Primary INSET MATHS

Organising and planning in-service training

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A S T I C

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Contents

INTRODUCTION

Effective INSET in mathematics requires careful planning. The needs of a school or cluster of schools, the individual strengths and weaknesses of the staff, the sensitive planning of staff meetings and the prevailing educational climate all play a part in determining the most effective programme of INSET activities.

The aim of this pack is to provide a springboard for those responsible for identifying and planning INSET requirements in mathematics. Not only does it consider developing new ideas for teaching mathematical content to pupils, but it also gives consideration to current thinking about styles of teaching and the roles the teacher can take.

We are in a time of transition, when personal styles of management need to be expansive enough to cope with the pace of the many current changes and their demands upon us. There is a need to:

- Mobilise resources;
- Identify and build on the best aspects of previous practice;
- Be sensitive when helping others to undertake change;
- Allow adequate time to plan and prepare.

The activities presented in this pack are intended to address these requirements.

The pack is divided into five sections, each covering a different aspect of organising an INSET activity, from inception to evaluation.

Preparing for INSET

This section helps anyone planning INSET in mathematics to identify and focus on areas in need of development. A sequence of activities is also provided which prepares you to tackle INSET activities confidently and successfully. Anyone interested in personal development in mathematics education may also select activities from this section to work on alone or with a small group of people. Further advice to support this section can be found in *Primary INSET*.

Current issues in mathematics

This section covers a broad spectrum of issues from teaching investigationally to assessment. The implications of government legislation for the classroom and its resources are considered, together with areas where current thinking and technology suggest a different approach to teaching mathematics.

Mathematical activities

Although the National Curriculum for mathematics sets out attainment targets for different areas, it is important to remember that mathematics is not a collection of disjointed topic areas but a hierarchical subject where previous knowledge in several areas comes together to make sense as a whole. It is the responsibility of each school to develop its approach to mathematics so that the National Curriculum requirements are properly covered. This section concentrates on mathematics and the way its teaching can be developed through a variety of windows such as art or the environment. Topic webs are used to illustrate the application of mathematics across the curriculum. This section also considers the applications of technology to mathematics and suggests ways in which parents can become more involved in their children's mathematical education.

Algebra and probability are covered in this section as separate topics. These are areas which have recently been introduced more explicitly into the primary mathematics curriculum, and which appear to cause concern to many teachers. The activities provided should dispel some of the myths surrounding these topics and enhance confidence in teaching them.

Taking stock and evaluating

Every INSET session should allow time for reflection and evaluation. Similarly every co-ordinator should take time to reflect on her role and the achievement of her aims in providing a cohesive and effective INSET programme. This section provides reflective activities to assist in this process.

Resources

Effective INSET provision requires keeping up to date with developments in mathematical education. It is important to be aware of new publications, software, and materials.

A list of these resources is provided on page 115, together with useful addresses. The resources section includes some details of those materials referred to in other sections of the pack.

PREPARING FOR INSET

INSET in mathematics may be initiated by a number of different people and for a variety of reasons.

The headteacher
You may be building or revising your curriculum plans, auditing your existing practices in light of the National Curriculum, or preparing a coherent resourcing programme in anticipation of emerging LMS frameworks.

The mathematics co-ordinator
You may be responding to a directive from the head, or answering a query from staff who are perhaps confused over policies or specific aims. You might also be setting up a dialogue over new issues, or satisfying the staff's desire to know more about latest initiatives.

Advisory staff
You may be reacting to a request from a school or a specific enquiry from a headteacher or a mathematics co-ordinator. Alternatively, you may have identified particular areas that it might be beneficial to develop.

Being an INSET leader

Our aim in writing this pack is to help the INSET leader:
- Deepen personal confidence;
- Widen educational horizons;
- Strengthen the idea of developing networks of ideas;
- Appreciate of the value of working with others.

To be a successful INSET leader, it is necessary to be able to recognise the needs of others. This assumes you have already identified your own anxieties, concerns and strengths.

The purpose of this pack is to help you build on your strengths, lessen any weaknesses that you think you may have, and transform any threats into opportunities for growth.

Establishing the climate

The following technique can be applied personally and then used later with those with whom you wish to work. It is known as SWOT analysis, SWOT being an acronym for Strengths, Weaknesses, Opportunities, Threats.

Activity 1

SWOT analysis

Using photocopiable page10, write in what you perceive as your personal strengths and weaknesses, as well as the current opportunities and threats that may help or hinder development within your institution.

After considering your own strengths and weaknesses, try out the same activity with colleagues to allow you to decide upon areas of priority for future INSET programmes. You may wish to use this approach to needs analysis alongside other techniques such as those outlined in *Primary INSET*, pages 9 - 16.

Talking to staff

When you encourage others to learn, it is important to stress that everyone involved will be learning ... yourself included. On your agenda for your own professional development and that of others should be:

- The acquisition of insights when instigating change;
- The acquisition of new skills;
- The gaining of fresh knowledge and ideas;
- The gradual development of a personal philosophy of teaching;
- The development of different ways of working;
- An awareness of the learning needs of children and adults.

All teachers should consider these aspects of professional development as a career-long process.

There are various ways of establishing dialogue about these issues:

- Informally on a one-to-one basis during break or over lunch;
- On a more formal basis at a specially convened staff meeting;
- Through shared activities in INSET sessions.

Finding a way forward

Once rapport with staff has been established it should be easy to define aspects of development on which you wish to work.

As a way of focusing on priorities the following activity could be used in addition to SWOT analysis.

As INSET co-ordinator you will need to think carefully about the various stages of this activity, taking into account the number of staff involved and their level of confidence in each other.

Activity 2

Focusing

Ask colleagues to fill in the grid on photocopiable page 11 to help identify any areas you may have overlooked. Allocate numbers 1 to 8 to indicate the order of priority for each item.Conclude this part of the activity by sharing the results as a group.

From the information you have gathered, prepare a list of possible INSET activities that meet those needs which staff have put in an order of personal priority.

Preparing yourself

It is important that you appear comfortable working with others, while at the same time people need to feel at ease with you. This will apply whether you work alone or as part of a team.

It is often easier said than done. The whole INSET event must be sustained at both the personal and the group level throughout. Personal confidence when delivering INSET often increases in direct proportion to the level of planning that has taken place.

Activity 3

Planning INSET

Before planning your INSET session, use the checklist on photocopiable page 12 to pencil in your initial thoughts when responding to a request to organise an INSET session.

SWOT analysis (see page 8)

STRENGTHS	WEAKNESSES
OPPORTUNITIES	**THREATS**

Focusing (see page 9)

ITEM	SPECIFIC EXAMPLES	PRIORITY (1- 8)
Aspects of the National Curriculum		
Classroom organisation		
Different styles of teaching		
Resources		
Working practically		
Finding time		
Using technology		
Assessing and recording		

Planning INSET (see page 9)

- Who is the audience?
- How have their needs been identified?
- What style(s) of INSET is (are) most appropriate?
- Do you need to involve others?
- What pre-course tasks could be of value?
- Draft an outline of the day.
- Is there continuity and progression throughout the envisaged activities?
- Is there sufficient flexibility to allow for a change in direction?
- Is there variety and access for all course members?
- Have you allowed for an effective feedback mechanism?
- Can teachers take away materials for subsequent use in their classrooms?

Management

Being an INSET leader or a teacher with special responsibility for some part of the school curriculum is an important job. The boundaries of the job are seldom static, more often they are constantly being pushed out.

Activity 1

See yourself as others do

Ask yourself the following questions for self-assessment:

- How many different people do you relate to in your job?
- What expectations do they have of you?
- What are the roles you fulfil? How many different hats do you have to wear?
- To whom are you accountable and for what?

Discuss these four questions with colleagues who have similar posts to yours.

Activity 2

Personal qualities

Think of colleagues who have had management roles to fill, either in your own or in another school.

On your own, then with colleagues, itemise the essential qualities of leadership.

It may help to think of management qualities under three headings:

- Personal qualities;
- Professional qualities;
- Communication and relationships.

At a previous INSET course these were some of the words used to describe an effective co-ordinator.

- Warm, supportive, adaptable;
- Committed, organised, efficient;
- Delegates, encourages, co-operates.

What management philosophy or styles can you identify? What are the essential characteristics of each?

Activity 3

'Not all is rosy'

Work together with colleagues to consider the following questions.
- What factors make for poor and inadequate management?
- How can they be overcome?

Managing change

Since the advent of the Cockcroft Committee of Enquiry and its subsequent report, education seems to have been in a state of never-ending change. Now with the successful presentation of the National Curriculum and plans for the close monitoring and assessment of pupils' progress, more changes to your existing policies and practices are inevitable.

Mathematics co-ordinators or those responsible for mathematics within a school might find it useful to consider the following activities.

Activity 4

If only ...

Often colleagues throw out smoke screens to confuse the issue of change. Discuss the following questions with other members of staff:
- What reasons are usually given for resisting change?
- Why do people resist change?
- What strategies can be used for overcoming resistance?
- What are the essential factors that assist the management of change?

Activity 5

Shutting up and putting up

Change to existing practices and policies may be perceived as a threat by some of your colleagues. Scepticism and growing personal

uncertainty are two aspects of professional conflict which have emerged during recent changes. Consider the following questions:
- There are other aspects of professional conflict. What are they?
- How can they be reduced?
- Can they be overcome? How?
- Can conflict over change be avoided? How?
- How different is group insecurity from individual apprehension?

Activity 6

Leading by example

Select a small change in your school's practices that you would like to see implemented.

Make two lists headed STRATEGY and TACTICS, showing how you would gain support from colleagues for the change you envisage.

Managing others

The management of others cannot be considered separately from the issues of teaching and learning. These are the main preoccupations of most teachers. The management of others can no longer be seen as a 'bolt on' concern; management must focus on current practices and policies, if it is to be seen as an integral part of all the processes taking place in our schools.

With this idea of management in mind, teachers will be seen as sound investments for the future, while the role of all managers and the aim of management should be to empower all staff to work more effectively with less stress.

Activity 7

Sharing with colleagues

Most interaction within schools is between young people and adults. The opportunity for adults to work together and share insights, problems and preoccupations is limited. Devise ways in which colleagues can meet and reflect on their ways of working. One possible focus could be to look at the ways in which they organise themselves or their rooms. Alternatively, how do they teach a particular ability grouping? Compare the similarities and differences in the various ways of working.

Think of a common event such as the school fete or Christmas production which could be used to encourage staff to examine the advantages as well as the disadvantages of working together.

Activity 8

Identifying strengths

Devise a special event, for example an INSET day on the subject of problem-solving, that will focus your staff's attention on working together and make explicit the strengths that exist. Ask colleagues to identify their own perceived strengths and weaknesses. How does this compare with their perceptions of others?

- How well known are individual strengths and interests among the staff?
- How have strengths been used?
- How many staff feel that their strengths have not been built upon?

Activity 9

Working together

When adults work together, confidence tends to grow, and it becomes easier to cope with the conflict and uncertainty caused by change. Sharing with others helps to free the individual to get on with the task in hand, and having more than one perspective can only be helpful.

'Professional growth is deeply rooted in personal security.' Discuss with colleagues whether you agree or disagree with this statement. What mechanisms can be devised that will allow staff to work more collaboratively?

Delegation

With so much to do in schools today, it is essential that teachers with special responsibilities delegate certain aspects of their role. This means entrusting authority and responsibility to others, *not* just asking them to carry out your instructions.

Activity 10

Delegating

Discuss with colleagues the concept of delegation.

- What is delegation?
- Why delegate? How well do you delegate?
- What ought you to delegate?

• How is a good delegator perceived by others?

List all the jobs you have to do and estimate the amount of time you spend per week on each aspect of your role. Then decide:

• What can you delegate?
• To whom?
• How will you do it?
• How will you prepare and support those to whom you have delegated responsibilities?
• How will you monitor, support and evaluate the progress made?

Activity 11

Letting go

Some people may believe that delegating undermines their authority or status. Perhaps they don't fully understand the extent of their responsibilities.

• What is it that prevents others from delegating?
• How could they make it easier for themselves to delegate?
• What would be the effect of increased delegation?

The management of meetings

Teaching staff now have to attend more and more meetings inside and outside school. Individual staff are often asked to organise, run and chair specific meetings.

Activity 12

Making meetings worthwhile

Use the following questions to help you consider the aspects of meetings which you have found worthwhile and useful:

• What makes a good meeting?
• What is achieved at good meetings?
• What preparatory activities ensure good meetings?
• How can you use these factors to build on when preparing your own meetings?

The management of time

'If only there were more hours in every day!' How often have we heard this cry? Time is something we all need to help us plan, notify, prepare, prioritise and process all those essential activities that make up our individual roles.

Activity 13

The urgent versus the important

Examine all that you (and your colleagues) do.

• Clarify the long-range objectives.
• Itemise the daily goals.
• Organise regular times for planning.
• List fully your daily and weekly plans, clearly highlighting the priorities you have to achieve and the deadlines you have to meet.

Activity 14

Awfully sorry, but no!

Why is it so many of us find it difficult to say 'No' to requests from other colleagues?

• Do you realise why you say 'Yes' when you should have said 'No'?
• Are there any strategies which might help you say 'No' more often? What are they?
• When and why is it important to say 'No'?

Building the programme

Once you have identified the type of course you think is appropriate for your INSET group, look more closely at the finer details of the course. You may find it beneficial to refer to *Primary INSET*, pages 17 - 39. You can now start building the actual programme.

Your programme should reflect the timing and duration of the activities proposed. Tiredness at the end of a school day can best be overcome with an activity that ensures total involvement and is perceived to be worthwhile, whereas activities at the beginning of a full day's INSET may need to be gentler and more sympathetic to those who may have had a long journey. Sensitivity to the physical comfort of others is essential.

Activity 1

Building a programme

Imagine your INSET group comprises the staff of a new school of whom you are the only one with a specific mathematical background. They have identified areas in need of attention as in Figure 1.

Plan a series of four activities for their next training day that will:

- Allow access to mathematics at the teachers' own level through a variety of tasks;
- Give the teachers space to take on board and develop ideas for subsequent use in their classrooms;
- Use technology and appropriate resources;
- Be in sympathy with latest requirements for the assessment and testing of children;
- Allow for discussion and reflection;
- Reflect the philosophy and spirit of paragraph 243 of the Cockcroft Report, which says: 'Mathematics teaching at all levels should include opportunities for

Item	Specific examples	Priority (1- 8)
Aspects of the National Curriculum		
Classroom organisation		
Different styles of teaching		
Resources		
Working practically		
Finding time		
Using technology		
Assessing and recording		

Figure 1

- exposition by the teacher;
- discussion between teacher and pupils and between pupils themselves;
- appropriate practical work;
- consolidation and practice of fundamental skills and routines;
- problem solving, including the application of mathematics to everyday situations;
- investigational work.'

When you have thought of some appropriate activities, compile a list of relevant materials and books to reinforce your training day.

A case study

There follows a description of the planning of an actual INSET day. All the activities mentioned are fully described in this pack. Two advisory teachers did the planning; as you read you might like to consider who would do it in your school.

Before the day

A brief had been given to the two leaders before meeting the INSET initiator. The requirements were succinct. The target group would comprise 22 women teachers considering a return to the classroom. The two days were to be concerned with updating their mathematical perspectives, informing them of current practice and discussing ways to implement them in light of the National Curriculum, with particular reference to Profile Component One.

First meeting
The organisers first met to examine the brief and brainstorm some initial ideas, trying to interpret and come to terms with the requirements in light of what they could offer. Experience dictated that the first meeting with the teachers would have to secure their confidence. They would also have to provide a breadth and variety of activities to engage and sustain their interest.

Second meeting
The leaders then met with the initiator to discuss their interpretation of the course brief. The initiator accepted certain aspects, but others did not meet her criteria and were abandoned. She clarified her objectives for the course, which were to increase the teachers' confidence in mathematics and mathematics teaching.

Third meeting
The organisers met a third time to plan in greater depth. On a large sheet of paper a framework was drawn up for both days, as follows:

8.45 Registration and coffee
9.15-10.45 Session one
10.45-11.15 Coffee

TIMES	SESSIONS	AIMS AND OBJECTIVES
DAY ONE		
9.15-10.45	Session one:' I like maths when..."I don't like maths when...' (NB Responses to be pinned up)	To locate strengths, identify inhibitions to be overcome and highlight the importance of different teaching styles.
10.45-11.15	Coffee	
11.15-12.45	Session two: 12 number activities (to be attempted in pairs)	To identify and justify the methods, formal or otherwise, that participants used.
1.00-1.45	Lunch	
1.45-3.15	Session three: A calculator trail (a series of activities)	To allow discussion about the growing role of the calculator.
3.15-3.45	Tea	
3.45-4.30	Plenary	To sum up and gauge reactions to the day.
DAY TWO		
9.15-10.45	Session one: A square of chairs	To show the need for generalising and examine the importance of pattern, to encourage group activity and reveal the value of discussion.
10.45-11.15	Coffee	
11.15-12.45	Session two: Bars of chocolate	To promote understanding of fractions in a practical situation, encourage group work and provide opportunities for discussion.
	The orchestra	To show that a light-hearted approach can be made to areas of the curriculum.
1.00-1.45	Lunch	
1.45-3.15	Session three: Piecing together PC1	To put what we have covered into the perspective of the Programmes of Study.
3.15-3.45	Tea	
3.45-4.30	Plenary	To provide an opportunity for evaluation sheets to be completed and to re-examine the teacher's feelings about mathematics, compared with their initial reactions.

Figure 2

11.15-12.45 Session two
1.00-1.45 Lunch
1.45-3.15 Session three
3.15-3.45 Tea
3.45-4.30 Plenary

For the two days there were six activity sessions and two plenaries that needed to be planned in depth. The organisers identified the necessary areas of mathematics within Profile Component One and investigated activities that were best suited to achieving the goals (Figure 2).

Fourth meeting

The organisers examined the plans so far and shared their reactions. Would each session be 'meaty' enough? Would there be enough:

- Material to sustain discussion and encourage the teachers to share their rections and insights?
- Variety a balance of doing, sharing, thinking, reflecting, discussing and conjecturing?
- Food for thought and future action?

The six sessions then had to be planned in greater detail:

- What materials would be required?
- What handouts had to be prepared?
- What resources had to be brought together or ordered?
- What needed to be done about matters such as booking rooms and catering?

Appropriate lists were made and tasks shared out, and the organisers were convinced that they had outlined a programme which delivered ideas while making the underlying philosophy explicit.

For the day in general:

- A personal welcome letter had to be constructed;
- A booklet outlining the programme for the course, names of the participants and a few puzzles and problems had to be written, printed and collated;
- An evaluation sheet had to be designed and printed;
- The catering arrangements had to be checked and confirmed.

Fifth meeting

At a final planning session, various ways of welcoming the teachers and introducing the course were discussed, and the organisers decided which of them would lead each session and what role the other would take.

CURRENT ISSUES IN MATHEMATICS

Any programme of teacher and curriculum development must be considered within the context of the whole school. Many schools will have a Development Plan which will make clear the spirit, style and emphasis of the work undertaken as part of INSET. Following the 1988 Act, this has been formalised as a requirement for each school in introducing the National Curriculum. We believe these Development Plans will be enhanced by focusing beforehand on:

- Management at all levels;
- Teachers acquiring knowledge;
- Developing different ways of working;
- Curriculum review and development;
- Assessment, record-keeping and reporting to others;
- Developing cross-curricular themes;
- Making available resources to match development;
- Retraining staff and building confidence.

School Development Plans are about strategic planning and will influence the next stage in which you will be directly involved, namely delivery. Remember, others will exercise 'quality control'.

When planning and organising INSET for others, it is essential that your aims and objectives for teacher and curriculum development are embedded in the wider aims and objectives of the school and are embodied in the school's Development Plans.

Whenever teachers meet to discuss development, whether informally over a cup of coffee at break time or more formally in staff meetings, courses or training days, there are certain issues that must be addressed.

These include:

- Access;
- Resources;
- Involving others;
- Technology;
- Classroom organisation;
- Assessment;
- Teachers' roles;
- Taking stock and evaluating.

These issues are addressed in more detail later in this section, and in the final section, 'Taking stock and evaluating'.

Also to be considered are general management issues concerning:

- Others;
- Yourself;
- Time;
- Curriculum balance and continuity;
- Change;
- Conflict;
- Resources and technology;
- Meetings with others.

Anyone intending to plan and deliver a programme of in-service support should consider these issues.

Access

The advent of the National Curriculum should ensure a continuity of experience for all children from five to sixteen. It should also allow pupils to progress through the Programmes of Study at a rate suited to their abilities rather than to their age. This framework allows for the provision of a curriculum that has:

- Entitlement for all pupils, irrespective of cultural background or gender;
- Breadth and balance;
- A variety of experiences matched to individual needs.

Before the INSET event, ask teachers to collect together representative teaching materials for mathematics to bring with them to the session.

Any programme of mathematics should adequately reflect the cultural diversity from which it evolved. All too often mathematics is portrayed as a western phenomenon. The following activity explores this area.

Activity 1

Identify the culture

In small groups, examine your existing schemes, resources and practices and respond to these questions.

- Are you encouraging a cultural perspective that will encompass all the children in your school?
- Are you at any time reflecting a non-European society or culture?
- Does your existing maths policy reflect the fact that maths belongs to everybody's cultural heritage?

In the light of this discussion, consider as a group the teaching materials the participants have brought to the session.

- Do the materials present images of different lifestyles?
- Is any one lifestyle more prominent than others?

• Does the material perpetuate stereotypes?
• Is it sensitive to the religious, moral and cultural values of the various ethnic groups?

In plenary, discuss how you will deal with any incompatibilities that arise and put them in order of priority.

Activity 2

Gender

Gender bias exists in almost all situations. In this activity we suggest a number of ways of looking for gender bias within your school.

Stage one

Read to the group the following quote from a mathematics adviser: 'The difference between real mathematics and everyday mathematics is that boys do the former...'. Research by Walden and Walkerdene (see Booklist, page 115) has shown that by the age of 16, girls tend not to perform as well as boys in mathematics. As a group, discuss the reasons for this fact. Consider the following questions:
• How can we redress this imbalance?
• Is it the place of the primary school to address this problem?

Stage two

Ask the group to form pairs. Ask each member of each pair to imagine a classroom scene in which two computers are being used as an integral part of teaching, then describe the picture, considering these questions.
• What are the computers being used for?
• Who is sitting at the computers?
• Who is tapping at the keyboards?
• Who is forcing the pace?

Ask the partners to share what they are 'seeing'.

Stage three

Still in pairs, imagine sitting with a group of children on the carpet discussing mosaic floors as part of a topic on the Romans.
• Are some pupils more vocal than others?
• Do some pupils command more of your attention?

Now as a group discuss the mental pictures the pairs have developed.

Stage four

Examine the classroom materials which participants have brought, and comment on how girls are portrayed. In what roles are they cast?

Ask participants to consider the 'best' boys and the 'best' girls in their classes, then list the attributes that make them 'best'.

Examine the differences and similarities between the lists. What conclusions can you draw about the way we perceive boys and girls?

As INSET leader you should challenge course members to identify the ways in which they might raise their expectations of girls' achievements and reduce any negative perceptions that may exist. As part of the continuing school development, teachers may find it beneficial to check their perceptions by short periods of classroom observation.

Activity 3

Mixed ability provision

Ask participants to consider the mathematical activity that takes place in their classrooms.
• How are the children grouped?
• Why do they arrange the class in the way that they do?

Ask the group to imagine they are setting a task for their class on number bonding.
• How will they present the activity?
• Who do they have in mind when presenting the new material?
• Are there materials or support for all children, including those children who are perceived as having special needs?

In the light of these discussions, do participants feel their present policies need revising?

Resources

People are the most important resource within a school. The quality of the experiences provided for a child's education will depend on people's attitudes, experiences, imagination and enthusiasm. The people involved include the cleaners, caretakers, cooks, teachers and visitors; in fact anyone who has contact with the school. Without well-motivated people, the management and use of all other resources will be ineffective.

Within your school there ought to be a policy statement about the provision and management of resources. Use the following activity to review the school's policy statement. If no such statement exists, the activity can be used to highlight the features the school would wish to include when the policy statement is written.

Activity 1

General resource issues

Ask participants to consider the way in which their school addresses the following issues concerned with resources:

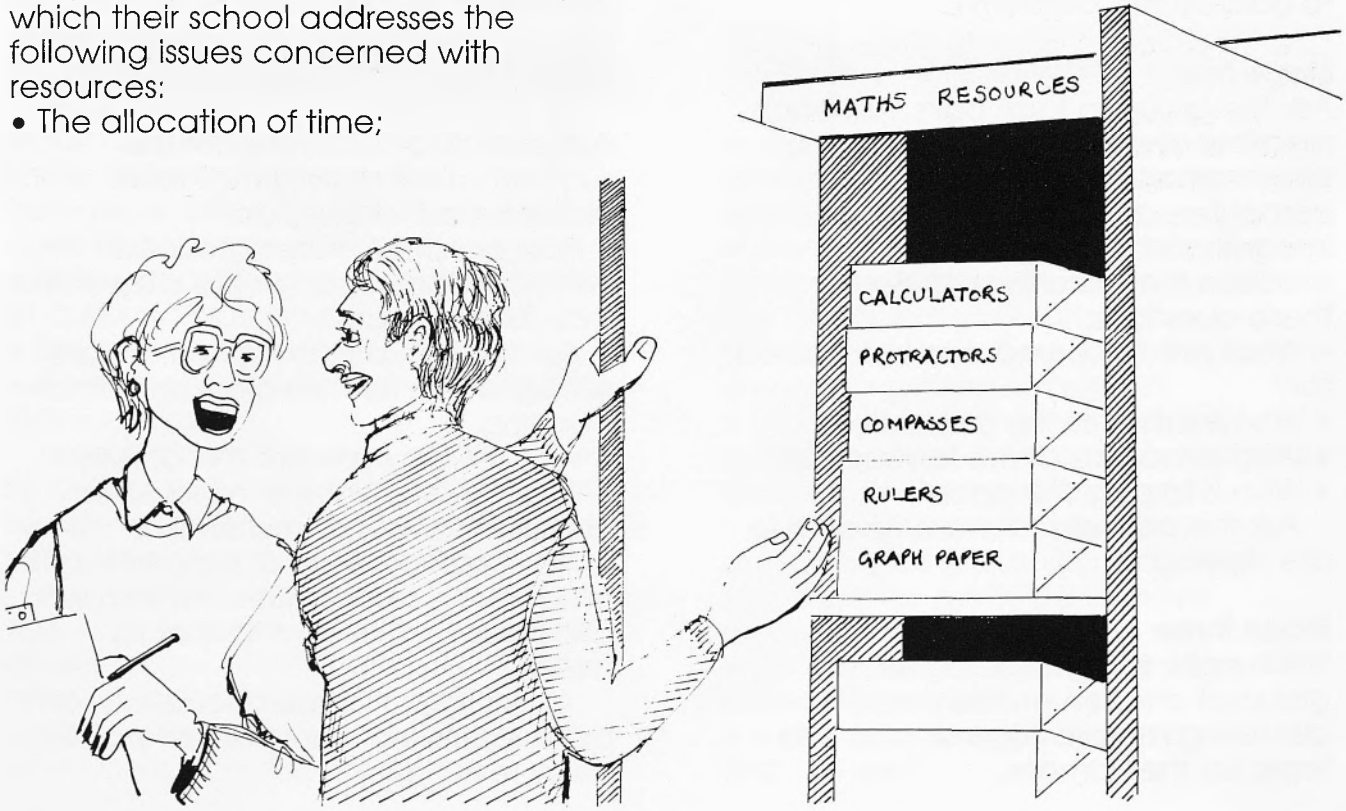
- The allocation of time;
- The provision of furniture;
- The size of classes;
- The allocation of rooms;
- The provision of storage facilities;
- The availability of outside help;
- The organisation of classrooms;
- The availability of finances.

How effective do they consider the school's approach to be? Can it be satisfactorily implemented? What improvements can be made? Is the financial spending well directed? Are there any new and emerging needs? If so, what are they? What mechanism exists for you to project your future needs?

Activity 2

Material resources

Apart from people, other resources generally used in classrooms include the following:



- Textbooks;
- Software;
- Videos;
- Published schemes;
- Calculators;
- Apparatus;
- Consumables;
- Microcomputers.

Ask the course members to form small groups and consider how these resources are allocated. Do participants believe that some resources are over-represented while other important ones are given insufficient emphasis?

Are all staff aware of the availability of existing resources? Where are the resources situated? Are they accessible to all? What are the implications of siting resources centrally?

In what way are both teachers' and pupils' knowledge and experiences used as a resource in the classroom? Ask participants to consider how effectively they use themselves as a resource, or allow others to make use of them.

Consider each of the material resources listed above and make a comprehensive catalogue of all that is available. You may have to peer into a few dusty cupboards! You may also find that some materials are inappropriate and some books are dated.

Discuss your catalogue and as a group attempt to evaluate the appropriateness of these items for children's mathematics education in the 1990s.

Activity 3

Design and balance

Whatever the level of resourcing within your institution, there are strong guidelines already written that will help you and your colleagues design schemes of work to ensure breadth and balance of experience for children. Distribute copies of photocopiable page 26 and ask the group to read carefully through them. Each of these headings from the Non-Statutory Guidance should be examined in detail by staff. Every attempt should be made to incorporate them into development work currently underway, and to integrate them into existing practices. In order to help you focus on all these issues, work in small groups and consider the questions below:

- Which of the criteria are you currently meeting?
- How satisfactorily are these criteria being addressed?
- How are each of the criteria being resourced?
- Would a reallocation of resources improve the way you meet the criteria?
- How can this be realistically achieved in the short term?
- What additional support do you need in order to meet the criteria more fully?

See Resources, page 115, for lists of recommended materials, books, software and videos.

Design and balance (see page 25)

In section five of the Non-Statutory Guidance for Mathematics, pages B7-11, it is stated that activities should:

- Bring together different areas of mathematics;
- Be flexible in their order;
- Be balanced between tasks which develop knowledge, skills and understanding, and those which develop the ability to tackle practical problems;
- Be balanced between the applications of mathematics and ideas which are purely mathematical;
- Be balanced between those which are short in duration and those which have scope for development over an extended period;
- Where appropriate, use pupils' own interests or questions either as starting points or as further lines of development;
- Where appropriate, involve both independent and co-operative work;
- Be both of the kind which have an exact result or answer and those which have many possible outcomes;
- Be balanced between different modes of learning: doing, observing, talking and listening, discussing with other pupils, reflecting, drafting, reading and writing, etc;
- Encourage pupils to use mental arithmetic and to become confident in the use of a range of mathematical tools;
- Enable pupils to communicate their mathematics;
- Enable pupils to develop their personal qualities;
- Enable pupils to develop a positive attitude to mathematics.

Involving others

Schools today are very busy places with different people involved in various activities at different times throughout the day. The people involved could be governors, parents, LEA support staff, other teachers, ancillary staff, students or older schoolchildren. All of them have a distinctive part to play in the education process as well as contributing to a richer environment for the children's education.

Activity 1

Who, what, when and why?

As a group, consider the following questions:

- Does your school have a policy for involving others?
- Do you actively encourage others to join you in your place of work and contribute to the jobs you are doing?
- What different groups of people could be invited to get involved in the education of children?
- What might be the benefits of having an open-door policy?
- How open-minded are you about involving others? What problems does this entail? Can the problems be adequately overcome?
- Is there a way of involving others more effectively?
- Are you involving your governors so that they can effectively fulfil their role in support of the school?
- Are you involving local industries enough? Can they be involved more constructively?
- Are you aware of the interests and strengths of people who live locally, and would be only too willing to drop in and get involved with the children?

Activity 2

Working with colleagues

Years ago it was all too easy to retreat into the privacy of one's classroom and firmly close the door. In these times of change, however, there is a great need to share with others and benefit from the strengths of colleagues. Yet talking to other teaching staff needs time, space, planning and preparation. Discuss the following questions:

- How often do you visit colleagues in their classrooms?
- What are the purposes of such visits?
- How often do you stay and work?
- Are there any ways in which liaison could be improved?

Technology

On the whole children accept technology far more readily than adults. For them there is no hesitation about programming the video, setting the microwave or dialling in the instructions on the washing machine. This is how it should be; they have grown up with technology, few of them understand our nostalgia for a black and white television, let alone understand the word wireless. For today's children, technology is simply a fact of life!

In our schools technology should abound. Calculators and microcomputers should be regarded as an integral part of any mathematics classroom and not as an extra item dictated by the National Curriculum. It is important to consider the opportunities and advantages this technology brings. Children should have direct experience of technology in all its manifestations.

In mathematics the support offered by technology for teaching and learning is obvious. The calculator, the computer and the video have an immense value and influence on the way we now learn and teach mathematics.

