approach.

Listen to students, and watch how they explain and listen to each other.

Try to keep out of their discussion, if possible.

Discussion How easy is it to stay out of a discussion?

Were you actually needed in the traditional teacher role?

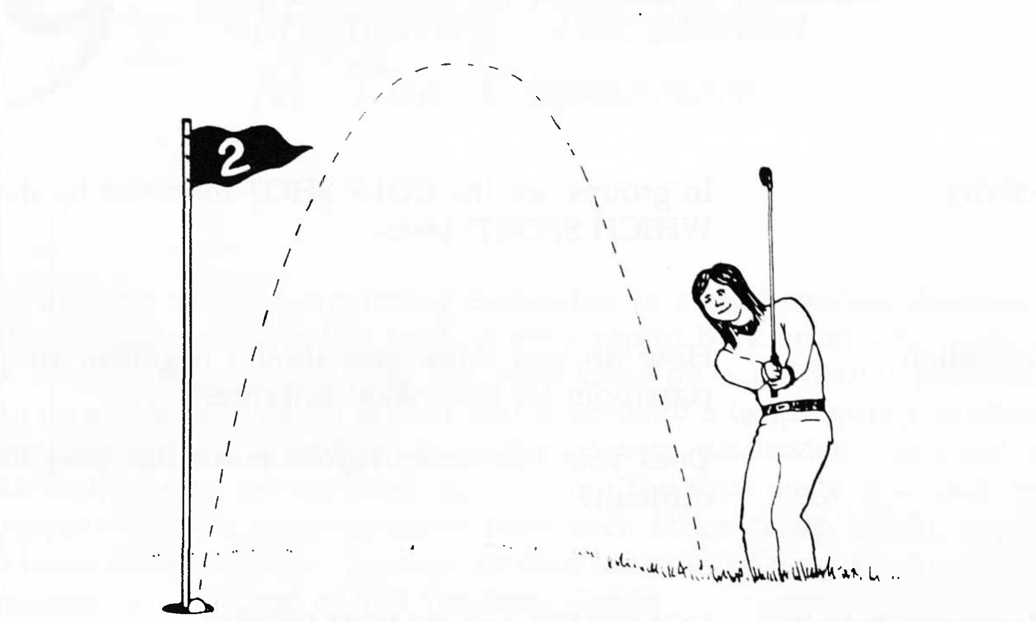
How can you utilise this teaching strategy in your everyday teaching?

Can students discuss without arguing?

Why do you feel your students learnt from this activity?

GOLF SHOT

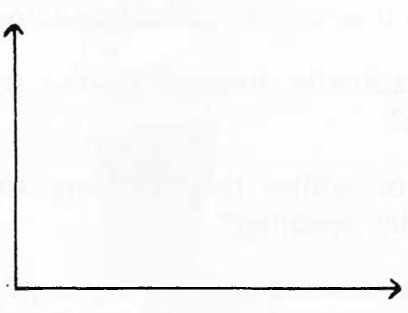
ARE GRAPHS JUST PICTURES?



How does the speed of the ball change as it flies through the air in this amazing golf shot?

* Discuss this situation with your neighbour, and write down a clear description stating how you both think the speed of the golf ball changes.
* Now sketch a rough graph to illustrate your description:

Speed of the ball

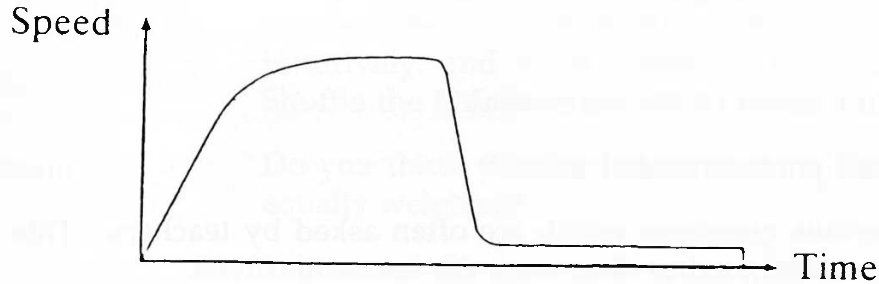


Time after the ball is hit by the golf club.