Calculators can take the drudgery out of 'number crunching' in many problem solving activities, and they allow the nature of the activity to become more prominent. Computer technology can introduce a dynamic aspect to many activities hitherto viewed as static. Computer spreadsheet and database activities can illuminate the different ways of displaying data, and the speed with which they are accomplished will allow more time to discuss their appropriateness to a variety of situations.

In the same way, pupils' appreciation of shape and space has been greatly enhanced by the introduction of LOGO. Their awareness of algebra is also developed as children learn how to use variables to produce similar shapes in a variety of sizes.

Activity 1

Calculators and computers

Discuss with the group your attitudes towards calculators and computers.

- How are the views within the group similar and/or different?
- How often do you have access to a computer?
- How many calculators are there in your classroom?
- When are the children allowed to use calculators or computers?
- Write down three instances in the last two weeks when your pupils have used either calculators or computers.
- What types of problems have you had when introducing new technology into your school?
- How realistic are the claims of those who prefer not to provide calculator work?
- How do parents feel about the use of calculators?
- Have you a school policy on the use of calculators? What does it say? What does it assume?
- How many members of the group carry a calculator?

The calculator

The pocket calculator has been around now for over twenty years; many homes now have them, and many people have their own personal calculator. However, some schools and some teachers feel that the arguments for and against calculator use have still not been adequately aired. There are still sceptics on this subject.

What role, if any, does the calculator have in the primary classroom? If used solely as a device for providing quick answers to sums, the calculator is of limited value. However, it can do much more than this; it can provide a rich stimulus for mathematical exploration and, more importantly, it can give pupils a deeper confidence in their ability to handle realistic numbers. Others have shown that the use of calculators also encourages mental work and promotes discussion, while allowing pupils the opportunity to generate their own mathematics and devise their own algorithms.

Activity 2

Promoting the use of calculators

Discuss the following questions:
- In what ways can you increase the confidence of staff in using calculators?
- In what ways can you increase the use of calculators in your classroom or school?
- How can you inform parents about the ways you or the school intend to use calculators?
- What are the resource implications if every member of staff wanted to use calculators more than they do now?
- At what age should children be allowed access to calculators? Should infants have ready access to calculators?

Activity 3

Investigating with a calculator

The results of research on calculator usage in primary schools have been well documented and it appears that pupils who have used calculators have increased their facility for number in a dramatic way.

The following problems are intended to illustrate the value of using a calculator. Try them in groups, and then consider the following questions:
- How did using a calculator alter your approach to these activities?
- In what way is the use of a calculator beneficial in these situations?
- What organisational problems can you envisage when undertaking similar activities with pupils?
- What implications does this have for your teaching style?

Pattern

Work out the following:
- 6 x 7;
- 66 x 77;
- 666 x 777.

What do you notice? Can you continue the pattern? Can you state a rule?

Now try the following:
- 9 x 6;
- 99 x 66;
- 999 x 666.

Can you continue this pattern? Can you state a rule?

Now consider:
- I x II;
- II x III;
- III x IIII.

or:
- II x II;
- III x III;
- IIII x IIII.

Can you continue the pattern? Can you state a rule?

Numbers ending in 5
- 45 x 55 = 2475;
- 45 x 65 = 2925;
- 65 x 25 = 1625;
- 85 x 35 = 2975.

Continue multiplying together numbers that end in five. Tabulate your results. What observations can you make?

Decimals

Find two decimal numbers which add up to 1 exactly. What is their product?

Try other pairs of numbers that add up to 1 and work out their products.
- What is the biggest product you can obtain?

• What is the smallest?

Extend your investigation by considering three decimal numbers which add up to 1.

Computers

In most schools, teachers will have access to at least one computer, which they will want to use in the most effective way. The computer can be incorporated into classroom activities for a variety of reasons:

• To introduce a new concept;
• To give practice in using a concept;
• To help reshape a concept that has been misunderstood.

Many children react happily to a computer because it doesn't prejudge them or give them big red crosses. Mistakes are between them and the computer and are willingly rectified.

Activity 4

Who uses the computer?

In small groups, discuss the following statements.

• Boys always use the computers more than girls.
• In a mixed group of children, the boys always do the typing.
• You cannot use one computer with a whole class.

Activity 5

Effective use of computers

Consider the software available in your school. As a group, identify pieces of software that can be used for each of the three applications previously mentioned: introducing, practising and reshaping a concept. Consider the following questions.

• What is it about the software that makes its use appropriate?
• Is there an alternative to the software? If so, can you justify its use?
• What other activities would you use to support or integrate the software?
• What conclusions can you draw from considering these questions?

Films and video

The use of film and video in schools has two main applications; to record pupils' activity for later assessment or as a focus for an INSET activity, or to show commercially prepared programmes, which may demonstrate concepts more explicitly than other visual resources can. One example of this is *Dance Squared*, a piece of animated film in which a square is dissected and rearranged in a wide variety of formats (see Resources). It is an excellent introduction to shape activities, including symmetry and tessellation (see page 48).

Activity 6

Using video

Discuss the uses you make of the video recorder and classify the type of activities this machine supports. Consider the following questions.

• How many video recorders do you have? What problems of organisation does this entail?
• Could you make better use of your video equipment? How would staff like to use the video recorder?
• How many mathematical programmes have you in your library? How are they used and built upon?

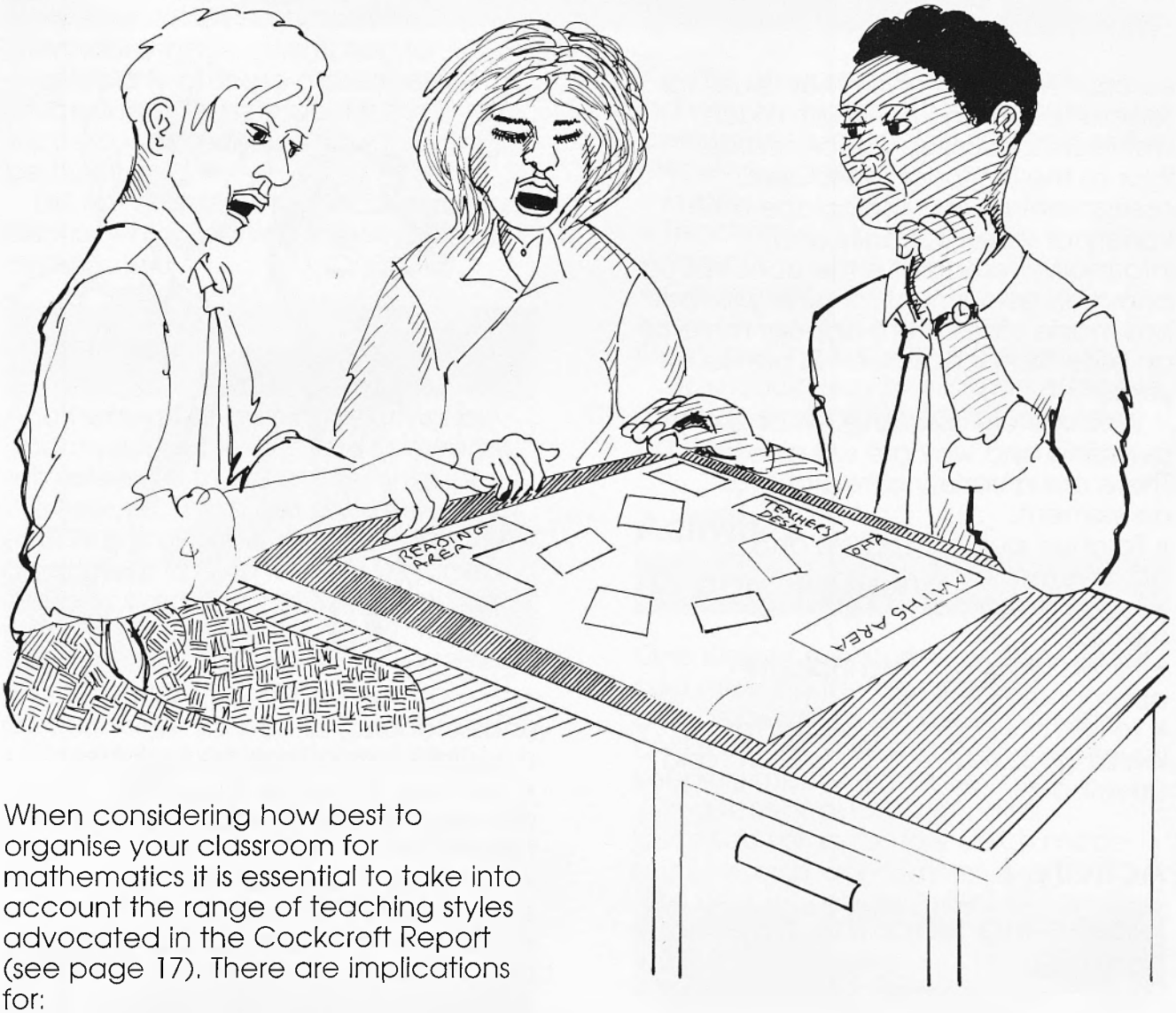
Activity 7

Interactive video

What do the staff understand by the term 'interactive video'?

• What examples of interactive video have they seen? Have they used any themselves?
• What do they think this aspect of technology might have to offer the teacher?
• How can the school budget for this latest technological initiative?

Classroom organisation



When considering how best to organise your classroom for mathematics it is essential to take into account the range of teaching styles advocated in the Cockcroft Report (see page 17). There are implications for:

- Furniture arrangement;
- Availability and accessibility of resources;
- Whole class activities;
- Group activities;
- Individual activities.

Activity 1

Organising your classroom

In pairs or threes, consider each other's classrooms and think about the various forms of organisation undertaken in each, indicating the advantages and disadvantages for the areas listed above.

- What similarities and differences are there?
- Are resources readily available and easily accessible to both pupils and teachers?
- What implications can others draw from this?
- Does any one of the teaching styles advocated in paragraph 243 of the Cockcroft Report (see page 17) dictate how your classroom is organised at present?
- Can you see a way of reorganising your classroom which would let all the teaching styles flourish?

Assessment and record-keeping

Assessment is one of the key issues for teachers and one on which much staffroom discussion concentrates. Prior to the National Curriculum, assessment always took place on a variety of levels, formally and informally. Perhaps it is the concept of common assessment for all pupils that has made assessment appear more of an issue than it has been in previous years.

Who are we assessing, what are we assessing and why are we assessing? There are a variety of reasons for assessment:

- To chart pupils' progress and achievement;
- To identify areas of weakness and success;
- To aid diagnosis and indicate appropriate action;
- To identify pupils' strategies for learning so they may be built on and developed.

Activity 1

Assessing what the pupils can do

Assessment should be about finding out what pupils *can* do, not what they cannot do.

As a group, examine a recent assessment activity in mathematics.

List the concepts and processes you have tried to assess, using the National Curriculum attainment targets if you wish.Can you assess the following factors?

- Have the children seen connections in the mathematics?
- Have they integrated a variety of disparate experiences under some general concept?
- Have they gained a sense of coherence about a topic, and an understanding of how all the associated language fits together?
- Are they articulate about the meaning of the associated technical terms?
- Can they apply standard and novel examples to a concept?
- Can they articulate what the topic is about and give examples of the sort of question it might answer?
- Will they be able to use this knowledge confidently in future topics where these ideas may be a tool?

Activity 2

Effective assessment

Examine the following two statements and list the reasons why you think they might be important.

- Assessment might look for evidence of pupils participating actively and constructively in group work and discussions.
- Assessment might take into account

a pupil's ability to respond in a variety of situations and to work mathematically in oral, practical and written tasks, in order to give each pupil the opportunity to express herself in the most appropriate way.

Ask staff to identify situations in which they have attempted to employ any of these assessment procedures. As a group, list the successes and discuss how they might be built on.

List the problems that occurred and discuss ways in which they might be overcome.

Self-assessment

Another way of gaining information about your pupils and to encourage self-esteem is to ask pupils to assess themselves. There are several ways of encouraging pupils to make self-assessment and to identify their own areas of strength and weakness. These include:

- Writing about a piece of mathematics they have recently completed;
- Completing a record sheet on a regular basis;
- Discussing their work with the teacher and recording the outcomes together.

Activity 3

Self-assessment guidelines

Ask individuals to consider each of the self-assessment approaches above and make a list of the guidelines they would need to give to the children in order to make the self-assessment procedure effective and successful.

Use the following questions as a focus for a group discussion.

- Should the assessment procedure reflect the pupils' feelings?
- Does self-assessment affect the pupils' self respect?
- Is the time spent in making self-assessment worthwhile?
- What are the implications for introducing self-assessment procedures in your school?

Activity 4

Who is assessment for?

Ask the group members to work individually to identify the reasons why assessment is important to each of the following groups:

- Pupils;
- Teachers;
- Parents;
- Governors;
- The LEA and government.

Compare the lists within the group.

How could you provide an effective mechanism to satisfy all interested parties?

Activity 5

Record-keeping

One way of monitoring pupil progress and meeting the demands of the groups identified above is to design and maintain an effective record-keeping mechanism.

In a recent publication, HMI identified some factors which made pupil records worthwhile:

'The best records included information about

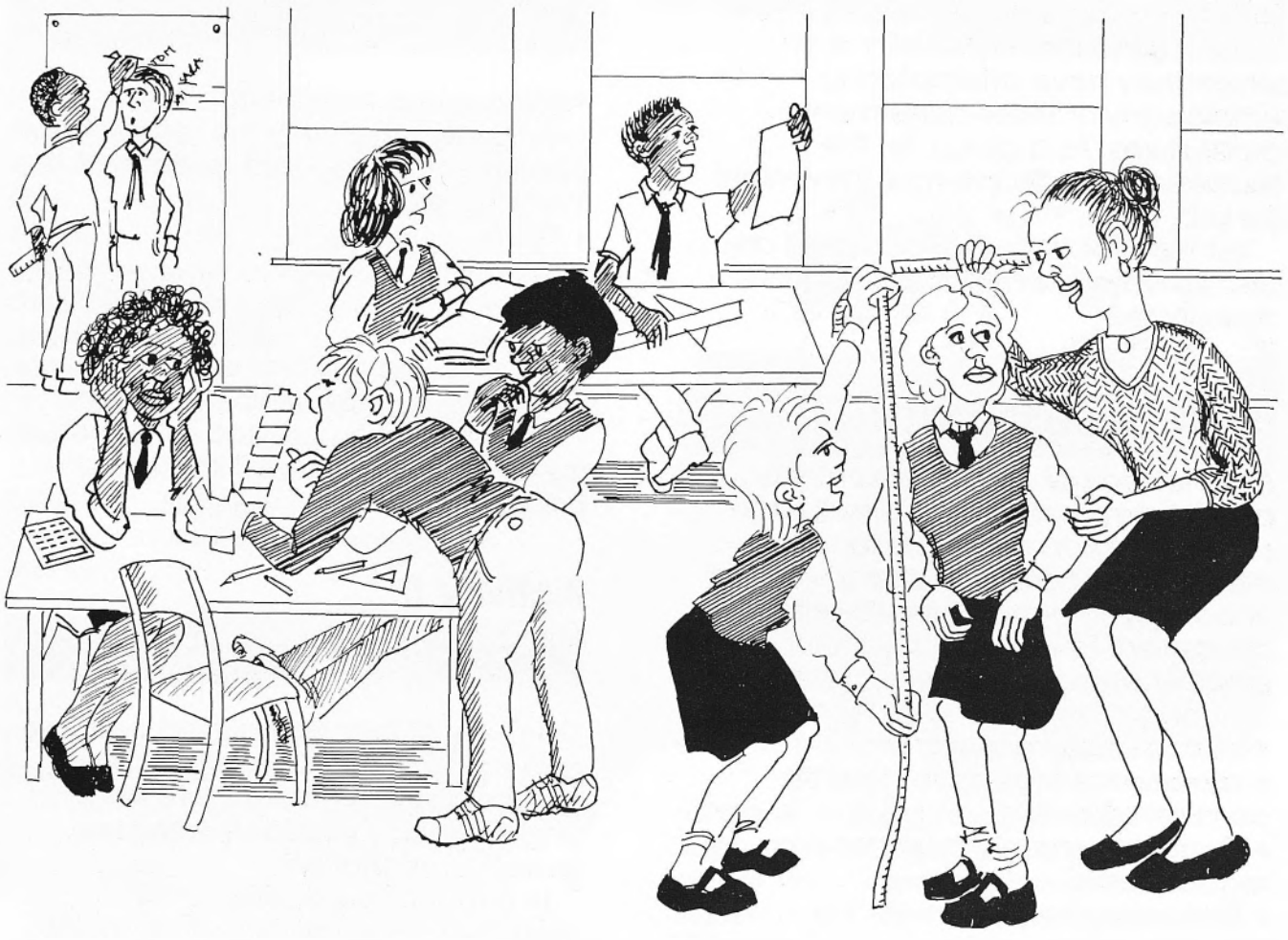
- the work covered
- the equipment used
- the evidence of concepts understood
- the skills practised
- samples of work
- comments about the children's attitudes to mathematics.

The records were also used as a basis for planning future work for the class, groups and individuals.'

HMI, *Aspects of Primary Education: The Teaching and Learning of Mathematics*, HMSO 1989 (Paragraph 76).

As a group, examine your current recording system. Does it provide for all the elements identified above? How could you improve your system?

The role of the teacher



Traditionally the role of the teacher has been that of a giver of knowledge, a figure of authority, a pedagogue. The Cockcroft Report publicly challenged this viewpoint which legitimised previous private thinking and discussion within mathematics education.

Activity 1

Paragraph 243

Read paragraph 243 of the Cockroft Report (see page17). Ask each group member which aspect of it they feel most comfortable with and why.

Ask group members to form pairs with colleagues who have selected a different aspect. In their pairs, they can discuss what it is about the teaching style they have chosen that makes them feel secure. Now ask them to choose the aspect with which they feel least comfortable, and repeat the sharing process.

Activity 2

The teacher as facilitator

A teacher can assume the role of facilitator, someone who provides:

- A supportive environment;
- Activities that are motivating;
- Adequate resources;
- Access for pupils of all abilities.

Ask group members to discuss the elements of their teaching style which make them good facilitators. Can they add any other points to describe more fully the role of the facilitator?

Activity 3

Intervention

Divide the staff into two groups. One group will work on Task A and the other group will work with you on Task B. Make no initial input into Task A, but once the work is underway offer such support as you are able.

For Task B you will assume the role of teacher. For this you should plan a lesson on sequences before the INSET session, using the information under the task heading.

Task A

Look at the examples on photocopiable page 36. What do you notice? Begin by saying how the sequence continues, and then record your observations. Talk about what you see with a colleague. See if you can find different descriptions of the sequence.

Try to articulate, formulate, then calculate how many objects will be needed to make as far as the tenth pattern in the sequence.

Try to generalise for any position in the sequence and make a record of it.

Task B

Teach the group about sequences, planning and delivering a lesson in which the following information is given.

A sequence is a specific subset of numbers that have been arranged with some definite order or criterion in mind. For example;

- 1, 2, 4, 8,.....
- 1, 3, 6, 10,.....
- 1, 4, 9, 16,.....
- 8, 13, 18, 23,....
- 4, 6, 10, 16, 26,..

Sequences provide an entry point for deeper mathematical thinking and problem solving. This topic affords the opportunity for pupils to generate and produce a general mathematical result or observation from a number of particular instances. It is this process of generation that mathematicians call induction. When you are working with number patterns, you are often acting inductively.

Follow-up

In a plenary session, consider together how far you have addressed the following questions through each of the activities:

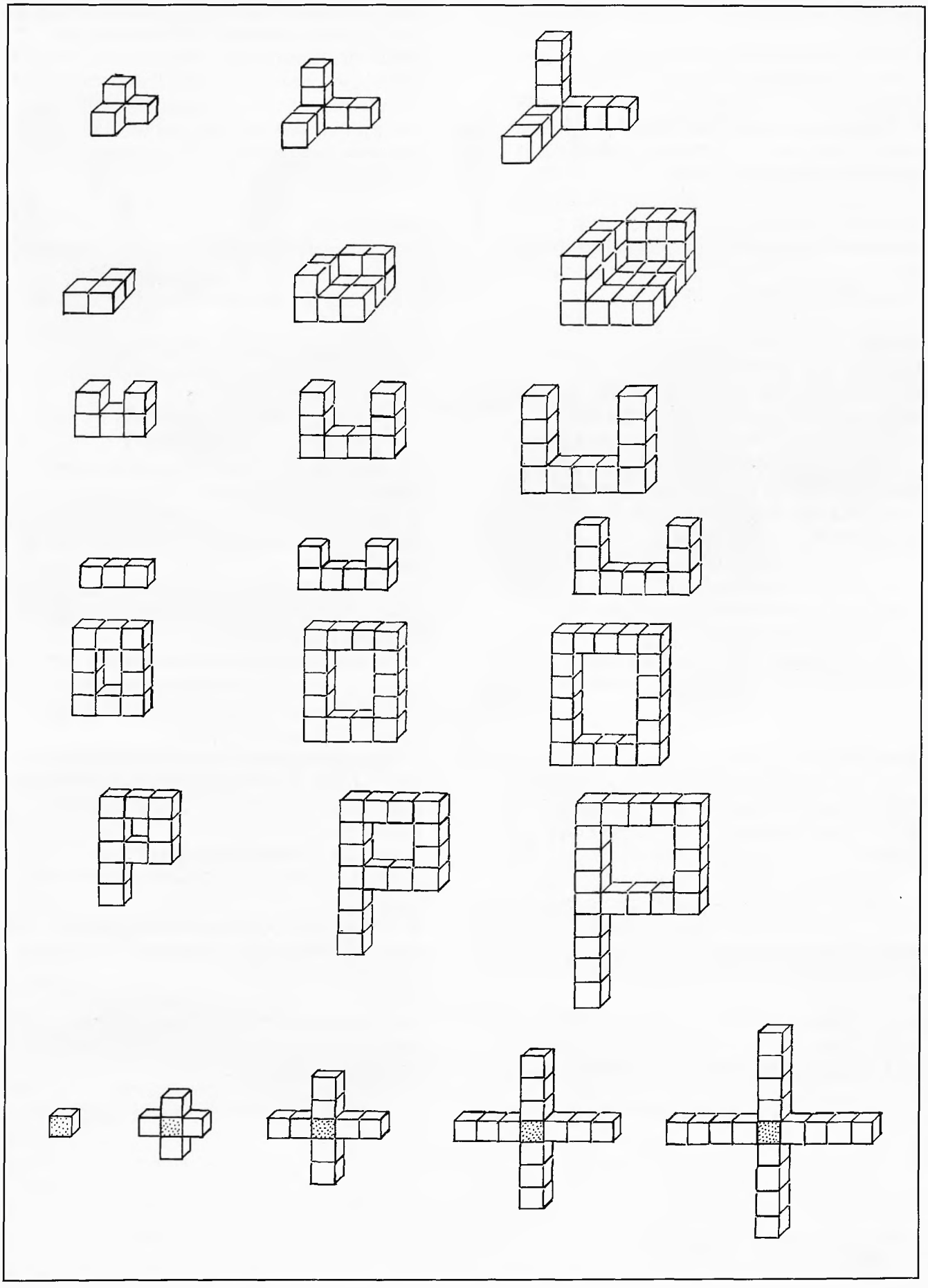
- Was the process of learning an absorbing, enjoyable and rewarding experience?
- Were the participants able to find out the results of their efforts soon enough to discover why they were correct or incorrect?
- How many of the participants were genuinely working at their own pace and level?
- Did the teaching style encourage the participants to learn by their own mental activity?
- Was opportunity provided for the participants a) to interact socially during the learning process or b) to learn from each other?

Ask group members to reflect on what they did today as they go home. Ask them to consider the following questions:

- How did the course leader's interaction support your work on the activity?
- Could you observe strategies to support those who were stuck or who had lost interest?
- How was motivation sustained?

Now reflect on your usual classroom practice and go through the three questions again.

Intervention (see page 35)



Liaison

For many staff, liaison with other colleagues will be a natural part of their role. Others, however, may need gentle persuasion about the benefits of this liaison.

The aims of liaison could be to make a child's stay in school meaningful and his progress through schooling as smooth and as worthwhile as possible. If liaison is to be a feature of an INSET activity you should consider carefully the following questions:

- Does your school have a policy on liaison? If not, why not?
- Is the policy fully implemented, or does it need reviewing?
- How on-going is your planned programme of liaison?

All too often in the past, liaison has involved just the staff teaching Y6 and Y7, and it usually took place in the summer after the children had left. If teachers are to come to terms with the issues of curriculum entitlement and continuity, there is an increasing need for liaison between colleagues within institutions, between home and school and between school and school.

There are at least three discrete types of liaison:

- Within school;
- Between schools in the same phase;
- Between schools across the phases.

The main objective of liaison is the ensuring of regular contact between people involved in the education of children. These people ought to have personal agendas that should dictate the pace, style and content of specific meetings.

Activity 1

Examining liaison

In small groups, consider the following questions.

- Who is usually involved in liaison activities? Why?
- What is the nature of your liaison meetings?
- How frequently do you meet?
- How often do you visit other classrooms within your school and in other institutions?
- How varied have your liaison meetings been?
- What ideas do you have about liaison, and have they been aired at previous meetings?

• How worthwhile have previous liaison meetings been?
• How are the results of liaison meetings implemented within your school?
• How could liaison meetings be made more efffective?

Activity 2

Primary/secondary liaison

Below are a set of liaison activities that have been successfully implemented. Discuss their value and rank them in the order of your own personal priorities or those of your school. Discuss with colleagues ways in which you could implement your first three priorities. What problems do you envisage?
• Y6 pupils start a piece of work, perhaps an investigation, and take it to their secondary school to finish.
• Y6 pupils have their work displayed in the foyer of the secondary school's reception area throughout September.
• Y6 children choose a portfolio of their 'best' work in a variety of subject areas, including mathematics, to take with them as a 'passport' to their secondary school.
• Y6 and Y7 children undertake a mathematics trail together at the secondary school.
• A secondary mathematics teacher and a primary mathematics co-ordinator spend a week in each other's school on an exchange basis.
• A secondary mathematics teacher and a primary mathematics co-ordinator spend a week working alongside each other.
• Y7 children design and make a mathematics game which they take to the feeder primary schools to play with Y6 pupils.
• Teachers of Y3 to Y7 from a group of schools devise a record card, together with the heads of mathematics from local secondary schools.

Attainment Targets 1 and 9

The successful implementation of Attainment Targets 1 and 9 has given rise to much discussion. In contrast to the other attainment targets, which are content-specific, Attainment Targets 1 and 9 relate directly to the process of 'doing' mathematics, the ways in which we all use and apply mathematics.

The two attainment targets state that:

• 'Pupils should use number, algebra and measures in practical tasks, in real life problems, and to investigate within mathematics itself.' (AT1)
• 'Pupils should use shape and space and handle data in practical tasks, in real life problems, and to investigate within mathematics itself.' (AT9)

The three main strands of Attainment Targets I and 9 are:

• Ways of working;
• Discussion and language development;
• Selection and use of appropriate materials.

Activity 1

'Doing' mathematics

Distribute copies of photocopiable page 43. In small groups, consider your current classroom practice. Think of the ways group members provide opportunities for some, if not all, of the actions listed. Where do you think you need to make changes in order to incorporate some of these actions? Consider what you do at present that might help you make these changes.

Activity 2

What is practical work?

Distribute copies of photocopiable page 44. In small groups, discuss the opportunities that exist in your classrooms for pupils to experience the listed aspects of 'doing' mathematics. What aspects do the group members find it difficult to make provision for?

Working practically allows you to use mathematics to argue, to prove and to communicate, but some questions need to be addressed in order for these aspects of the National Curriculum to be successfully implemented.

Many see practical work as simply using apparatus such as Multilink, Cuisenaire rods, scissors and protractors. But apparatus is just one of many elements involved. Other aspects are:

- Using a variety of measuring instruments;
- Making models;
- Using technology;
- Organising school events;
- Handling timetables, price lists, databases, spreadsheets, pictures and diagrams.

Ask teachers to list examples under each of these elements, and then, in small groups, explore ways of increasing the opportunities they can provide for all pupils to extend their experiences under these headings. Identify and consider the more difficult areas.

Activity 3

Why do practical work?

Children often enjoy the challenge and variety of different approaches to mathematics. Approaching topics practically can:

• Illustrate and clarify a concept;
• Make abstract concepts accessible through concrete experience;
• Provide a tangible means of exploring ideas;
• Allow mathematics to be applied to everyday situations.

Ask group members to identify the frequency with which they incorporate practical work into their own teaching. Ask them to give examples of instances when practical work might be appropriate. Ask individuals to compare their findings. Are there common patterns?

Activity 4

Assessing practical work

Pupils often work on practical activities in groups, which makes individual assessment difficult. There are several ways of addressing this problem.
• Ask pupils to give an individual account of their activity.
• Observe and listen to individual pupils while they are undertaking an activity.
• Devise a simple method of recording your observations and thoughts.
• Video and tape pupils at work.

As a group, discuss the merits of each of these techniques.

When children are organising their work, thinking clearly, making connections and explaining what they do, they are involved in many processes, all of which need to be considered when assessing individual pupils.

When working practically, children can be observed:
• Initiating their response to an activity by planning, checking information and designing their way forward;
• Doing mathematics by selecting appropriate materials, building on mathematical knowledge, working methodically and reviewing their progress;
• Checking and improving their results.

How might these approaches be integrated into a whole-school approach to assessment?

Activity 5

Present practice

Close observation can show that there are different levels of argument and evidence being used when pupils are conjecturing, stating, testing, defining, reasoning and convincing themselves and others.

When approaching their work in this way, children are communicating mathematically. They will be:
• Asking questions;
• Interpreting data;
• Discussing their work;
• Recording what they find;
• Presenting their work in a variety of forms.

Ask the group to consider the following points.
• What implications are there for your classroom organisation when working practically?
• When is the best time to use practical work?
• Is it feasible and logistically possible for students to be working practically?
• If some pupils work on practical activities, what will the other pupils be doing?
• Will your school's policy on resources have to be reviewed?
• Does your classroom environment and layout allow space for practical activity?
• What techniques can you adapt and develop to collect the evidence of achievement required by the National Curriculum?

Setting up practical work

Before undertaking the following INSET activity on practical mathematics, you may need to consider the following questions in order to convince your colleagues of the

appropriateness of this way of working.

- Will the pupils be motivated by observing the practical applications of mathematics to real life situations?
- Does the activity provide sufficient stimulus for mathematical thought?
- Is the activity appropriate to the concept you want to introduce?
- Does the activity provide opportunity for expansion?
- Is the activity of sufficient clarity that pupils can work confidently and not have their progress impeded?

Activity 6

An estimation circus

Ask the group to consider how good they are at estimating. Attempt some or all of these activities in smaller groups and consider ways of summarising the results you obtain.

Task one

Materials required: one litre container labelled A; three containers of an unusual shape, marked B, C and D, which hold at least 0.5 litres; an unmarked jug.

Give the group container A filled with water and ask them to pour equal amounts into two smaller containers.

Can they half-fill B and C?

Can they pour a half litre of water into each of the three containers from an unmarked jug? Which container was the easiest to fill?

Task two

Materials required: a variety of different weights including a 1kg weight; a set of balances; a variety of substances to weigh, such as rice, pebbles and sugar.

Ask the group to lift a kilogram weight several times, and then try to imagine how a kilogram weighs in their hands.

Now ask them to try to estimate a half kilogram of different substances and materials. Were some easier than others? Can they think why?

Task three

Materials required: a ball of string; a tape measure.

Ask group members to unravel a ball of string and to stop pulling when they think they have 3 metres of string. Then they can measure and see how accurate they have been. Ask them to repeat the activity several times. Do the results improve?

Would it have been easier to estimate three yards or three feet? Can group members estimate five metres? Ten metres? How high is the room? How wide is it?

Task four

Materials required: paper; protractors.

Ask participants to fold a piece of paper so that at one corner there is an angle of 60 degrees; then 130 degrees; then 290 degrees. How close were they in each instance?

What activities can they devise that would help them develop the ability to estimate angle?

Task five
Materials required: 150 counters, a tray.

Ask participants to estimate and separate off 100 counters from a tray. Allow them 10 seconds to do this. Quickly count how many they actually separated off and return the counters to the tray.

Now repeat the activity eight or nine times. Did they improve?

Follow-up
At the end of the circus, ask the group to attempt to answer the following questions in a plenary discussion:
- Was the practical activity on estimating adequate, useful or essential?
- What did you learn from doing these activities?
- Can you extend them?
- Can you write similar activities that will enable you to estimate temperature, time, speed or volume?
- Are there are resource implications for doing work on estimation?
- In what context would you do these activities and why?
- What other aspects of the National Curriculum have you addressed?
- To what levels can these ideas be extended and applied?

Some alternative activities are given below, with space provided for you to list additional discussion points relevant to the activity.

Activity 7

Boxes, bottles and whatevers

Before the event collect together a large number of boxes, bottles and other containers. Each container needs to be clearly labelled with either a letter or a number and displayed in an accessible area.

Invite your colleagues to try the following tasks:
- Sort and classify the containers;
- Order the containers according to any specified criterion. Discuss the reasons for the ways in which the containers have been sorted, classified or ordered.

Take a cereal box and examine it carefully. Discuss the most appropriate ways of finding out how much it holds.

Tell the group that you want to increase the contents of the box by 25 per cent. How would they alter the box?

They might like to consider:
- The amount of card required;
- The wastage of materials (what size are the sheets from which the card is cut?);
- The optimum amount of cereal per box;
- Shelf display;
- Packing the boxes for dispatch.

Activity 8

Metric paper

Before the event, collect together a supply of A3, A4 and A5 paper.

Ask participants to find out what is the largest container they can make with each size of paper. Is there a relationship between the amounts the different sized containers hold?

Do the containers stand up? If not, use A4 paper to make some that will. Whose container has the largest capacity? Could there be a larger one?

Activity 9

Packing shapes

Before the event, organise a supply of discs and ATM MATs (Mathematical Activitiy Tiles, from the Association of Teachers of Mathematics).

Let participants choose eight of the same shape and explore ways of arranging them.

Which way takes up the least space? How do they know? Ask participants to explain their thinking.

Now use eight pieces of different shapes. What observations can the participants make? What conclusions can they draw?

'Doing' mathematics (see page 38)

Whenever we use and apply mathematics, the associated actions include:

- Planning;
- Devising;
- Exploring;
- Selecting;
- Reviewing;
- Deciding;
- Designing;
- Trialling and improving;
- Recording;
- Concluding.

In the space below each point, write down the ways in which you provide opportunities for these actions to take place. What might you do in order to incorporate these actions?

What is practical work? (see page 39)

Attainment Targets I and 9 are important because they encourage students to:

- Investigate;
- Be systematic and methodical;
- Predict;
- Hypothesise;
- Conjecture;
- Generalise.

In the space beneath each point write down the opportunities that exist in your classrooms for pupils to experience these aspects of mathematics.

Investigations and investigating

For some teachers investigations are all too often seen as 'bolt-on' activities to the existing mathematics curriculum or scheme. For others investigating is a philosophy and a valid way of working.

Investigating is about doing, asking questions and building on to a body of knowledge; it is the means to an end. Investigation *per se* sets out an area of activity and provides a focus; it is concerned with the end itself. One is about process, the other is about product. To resolve this apparent dilemma, an INSET activity could focus on the similarities and differences between the two terms.

Activity 1

Investigation v investigating

Before the session, make copies of photocopiable page 46 and paste them on to card. Cut along the black lines and ask participants to arrange the cards under the two headings, 'Investigation' and 'Investigating'.

Activity 2

Doing an investigation

Divide the group into pairs or threes, and let them choose one of the following tasks. They should spend some time working on it. Ask them to keep a record of their reactions, ideas, anxieties and frustrations as they progress through the activity. These notes should be shared in a plenary session to highlight the differences between investigation and investigating.

INSET course numbers

16 teachers attend a weekly in-service course. The course leader decides that they should work in groups of four; but in order to ensure a good interchange of ideas it is insisted that the groups are rearranged each session. No two teachers are to work together more than once.

For how many weeks can the course run?

Suppose that the rule is relaxed and teachers are allowed to work together at least twice. How long can it run in this case?

Consecutive sums

$1 + 2 + 3 = 6$

$1 + 2 + 3 + 4 = 10$

Using the above sum as an example, ask participants to investigate consecutive sums.

Try two numbers, and then three numbers.

Are there any numbers you cannot make?

A square of squares

Tell participants they have nine squares in a 3 x 3 array. The outside edge is painted red.

Ask them to rearrange the nine squares so that the red edges are hidden and colour the new outside edge green. Can they rearrange the squares yet again to hide both the red and the green edges and then colour the outside edge yellow?

Try the same activity with a 4 x 4 array, then a 5 x 5 array.

Investigation v investigating (see page 45)

Problem-posing	My number has exactly 3 divisors
An open ended problem or puzzle	Questions
Using and applying mathematics	Being exact
Any situation for which the outcomes are unknown	Self-defined problem
Problem solving	Active learning
What if not?	Introduce a new concept
What if?	Participant sport
0 + 1 + 2 = 1 + 1 + 1 1 + 2 + 3 = 2 + 2 + 2 2 + 3 + 4 = 3 + 3 + 3	Answers
Keep the pupils busy on a Friday afternoon	Starting points
Open-ended approach	Approximating
Spectator sport	Person-defined problem

MATHEMATICAL ACTIVITIES

In the following section we will look at certain aspects of mathematics, relating them to six specific areas identified within the Programmes of Study: using and applying mathematics; number; algebra; measures; shape and space; and handling data.

In particular we shall look at the following aspects of mathematical activity:

- Mathematics and art;
- Mathematics in the environment;
- Mathematics and parents;
- Mathematics and technology;
- Mathematics across the curriculum.

This section will also consider ways of teaching algebra and probability.

Mathematics and art

At the interface of mathematics and art there are many rich opportunities that can increase our understanding and enjoyment of the world around us. In particular, work on pattern, structure and form can provide ways for children to experience mathematics creatively. The following topics can be interesting to explore in art:

- The properties of specific shapes;
- Manipulation of shapes through symmetry, rotation, translation, enlargement, tessellation, weaving, plaiting and perspective;
- Two and three dimensions.

Activity 1

Printing

Before the event, collect together a range of cylindrical objects, paint, ink, potatoes, knives, string, blocks of wood or hardboard, matchsticks, adhesives and pieces of paper.

Ask the participants to form small groups to try out the following activities.

Circle printing
Choose one or two colours with which to coat the ends of a variety of cylindrical objects and use them for printing.

Potato printing
Use a sharp knife to cut out a pattern from half a potato. Ink the cut half of the potato, then remove the excess ink on a piece of old newspaper. Print on to paper and experiment with turning the potato in different directions.

Try making patterns with potatoes cut into the shapes of letters of the alphabet.

Block printing
Coat one face of a block of wood with adhesive and arrange pieces of string or matchsticks to form a pattern. When the adhesive has dried, coat the blocks with ink and print with them.

Follow-up
Discuss the opportunities for language work, aesthetics and mathematics provided by these activities.

Ask the group to consider how they would use the activities with their pupils.

Activity 2

Symmetry

Before the day, obtain a set of mirror tiles. Ask participants to work in small groups to try out the following activities which are all starting points for group work on symmetry.

Movement
Ask the group to work in pairs, one person making a series of movements which their partner has to copy as a mirror image.

Now try the activity again in groups of four, where one person makes a movement and the others respond as though there were two intersecting mirrors between them.

Images
Experiment with different images by putting three mirror tiles together, one on the table with a small object placed on it, and the other two perpendicular to the flat tile.

Marion's icon
Ask participants to place a mirror on the mirror master on photocopiable page 50, moving it so that each of the shapes numbered 1 to 12 can be made. Ask participants to make a mirror master of their own. How many different shapes can they make?

The world of symmetry
Invite a small group to take sketch pads outside and look for examples of symmetry manifesting itself in every day life, for example in buildings, plants, trees, animals and insects.

Follow-up
Ask the group which of the following skills were used in these activities:
- Art and craft;
- Mathematics;
- Language;
- Observation;
- Physical skills;
- Problem solving;
- Investigational skills;
- Research;
- Technical skills.

To what extent do they think pupils will be able to enhance their skills in these areas through similar activities?

Ask participants to design a set of activities on symmetry that will develop the skills of their pupils.

Activity 3

Tiling

Before the event you will need to obtain a set of ATM Mathematical Activity Tiles (MATs) and/or Tiling Generators and graph paper.

Ask small groups of teachers to try out the following activities.

Using MATs
Make patterns on the floor or table.
- What do you notice about what you have done?
- How do the limitations of the materials affect this?
- How would you use them in your classroom?
- What is your school's policy on the use of such disposable materials?

Systematic tiling
Using graph paper, draw three identical squares. With one line divide

each square into two parts. Make several copies of each square.

To make four-by-four tiling, the squares could be laid as in Figure 1.

16	5	6	7
15	4	1	8
14	3	2	9
13	12	11	10

Figure 1

The order in which the different squares are laid down could be: A,B,B,C,A,B,B,C,A,B,B,C,A,B,B,C, as in Figure 2.

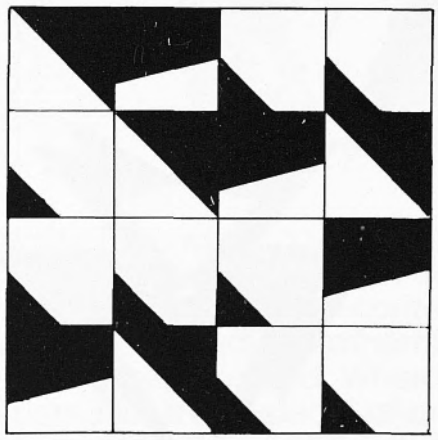


Figure 2

Try to design other tiling systems using squares, equilateral triangles and hexagons in the following ways:

- With more than one line to divide them;
- With different orders of tilings;
- With different systems for which tile to lay.

Latin squares

The idea of latin squares was devised and developed by Leonhard Euler (1707-1783). It provides a specific mathematical starting point for tiling.

A latin square of order four, for example, has 16 elements in a four-by-four array with four distinct elements appearing once only in each row and column, as in Figure 3.

1	2	3	4
2	1	4	3
3	4	1	2
4	3	2	1

Figure 3

Here, 1 is represented by:

2 is represented by:

3 is represented by:

and 4 is represented by:

Using these squares to translate Figure 3, the end result is Figure 4.

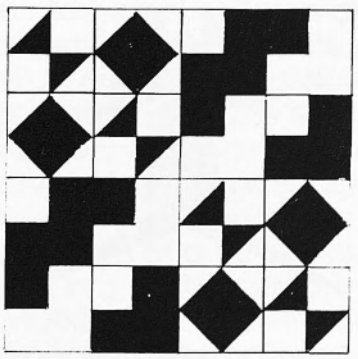


Figure 4

Alternatively, try this idea using

- Latin squares of different orders,
- Magic squares of differing sizes.

Activity 4

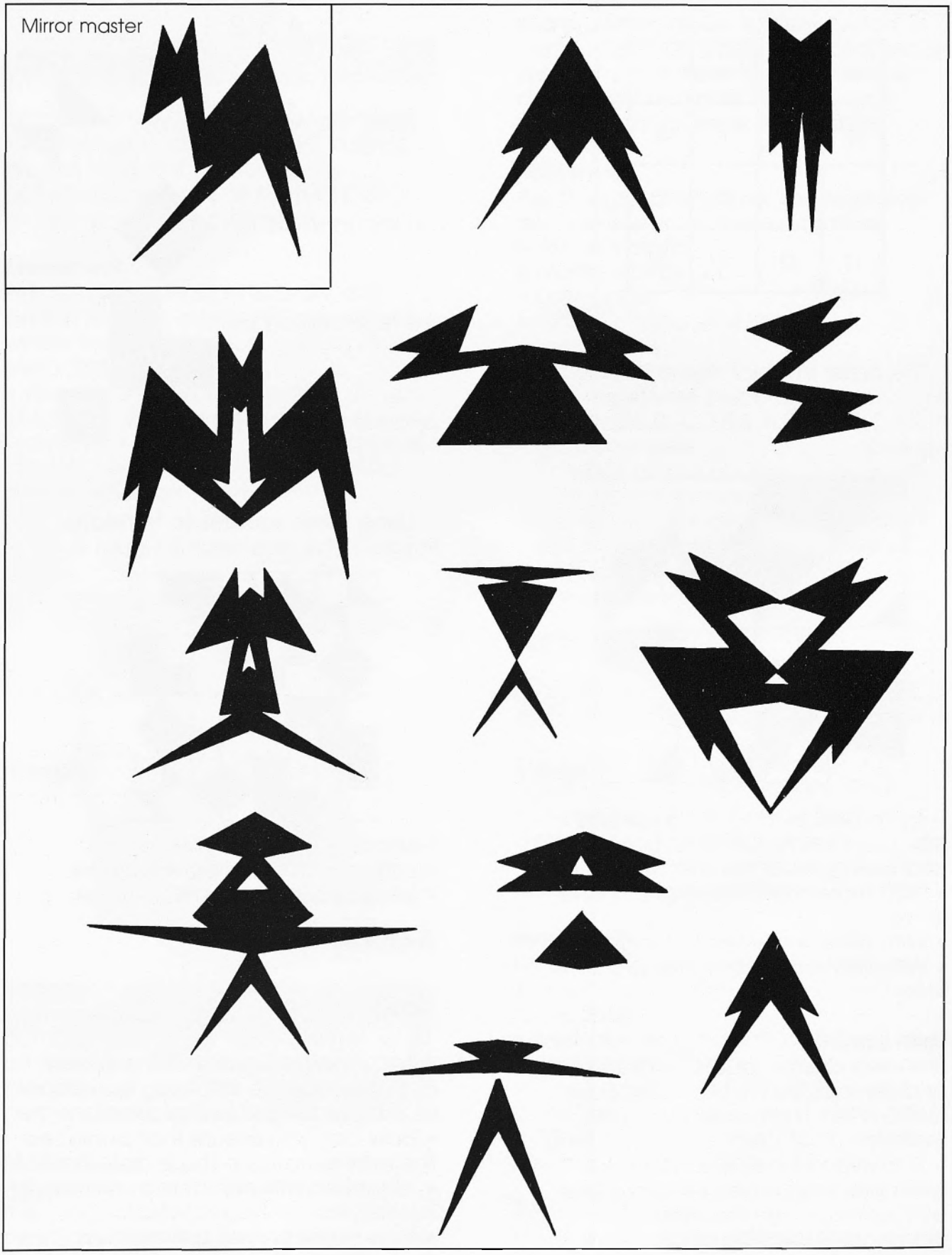
Reflecting

After undertaking any of the above activities, use the following questions as a focus for group discussion.

- How can you ensure that pupils see the mathematics in these activities?
- What benefits are there in working in this way?
- How best can you use mathematics and art activities in your classroom?

Symmetry (see page 48)

Marion's icon



Source: Marion Walter in *The Mirror Puzzle Book*, Tarquin Publications.

Mathematics and the environment

Schools often adopt a thematic approach to most aspects of the curriculum, but within the context of environmental studies mathematics is often thinly represented. Where mathematics is included it often seems contrived and dislocated. Mathematics, as a consequence, may be perceived by some pupils as something separate from the world in which they live. The environment, however, involves us all; it impinges on every aspect of what we do, and mathematics can be used to structure, interpret and describe our interaction with it.Whatever aspect is being pursued, the environment is an access point to some mathematical activity.

The danger of trivialising mathematics is ever present. The activities in this chapter are intended to help you develop ideas for incorporating a coherent mathematical experience for your pupils in each of your chosen topics.

Mathematics trails

Maths trails are the mathematical version of nature trails. They are intended to encourage children to:
- Seek out the mathematics in their environment;
- Become aware of the wonder of mathematics;
- Observe their school, town or village from a different viewpoint;
- See how mathematics is used by both man and nature to shape the world in which we live.

A maths trail can help children to see the relevance of mathematics outside the classroom and to appreciate its aesthetic value.

In a maths trail children are encouraged to follow instructions; to gather information and data; to sketch patterns and to estimate a wide variety of measurements ranging from the heights of buildings to the number of squares in a rose trellis and from the age of a tree to the number of bricks in a wall. There are opportunities to observe and gather a wide range of examples of tessellations and symmetry, or to try to make the largest and smallest total from the date on an old cottage. The opportunities are endless.

Maths trails can be used for many reasons. As a primary/secondary liaison exercise maths trails can help:
- To familiarise primary children with their new school;
- To encourage top juniors and first year secondary pupils to work together in the summer term, in order to forge links and friendships, and to help the younger children feel confident about transferring to a new school. (Older children could write a maths trail for primary children as a course work exercise.)

As part of a family open day at school, maths trails in the village or town can:
• Encourage parents to enjoy mathematics with their children;
• Illustrate that mathematics is more than just 'sums'.

As a topic for a term's work, a maths trail can:
• Emphasise the cross-curricular nature of mathematics;
• Be an alternative to finding the mathematics within a topic, and lead to a situation in which the teacher can draw out the art and design, the science and technology, the history and geography from the maths.

As an introduction to many topics in mathematics, developing a maths trail can help to:
• Emphasise the fact that mathematics is a whole, and not a disembodied collection of topics like ratio, trigonometry and algebra;
• Show children how to use and apply mathematics which they have already learnt;
• Provide a variety of contexts in which mathematical ideas can occur;
• Emphasise the practical applications of mathematics;
• Develop children's understanding of mathematical modelling;
• Introduce investigation within mathematics;
• Increase children's awareness of the world around them.

Writing a maths trail demands a fair amount of time from at least two people working together. It can be great fun, and you will be amazed at the mathematics you can find in apparently the most boring of landscapes or buildings.

Activity 1

Writing a trail

Ask the group to form smaller working groups and devise a plan for creating a maths trail around the school grounds. Encourage them to discuss fully the following points before starting to write the trail.

Age range
• If you are working with young children, will there be sufficient helpers available?
• If you are planning a family or whole-school trail, will there be activities which can interest and stimulate all participants?

Venue
• What aspects of safety need be considered?
• Can you minimise disturbance to other children and classes?
• What outside agencies need to be involved? For example, shops may be willing to display clues in their windows or to allow pupils to enquire about prices, opening times, etc.

Equipment
• Are the instructions and directions sufficiently self-explanatory, or is a map required?
• Can you supply clipboards, calculators, pencils and any other equipment that might be necessary?

The activities
The best maths trails have a wide variety of activities, including some that can be solved on the spot, and others which can be extended at a later date in the classroom or at home. Extended activities could include data collection for work on computer databases. Recognition could also be involved.
• What type of activities could be solved on the spot? (Example: estimate the width of the oak tree 10m from the ground.)
• What type of activities could be extended at a later date? (Example: using wax crayons and copy paper, make some tyre rubbings from the cars in the car park. Back in the classroom, compare the tyre rubbings and see how many different patterns there are.)
• What type of activities can involve data collection for work on computer databases or statistics projects? (Example: collect the prices of five everyday food items from four different shops. This could form the

basis for a shopping survey.)
• What type of activities can involve recognition? (Example: piece together a given silhouette of the shops in your high street.)

Presenting the trail
Finally, ask the pairs to consider what ways of presenting a trail will best promote mathematical discussion. Once all of these points have been considered, ask the groups to explore the area, then spend an hour writing questions for a maths trail to be shared later with all the course members.

Mathematics in nature

Children are often encouraged to go out into their school grounds and local parks to observe and, where feasible, to collect items from nature. Handfuls of leaves, seeds, grasses, stones and fir-cones can easily be collected. These can form the focus for much mathematical investigation.

Activity 2

Leaves

Ask participants to go out and collect two samples of a range of leaves. Remind group members of the Country Code. Back in the group, discuss and show how the collections can be classified and recorded. How many different ways can this be done? Discuss the following ideas for later use in the classroom and, if practicable, try them out in the group.

• Paint the leaves and use them as leaf prints to explore different patterns.
• Construct and interrogate a database on the information you have gathered about leaves.
• Put the leaves that you have collected into different orders according to weight, size and perimeter.
• Do leaves tessellate?

Activity 3

Trees

Trees are a splendid source for mathematical discussion and activity. Ask the teachers to look around them. How many different types of tree are there? What words do they use to describe different trees? Try out the following ideas.
• Go out and look at the way trees grow. Look at a tree, then sketch the way it branches. Look at other trees that branch differently.
• Look closely at some of the lines that can be found on trees.
• Look at profiles of trees. How would you categorise them?
• Discuss different ways of estimating the number of leaves on a tree.
• How high are the trees near you? Devise a good method of finding this out without climbing, and try it out.

Activity 4

LOGO trees

The topic of trees can be easily extended to further mathematical activities. For this activity you will need access to a computer with a LOGO facility.

Type this LOGO program into your computer:

```
TO TREE "BRANCH
    IF : BRANCH <8 (STOP)
```

```
    FD : BRANCH
    RT 45
    TREE : BRANCH/2
    LT 90
    TREE : BRANCH/2
    RT 45
    BK : BRANCH
END
```

Read the program through and ask participants to guess what it will do. Then run the program and discuss what you see.

Discuss how you can alter the program in order to trace different trees.

Activity 5

Tournament trees

Present the group with the following problem.

16 people divide into eight pairs. Each pair plays a game until one of them wins. The eight winners then pair and play again to give four winners. The four winners then pair to play, and there are two winners.

Ask the group members to construct a tournament tree diagram to illustrate the activity.

Extend the activity to consider tournaments of different sized groups. Compare this with other ways of running a tournament.

Activity 6

Family trees

Distribute copies of photocopiable page 57 which shows a 'family tree' on which the odd numbers represent males and the even numbers females.

Ask the group the following questions:

- 20 has two grandmothers, who are they?
- Who is 1's daughter-in-law?
- Who are 24's aunts?
- What other family relationships can be discussed and illustrated?

Ask participants to draw their own family trees. What practical problems exist? When using this type of activity with children, what drawbacks might be encountered?

Activity 7

Probability trees

Set the group the following probability exercise.

If a marble is placed in the groove at S it will roll down and drop out at A or B or C (Figure l).

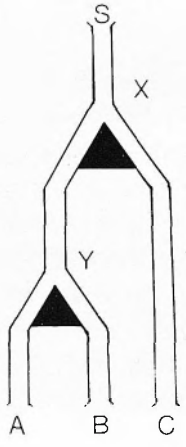


Figure 1

When a marble reaches a point where the groove divides into two, it has an equal chance of going to the right or the left so we will suppose that if we had eight marbles, four would go to the right and four to the left.

If eight marbles are fed into the network, we have supposed that at point X four will follow the right groove and drop out at C, and four will follow the left groove.

At point Y we have supposed that two will take the right groove and drop out at B, and two will take the left groove and drop out at A.

Distribute copies of photocopiable page 58. What would happen with these networks? Imagine feeding in eight marbles each time.

Design networks to give the expected drop-outs as shown in Figure 2 using l6 marbles.

When marbles are dropped in the grooves at point S we cannot be sure of getting exactly the supposed results. In other words we would never

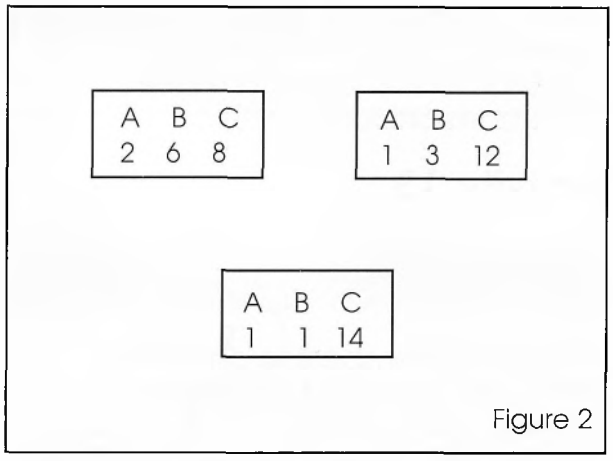


Figure 2

be sure that exactly half would go to the left and half to the right when a groove divides into two. Ask group members to simulate the tracks by tossing a coin, letting heads be the left groove and tails the right groove. Do this eight times and see if the results are what you would expect. Design similar activities using a die or a coin and a die.

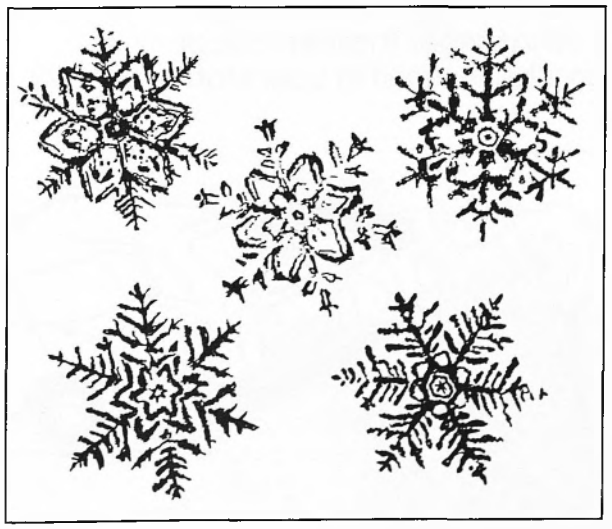
Activity 8

Snowflakes

Snowflakes are beautiful hexagonal crystals of water, each one different and worthy of examination, if only you could keep them cold and separate!

Many crystal structures have been recorded, some of which are illustrated below.

- Try the activities of 'throwing a snowflake' and 'folding a snowflake'.
- Discuss the relevance of these activities. What skills can they help develop?
- How can you build on these activities with your class?



Ourselves

When planning statistical activities, it is often difficult to find data that interest all children. 'Bodymaths' is an ideal source for collecting, analysing and representing data. In addition there are other activities which can be used to illustrate other areas of mathematics.

Activity 9

Pulse rate

As a group, discuss ways of measuring your pulse rate for one minute (for example by timing it for ten seconds and multiplying the number of beats by six).

Ask for a volunteer to have his pulse taken before and after exercising. Take his pulse, ask him to step up and down on a gym bench for two minutes, and then take his pulse again. Wait for two minutes and take his pulse for a third time.

Discuss the following points with the group:

- What activities that can easily be organised are best for increasing pulse rate?
- Could you organise a circus of activities to explore pulse rates?
- What mathematical activity is there in this exercise? What other mathematical activities could be incorporated?

Activity 10

I am 26 tea-bags high

Discuss how many different ways there are to measure your height. Are there any connections between the methods? What is the value in such an activity?

When dealing with comparatives and superlatives, many interesting aspects of body measurements can be used, some more subjective than others. List some attributes and discuss their acceptability.

Activity 11

Do you correlate?

Ask each member of the group to measure their height and their armspan. What do they notice? How best can they represent this information? Are there any other body measurements that have the same degree of correlation?

Discuss the problems that may arise in this activity and how they can best be avoided.

Activity 12

Fitting feet

Ask group members to find the area of their feet. How many times can they fit their feet on to a square metre? How many people will fit on to a square metre? What is the area of the school hall in metres? How many people will fit into it?

Ask this question: 'I am 45 cm wide at my widest part. How many times will I fit on to a line five metres long?'

Ask the group to devise some similar activities.

As a group discuss when, why and how you would use this aspect of measuring. What are the benefits for language and mathematical development in working this way? How would you build on these experiences?

The built environment

Human activity has restructured and remodelled the natural environment. Aspects of this development can be seen in the buildings that surround us, the transport we use, the clothes we wear, the food we eat, the ways we communicate and the items we manufacture in order to make life more comfortable.

Activity 13

Topic webs

Ask group members to choose a particular aspect of human development and form a topic web to show the mathematical possibilities of the subject.

Ask them to devise some activities to help develop an awareness of mathematics in the man-made environment. Use the following task as an example.

Cars

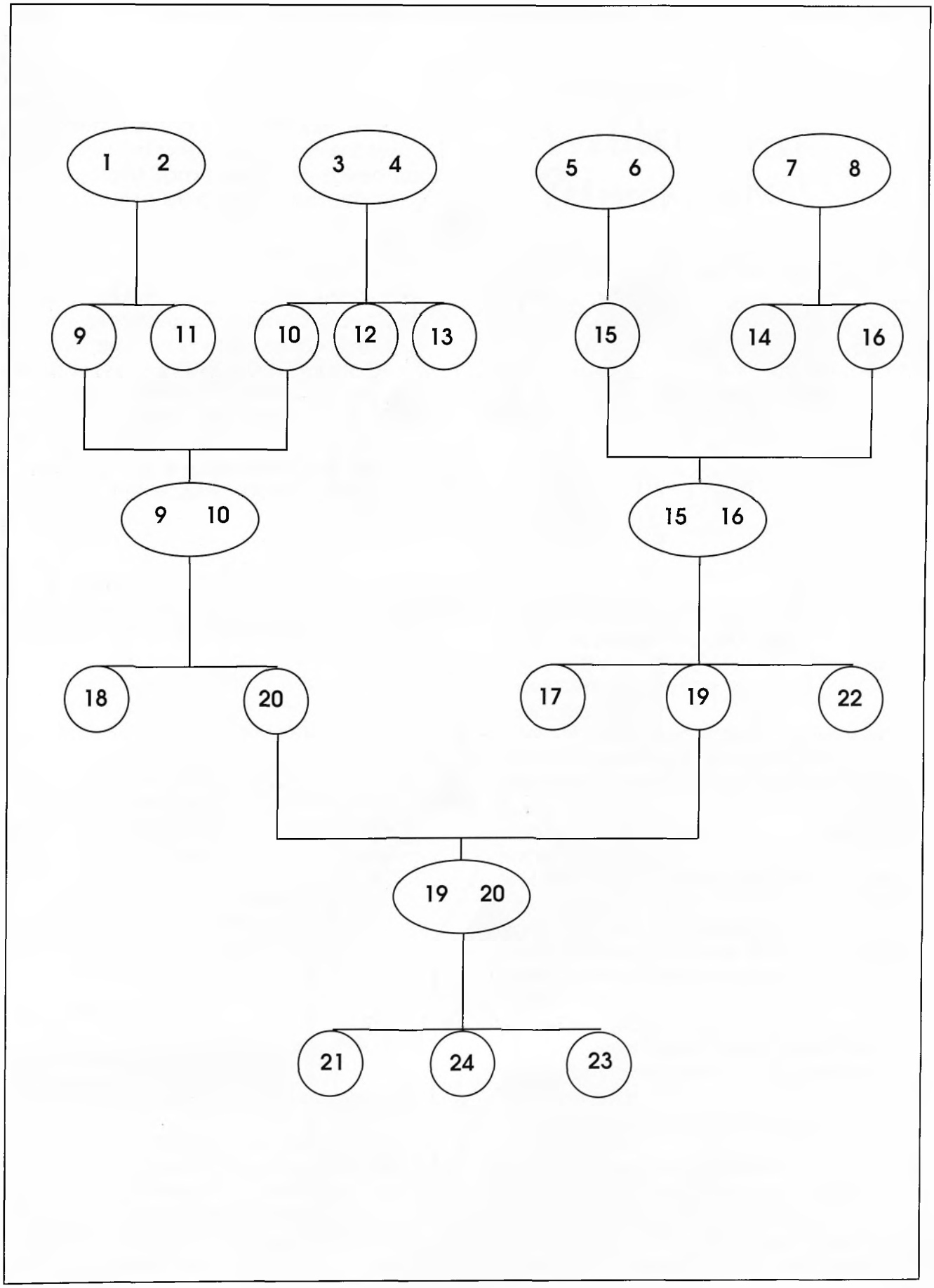
Go out into the staff car park. Look at the pattern of the treads on the car tyres. Using a wax crayon and bank paper, make tyre rubbings of all the different patterns that you can find.

Now look at car wheel trims. How many different ones can you find? Sketch at least five that catch your attention. Use these sketches as a basis for more detailed reconstruction back in the classroom.