From The Language of Functions and Graphs

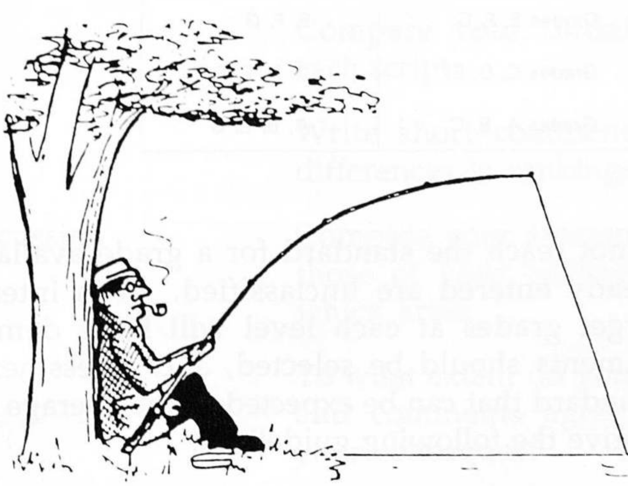
WHICH SPORT?

Which sport will produce a graph like this?



Choose the best answer from the following and explain exactly how it fits the graph.

Write down reasons why you reject alternatives.



Fishing
Pole Vaulting
100 metre Sprint
Sky Diving
Golf
Archery
Javelin Throwing
High Jumping
High Diving
Snooker
Drag Racing
Water Skiing

From The Language of Functions and Graphs

10 *Assessing GCSE Coursework*

"How should I assess GCSE coursework?"

"How should I grade extended tasks?"

These are serious questions which are often asked by teachers. This chapter and Activity 10 are designed to illuminate the issues involved.

The coursework component has been designed to assess objectives which are more appropriately assessed by means other than short, timed, written examinations. It is also intended that the completion of coursework tasks should make important contributions to learning, through practical work and through the application of mathematics across the curriculum, for example.

Assessment is available at three levels, and at each level only a certain range of grades is available as indicated in the following table.

Level	Intended Target Group	Grades Available
Foundation	Grades E, F, G	E, F, G
Intermediate	Grades C, D, E	C, D, E, F
Higher	Grades A, B, C	A, B, C, D

Candidates whose work does not reach the standard for a grade available at the level at which they have already entered are unclassified. It is intended that students who achieve the target grades at each level will have demonstrated positive achievement. Assignments should be selected, and assessment criteria applied, bearing in mind the standard that can be expected of the average student at that level. MEG, for example, give the following guidelines:

Foundation level students are expected to demonstrate a good knowledge of the subject content in the Foundation level syllabus. They should be able to express their ideas within the bounds of a single-concept problem, respond to suggested alternative strategies, record results and draw basic conclusions.

ACTIVITY 10

Assessing GCSE · Coursework

Activity

Photocopy the scripts provided for one of the 'lead tasks'. Shuffle the scripts. Read through the scripts without looking at the external moderator's comments. Rank them, intuitively, and make a note of your ranking. Shuffle the scripts.

Discussion

Do you think that the five categories should be equally weighted?

What would you accept as evidence of achievement within these five categories?

Activity

Read through each script carefully, ignoring your previous reactions to it. Using the guidelines provided, allocate marks or grades to each section of each script.

Write short comments which explain why you feel these marks/grades are appropriate.

Total the marks for each script and re-rank the scripts.

Compare your initial and final rankings for each script.

Write short comments relating to any major differences in rankings.

Discussion

Compare your assessment of these scripts with those of your colleagues. Discuss the issues which arise.