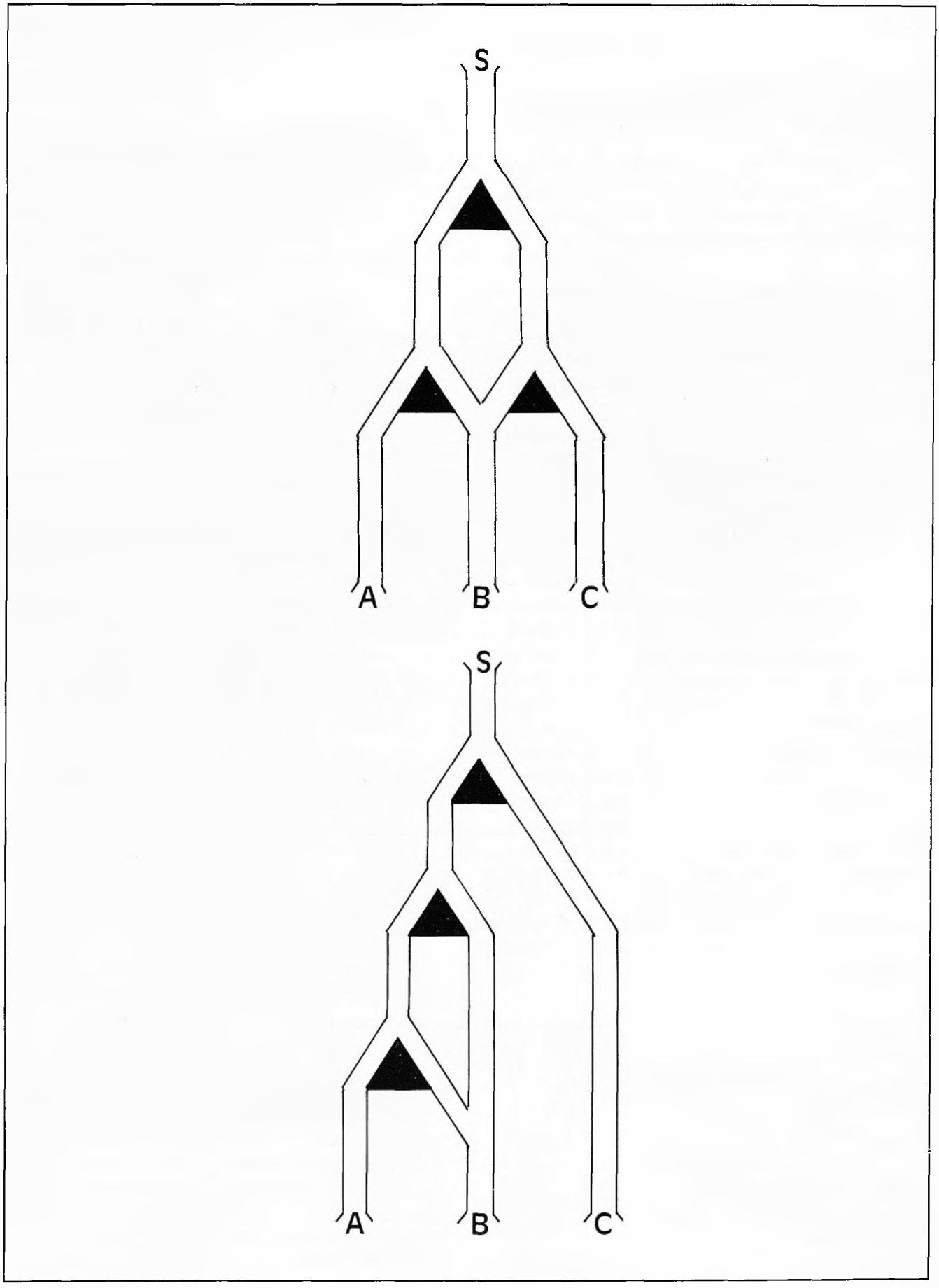
Look at the car registration numbers. Sort and classify these. Make up some harder arithmetic questions using these numbers. How else could you sort and classify the cars?

- What aspects of mathematics are covered by tasks like the one above?
- What are the advantages and disadvantages of working this way?
- What other mathematical possibilities exist in your staff car park?

Family trees (see page 54)



Probability trees (see page 54)



Mathematics and parents

The education of our children is a responsibility which should be shared between parents and schools. Alas, deep-seated prejudices prevent this responsibility from being fully taken up. Strong memories of their own school days colour the attitudes of both teachers and parents, and although their shared commitment to the children ought to be strong, there are often conflicts and misunderstandings. It may take some effort to involve parents more in the mathematical education of their children. Parents do need to be kept fully informed of developments within the changing curriculum, as well as being made aware of more up-to-date ways of working.

Activity 1

Why involve parents?

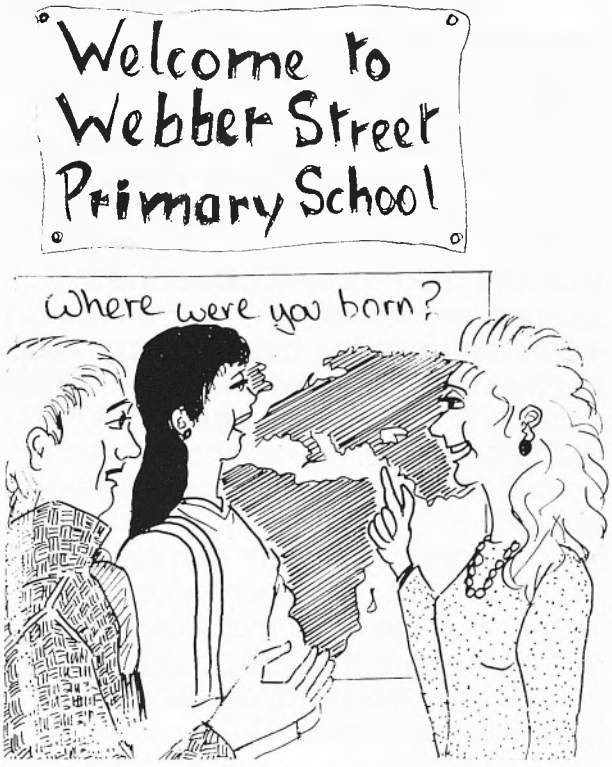
Individually, list the reasons for involving parents more in school generally and in mathematics in particular. Compare the lists group members have drawn up. Are everyone's reasons the same? If not, why not? What sort of involvement do group members want parents to have?

Ask the group to devise a programme of activities that could increase parental involvement.

Activity 2

A 'hands-on' parents' evening

Tell group members that they are to organise a parents' evening to dispel parents' mathematical fears, to encourage participation and to illustrate present practice. Discuss the following questions.



- What aspect of your mathematics work would be an appropriate focus for the evening? (For example, you could introduce the topic of calculators.)
- What mathematical activities would be suitable, bearing in mind the different levels of confidence you will encounter?
- When is the best time to organise such an activity?
- How will the evening be structured and organised?
- Whom will you involve?
- What aspects of the evening will be static? What others could be interactive?
- In what ways can you make a parent feel relaxed, welcome and willing to participate in the planned mathematics?
- Would you set family homework?

A programme of activities

The following activities have been tried and tested successfully with parents, and may give you some inspiration to devise your own ideas or

extend these. Discuss the advantages and disadvantages of each.

- In the entrance hall, set up a data bank. You will need large sheets of graph paper on which parents can add to pictograms that illustrate shoe size, favourite colour, make of car etc, using sticky-backed shapes to represent each parent.
- Along the corridor parents could be invited to measure their height and weight and to record this data on a stereogram using Multilink cubes. Indicate men in one colour and women in another.
- Further down the corridor, pin a map of Great Britain to the wall and invite parents to stick a coloured pin in the place of their birth. Have a world map as well for those parents born outside the UK.
- Once inside the room ask the parents to place a counter on a Venn diagram in the area that describes whether or not they wear spectacles, are local to the area, and are over 30 years of age (Figure 1).

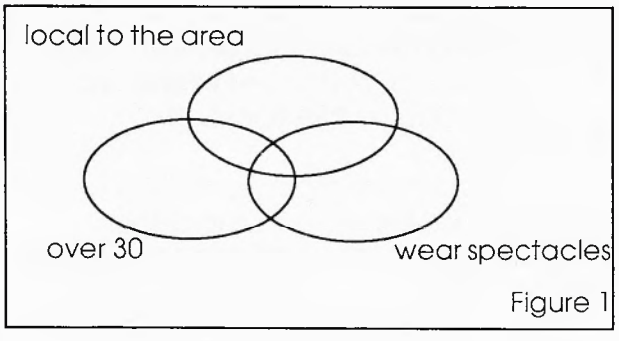


Figure 1

- Further into the room parents can be given a counter and asked to 'drive' their counter to a destination along a probability tree (Figure 2) that best indicates their preferences for mathematics.

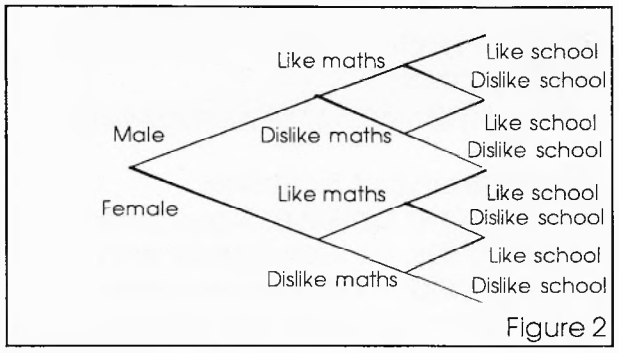


Figure 2

- Finally parents can be asked to tick along a preference line (Figure 3) the position that best indicates their attitude to mathematics.

Alternatively, a computer database

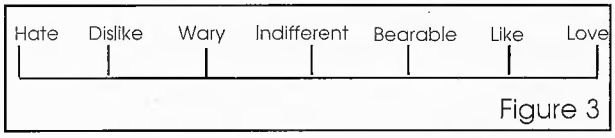


Figure 3

could be established. A user-friendly package like *Our Facts* can be made available to record and represent personal data.

Activity 3

So you think you know your tables?

Distribute copies of photocopiable pages 64 to 68 and discuss how they could be used to help increase parents' understanding of why teachers use methods other than rote learning to help children learn and understand about numbers.

- Link ups 1 (page 64) could be used by asking parents to connect the given numbers inside the circles with lines that mean 'when added to ... gives'.
- Link ups 2 (page 65) could be used when asking parents to place the given numbers inside the circles and link them with lines that mean 'When multiplied by ... gives'.
- Use Number squares (page 66) and invite parents to complete the squares using addition facts for examples (a) to (f) and multiplication facts for examples (g) to (l). In (m) to (o) they can be encouraged to invent their own methods.
- A long-standing favourite called Arithmogons (page 67) always ensures that parents become involved in talking about number facts. The rule is to take the numbers in the circles and write down the difference between circled numbers inside the squares, as in the example shown. Alternatively, and slightly harder, numbers can be placed in the squares and parents

asked to fill in the numbers in the circles!

• Parents can be invited to study the diagram which illustrates the notion of 'is a divisor' (page 68). Further work can entail trying to fit other numbers to similar diagrams. What set of numbers has the lowest total? Other more complex diagrams can also be used.

Activity 4

Games

The following are some games for parents to play which involve forward-thinking and searching for winning strategies to gain high scores.

Try these games out in the group and discuss how they could be used to enhance parents' understanding of the way their children learn mathematics.

Multiple bingo

Before the event, make sure you have available two dice of different colours and make enough 3x3 grid cards for the participants to have one each.

Heading	11	5	8	Score
4	24	64	16	3
7	14	35	26	2
9	33	15	36	1
Score	1	2	1	Total 10

Figure 1

Tell the group that one die represents the tens digits and the other represents the units. Throw the two dice and call out the two-digit number. Ask the players to write that number in one of the nine boxes on their grid. Repeat this process until all the boxes have been filled.

Ask the players to count up their scores, allowing one point each time a number in a row or a column is a multiple of the number at the beginning of that row or column (see Figure 1).

Divisor bingo

Before the event, prepare sufficient 3x3 grids as before and have a die available.

Throw the die and call out the number shown. Ask the players to write that number in one of the boxes on their cards. Continue in this way until all the boxes are filled.

Count up the scores by allowing one point every time a number is a divisor of the number in the first square of the column or row, as in Figure 2.

Heading	15	36	38	Score
34	5	3	4	0
9	4	1	2	1
42	3	6	5	2
Score	2	3	2	Total 10

Figure 2

Thirty-one

Ask the group to form pairs, each having one die. Ask them to draw rough score sheets as in Figure 3 on page 62, then roll the die and write the score in the table.

The first player should then roll a new score with the die, and perform one of the following operations:

• Add the start score to the new score;

• Multiply one score by the other;

- Divide one score by the other;
- Take one score from the other.

START SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	
NEW SCORE	

Figure 3

Continue taking turns at rolling the die. The winner is the first player to reach 31, as in the example in Figure 4. Play three games and ask the pairs to make a table of their scores.

START SCORE 4
NEW SCORE 3
MULTIPLY 3 X 4 12
NEW SCORE 4
ADD 4 + 12 16
NEW SCORE 2
MULTIPLY 2 X 16 32
NEW SCORE 1
SUBTRACT 32 - 1 31
GAME ENDS

Figure 4

Cross it out
Ask the players to form pairs and give them two dice, a shaker and a 6 x 6 table square (for example, Figure 5).

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

Figure 5

Ask one player from each pair to roll the dice. If for example, his scores are 6 and 2, he can now:
- Cross out 8 because 6 + 2 = 8;
- Cross out 4 because 6 - 2 = 4;
- Cross out 12 because 6 x 2 = 12;
- Cross out 3 because 6 ÷ 2 = 3.

Let the second player take a turn at rolling the dice, but ask him to cross his numbers out on the 6x6 table square in a different colour.

Keep a table of results for checking, as in Figure 6.

BLUE						RED					
Score		+	-	x	÷	Score		+	-	x	÷
6	2	8	4	12	3	4	3	7	1	12	X

Figure 6

So you think you know your place?
Before the event, make sets of cards numbered 0 to 9, and make copies of photocopiable page 69 for all the participants.

Ask the group to work in pairs, taking turns to do the activities. Give each pair a set of cards.

Ask them to shuffle the cards and place them face down. One player should then turn over the top card, and write the digit showing in one of the boxes on the score sheet. Then he can place the card at the bottom of the pile and repeat this process until all the eight boxes have been filled.

NB It is important to place the digit resulting from the first card in a box *before* taking a second card.

Complete the two sums. On the score sheet, the two result boxes have been arranged to form a mathematical sentence (for example, 126<274).

If the sentence is correct, score points in the following way.

- If both are 3-digit numbers, score 5 points.
- If both are 2-digit numbers, score 3 points.
- If only the larger sum is a 3-digit number, score 2 points.
- Otherwise, score 0 points.

Mappings

Working in pairs, complete the work sheets on photocopiable pages 70 to 72.

The windmill puzzle

Mark the numbers 1 to 8 on counters and ask participants to place one number in each square of photocopiable page 73. Add up the numbers along each line.

Ask participants to try to place the numbers so that each line adds up to the same total. Then ask them to try to find four different answers.

The letter 'F' puzzle

Use counters numbered 1 to 8 again, and copies of photocopiable page 74.

Ask participants to put one number in each square and add up the numbers in each line. They should try to find a way of placing the numbers so that all the lines add up to the same total.

There are five correct solutions to this problem: one solution has a line total of eight,two have line totals of nine, and two have line totals of ten.

The wigwam puzzle

Mark the numbers on the counters as before, and distribute copies of photocopiable page 75.

Put one number in each square and add up the numbers along each line.

Find a way of placing the numbers so that all the lines add up the the same total.

There are four different solutions to this problem: one has line totals of ten; two have line totals of twelve; one has line totals of fourteen.

Sevens puzzle

Use number counters again, this time marked in units of five between 5 and 35, and distribute copies of photocopiable page 76.

Ask participants to add up the numbers along each line, then find a way of placing the numbers so that all the lines add up to the same total.

There are three correct solutions: one has a line total of 50, one has a line total of 60 and one has a line total of 70.

The big E puzzle

Use counters numbered 1 to 8 and put one number in each square on photocopiable page 77.

Ask participants to add up the numbers along each line.

Find a way of placing the numbers so that all the lines add up to 12.

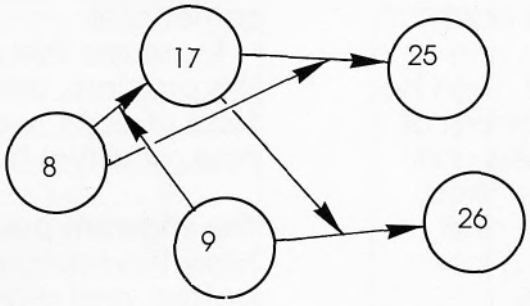
There are eight correct solutions to this puzzle.

So you think you know your tables? (see page 60)

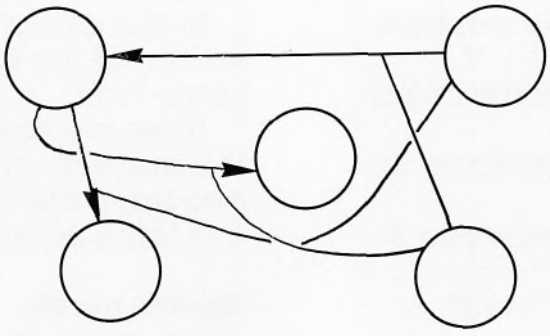
Link ups 1

Example

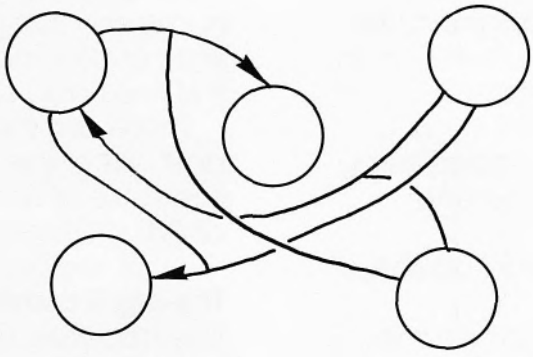
25 9 8 26 17



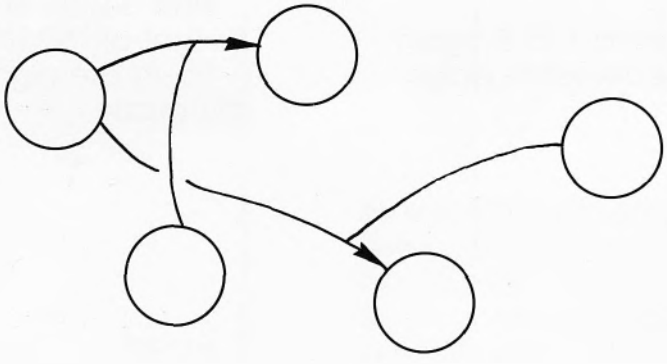
55 65 15 40 25



47 32 49 15 17

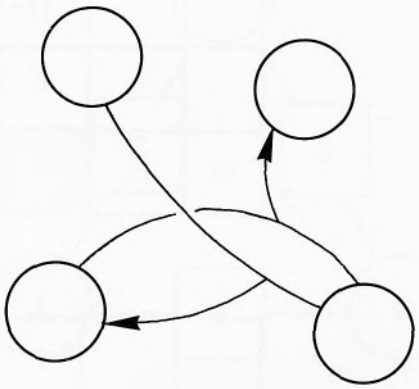


23 17 36 40 53

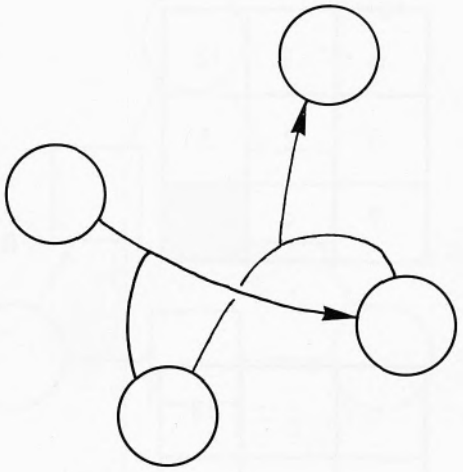


So you think you know your tables? (see page 60)

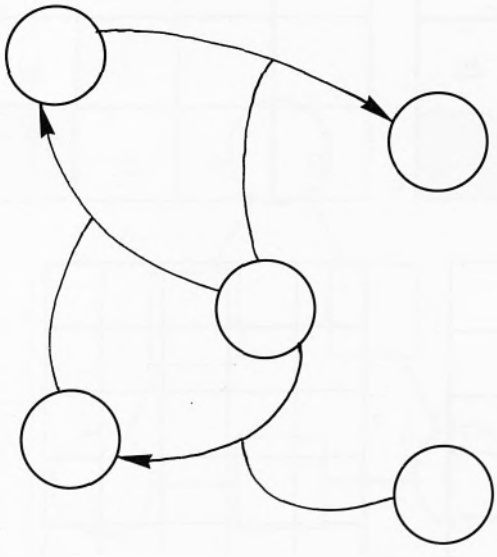
Link ups 2



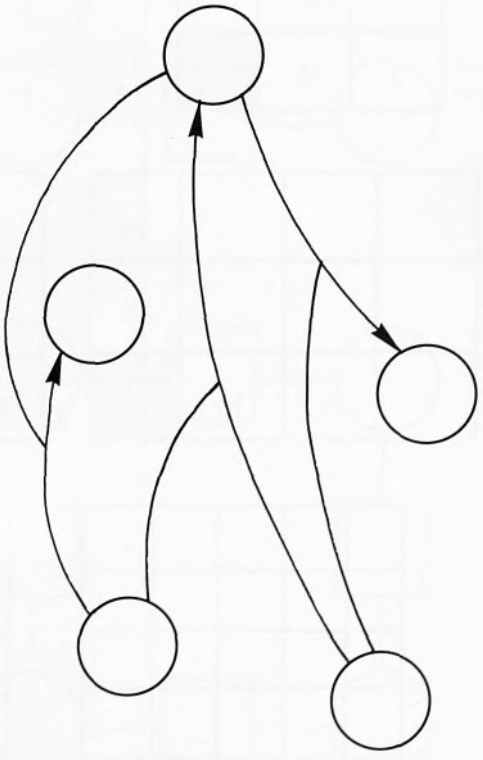
15 75 3 5



63 7 21 3



3 9 81 27 3

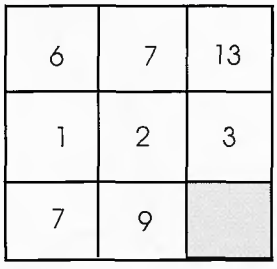


12 2 6 3 18

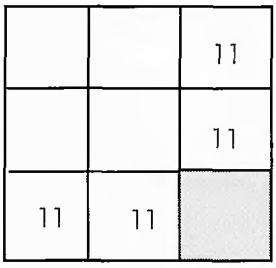
So you think you know your tables? (see page 60)

Number squares

Example



A



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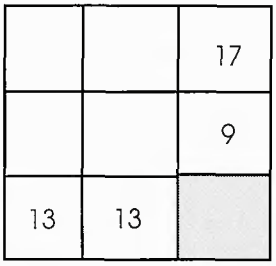

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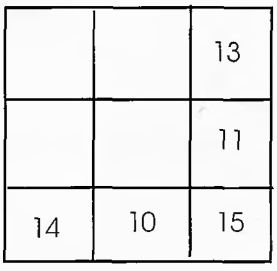

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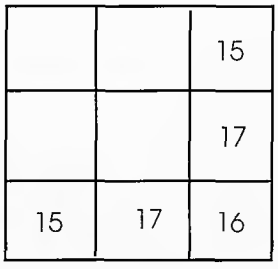

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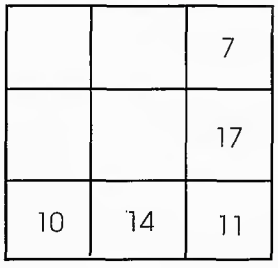

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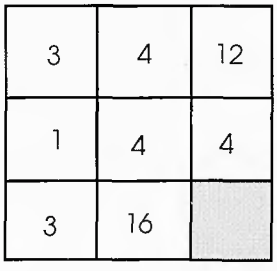

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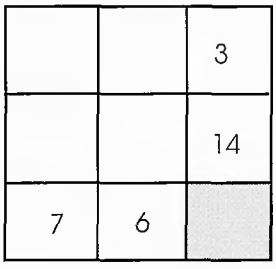

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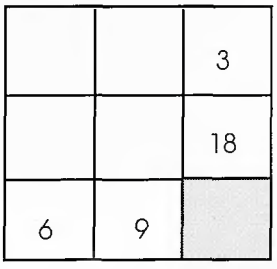

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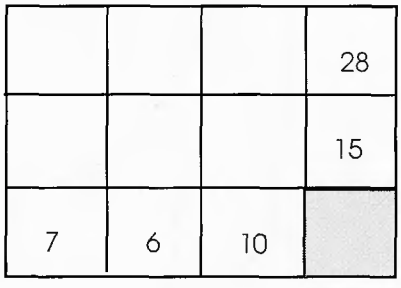

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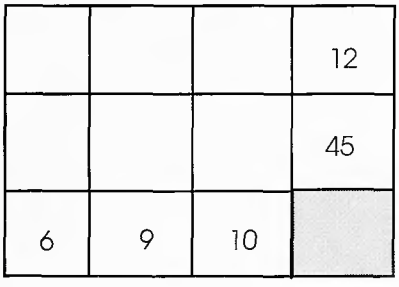

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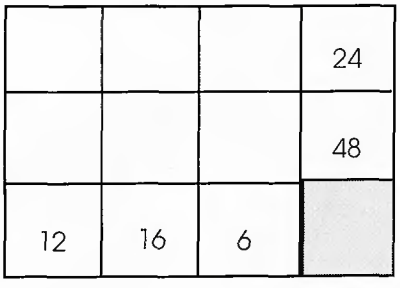

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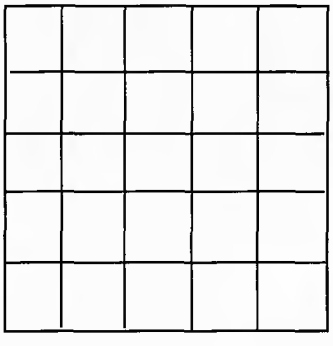

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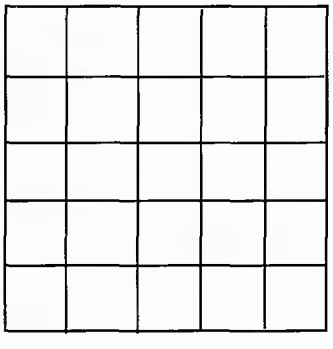

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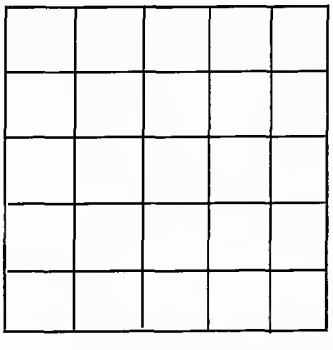
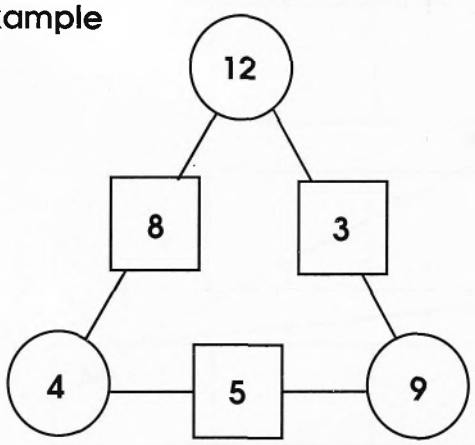


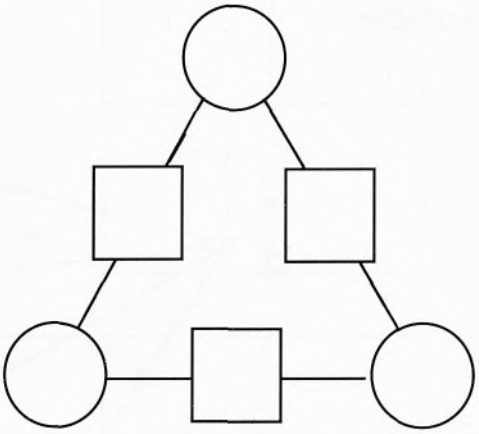
O

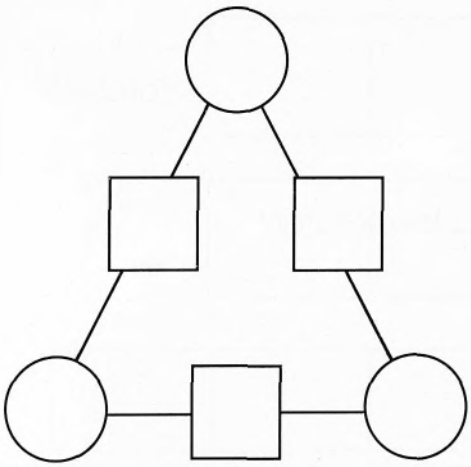
So you think you know your tables? (see page 60)

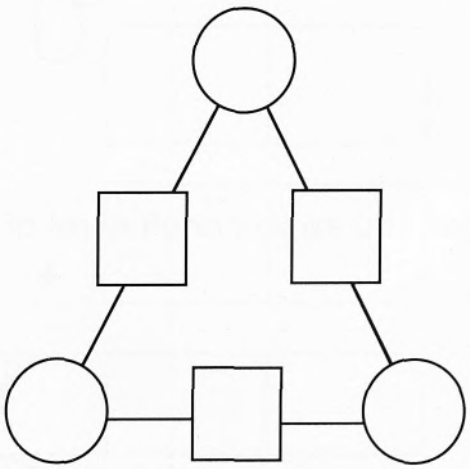
Arithmogons

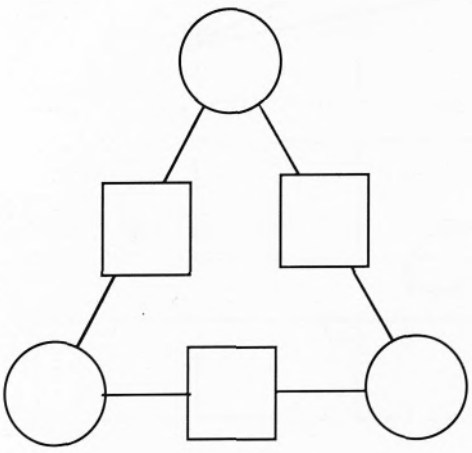
Example

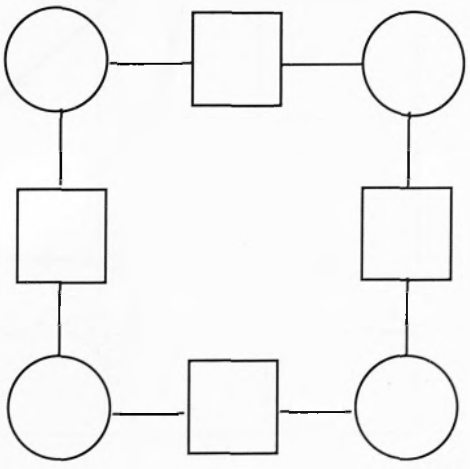








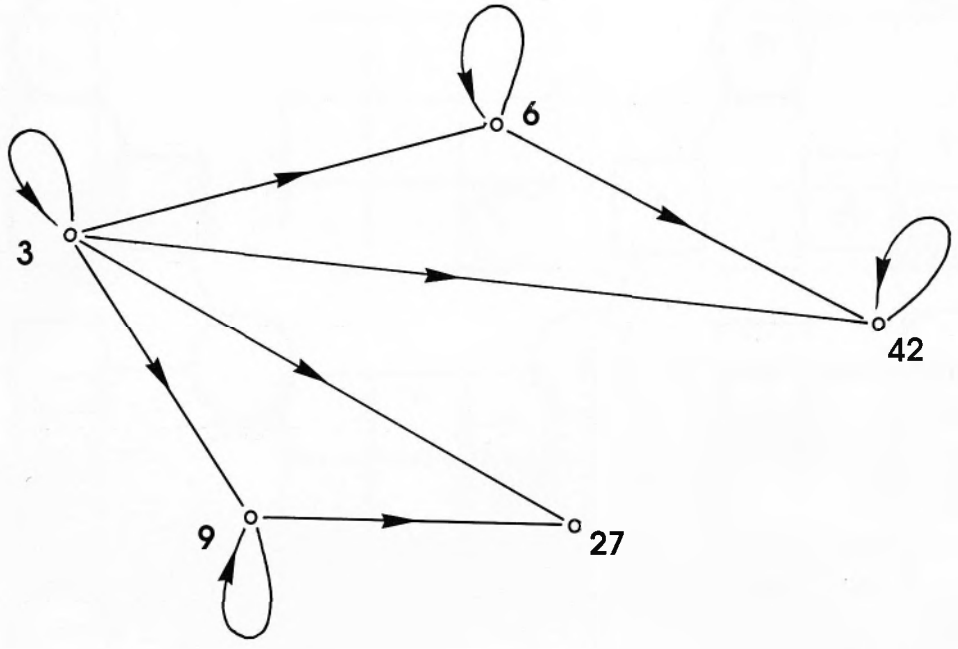




So you think you know your tables? (see page 60)

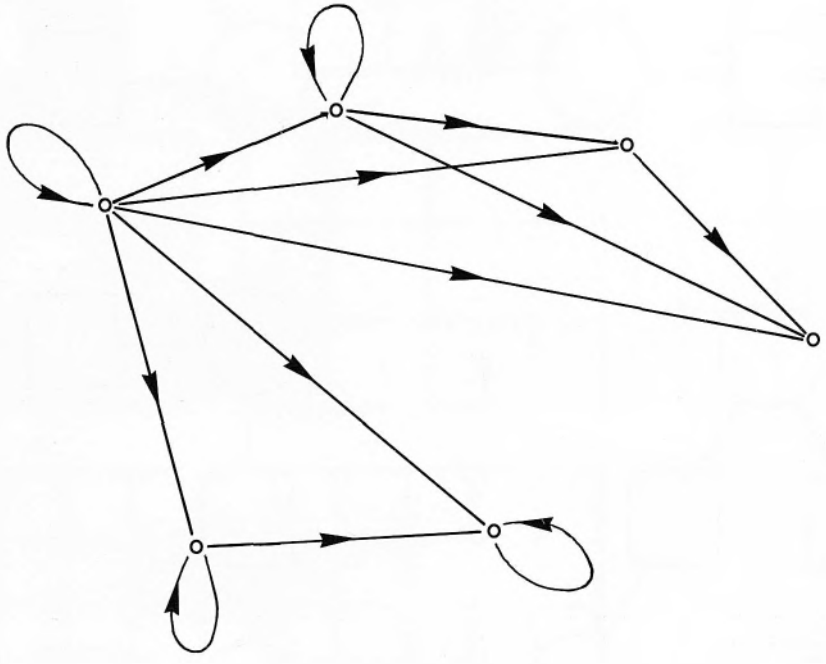
Divisors

Example



Total =87

Can you think of another set of numbers with a lower total?

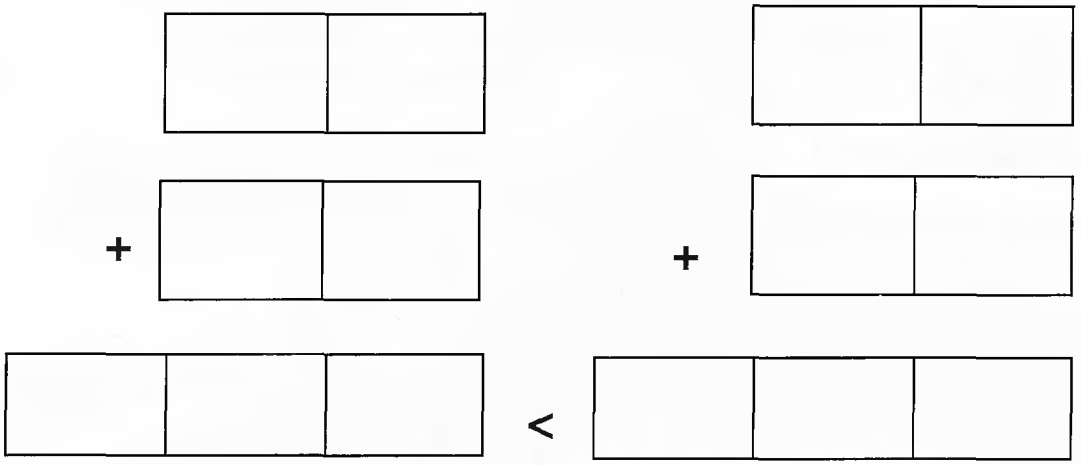


Games (see page 61)

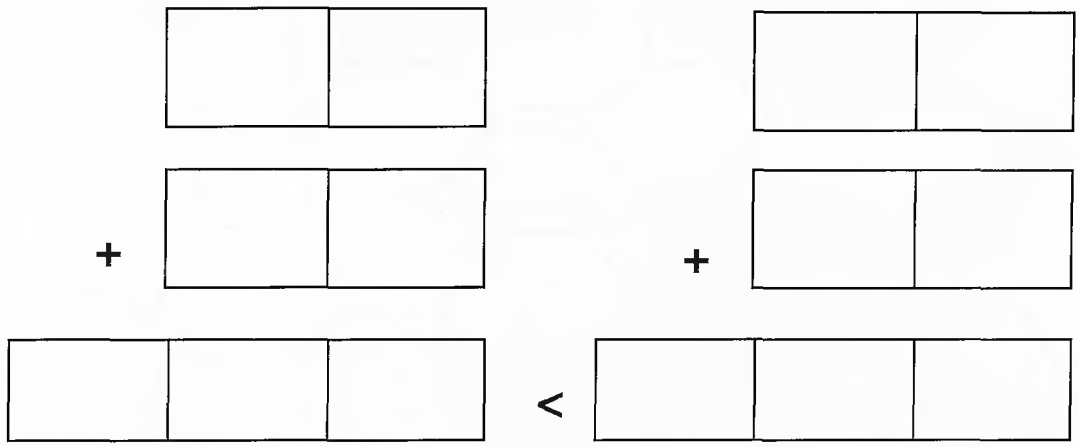
So you think you know your place? (see page 62)

SCORE

1



2



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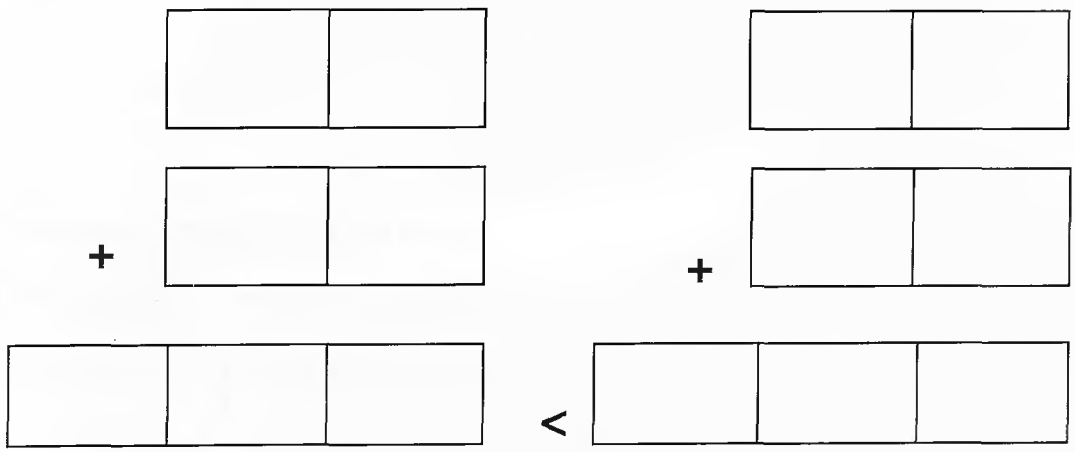


TOTAL SCORE _____

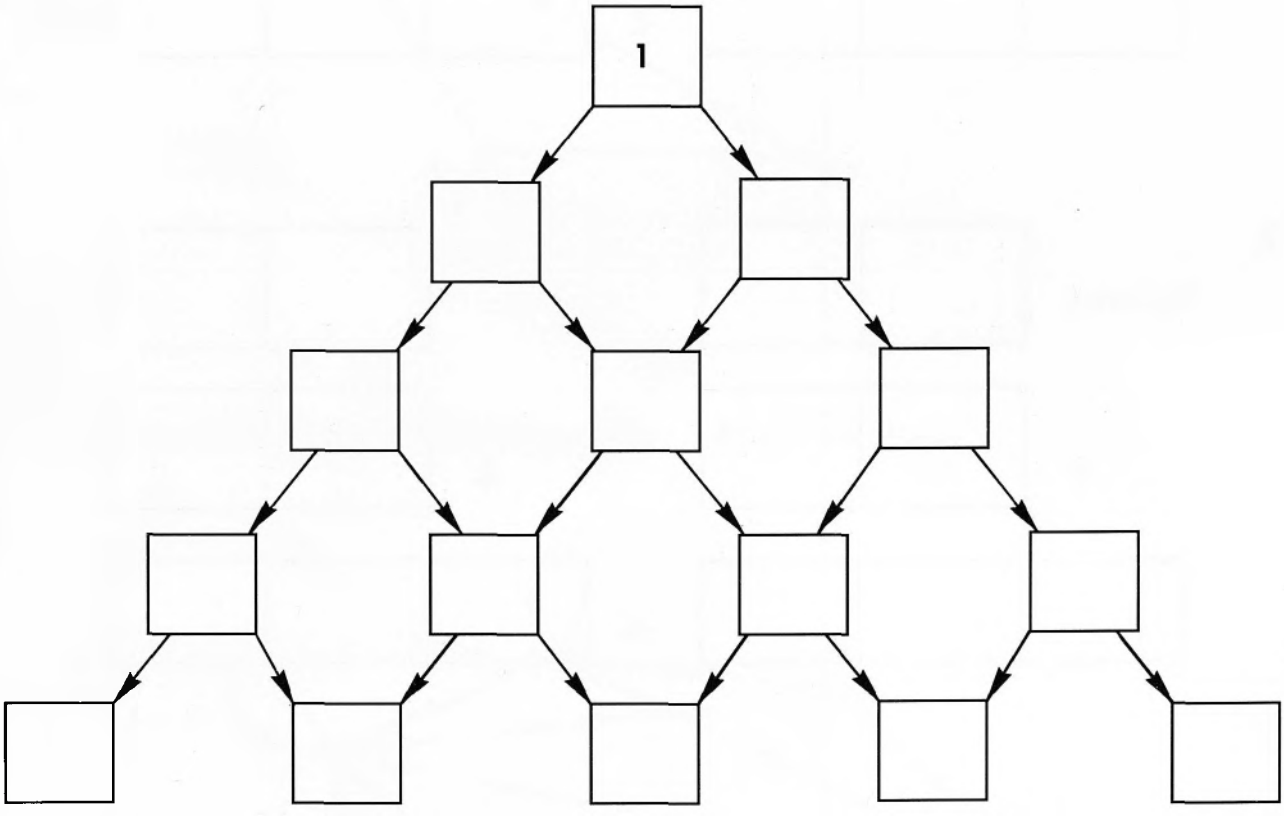
Games (see page 61)

Mappings 1 (see page 63)

IF ↙ MEANS X 2

AND ↘ MEANS X 3

COMPLETE THE MAPPING



WHAT WOULD ↗ MEAN?

WHAT WOULD ↖ MEAN?

WHAT WOULD ↓ MEAN?

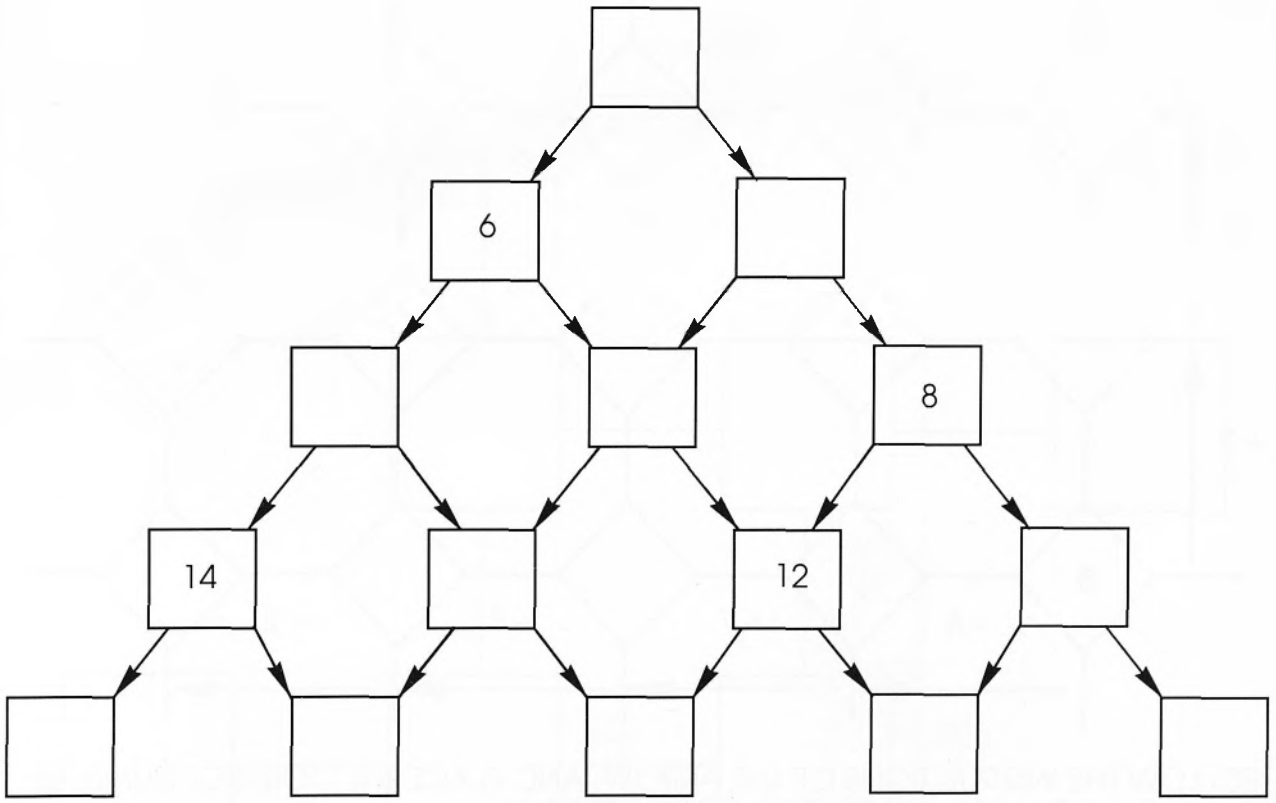
WHAT WOULD → MEAN?

WHAT WOULD ← MEAN?

Games (see page 61)

Mappings 2 (see page 63)

STUDY THE PARTLY COMPLETED MAPPING CAREFULLY. DECIDE WHAT ↙ AND ↓ MEAN, THEN FILL IN THE BLANK SQUARES.



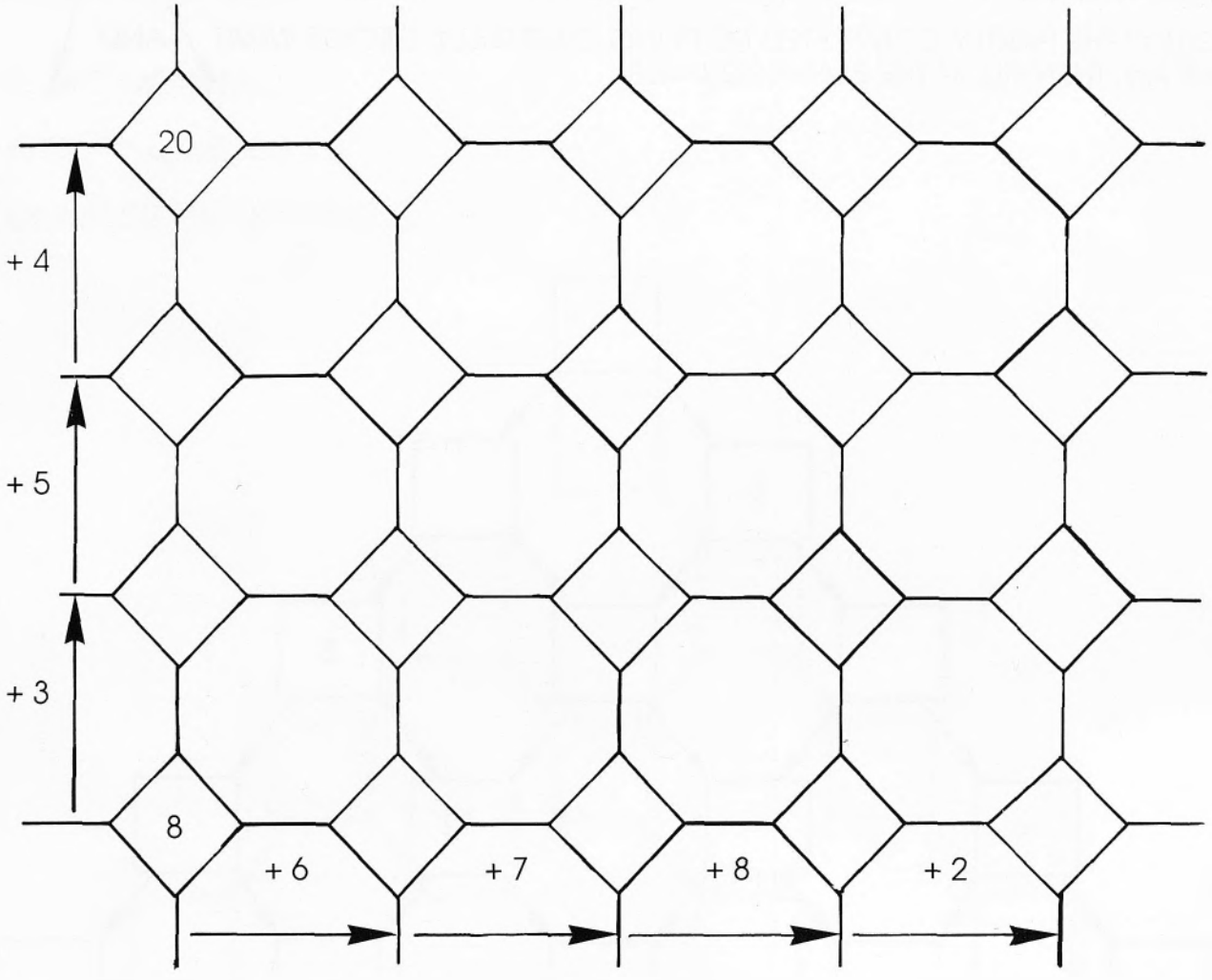
WHAT WOULD ↓ MEAN?

WHAT WOULD ↙ MEAN?

WHAT WOULD → MEAN?

Games (see page 61)

Mappings 3 (see page 63)

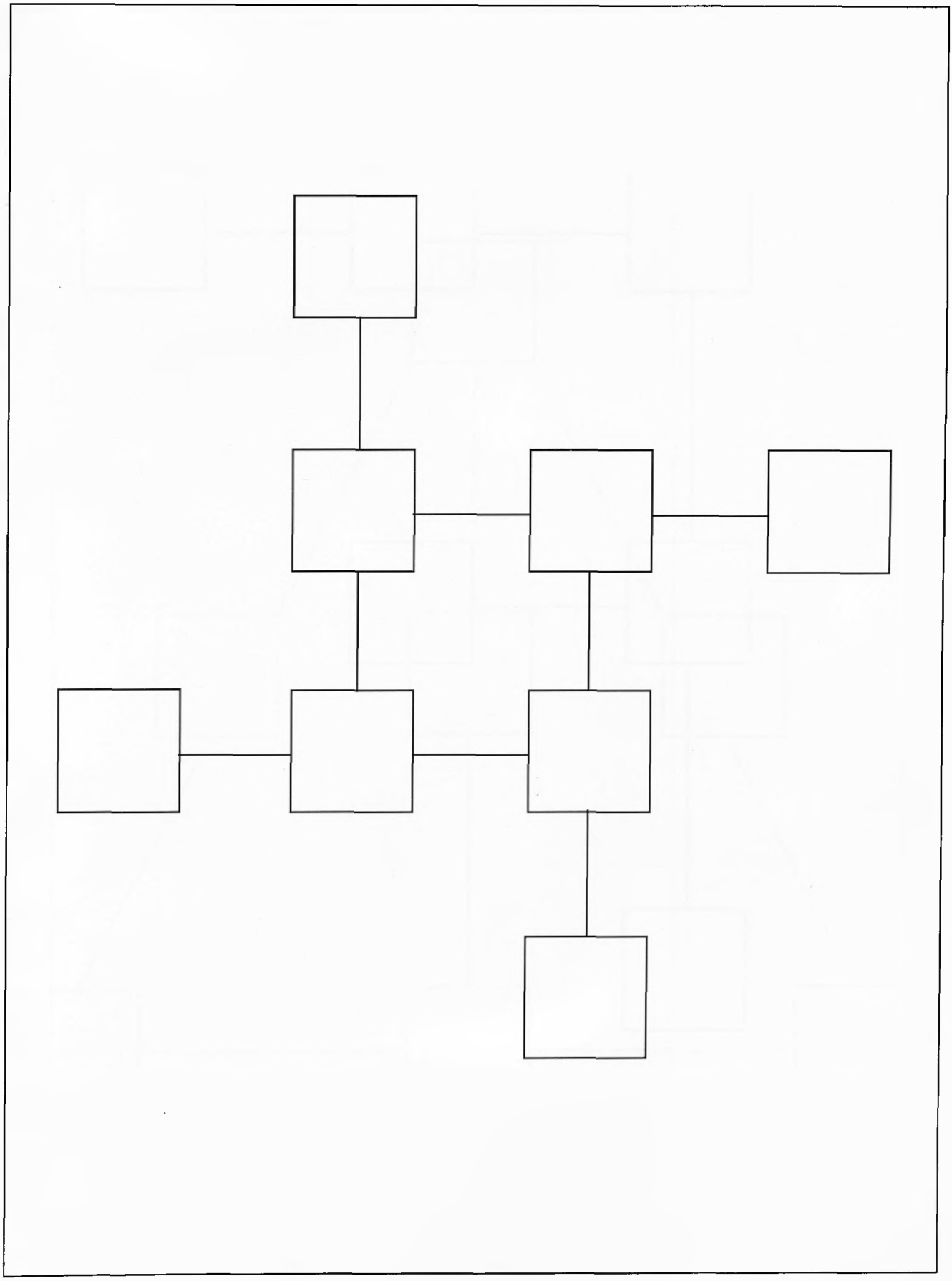


FOLLOW THE INSTRUCTIONS OF THE ARROW, AND PLACE THE CORRECT NUMBERS IN ALL THE SQUARES.COMPLETE THE TABLE BELOW.

Start at square	Code of directions	Arrive at square	Give a code for a shorter route
8	→ → ↑ ← ↑	22	
22	↓ ↓ → → ↑ ←		
29	← ← ↑ → ↓ → ↑		
37	↑ ← ← ← ↓ →		
24	→ ↑ ← ↓ ↓ →		

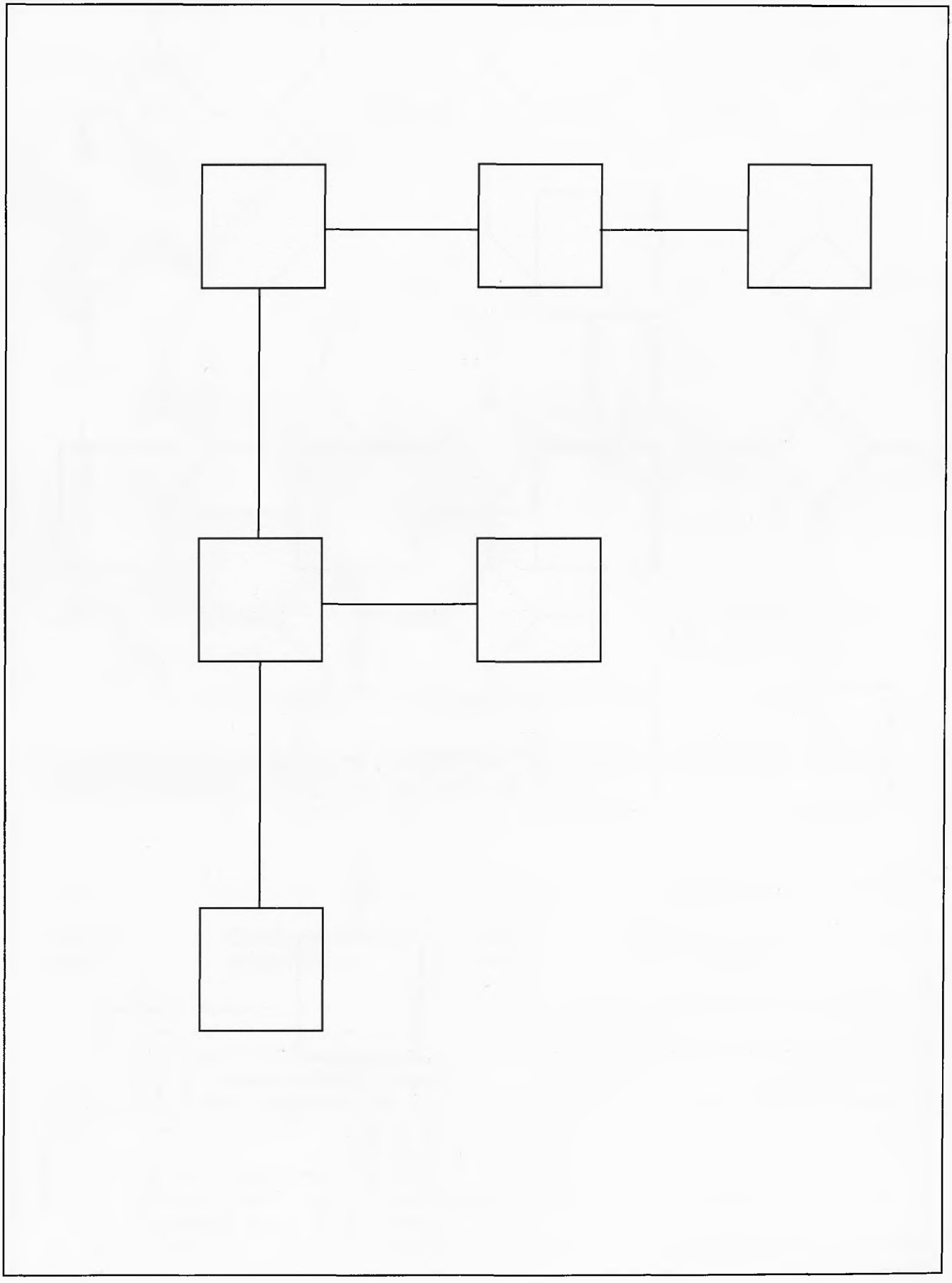
Games (see page 61)

The windmill puzzle (see page 63)



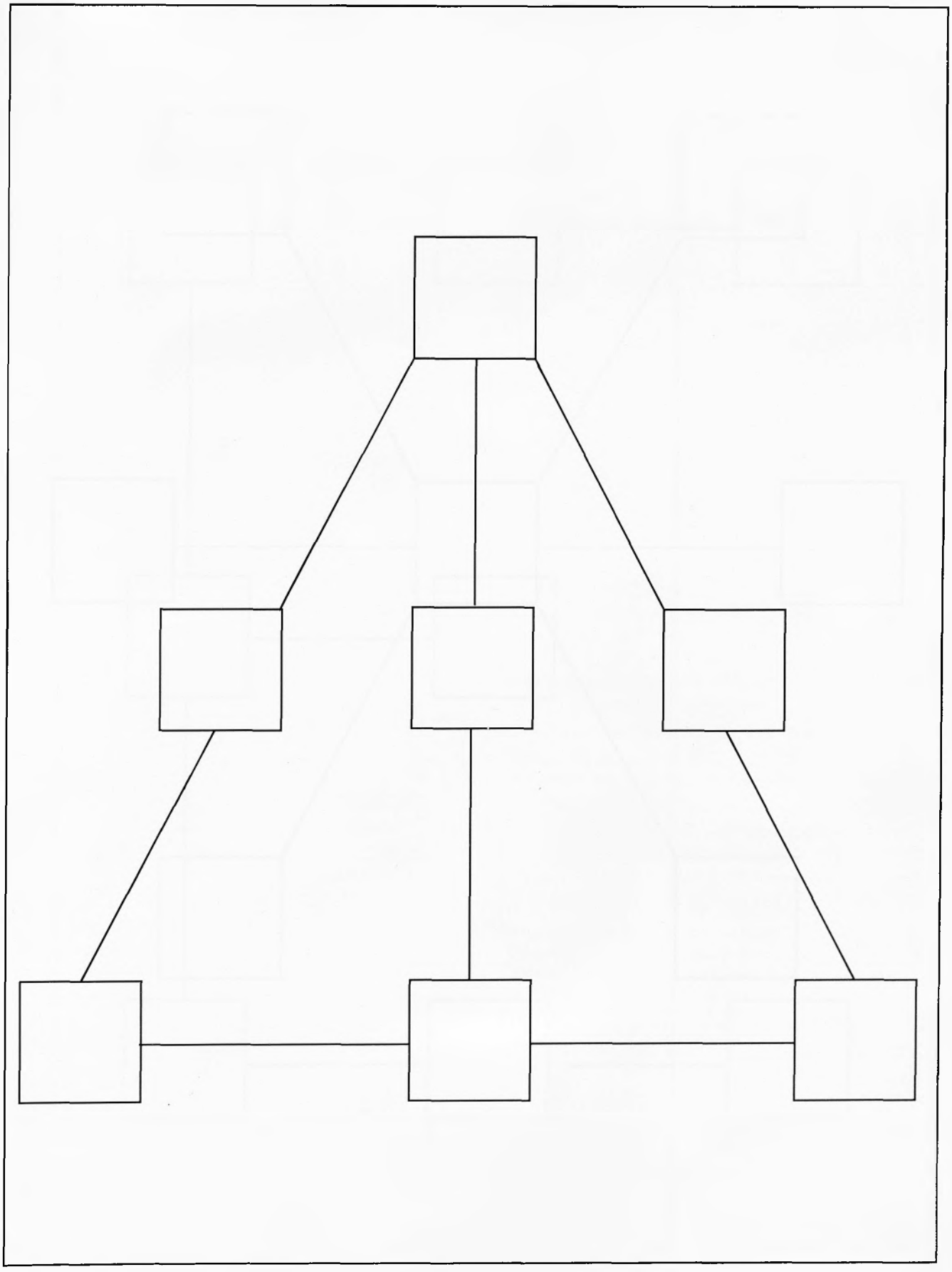
Games (see page 61)

The letter 'F' puzzle (see page 63)



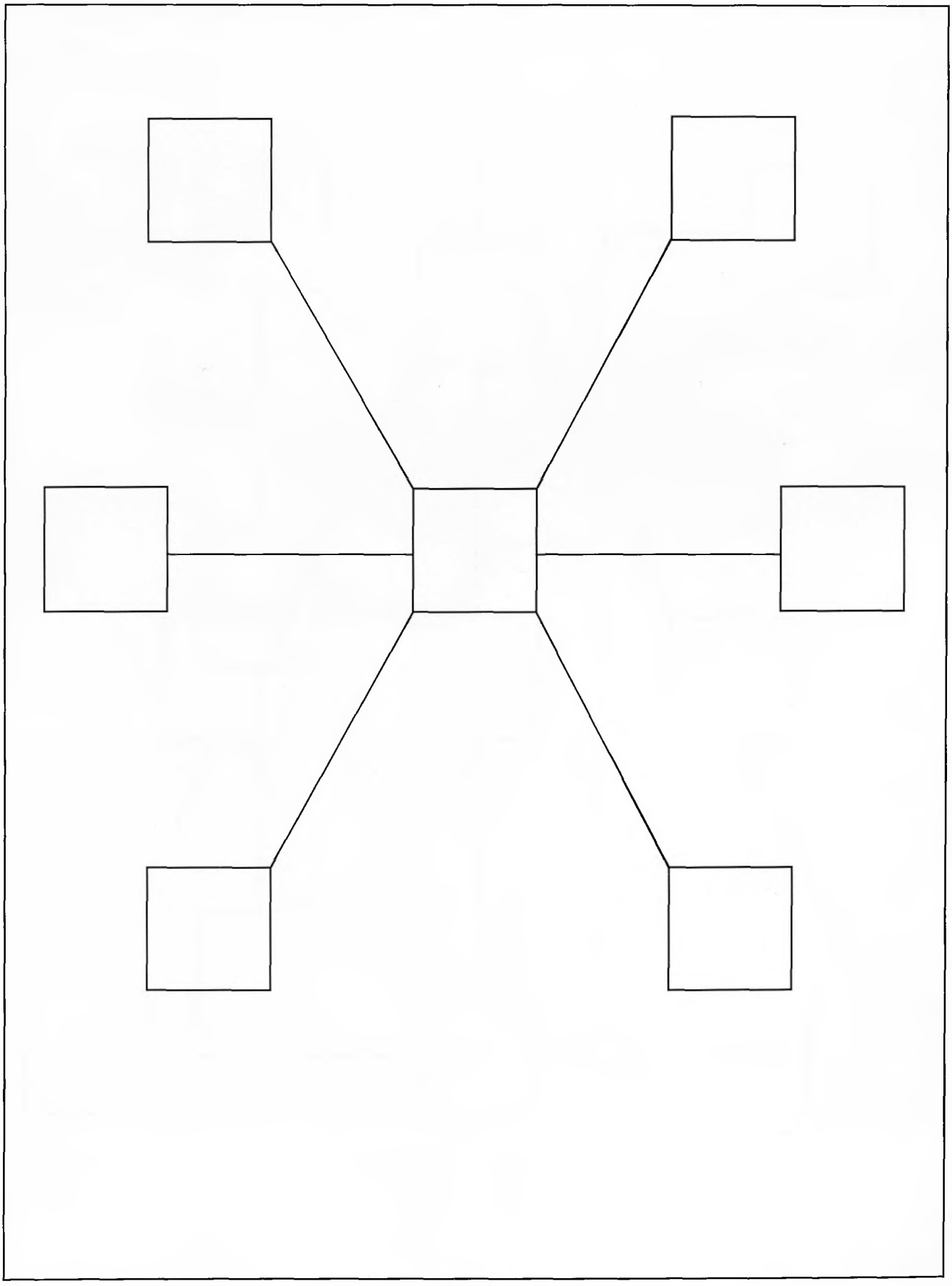
Games (see page 61)

The wigwam puzzle (see page 63)



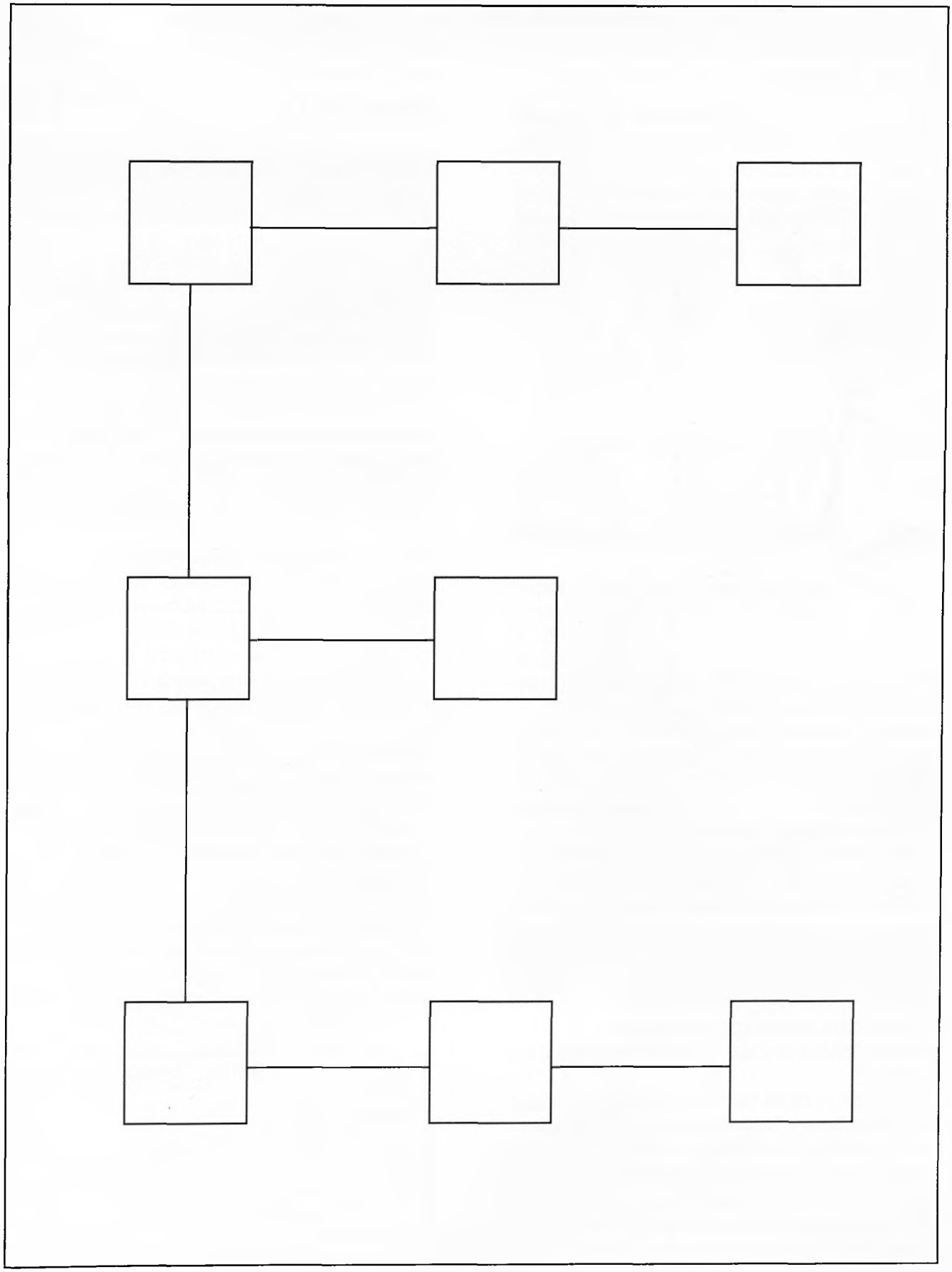
Games (see page 61)

Sevens puzzle (see page 63)



Games (see page 61)

The big E puzzle (see page 63)



Mathematics and technology

The mathematical implications of the advent of new technology have been discussed in a previous chapter. In this chapter, we intend to highlight mathematical activities for teachers which could promote discussion about the benefits of working with computers, calculators and video. Many of these activities can be adapted for use in the classroom.