To what extent do your rankings, marks, grades and comments agree/disagree with those of your colleagues?

Compare your reactions to the scripts with the external moderator's comments which are included at the end of the cluster book.

Intermediate level students are expected to demonstrate a good knowledge of the subject content in the Intermediate level syllabus. They should be able to deal with a multi-concept problem, be aware of and use alternative strategies, comment on results and pursue a straightforward argument.

Higher level students are expected to demonstrate a good knowledge of the subject content in the Higher level syllabus. They should be able to draw on a variety of techniques, be able to select, design and describe alternative strategies and apply conclusions to more general situations.

An example of an assessment form is included on page 61. With this particular scheme, it is important to remember that the whole range of marks is available at each level. Each of the five classifications has a maximum of four marks and guidance on work worth 0, 2, 4 is provided. For each assignment a maximum of twenty marks is therefore available. It is anticipated that teachers will provide written comments on each student's assignment as and when necessary. These comments are intended to provide information relating to how marks have been awarded, and any help given. Since the assignments form part of the learning process, it is expected that all students will receive help and advice from their teachers. The marks awarded should reflect the personal contributions of students, including the extent to which they are able to use the help and advice they receive as they develop their assignments. The way in which accuracy marks are allocated varies from one assignment to another. Some problems require numerical accuracy or accuracy in the manipulation of algebra, whilst others demand accuracy in drawing or measuring. The fact that accuracy marks may be limited by a lack of depth in mathematical content requires careful consideration and discussion.

Oral skills may be assessed through conversation between student and teacher during and after the completion of an assignment. The purpose of oral assessment is to assess students' ability to communicate mathematically as they

* respond directly to questions
* discuss mathematical ideas
* explain mathematical arguments.

It is anticipated that the assessment will be made as a result of a continuing evaluation of students' performance in discussing the progress of their assignments and their conclusions with their teacher and fellow students. Formal one-to-one interviews are not required.

It is envisaged that oral exchanges will also serve to establish the authenticity of assignments.

The following grid may prove helpful for relating, for a student at any particular level, the total marks given for an assignment to the appropriate grade. Teachers will need practise at achieving consistency of marking.

Grade \ Level	HIGHER	INTERMEDIATE	FOUNDATION
A	17, 18, 19, 20		
B	13, 14, 15, 16		
C	10, 11, 12	17, 18, 19, 20	
D	7, 8, 9	13, 14, 15, 16	
E		10, 11, 12	17, 18, 19, 20
F		7, 8, 9	13, 14, 15, 16
G			9, 10, 11, 12
U	< 7	< 7	< 9

During the school trials of these materials, some teachers found it useful to devise assessment frameworks which were more specific to the three main mathematical areas within most GCSE schemes: Pure investigations; Problems, practical in method; Applications, practical in purpose. Three categories of assessment were used for this purpose; these were suggested in the SEC document Draft Guide Criteria (1985): Identification of task and selection of strategy; Implementation, content and accuracy; Interpretation and communication. Assessment frameworks based on these are shown on pages 62-64. Further, during the school trials of these materials, some teachers found it useful to devise assessment frameworks which were task specific. Two examples of such frameworks, devised for the tasks *Why Are We Waiting* and *Sorting Shapes* are included in The Teacher's Guide.

The assessment of GCSE coursework tasks will form an important part of a continuing dialogue between teachers and examining groups during the next few years.

As they read through their students' scripts, teachers may find it helpful to ask themselves questions such as the following. Was the student able to:

* Understand what needed to be done in general terms
* Follow the instructions provided
* Distinguish between important and irrelevant information
* Recognise how the task was similar to, or differed from, previous tasks
* Formulate a plan of what needed to be done
* Debate possible courses of action
* Discuss difficulties and ask questions
* Use appropriate reference materials to find additional information
* Select appropriate mathematics to create a model
* Use appropriate mathematical skills with accuracy
* Apply commonsense and reasoning skills
* Recognise patterns/relationships/connections/general rules
* Recognise when the best mathematical solution was not the best real solution
* Present and explain the results
* Discuss the implications and accuracy of conclusions reached
* Make a clear written report.