Calculators

Calculator practice can be broadly categorised under three main aims, as follows:

- To teach and reinforce basic concepts and relationships in number;
- To provide feedback when outcomes based on prediction or estimation are sought;
- To act as a resource for further mathematical endeavour.

Activity 1

Mathematics with a calculator

Ask participants to indentify and discuss the categories of calculator provision in their classrooms and schools. Discuss the type of provision that predominates. What reasons are there for this provision?

Ask staff to work through the following tasks in pairs, and then discuss with the rest of the group the questions below:

- What mathematical insights did they gain?
- What skills did they develop?
- How would they adapt the activity for use with the children they teach?
- What aspects of the activity did they enjoy and value, and why?
- If the activity was used in their class, what aspects of it would they assess?

Twenty-one

Write down the numbers 1 to 9 on a piece of paper.

Each player takes it in turn to press one of the numbers on a calculator and then +.

When a number has been used, ask players to cross it out so that they do not use it again. The loser is the player who makes 21 or above. In the example in Figure 1, player A will win.

		Keys in		Displaying
Player	A	2	+	2
	B	5	+	7
	A	4	+	11
	B	3	+	14
	A	6	+	20

Figure 1

Swallows
Distribute copies of photocopiable page 85 to each pair, and tell them that any three swallows can return home after the summer.

What is the lowest total numerical value that can return home? What is the highest? How many different totals are possible?

Sentences
Choose from the numbers and signs 6, 8, 4, 9, 5, 7, +, -, =, to make the number sentence x + y equal to a target number. Ask staff to check their answers with a calculator, and record the calculator answer in a box, using Figure 2 for reference. Give a tick or cross to indicate whether the answers are correct.

x	+/-	y =	target	calculator	✔✘
6		8	14	14	✓
9		7	15	16	✘

Figure 2

End digits
In a group, ask everyone to think of a different number that ends in seven. They should then multiply these numbers by eight, and everyone should compare answers, looking in particular at the end digit.

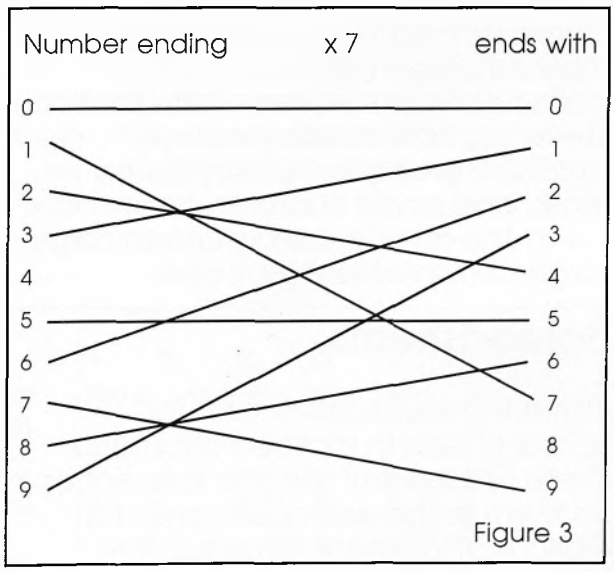


Figure 3

Continue this activity by giving numbers ending in different digits and using different multipliers to build up a ladder as in Figure 3.

Different ladder patterns can be built from the answers produced by multiplying by 2, 3, 4, 5, 6, 7, 8, 9 and 12.

Dead key arithmetic
Set the group the following problem. You find that the zero button on your calculator does not work. How are you going to display the following numbers:

- 20?
- 203?
- 2008?
- 3040?
- 305006?
- 600700?

What about displaying these numbers:

- 0.20?
- 0.203?
- 0.2008?
- 0.305006?

How would you perform the following calculations:

- 20 x 0.20?
- 203 + 2008?
- 305006 ÷ 3040?
- 600700 - 2008.203?

Powers of sevens
Ask the group to work out the rest of this sequence:

- $7^1 = 7$; 7^2 (that is 7 x 7) = 49;
- 7^3 (that is 7 x 7 x 7) = 343;

and so on as far as 7^7.

Look at the final digit of these numbers. Is there a pattern? Does the pattern continue for ever? Is there a pattern to the last two digits?

Ask the group to experiment with other numbers, raising them to different powers.

Rectangles
Ask the group to draw rectangles which have an area of 24 cm^2 and whose sides are all whole numbers of centimetres, such as 8 cm x 3 cm. What breadth must a rectangle 24 cm^2 have if its length is 13 cm or 7 cm?

Missing digits

Each star in Figure 4 represents a missing digit. Ask participants to use the calculator to find what they are.

93 X 8* = 7**6
45* X *6 = 16452
**8 X 23* = 124608
3*9* ÷ 4* = 82
5418 ÷ ** = 8*

Figure 4

Square-and-add chains

Ask participants to choose a 2-digit number, square each digit and add the numbers together. Let them repeat this process and keep going until they have a good reason for stopping! The results should be as in Figure 5.

26 (for example)
⇓
$2^2 + 6^2 = 4 + 36 = 40$
⇓
$4^2 + 0^2 = 16 + 0 = 16$
⇓
$1^2 + 6^2 =$
⇓

Figure 5

Ask them to choose some starting numbers of their own and try the activity again.

Escape!

On a flipchart, reproduce Figure 6. Ask participants to try the process shown here with different starting numbers.

- Do they always escape?
- What number should you choose to escape as fast as possible?
- Do some numbers make escape difficult?

Design a flow-chart of your own with different rules.

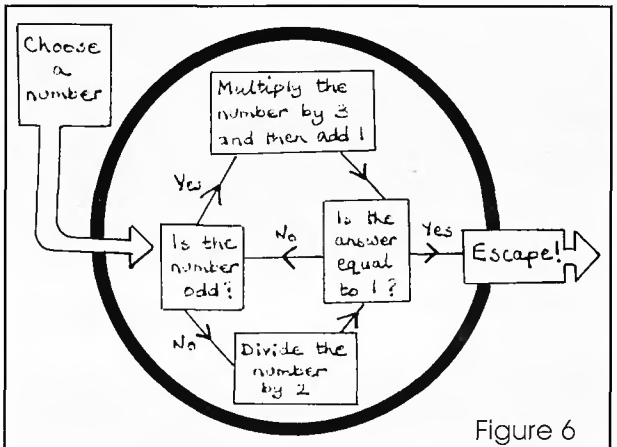


Figure 6

Computers

There are several ways of using a microcomputer in the classroom, and these have been discussed in the section on technology. In this section we shall concentrate on activities which need the use of a computer or in which a computer would reduce the drudgery of data handling.

Spreadsheets and databases are both excellent for most kinds of information handling. They can perform the following functions:

- Recognise patterns;
- Search;
- Record;
- Classify and sort;
- Evaluate;
- Verify;
- Collect;
- Display results;
- Test and pose hypotheses.

Most areas of the National Curriculum can be tackled through mathematics in some way, and computers can be very useful for this. There is ample scope for cross-curricular projects and collaborative work, and pupils can gain access to up-to-the-minute world data through large commercial databases.

Spreadsheets

There is a multitude of uses for spreadsheets in mathematics, and there are several specific references to them in the examples given for various attainment targets in the

National Curriculum. Children take to spreadsheets very readily, but often teachers are confused and bewildered by this relatively new application of technology. An INSET activity may therefore be a necessary prerequisite to using spreadsheets in the classroom.

Activity 2

Where's the mathematics?

An INSET session could start by an introduction to *Grasshopper,* a very basic but effective primary spreadsheet, using the sample files 'Grades' and 'Traffic' as indicated in the handbook accompanying the package.

Once colleagues feel comfortable about building formulae and copying across and down, they can be encouraged to set up some files of their own.

There are two main areas in which spreadsheets can be used in the classroom; in data handling exercises and in mathematical investigation.

Activity 3

Data handling and spreadsheets

Select ten jokes from any joke book and ask colleagues rank them in order of 'funniness', giving their first choice 10 points, their second 9, and so on.

In row 00 of a spreadsheet write the names of the teachers. Label column A with the jokes, lettered A to J.

Invite each teacher to enter her ranking for the jokes in her own column, as in Figure 7.

	A	B	C	D	E	F	G
00:	Name	Jane	Peter	John	Ellen	Mary	Total
01:							
02:	Joke						
03:	A	9	6	3	5	4	30
04:	B	7	5	1	2	5	20

Figure 7

Once completed, this table can be used in several ways:

- For sorting the data;
- For displaying and printing bar graphs;
- For comparing the sense of humour of pairs of teachers, using the scattergram facility. In how many ways can you do this?

This activity has been used successfully with ten-year-olds and is reported in 'Micromaths' Vol 6 No 3. Discuss the activity with colleagues.

- What are the benefits in using a spreadsheet?
- Would it effect the way you approached a data handling activity with your pupils? In what way? Why?
- What else is necessary to make this an effective approach?

Activity 4

Cannonballs

Cannonballs are usually put into piles with square bases. Ask the group to investigate the number of cannonballs in a pile with 10 layers. Ask them to use the spreadsheet to generate this pattern, as well as solving the problem on paper.

What happens if the piles have a triangular or hexagonal base?

Now consider these questions.

- What was the same and what was different about using a spreadsheet instead of a pencil and paper to investigate this problem?
- Did using a spreadsheet give you any insights into the problem that you may have missed using more traditional methods?

Identify some other investigations that you have used with your class. How could a spreadsheet have helped? What techniques should the pupils be familiar with before undertaking such an activity?

Databases

There are several types of database available for use in the classroom and all are excellent for a whole range of

database handling activities. In fact many spreadsheet activities can also be undertaken just as effectively with a database. The questions are often more important than the answers, and pupils soon realise that the information sought must be accurate and of value in order to allow pointed questions to be posed and to provide satisfactory and meaningful answers.

Binary trees
These are used to classify sets of objects and require questions to which the answers are either yes or no. An example of a binary tree database is *Branch*.

Relational
In relational databases the data is entered in fields, for example:

HOUSES	
Reception:	3
Bedrooms:	4
Garage:	1
Central heating	No

These will deal with questions of the nature 'Can I have details of all the houses with 3 bedrooms, a garage and central heating, please?'

Examples of relational databases are *Our Facts*, *Grass* and *Key*.

Activity 5

Sorting quadrilaterals

Use *Branch* to sort all possible quadrilaterals.

Check the accuracy of your sorting by changing the names of all the types of quadrilaterals. For example, make a square into a cod, a rectangle into a haddock, and so on, and ask the group to identify which fish is which shape. Then discuss the following questions:

- What are your reflections on the activity?
- What were your problems in undertaking this activity?

Consider the misunderstandings children have about squares and rectangles and squares and rhombuses. How can this activity help with this? Would the discussion between pupils caused by the actvity help clear up misunderstandings?

Ask participants to devise another activity in which using *Branch* may be worthwhile. Then let them convince the rest of the group.

Activity 6

Sorting bottles

Collect a whole range of bottles and ask the group to sort them according to various criteria, using a relational database. The criteria could include:

- Height;
- Diameter;
- Capacity;
- Colour.

Consider how this database can be used to help your pupils learn various mathematical concepts.

LOGO

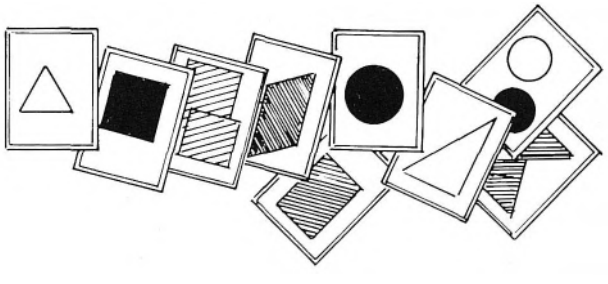
LOGO is a computer language which helps children to program easily because it has a very similar syntax to English and therefore it is simple to learn.

There follow some pre-LOGO activities which will help both pupils and teachers to understand the nature of LOGO and turtle graphics.

Activity 7

Describing shapes

Draw some simple shapes such as overlapping squares, triangles and circles on pieces of card.



Invite colleagues to work in pairs. Give each person a card and ask them to describe the picture on their card in such a way that their partner can draw it without seeing the card.

After the activity has been completed, ask the teachers what it was about their partners' description that made it easy or difficult to draw the picture. A list of positive attributes can be then drawn up.

Activity 8

Human turtles

Ask for a volunteer to be blindfolded. Send them out of the room and arrange the furniture to turn the room into some sort of maze. Invite the blindfolded volunteer back in and give instructions, one at a time, that will negotiate him around the room successfully.

- How precise did you have to be?
- List the instructions you had to give.

LOGO works very much in this way.

Now invite the group to work in fours, with two members of each group facing forward to act as 'human turtles'. The other two have to give instructions to the 'turtles', following instructions similar to the ones below:

- Forward x steps;
- Backwards x steps;
- Right y degrees;
- Left y degrees.

The object of the game is to ensure that the turtles end up facing each other with no steps between them.

To make the game more complicated, the 'turtles' can agree a rule between themselves. One rule may be that turtle 2 always doubles the number of steps or degrees given. Other variations can be quite complicated, and the 'drivers' may have great difficulty in sorting out your rule!

- Are all starting positions possible?
- Are all rules possible?

You are now ready to use LOGO with your computer. There are some excellent books on this topic, some of

which are included in the booklist on page 116.

Software

As mentioned earlier, there is a wide range of software available, serving a variety of purposes. It is important to try out software first and to be convinced it is an appropriate teaching medium for the concepts you want your pupils to understand.

Below is a range of activities that can be tried with *Monty*, available on *Slimwam 2* published by the Association of Teachers of Mathematics.

Activity 9

Monty

You will need to familiarise yourself and your colleagues with *Monty* before undertaking this activity. Now consider the following activities possible using *Monty*. Discuss how you would introduce the software into the classroom, the concepts involved and the benefits of using the software.

Seven squares
Monty is made of seven squares; how many seven-square shapes make *Monty*?

Other grids
Make up your own *Monty* grid. Place *Monty* on the grid so that he is hidden and ask a partner to find him. Have a blank grid for your partner to fill in.

Number spirals
Create a number spiral grid like this:

7 8 9
6 1 2
5 4 3

What patterns do you notice? Describe them to a partner.

Which grid?
If you shade in all the multiples of three on *Monty*'s grids, you will notice different patterns arising. Can you tell from an unnumbered shaded grid which of *Monty*'s grids it is?

Activity 10

Using software

Find a piece of software which the group may not have used before. Ask group members to explore its potential, and devise four activities which can be undertaken away from the computer.

Film and video

Below are two activities which can stimulate a great deal of work when used in the classroom.

Activity 11

Dance Squared

Get hold of a copy of the film *Dance Squared*, and ask staff to view it, preferably in silence. After the first viewing, talk about the film. What parts of it stayed in their minds? How many different sequences did it show?

Now let them watch the film again, but after about a minute and a half, stop the machine. Ask them to reconstruct the film's progression. How did it start? What happened next?

Rerun the sequences and let them see what it was they had noticed and what they thought they had seen.

Activity 12

Dance Squared continued

For this activity you need squared paper, gummed squares and any other square stimuli you can think of.

Watch the whole of *Dance Squared*, maybe more than once. Now ask staff the following questions.

- What do you know about squares?
- What new aspects of 'squareness' have you found?

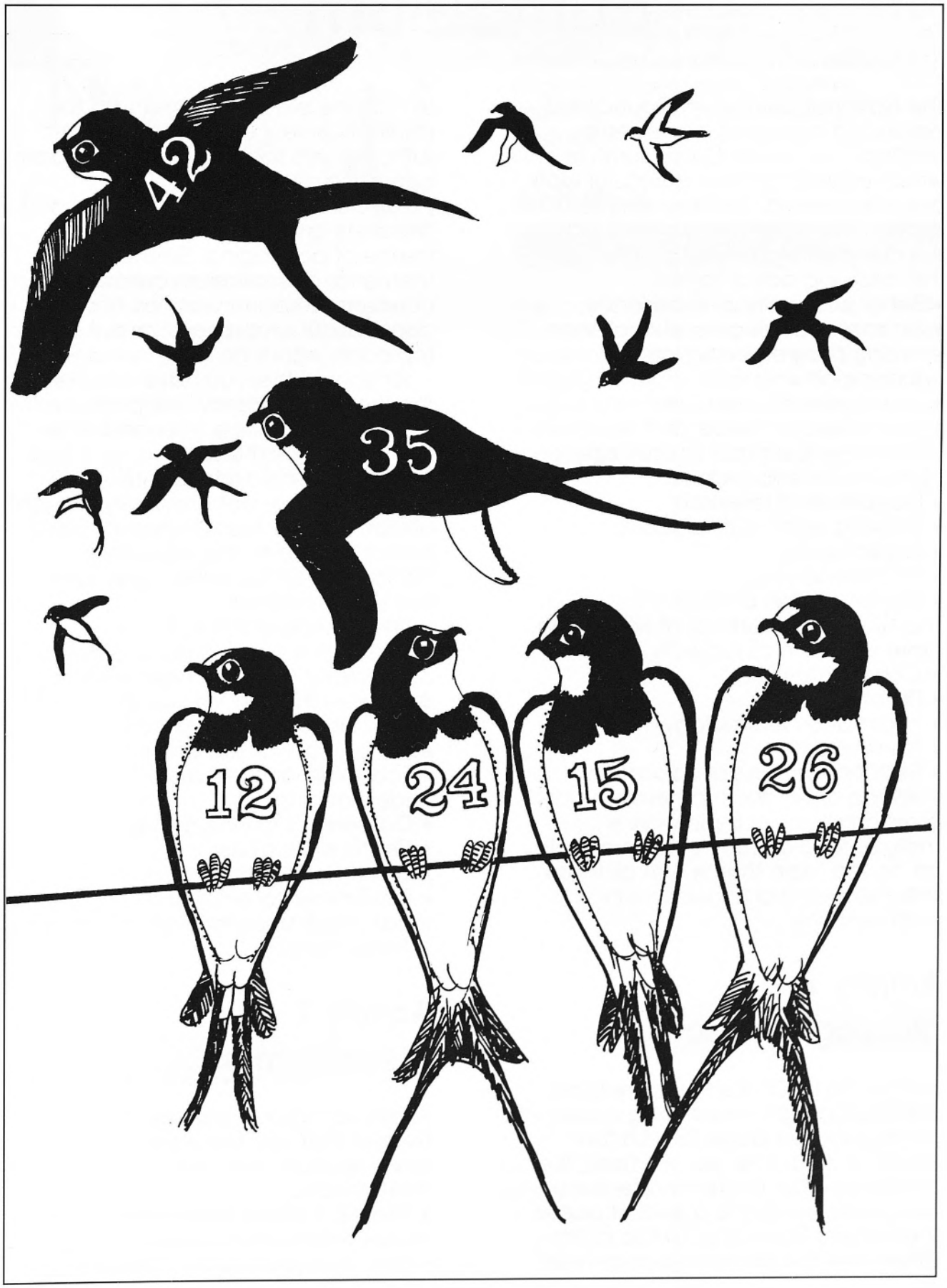
Activity 13

Notes on a Triangle

Show the film *Notes on a Triangle*. What lessons could staff prepare around this film? What mathematical value do they see in working this way?

Mathematics with a calculator (see page 78)

Swallows (see page 79)



Mathematics across the curriculum

The National Curriculum Council has produced a series of documents entitled 'The Whole Curriculum', in which aspects of cross-curricular work are emphasised. The documents express the belief that working across the curriculum provides children with the following advantages:

- Better continuity of experience;
- An improved degree of challenge, ensuring progression which will enhance attainment;
- Less duplication of work.

Cross-curricular themes are used extensively in schools to promote higher-order skills such as:

- Independent research;
- Working within a time scale;
- Project work;
- Problem solving;
- Working within a team.

The NCC lists a number of skills which have a basis in all subjects:

- Communication;
- Problem solving;
- Information technology;
- Numeracy;
- Personal and social education.

All too often, the mathematics in cross-curricular or topic work is marginalised or contrived, as a 'bolt-on' to the main theme; yet all these skills are essential for success in mathematics.

Activity 1

Packaging topic web

Before the INSET day, prepare some packaging topic webs using copies of photocopiable page 88 and four sheets of A4 paper per set. Using the photocopiable page for reference, cut circles out of the sheets of paper, then staple them one on top of the other over the photocopiable sheet so that the piece of paper with the smallest circle is on top. Prepare sufficient sets so that each participant can have one.

Ask participants to look through the first circle and discuss the overall theme of packaging. Extend the theme for all curriculum areas, but concentrate particularly on how you can draw the mathematics out of the topic.

When you feel you have explored the theme sufficiently, ask participants to turn the first circle over and look through the next one.

If the second circle reveals any areas you have not previously thought about, explore them in greater depth before turning to the next circle. Continue until the entire topic web has been revealed.

What areas of the National Curriculum for mathematics have you addressed? Consider how the topic addresses the five themes identified by the National Curriculum Council as essential parts of the whole curriculum:

- Economic and industrial understanding;
- Careers education and guidance;
- Health education;
- Education for citizenship;
- Environmental education.

What place does mathematics have in these areas?

Activity 2

Other themes

Within your group, discuss other themes that you feel may contain areas explicitly relevant to mathematics.

- What is it about these themes that makes them rich in mathematics?
- How can you ensure a balance of

mathematical experiences?
- How can you ensure that there is a balance of mathematical topics, and not just cover work on shape and space?
- What are the differences and similarities in working thematically and across the curriculum?

Activity 3

Mathematics and science

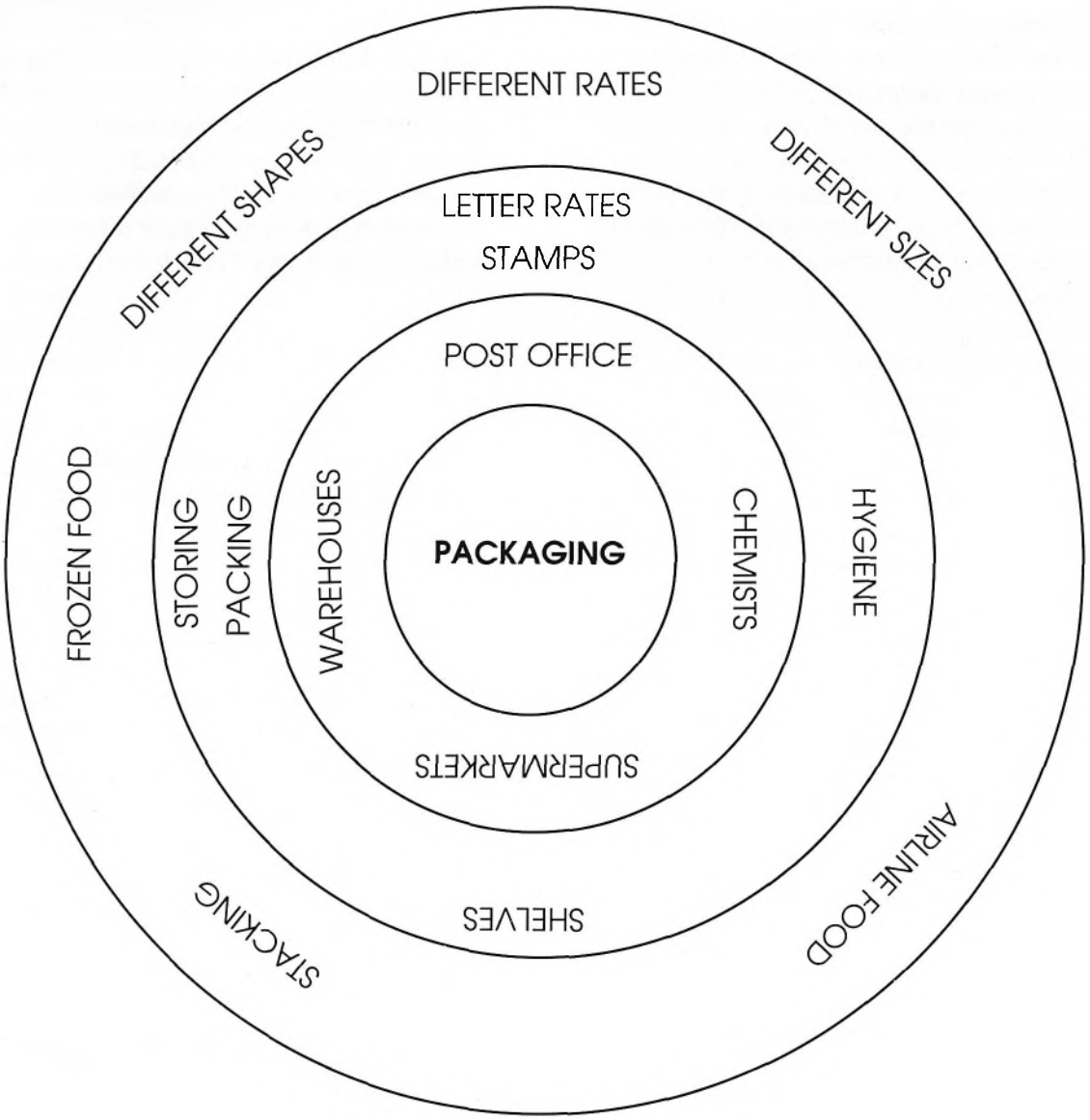
As a group, look through the National Curriculum Science document. What topics can the group think of that would best bring together aspects of both mathematics and science?

Activity 4

There's no maths here...

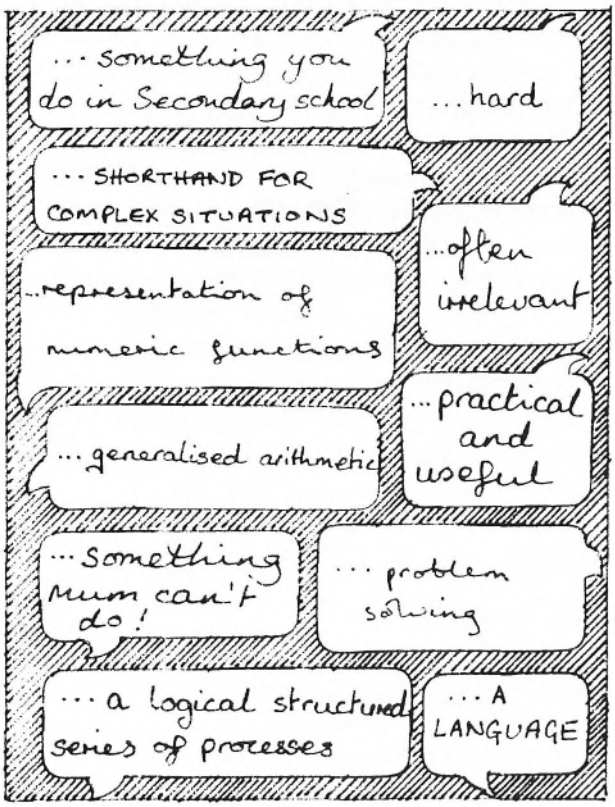
Ask participants to choose one or two themes that seem to have little or no application to mathematics. Try to extract as many mathematical ideas as you can from these themes.
- What are the problems here?
- How can they be overcome?

Packaging topic web (see page 86)



Algebra

Below are some quotes from a group of teachers on an INSET course who were asked to complete the sentence 'Algebra is ...'.



This could be used as a starting point for an INSET meeting on algebra.

- What do your pupils think that algebra is?
- Do you know the origins of the word 'algebra'?

Activity 1

Algebra as codes

Bliss symbols

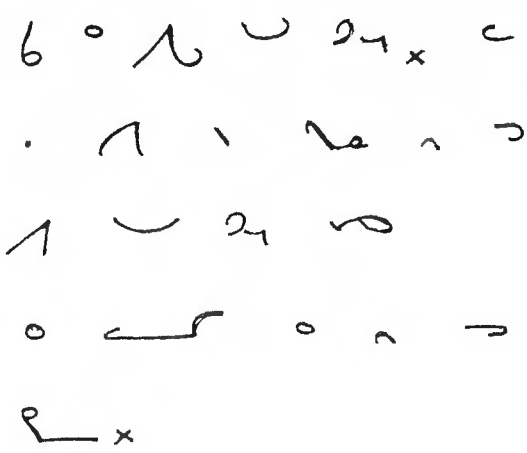
Distribute copies of photocopiable page 93 which shows Bliss symbols. What symbols would group members use forthe following places:

- A cinema?
- A post office?
- A school?
- A restaurant?

What other symbols can the group think of? What is the relevance of this activity?

Shorthand

A shorthand typist could read this:



It says, 'This is written in shorthand. With a lot of practice you can write in shorthand almost as quickly as you can speak.'

Morse Code

Samuel Morse (1791-1872) devised a code, known as the Morse Code, which is still used to this day and is a little more accessible than shorthand. The code uses as a maximum four bleeps, combining long and short bleeps.

Distribute copies of photocopiable page 94, and ask participants how they would send the message 'Maths is fun'. Ask them to try 'singing' a coded message to a colleague, or to devise a machine that will do this. Ask them to devise a new code that uses a five-bleep system.

Knitting patterns
An excerpt from a knitting pattern reads:
'2nd row - P1, *K1, P1; rep from * to end'.

Discuss why it is that some people can read and interpret this, but feel perplexed and bewildered by:
3 ■ + 2 ▲ = 15?

What are the implications of this for teaching children algebra?

Algebra as patterns and sequences

The dictionary defines a sequence as 'a specific subset of numbers that have been arranged with some definite order or criteria in mind'.
For example:
- 1, 2, 3, 4,...
- 1, 2, 4, 8,...
- 1, 3, 6, 10,...

However, there is more than this to sequences. They can provide an early stimulus for deeper mathematical thinking and problem-solving. This topic gives pupils the opportunity to generate and produce a general mathematical observation from a number of particular instances. It is this process of generation that mathematicians call induction. Induction is a way of working often used in the classroom, whether you recognise it from its name or not.

Induction is not a simple process, but without it, very little mathematical thinking can take place. Very often, for example when you are working with number patterns, you are naturally thinking inductively. It is a process that we take part in intuitively, often unaware that we are doing so.

Below are some situations that can give rise to the topic of sequences. In putting such situations in front of children, we are making many assumptions. In considering some of these assumptions, we may also become aware of the range of mental activities that the word induction covers.

Activity 2

Induction

Distribute copies of photocopiable page 95 and ask the group to work through the following activities using Multilink cubes. Explain that there are several stages involved for each sequence. Ask them to work through the following process.
- Always begin by saying, then recording a description of how the sequence continues. Check carefully.
- See if you can find different descriptions for the sequences.
- Try to articulate, formulate and calculate how many will be needed to make any given position in the sequence.
- If you can find the rule for generating any position in the sequence, you have generalised. Try to record this generalisation in some format.
- Compare your record of the

generalisation for each sequence with colleagues. What are the benefits of a standard notation?

Activity 3

Patterns

Distribute copies of photocopiable page 96, and ask the group to look at the patterns and discuss the different ways in which they can be constructed. Ask them to describe what they see to a neighbour. Do they all see the patterns in the same ways?

Ask them to try to extend the patterns, first orally and then using squared paper for the first three patterns and counters for the last three patterns.

Ask them to tabulate their results. Does the table help to make the pattern more obvious?

Activity 4

Mappings

Distribute copies of photocopiable pages 97 to 99. Ask the group to look first at the mapping diagrams.

In each case, can they find out what the rule is?

Ask them to make up some mappings of their own using the last four boxes, then ask other group members to try to work out the rule.

Now look at the sheets of Anagranimals and ask the teachers to work out the rules. Ask them to make up some of their own, perhaps using names of colleagues as we have.

Activity 5

Truth tables

Ask the teachers to interpret the following equation:

■ + ▲ = 12.

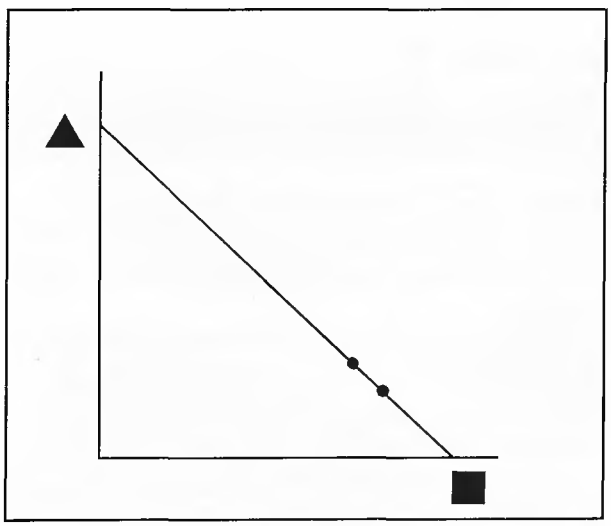
Now ask them to complete a 'truth table' as in Figure 1.

■	▲	■ + ▲ = 12
13	2	✘
11	1	✓
9	3	✓
0	12	✓

Figure 1

Ask them to turn the 'ticks' on the truth table into a graph by plotting the value of ■ on the horizontal axis and the corresponding value of ▲ on the vertical axis.

How might this graph be used in the classroom with a truth table activity?



Activity 6

THOANs

Ask the group to consider the equation 2x + 5 = 11, and to try turning it into a 'Think Of A Number'(THOAN) type problem.

Ask the following question: 'I think of a number; I multiply it by 2, then add 5, and get 11; what is my number?'

Ask the group how they found the answer to the question. Does

everyone agree about the solution?

Ask the group to try turning the following equations into THOANS.

- $3x - 4 = 8$
- $\frac{x + 6}{5} = 2$
- $2 (x+5) = 12$.

What are the similarities and what are the differences between the four equations?

Ask each person to write down an equation, turn it into a THOAN and invite colleagues to turn this THOAN back into the original equation. Do they end up with the same equation? Suggest that group members try a similar activity with children, starting with a THOAN and encouraging them to record some representation of the THOAN in their own way.

How can you move from their informal recording to the more generally accepted algebraic notation?

How can the activities on sequences help in this situation?

Activity 7

The words of inequality

Distribute copies of photocopiable page 100 and ask participants to fill in the 'less than' and 'greater than' words.

When they have completed this part of the activity, ask them which sign, <, =, >, they think of when reading the following:

- Ann is shorter Bryan.
- Charlie is fatter than Derek.
- They are identical twins.
- Erica is thinner than Fred.
- Georgina is older than Henry.
- Ian is younger than Jean.
- Kenneth is taller than Louise.
- It can't be as much as that.
- I haven't got that much.
- Low Bridge. Headroom 5m.

Discuss the value of the tasks, then ask the group to make up some more of their own.

Activity 8

Ordering and relations

Distribute copies of photocopiable page 101 which shows a series of balances in the form of mobiles. Look at example 1, where C is heavier than P and P is heavier than R; the order of the weights (heaviest first) is C, P, R. The resulting arrow graph shows the relation 'is heavier than ...'. Examine and discuss the remaining examples.

Distribute copies of page 102. On the first line ask participants to write the inequality for the mobile. On the second line ask them to try to write a simpler inequality.

Activity 9

Yes, perhaps, no

Distribute copies of page 103 and explain to the group that:
T>R; S>C; T>C; R>S.

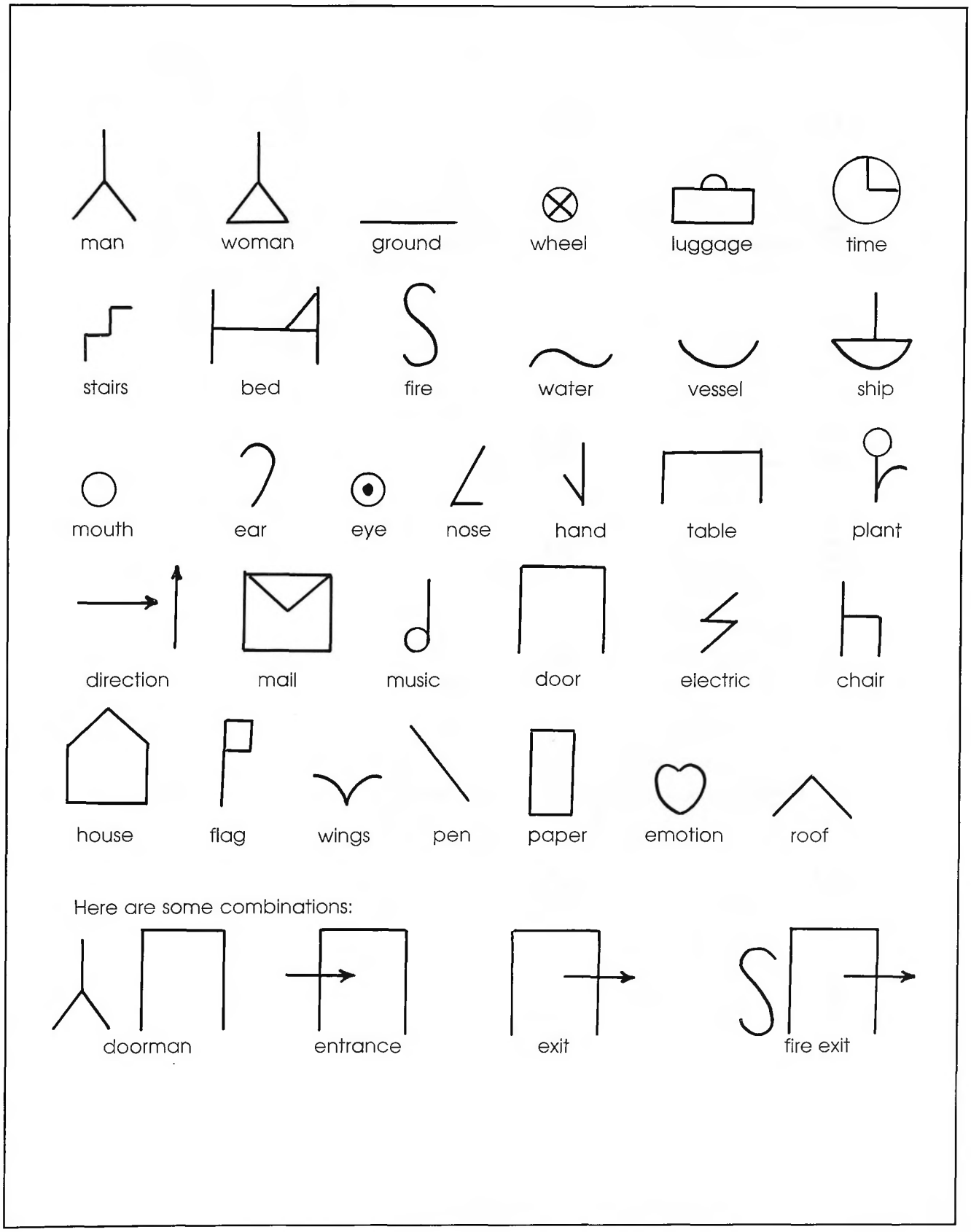
Ask participants to write next to each diagram 'Yes, 'No' or 'Perhaps' depending on whether or not each mobile could hang in the way that is shown.

Discuss with colleagues how these activities can be used in the classroom and what modifications or additions you would make in order to use them with younger children.

Algebra as codes (see page 89)

The Bliss symbol system

Charles Bliss feels that his system of picture symbols can be read in all languages with no need for translations. There are about 100 basic symbols and these can be combined to make almost any meaning.



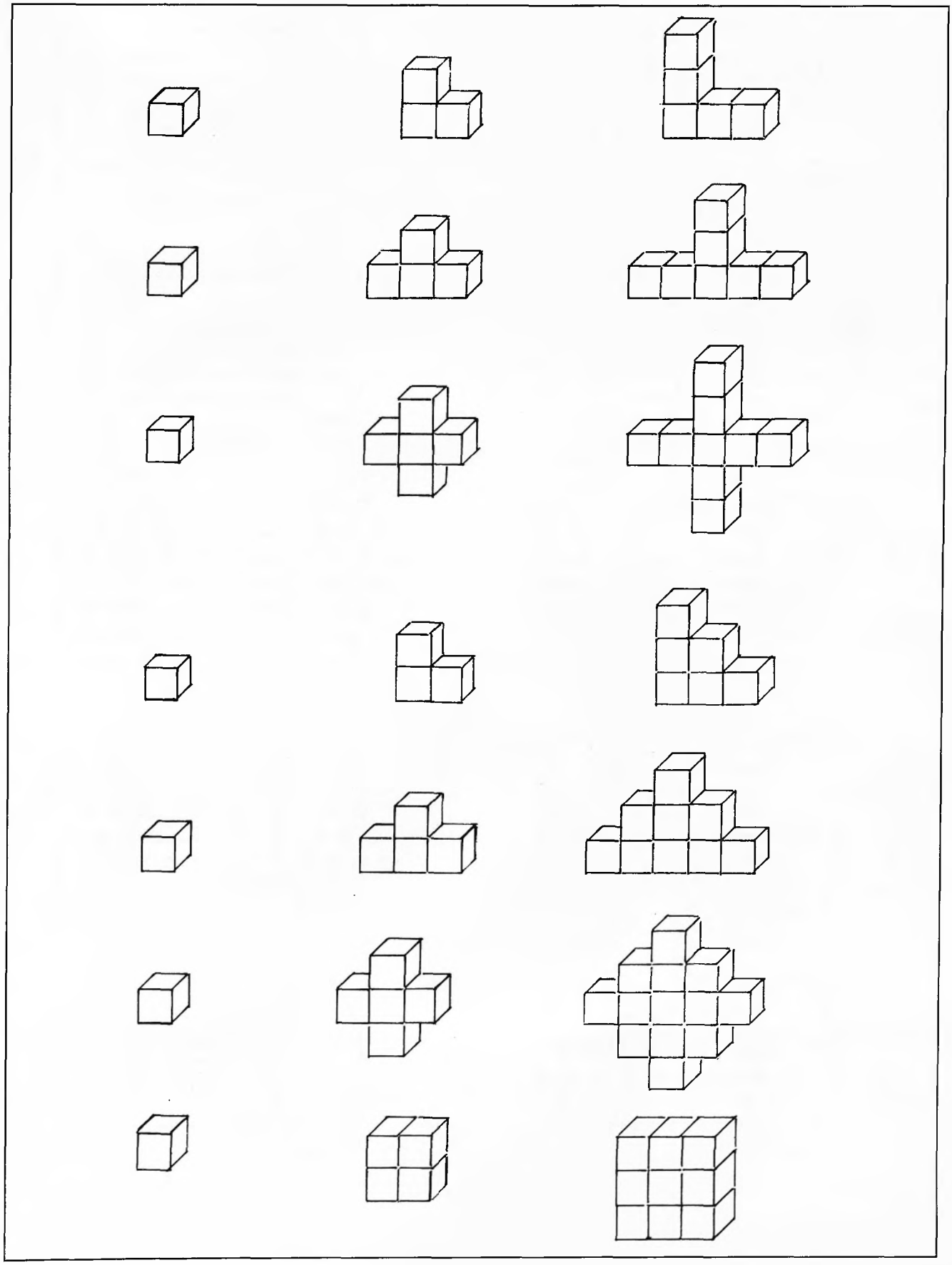
Algebra as codes (see page 89)

Morse code

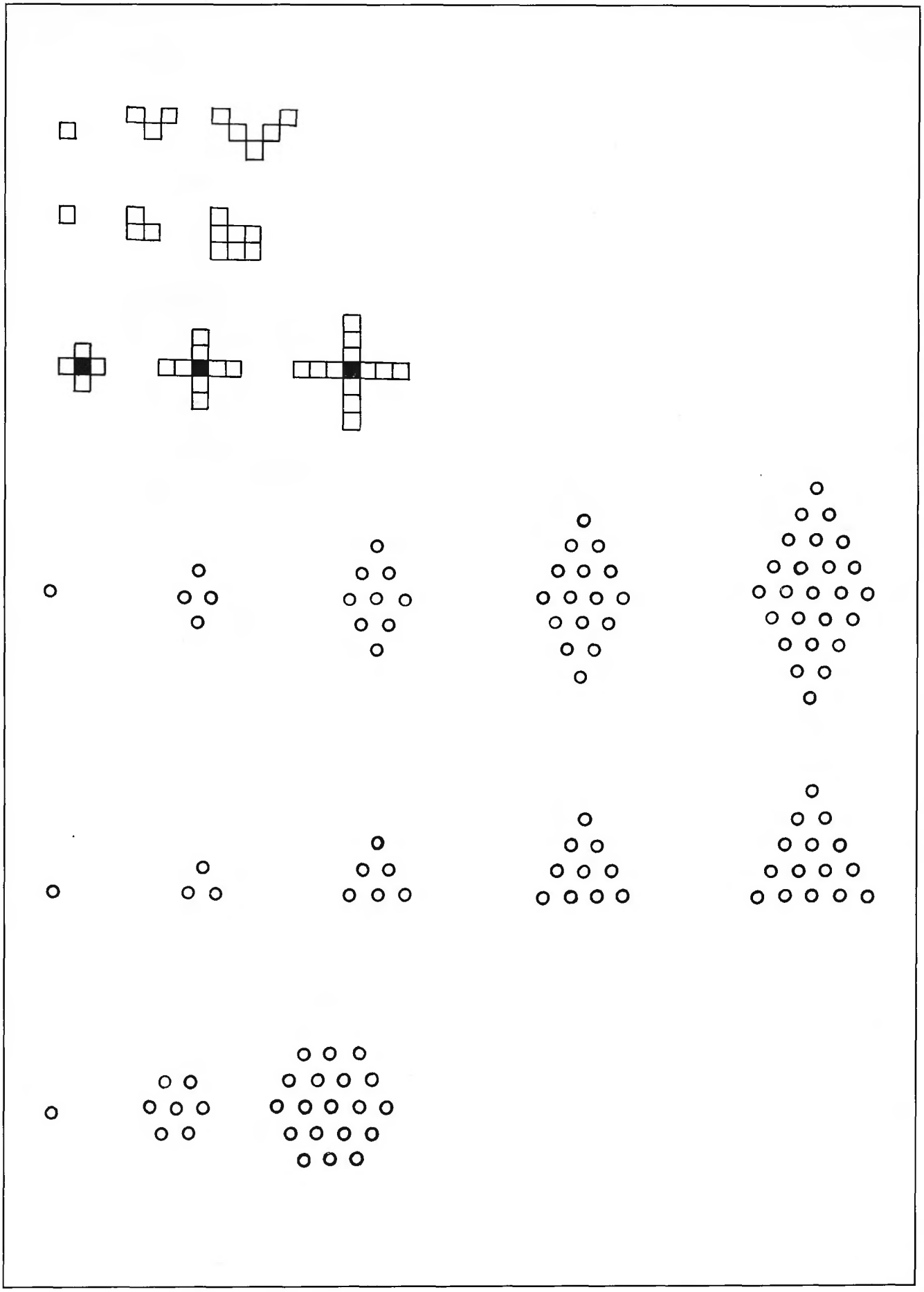
A . _	J . _ _ _	S . . .
B _ . . .	K _ . _	T _
C _ . _ .	L . _ . .	U . . _
D _ . .	M _ _	V . . . _
E .	N _ .	W . _ _
F . . _ .	O _ _ _	X _ . . _
G _ _ .	P . _ _ .	Y _ . _ _
H	Q _ _ . _	Z _ _ . .
I . .	R . _ .	

Induction (see page 90)

These sets of drawings show the first three models of various building patterns using interlocking cubes. Using Multilink, continue the sequences and make models 4, 5 and 6 for the examples shown. Describe to your neighbour what you are doing.

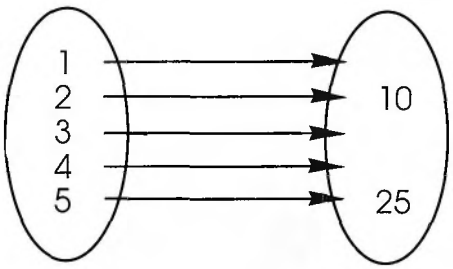


Patterns (see page 91)



Mappings (see page 91)

1



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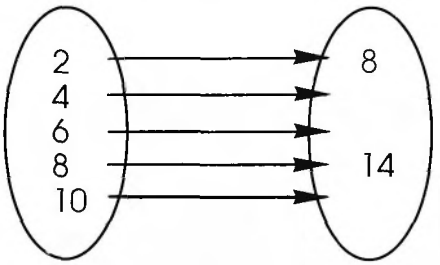
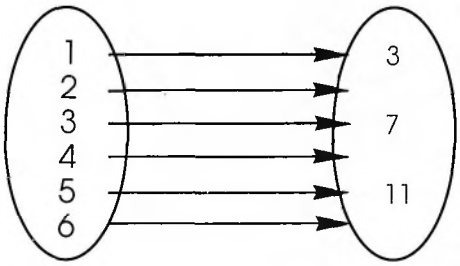


3



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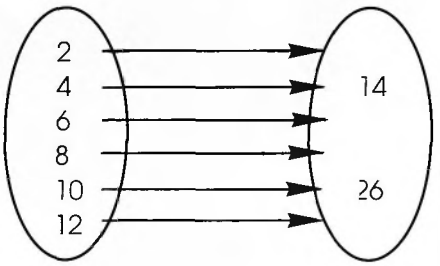

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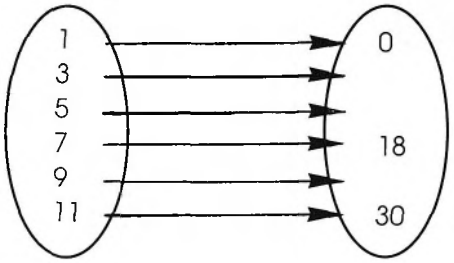

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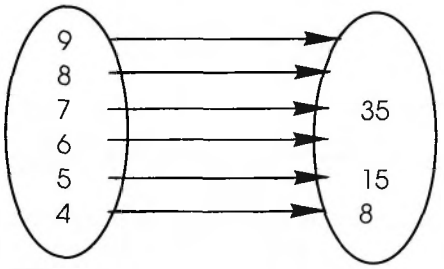

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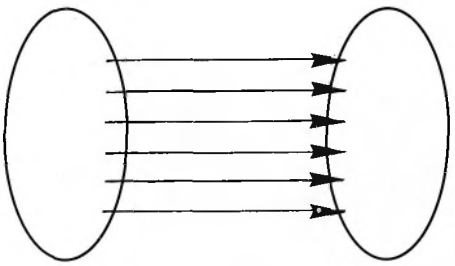

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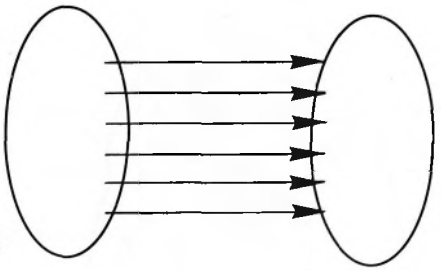

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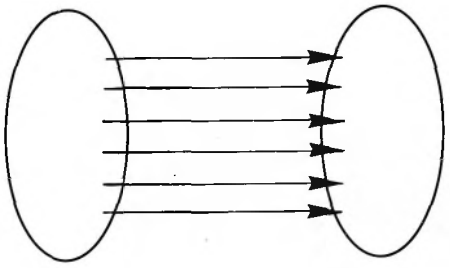

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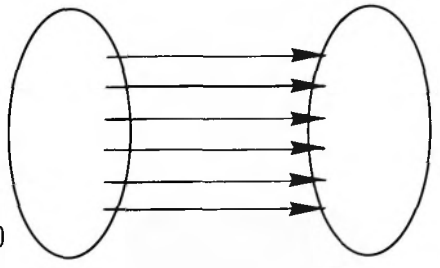
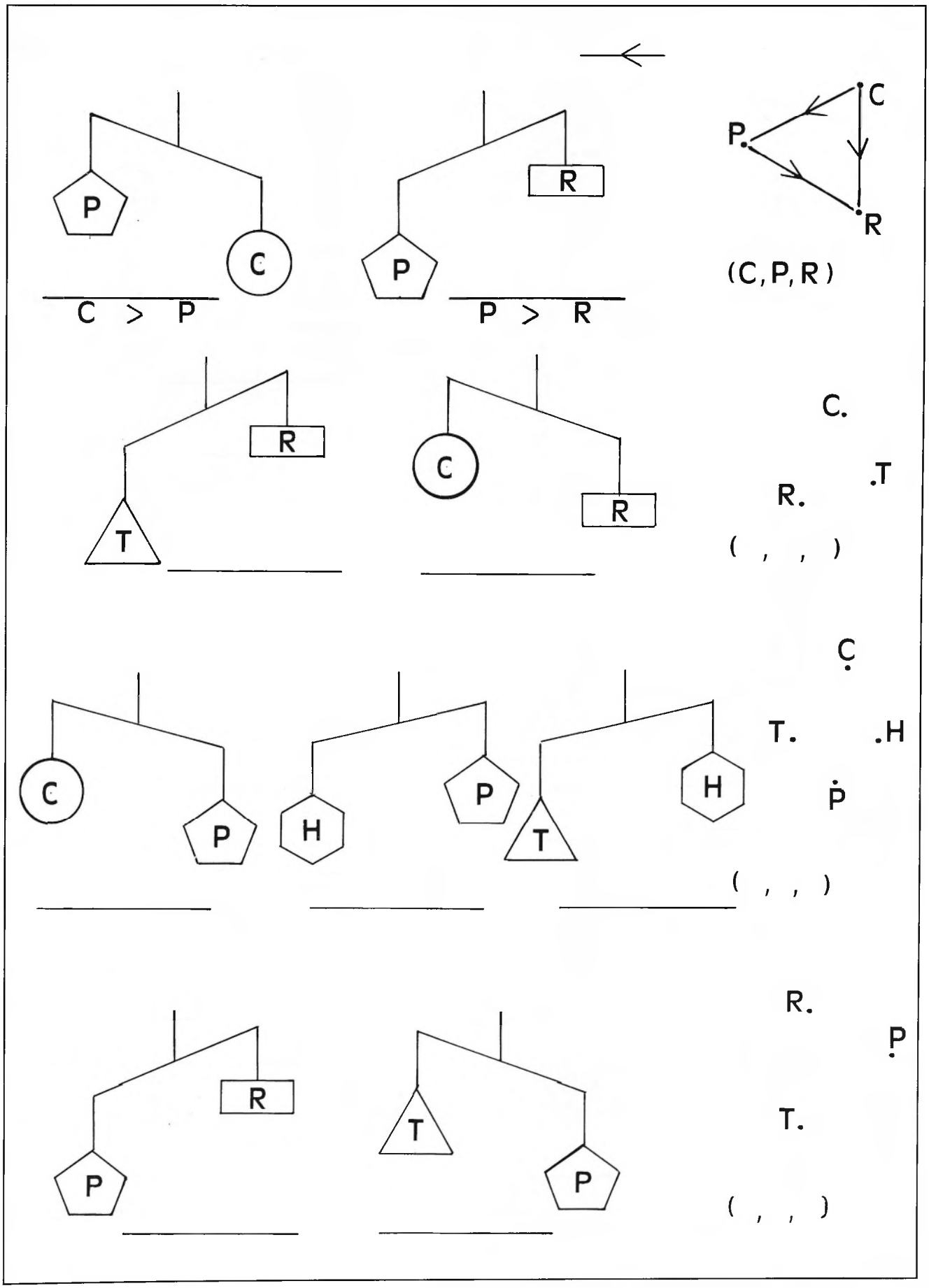


The words of inequality (see page 92)

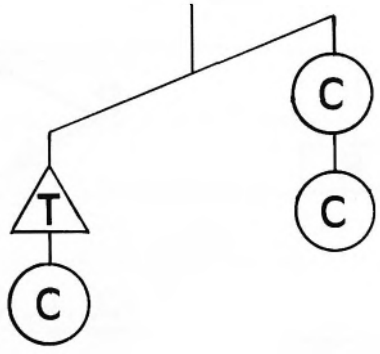
Less than	Word	Greater than
Younger	Age	Older
	Height	
	Heat	
	Weight	
	Now	
	Length	
	Speed	
	Colour	
	Time	
	Size	
	Wealth	
	Noise	
	Strength	
	Distance	
	Light	
	Touch	
	Slope	
	Feel	
	Present	
	Taste	
	Depth	
	Cost	
	Thickness	
	Width	

Ordering and relations (see page 92)

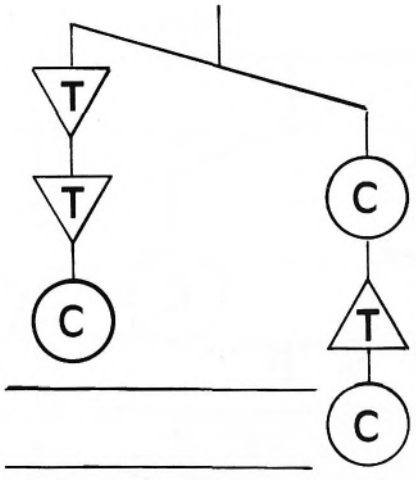


Ordering and relations (see page 92)

1.



2.



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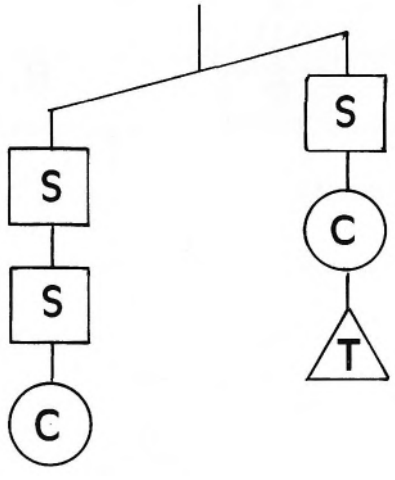

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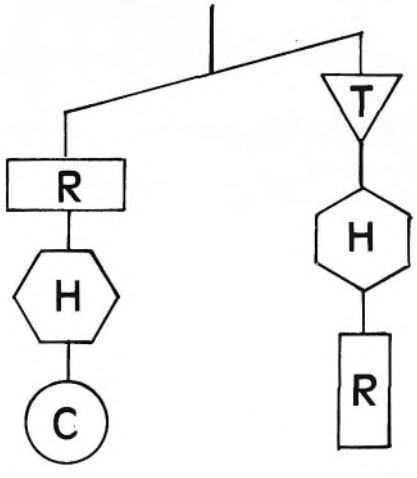

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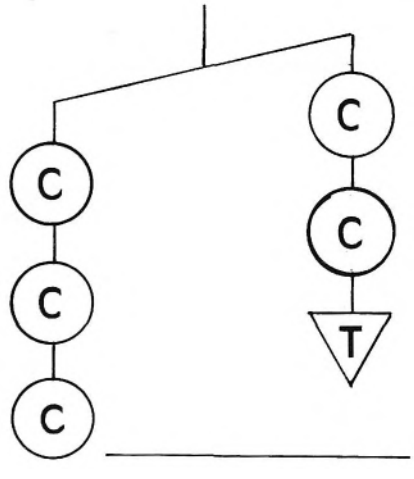
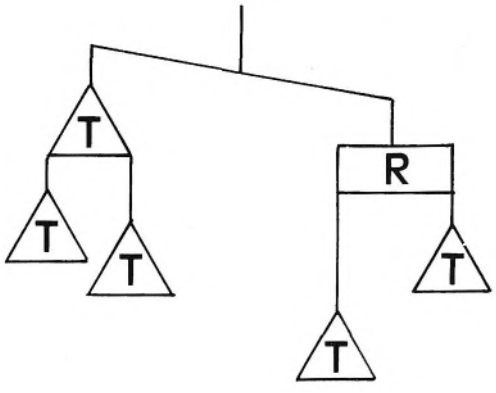
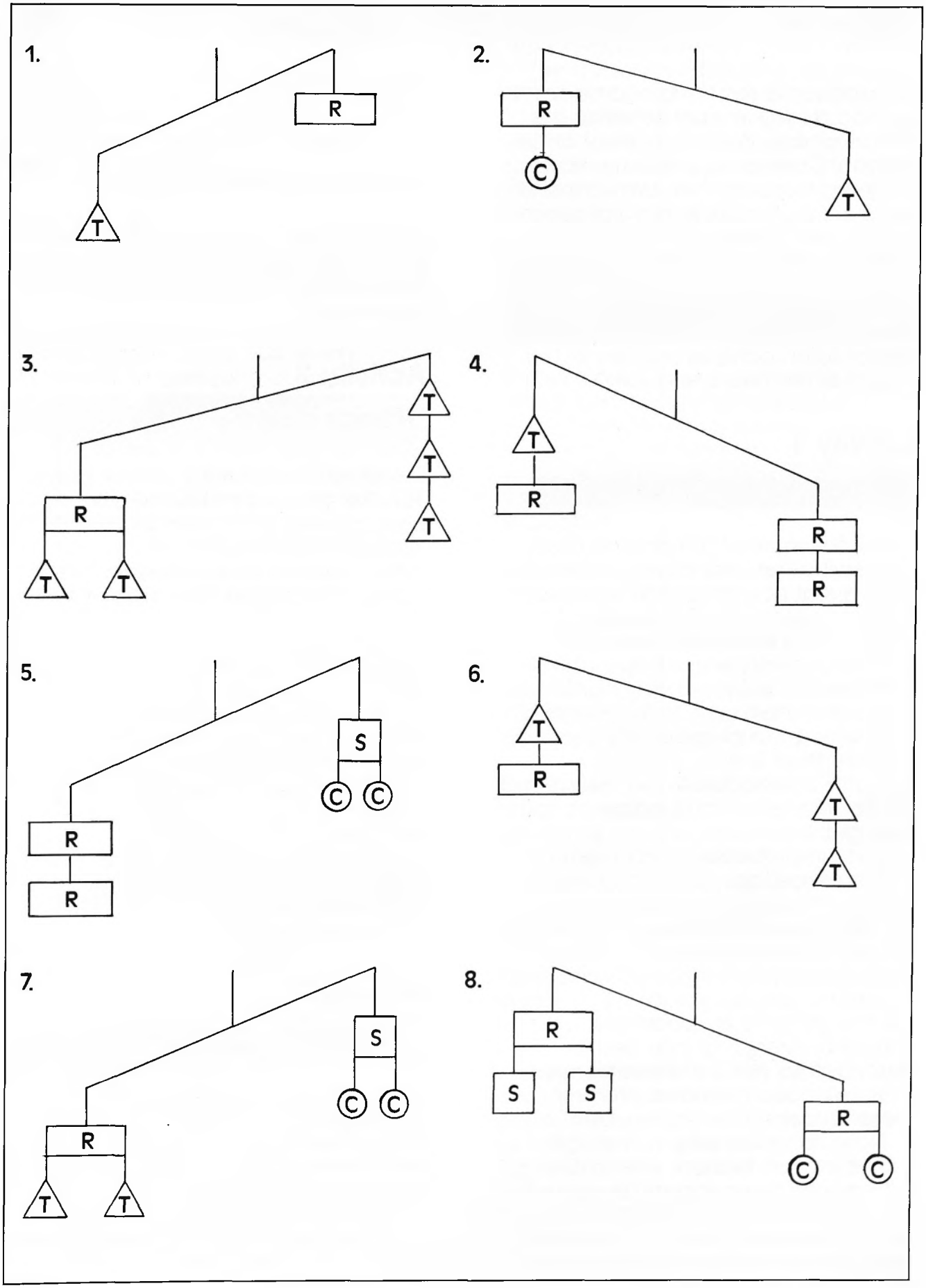


6.