When making oral assessments, the Midland Examining Group suggests it may be helpful to consider the following attributes:

* Discussion of the problem and how to begin
* Discussion of avenues of approach, including why some are adopted and others rejected
* Questions asked both of themselves and their teachers
* Justification of their work and their conclusions
* Explanation to others of their problem, their work and their conclusions
* Insight shown in discussion about the work of other candidates
* Clarity of expression of ideas using appropriate language.

MEG Mathematics Course Work Assessment Form GCSE Examinations

CLASSIFICATION OF ASSESSMENT	MAXIMUM MARKS	GUIDANCE FOR MARKING
OVERALL DESIGN AND STRATEGY	4	4 - A well defined project, appropriate use of techniques, well-stated conclusions, strong personal contribution. 2 - Adequately defined project, satisfactory techniques, some statement(s) of conclusion(s), average help needed. 0 - Trivial or poorly stated project, unsuitable techniques, a lack of conclusion, even with considerable help.
MATHEMATICAL CONTENT	4	4 - Commendable use of concepts and methods showing a good range of knowledge; developments of these concepts and methods as the work progresses. 2 - Appropriate concepts and methods without development or refinement, showing competence in a limited range of techniques. 0 - Inadequate for the assignment.
ACCURACY	4	4 - Careful and accurate work including, where appropriate, computation, manipulation, construction and measurement with correct units. 2 - Some errors, but not sufficient to invalidate the work. 0 - Inaccurate work.
CLARITY OF ARGUMENT AND PRESENTATION	4	4 - A clearly-expressed contribution with effective use of mathematical language, symbols, conventions, tables, diagrams, graphs etc. 2 - Adequate presentation, average use of appropriate language, symbols, conventions etc. 0 - Disorganised work, poorly expressed.
ORAL SKILLS	4	4 - Responds well to questions. Discusses and develops ideas clearly. 2 - Responds adequately to questions. Discusses and develops ideas with prompting. 0 - Incoherent muddled responses. Fails to comment effectively.

CATEGORY: PURE INVESTIGATIONS

CLASSIFICATION OF ASSESSMENT	TARGET GRADE	EXPECTED POSITIVE ACHIEVEMENT
IDENTIFICATION OF TASK AND SELECTION OF STRATEGY	B	Selects an efficient strategy. Identifies areas for investigation, adopts a systematic approach and controls the variables. Forms broad generalisations.
	D	Adopts a suitable strategy. Identifies some areas for investigation, adopts a systematic but perhaps lengthy approach and controls some variables. Forms incomplete set of rules and limited generalisations.
	F	Shows no clear reasoning to plan a strategy. Identifies a limited area for investigation, adopts an unsystematic approach. Makes simple generalisations.
IMPLEMENTATION, CONTENT AND ACCURACY	B	Wide use of mathematical concepts and methods.
	D	Sufficient use of mathematical concepts and methods.
	F	Limited use of mathematical concepts and methods.
		The target grade student would be expected to carry out their work to a considerable degree of accuracy, with possibly some errors but not sufficient to invalidate their work.
INTERPRETATION AND COMMUNICATION	B	Clear, concise explanations forming a continuous commentary with clear reasons for chosen lines of enquiry. Efficient use of mathematical language e.g. symbols, notation, tables, graphs, diagrams etc.
	D	Some explanations forming a commentary of the chosen lines of enquiry. Suitable use of mathematical language e.g *symbols, notation, tables, graphs, diagrams etc.*
	F	Some simple explanations of chosen lines of enquiry. Limited use of mathematical language e.g. symbols, notation, tables, graphs, diagrams etc.

CATEGORY: PROBLEMS, PRACTICAL IN METHOD

CLASSIFICATION OF ASSESSMENT	TARGET GRADE	EXPECTED POSITIVE ACHIEVEMENT
IDENTIFICATION OF TASK AND SELECTION OF STRATEGY	B	Efficient clearly-defined overall approach. Takes into account necessary constraints or conditions and consider alternatives. Effective use of geometrical techniques and appropriate choice and range of equipment. Produces product to meet all conditions.
	D	Suitable overall approach. Takes into account some of the necessary constraints and conditions and is aware of possible alternatives. Suitable use of geometrical techniques and appropriate choice of some equipment. Produces product to meet some of the conditions.
	F	No clear overall approach. Limited awareness of necessary constraints and considers no alternatives. Limited use of geometrical techniques and equipment. Produces product which meets few of the conditions.
IMPLEMENTATION CONTENT AND ACCURACY	B	Wide use of concepts and methods relating to drawing shape, construction, etc in the development of a practical solution.
	D	Sufficient use of concepts and methods relating to drawing shape, construction, etc in the development of a practical solution.
	F	Limited use of concepts and methods relating to drawing shape, construction, etc in the development of a practical solution.
		The target grade student would be expected to carry out their work to a considerable degree of accuracy with some possible errors, but not sufficient to distort their final product.
INTERPRETATION AND COMMUNICATION	B	Clear, concise explanations forming a continuous commentary with clear reasons for chosen approaches. Efficient use of mathematical language e.g. sketches, diagrams, nets, instructions, symbols, notations, tables, graphs, etc.
	D	Some explanations forming a commentary of the chosen approaches. Efficient use of mathematical language e.g. sketches, diagrams, nets, instructions, symbols, notations, tables, graphs, etc.
	F	Some simple explanations of chosen approaches. Limited use of mathematical language, e.g, sketches, diagrams, nets, instructions, symbols, notations, tables, graphs, etc.

CATEGORY: APPLICATIONS, PRACTICAL IN PURPOSE

CLASSIFICATION OF ASSESSMENT	TARGET GRADE	EXPECTED POSITIVE ACHIEVEMENT
IDENTIFICATION OF TASK AND SELECTION OF STRATEGY	B	Clearly defined problem. Selects an efficient strategy/overall approach in the development of a solution. Takes into account necessary conditions/constraints and considers alternatives. Effective use of techniques appropriate to problem leading to an acceptable and desirable outcome.
	D	Defines a narrow problem. Adopts a suitable strategy/overall approach in the development of a solution. Takes into account some necessary conditions/constraints and shows an awareness of possible alternatives. Suitable use of techniques appropriate to problem leading to a satisfactory outcome.
	F	Ill-defined problem. no clear strategy/overall approach in the development of a solution. Limited awareness of necessary conditions/constraints and consider no alternatives. Limited use of techniques appropriate to problem leading to a simple outcome.
IMPLEMENTATION, CONTENT AND ACCURACY	B	Wide use of mathematical concepts and methods relevant to the problem.
	D	Sufficient use of mathematical concepts and methods relevant to the problem.
	F	Limited use of mathematical concepts and methods relevant to the problem.
		The target grade student would be expected to carry out their work to a considerable degree of accuracy, with some errors possible but not sufficient to invalidate work.
INTERPRETATION AND COMMUNICATION	B	Clear, concise explanations forming a continuous commentary with clear reasons for chosen areas for of study. Efficient use of mathematical language e.g sketches, diagrams, nets, tables, graphs, lists, symbols etc.
	D	Some explanations forming a commentary of the chosen lines of enquiry. Suitable use of mathematical language, e.g. symbols, notation, tables, graphs, diagrams etc.
	F	Some simple explanations of chosen lines of enquiry. Limited use of mathematical language e.g. symbols, notation, tables, graphs, diagrams, etc.

Printed in England by Burgess & Son (Abingdon) Limited.

Published by the Shell Centre for Mathematical Education.

ISBN 0 906126 44 4

First published 1989.

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