Yes, perhaps, no (see page 92)



Teaching probability

Historically, the teaching of probability has had a fairly low profile within the primary phase. With the advent of the National Curriculum, pupils are now required to understand, estimate and calculate probabilities. Naturally such a move has caused some consternation among teachers. Just what does understanding, estimating and calculating probabilities entail? What experiences can be provided to help children achieve mastery of this aspect of the new curriculum?

Activity 1

The language of probability

Below are some of the phrases used to describe the chance or probability of an event occurring. Write them on a blackboard or flipchart so that the whole group can see them.

A - a small chance
B - extremely likely
C - quite certain
D - a very good chance
E - more than likely
F - highly improbable
G - not in a month of Sundays
H - a good chance
J - quite improbable
K - almost certain
L - in all probability
M - not a great chance
N - a 50-50 chance
O - fairly likely
P - likely

Ask the group to try to identify an everyday event that can best be described by each of these phrases.

Did all group members interpret these phrases in the same way?

Now, using the letters given, ask individual staff to mark where they think each phrase should be placed on a line to represent a scale from zero to one as in Figure 1. Compare responses and note any differences.

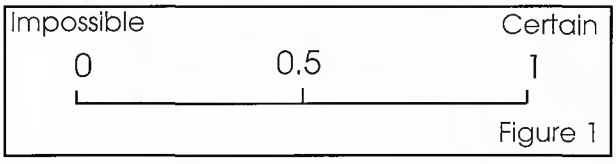


Figure 1

Make notes about reactions and insights gained during this activity, then use them for a follow-up discussion.

Activity 2

Heads down

Distribute copies of the grid on page 107. Ask group members to work in pairs, placing a counter at 'S', and tossing a coin to start.

If the result is heads, they should move down to the next circle; if tails they should move to the right.

To score, each player should start with 10 points, then score 2 points every time they reach H. They should deduct a point every time they move off the grid. The game ends when a player wins by reaching 20 points or loses by reaching 0 points.

Discuss this game in pairs before and after playing the game.

Make notes about reactions and insights gained when doing this activity and use them as a basis for a follow-up discussion.

Activity 3

Matching game

Ask the group to work in pairs. Explain the rules as follows. Players have to show their right hands to each other simultaneously, with either one, two or three fingers extended.

Discuss the idea behind this game, then ask them to play it several times and record their results.

How likely is it that the total number of fingers showing is:
- Odd?
- Even?
- Less than four?
- A maximum/minimum?

Make notes about reactions and insights gained when doing this activity and use them as a basis for a follow-up discussion.

Activity 4

A day at the races

Distribute copies of the grid on photocopiable page 108 which represents a horse race course, with numbers representing the horses. Explain the rules of the game as follows: to move a horse, players have to roll two dice. If the sum of the two dice is ten, the player can move horse ten on one square, and so on.

Do participants think that this is a fair game? If anyone thinks that the game is unfair, ask her to explain why. Can the group invent a fairer game? Record the explanations.

Ask the group to form pairs to play the game.

Make notes about reactions and insights gained when doing this activity and use them as a basis for a follow-up discussion.

Activity 5

Reactions and insights

In the previous activities of this chapter, group members were asked to record the reactions and insights gained. Use these notes to organise a group discussion to consider the following questions:
- What mathematical processes have you used when doing these activities?
- What skills did you employ when doing the activities?
- What do you think is the purpose of the activities?
- What aspects of these activities could be assessed?
- What would you record about your progress on these activities? Why?
- When children repeat these activities, would their reactions and responses be different? How? Why?

The study of probability can provide the teacher with an ideal opportunity to establish the precedent of experimenting, collecting data, recording results in a variety of different ways and interpreting the information gathered.

Activity 6

Experimental probability

Below is a series of experiments in which participants are asked to:
- Talk through with a partner what they expect to happen;
- Complete the experiment;
- Compare their results with what they expected.

Experiment one: A fair die
Throw a die 50 times and make a tally of the results as you go along. Is the outcome what you expected?

What would happen if you repeated the experiment for another 100 throws? Try it, keeping a tally of your results. Do you notice anything?

Experiment two: A fair coin
What do you expect to happen when you throw a coin? How many different outcomes can there be?

Throw a coin 20 times, keeping a tally of your results. Do you notice anything? Now do it for another 20 throws; do you notice anything yet? Now throw the coin 60 times, keeping a tally. What do you notice? What can you say about your coin?

Experiment three: A lucky dip?
Each pair should be provided with a paper bag, a copy of the score sheet as in Figure 1, a base board as in Figure 2, and six squares of card the same size as the picture squares on the base board.

Write T for tree on one of the squares, K for kite on the second, F for

SCORE SHEET Correct guesses					
1st	2nd	3rd	4th	5th	6th

Figure 1

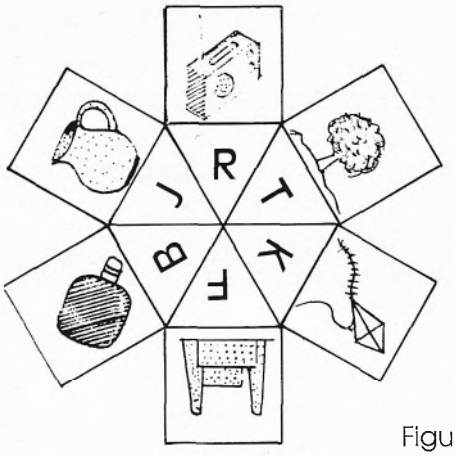


Figure 2

factory on the third and so on.
Place the six squares in the paper bag and shake them up. Before picking out the first card, guess what it will be.

Pick out a card, and if you have guessed correctly, place a tick in the first guess column on your score sheet. Whether you guessed correctly or not, place the card you picked on the base board. For example, if you picked card J, place it over the picture on the jug.

Guess what the second card will be. If you are correct, place a tick in the second guess column. Correct or not, place the card on the base board as before. Continue until all the cards have been picked out.

Carry out the experiment a number of times scoring your correct guesses on the same score sheet.

Experiment four: A good sample
Distribute copies of photocopiable page 109. Ask participants to look at the letters and then write a few sentences about them and about the way they are arranged.

Use sentences like:
- I would think that ....
- There must be ....
- It is possible that ....

To help participants, tell them that the rectangle will cover the page of letters ten times. Trace the rectangle on to the centre of a sheet of paper and then cut it out so that the sheet has a rectangular window in it. Place the sheet of paper over the page of letters and look at the letters showing through the window. Move the window to different positions and use the information to check what you wrote earlier on. Try writing more about the page of letters with the help of the window.

Use the window to help you estimate how many letters there are on the page.

Experiment five: A fair deal
Shuffle a pack of cards and place it face down on the table.

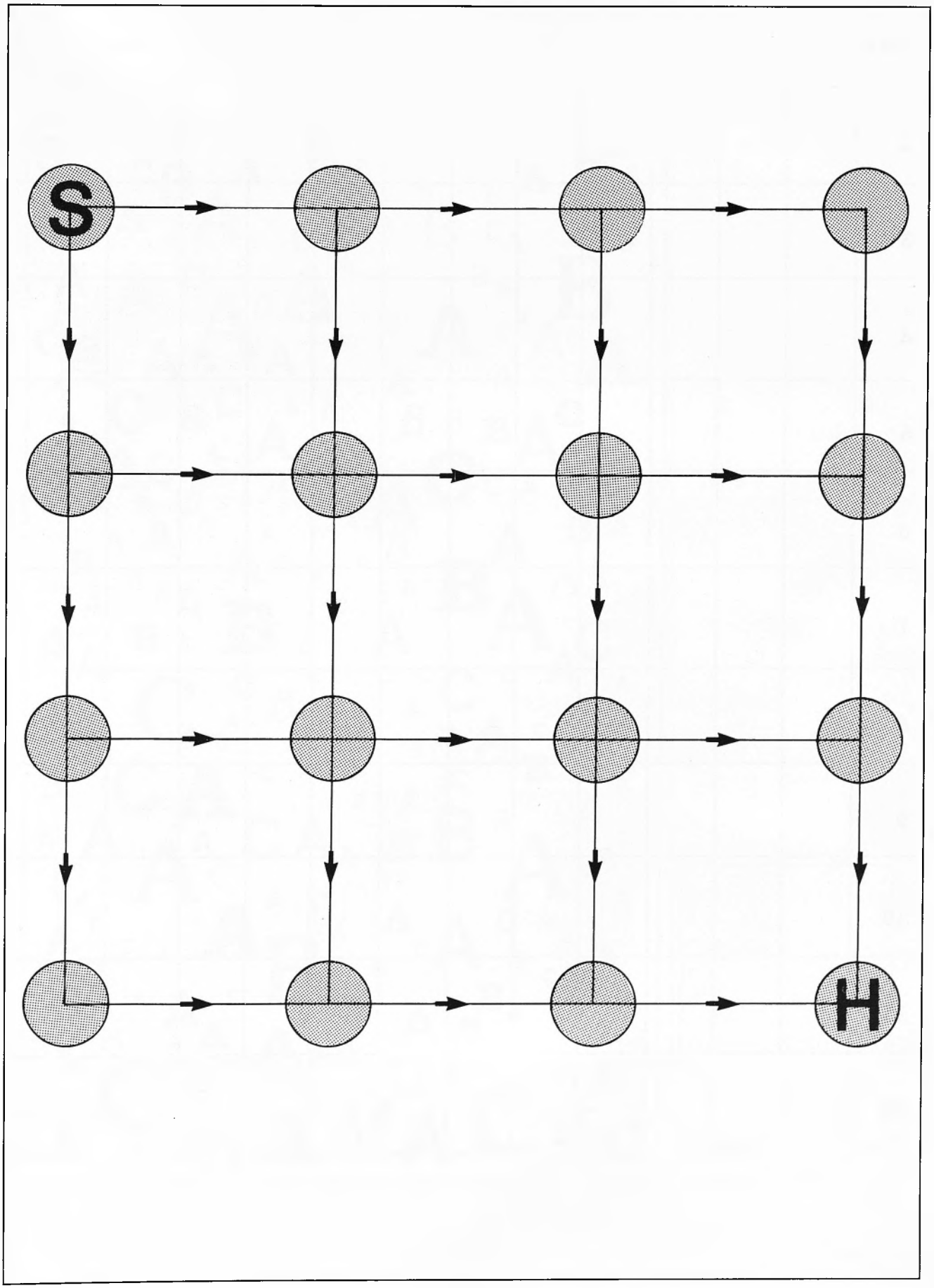
Devise a 'pick a card' score sheet and write down your guesses about the top card. This should illustrate whether the card is:
- An ace, 2, 3, 4, 5, 6, 7, 8, 9, 10, Jack, Queen or King;
- Diamond, club, heart or spade;
- Red or black.

Turn over the top card and score a tick for each correct guess.

Place the card to one side and write your guesses about the next top card.

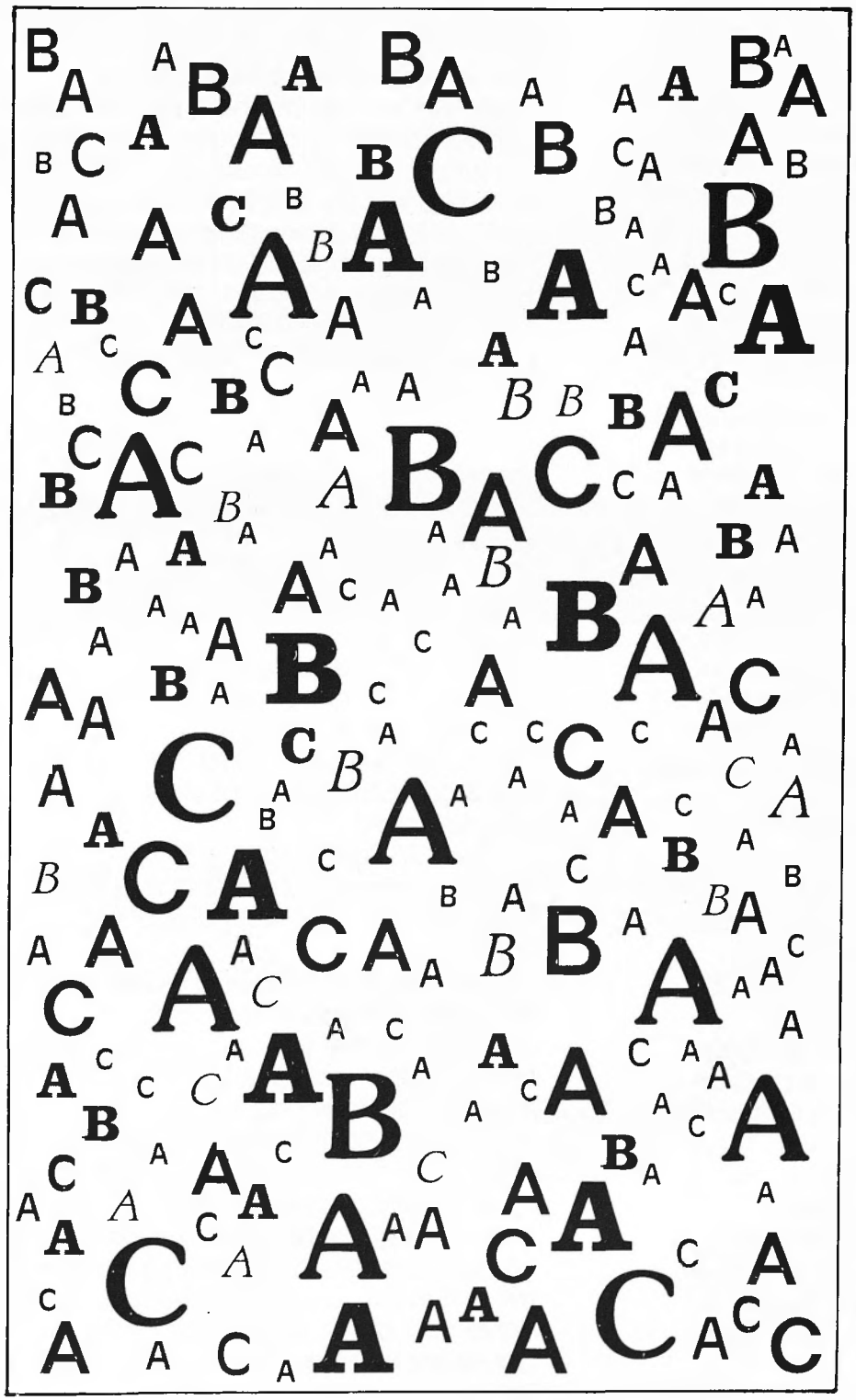
Conclusion
Having completed the experiments above, discuss the desirability and practicality of establishing a batch of similar experiments in your schools.
- Would a circus of activities on chance be appropriate?
- What organisational and administrative details need be kept to the forefront?
- What insights have you gained about probability?
- What do you think your children will gain from doing these or similar experiments?

Heads down (see page 104)



A day at the races (see page 105)

START												FINISH
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												



TAKING STOCK AND EVALUATING

Reflection on any INSET activity plays an integral and important part in determining how effective the INSET leader will be. It is essential that after any event, the leader takes stock of the day or the session, and decides whether the aims and objectives have been achieved. The decision as to the next possible course of action cannot be taken unless time is spent in evaluating the preceding activities.

This section, therefore, aims to help focus the thoughts of the INSET leader on the questions that should be asked in order to take stock, evaluate and prepare the next session effectively. The activities suggested here are intended for use by the INSET leader or mathematics co-ordinator, and not by the whole group. However, some may be adapted for use with a group of mathematics co-ordinators.

This section has been divided into three parts:

- Management;
- Job satisfaction;
- Evaluation.

Management

Paragraph 355 of the Cockcroft Report states:

'In our view it should be part of the duties of the mathematics coordinator to:

- prepare a scheme of work for the school in consultation with the head teacher and staff and, where possible, with schools from which the children come and to which they go;
- provide guidance and support to other members of staff in implementing the scheme of work, both by means of meetings and by working alongside individual teachers;
- organise and be responsible for procuring, within the funds made available, the necessary teaching resources for mathematics, maintain an up-to-date inventory and ensure that members of staff are aware of how to use the resources which are available;
- monitor work in mathematics throughout the school, including methods of assessment and record keeping;
- assist with the diagnosis of children's learning difficulties and with their remediation;
- arrange school-based inservice training for members of staff as appropriate;
- maintain liaison with schools from which children come and to which they go, and also with LEA advisory staff'.

Consider the following questions in the light of these statements.

- How far have you as a mathematics co-ordinator achieved the aspects of the post outlined above?
- How far has the role changed since Cockcroft itemised these duties for the mathematics co-ordinator?

List the elements of your role in order of your success in achieving the goals set out in the Cockcroft Report. Why have you been successful? Where could more assistance and advice have been helpful?

Prioritise one or two areas on which you feel you will need to work in the next few months. Set out a list of

objectives you believe will help you to achieve success in these areas, and consider an action plan. Draw on successful strategies that have helped you to achieve prior goals.

Effective management

Effectiveness in any post is dependent on many factors, including the following:

- Knowing what you are supposed to be doing;
- Being capable of doing the job;
- Having adequate resources;
- Having time and space for the job;
- Receiving the support and encouragement of others;
- Being rewarded for a role fulfilled.

Activity 1

Your own inventory

Examine some of the factors listed above. What are the antecedents and consequences of these factors? What additional factors would make you more effective?

Effective leadership

At a recent course it was decided that an effective INSET leader or post holder was someone who is successful, knowledgeable, thorough, imaginative and understanding, while also having the following desirable qualities:

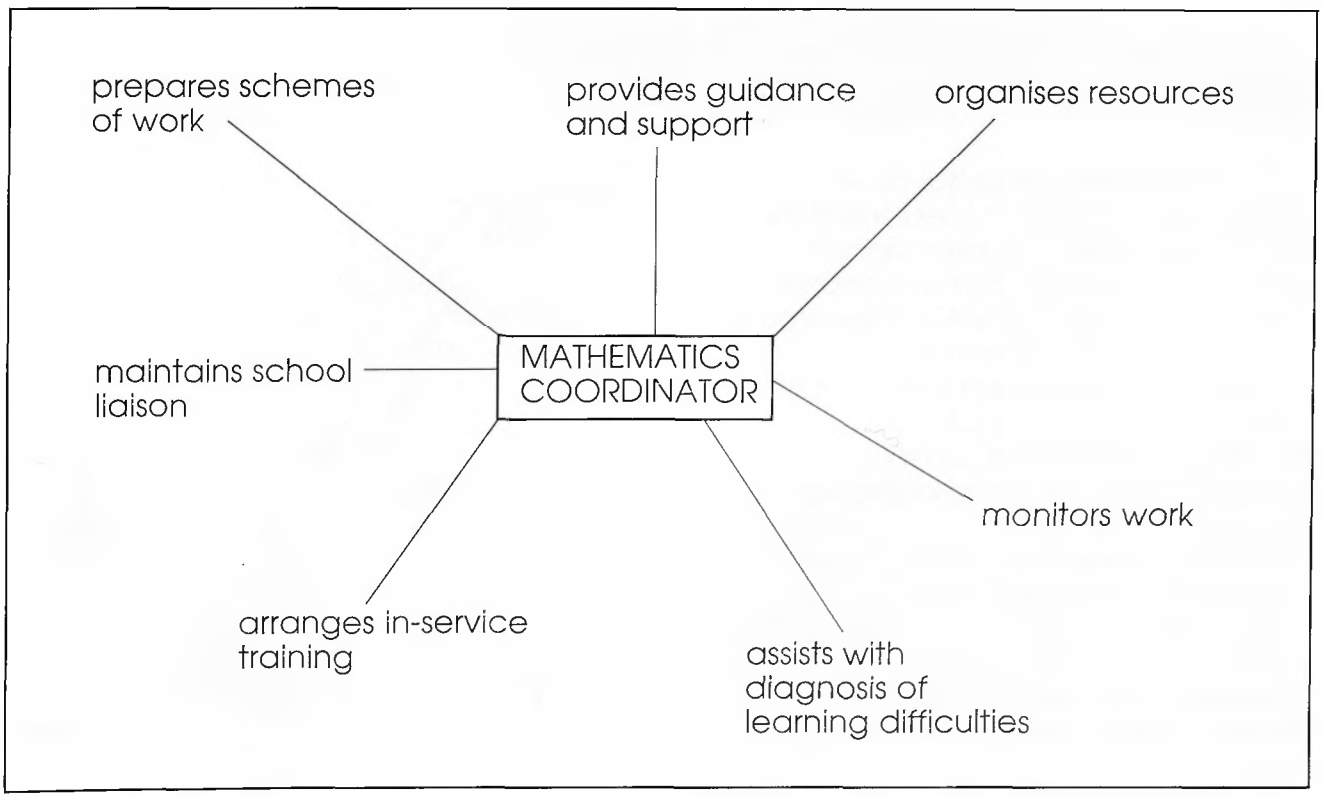
- Clarity;
- Ability to utilise the strengths of others;
- Ability to listen to other people and share things with them.

Activity 2

Am I a good leader?

Discuss the findings above more closely with some of your colleagues and other INSET leaders.

- How interrelated and dependent are the factors of ability, motivation and opportunity?
- What could possibly detract from your efficiency?
- Can certain crisis or tension points be overcome?



Job satisfaction and self-evaluation

Whatever your post there are certain interdependent factors that affect your performance, which in turn affects your job satisfaction and your expectations about the role you attempt to fulfil.

Factor 1
The degree of authority and autonomy you have within the role.

Factor 2
The amount of experience and commitment you bring to the task.

Factor 3
The quality of relationships with staff.

Factor 4
The adequacy of the job description and the clarity of the guidelines for the task.

Activity 1

Job satisfaction

Examine your present position in relation to the factors above and gauge their likely effect on your job satisfaction.

How could you increase your job satisfaction?

Complete the tick list on photocopiable page 113.

Analyse your responses and discuss with a colleague any notes, observations, anomalies and conflicts about the exercise and its results.

Evaluating meetings and courses

If you are to be successful at implementing INSET, it is essential that you find out from the participants what they learned from the course, what was useful and what they would have liked to do differently.

Page 114 gives a sample evaluation sheet which you can give out at the end of your meetings, although a plenary session at the end should also be part of any evaluation ... people can be far more negative to a piece of paper than to a person! On the whole, colleagues' comments in any evaluation will help you to avoid previous pitfalls and make the next meeting even better.

Job satisfaction (see page 112)

Complete the following tick list.

	-5	0	5
Leadership given by you			
Amount of initiative taken by you			
Amount of persistence needed			
How co-operative do you have to be?			
How often is judgement called for?			
How forward thinking are you?			
How consistent?			
How caring?			
How flexible?			
How enthusiastic?			
Other qualities: Imaginative			
Dependable			
.....			
How successful?			
How satisfied?			

Evaluation questionnaire (see page 112)

Staff development in mathematics

1. What were your expectations of the meeting?

2. Were your expectations realised, exceeded or unfulfilled? Why?

3. Will you be able to exploit the developments from this meeting? How?

4. What features did you find particularly good? Why?

5. What features did you find deficient? Why?

6. How would you rate the meeting against the descriptions below? Please circle the appropriate statement.

excellent

very good

good

quite good

inadequate

7. Any other comments?

Please return this sheet to the INSET leader. Your help in this matter is greatly appreciated and will assist in planning and delivering meetings of this nature in the future.

Resources

Mathematical software

Adventure games

Dread Dragon Droom, available from Resource.

The Lost Frog, by Anita Straker. Machine versions BBC. Available from ESM.

Merlin's Castle, by Anita Straker. Machine versions BBC. Available from ESM.

Puff, by Anita Straker. Machine versions BBC. Available from ESM.

Number and puzzles

Maths 9-13, by Anita Straker. Machine versions BBC. Available from ESM.

Number in the National Curriculum, by Anita Straker (three discs). Machine versions BBC. Available from ESM.

Pressure Mat Programs (a pack containing two pressure mats wired for connection to the computer, with a disc containing five programs). Available from Panthera.

Slimwam 1 and *2* (various mathematical situations). Machine version BBC, RM 380Z. Available from the Association of Teachers of Mathematics.

SMILE - The First 30; The Next Seventeen; Eleven More (collections of problems for upper primary and lower secondary schools). Machine versions BBC B, Master, RM 380Z, 480Z, Nimbus, network version for 480Z. Available from ILECC.

Databases

DIY Base (an easy-to-use database designed for primary children). Machine versions BBC, Compact, Archimedes. Available from Resource.

Find (a medium-sized database, producing bar-charts, pie-charts scattergrams and tables). Machine versions BBC, Master (including networks), RM Nimbus. Available from Resource.

Grass (a useful cross-phase database, linking with the *Grasshopper* spreadsheet). Machine versions BBC, Master, Econet, 480Z, Nimbus, Nimbus network. Available from Newman College, Birmingham.

Information Handling Pack (containing *Our Facts* database, *Branch*, *Sorting game*, *Datashow* and *Noticeboard*). Machine versions BBC. Available from Resource.

Key (a larger cross-phase database with graphic facilities). Machine versions BBC, Master, 480Z. Available from ITV Associations Ltd.

Spreadsheets

Grasshopper (a colour spreadsheet with a wide range of uses, linking with *Grass* database). Machine versions BBC, Master, RM Nimbus. Available from Newman College, Birmingham.

PSS - Primary Spreadsheet (a 16 x 10 grid, all on screen, with facility for bar-charts, graphs and pie-charts).

Machine versions RM Nimbus, Nimbus network. Available from Cambridge Software House.

LOGO software

Archimedes LOGO (a fuller, more powerful version of the *Logotron LOGO* package). Available from Logotron.

Arrow (a turtle graphics package). Machine versions 480Z, Nimbus. Available from Flexible Software Limited.

Clare (Control LOGO And the Real Environment - includes the Clare control board). Machine versions BBC (with *Logotron LOGO*), Econet, RM 380Z, 480Z (with *RM LOGO*), Nimbus, Spectrum. Available from the Advisory Unit, Hertfordshire (see suppliers list).

Control LOGO. Machine versions BBC (with *Logotron LOGO*). Available from Logotron.

Dart (a turtle graphics package for use with LOGO). Machine versions for BBC B, B+, Master. Available from the Advisory Unit, Hertfordshire.

Logotron LOGO (the most popular full version of LOGO for the BBC computer, including updated manual and utilities disc.) Machine versions BBC B, B+, Master 128, Compact, Archimedes. Available from Logotron.

Music LOGO (this software package enables you to make use of the sound facilities on the BBC with LOGO). Machine versions BBC (with *Logotron LOGO*). Available from Logotron.

RM LOGO (this is the only full version of LOGO for the RM machines). Machine versions RM 380Z, 480Z. Available from Research Machines Ltd.

3D LOGO (this package enables you to manoeuvre the turtle in three dimensions and generate perspective drawings on screen). Machine versions BBC B, B+, Master 128. Available from Logotron.

Books and written resources

Association of Teachers of Mathematics *Co-ordinating Mathematics in the Primary and Middle School* (ATM).

Association of Teachers of Mathematics (1967) *Notes on Mathematics for Primary Children* (Cambridge University Press).

Association of Teachers of Mathematics (1977) *Notes on Mathematics in Primary Schools* (Cambridge University Press).

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RAMP East Anglian Region *Parents into Mathematics* (Cambridge Institute of Education).

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Activity starting points

Association of Teachers of Mathematics: *Points of Departure 1, 2, 3 and 4;*

Mathematical Activities from Poland, 10²;
67 Investigation Cards (ATM).

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Marion Bird: *Mathematics with 7-8 year olds;*
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Mathematics with 9-10 year olds;
Mathematics with 10-11 year olds (Mathematics Association).

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Wendy Garrard *I Don't Know, Let's Find Out* (Mathematics Association).

Alan T Graham *Help Your Child With Mathematics* (Fontana).

Gillian Hatch: *Jump to it;*
Leap to it;
Bounce to it;
Race to it;
Puzzle Cards;
Shape Workshop;
Calculator Workshop
(Manchester Polytechnic School of Education).

Leapfrogs Group: *Action Books* (17 titles); *Link Books* (Tarquin Publications).

Jim Seth (1984) *Problem Solving Workcards for Use with Microcomputers* (Association of Teachers of Mathematics).

Angela Walsh (ed) (1988) *Help Your Child with Mathematics* (BBC Publications).

Journals

Logos (A journal which covers all aspects of LOGO. It is produced about three times a year by the British Logo User Group.)

Mathematics Teaching (The journal of the Association of Teachers of Mathematics, which is published quarterly.)

Maths in Schools (The journal of the Mathematical Association, which is published quarterly.)

Micromath (Covers the use of computers in primary and secondary schools, and is produced three times a year. Available from the Association of Teachers of Mathematics and Basil Blackwell.)

In-service packs

SMILE Maths and Logo Pack (Contains help cards, information cards, posters and a teachers' guide; available from Highmead Stationers Ltd - see suppliers list.)

MEP Primary Packs: Mathematics; Posing and Solving Problems with a Micro; Posing and Solving Problems with LOGO. (These packs are now out of print, but copies were sent to each LEA and teacher education institution, so it should still be possible to get hold of them.)

NCET Number Grids Pack (A complete pack suitable for in-service courses, containing discs with *Engram, Monty, Numbers* and *Window*, together with classroom resources. Available from NCET.)

Films, videos and television

Dance Squared (film, available from D.S. Ltd).

Mosaic (video, available from the Film and Video Library, British Film Institute).

Notes on a Triangle (film, available from D.S. Ltd).

Turning Point (a video which shows primary school children using LOGO; available from Videotext Educational Publishing).

Wondermaths - LOGO (five fifteen-minute programmes on LOGO for upper primary children; available from BBC Television).

Suppliers

Advisory Unit,
Endymion Road,
Hatfield,
Hertfordshire
AL10 8AU

Association of Teachers of Mathematics,
7 Shaftesbury Street,
Derby,
DE3 8YB

BBC Television,
School Broadcasting Information,
Villiers House,
The Broadway,
London
W5 2PA

British Film Institute,
Film and Video Library
21 Stephen Street,
London
W1P 1PL

British Logo Users Group,
PO Box 79,
Walsall,
West Midlands
WS5 3RW

Cambridge Micro Software,
Home Sales Department,
Cambridge University Press,
The Edinburgh Building,
Shaftesbury Road,
Cambridge
CB2 2RU

Cambridgeshire Institute of Education,
Shaftesbury Road,
Cambridge

Cambridgeshire Software House Ltd,
The Town Hall,
St Ives,
Huntingdon,
Cambridgeshire
PE17 4AL

Centre for Learning Resources,
ILEA,
275 Kennington Lane,
London
SE11 5QZ

D.S.Ltd,
The George Building,
Normal College,
Bangor,
Gwynned

ESM,
Duke Street,
Wisbech,
PE13 2AE

Flexible Software Ltd,
PO Box 100,
Abingdon,
Oxfordshire
OX13 6PQ

Highmead Stationers Ltd,
19/20 Forward Drive,
Wealdstone,
Middlesex,
HA3 8NT

ILECC,
John Ruskin Street,
London
SE5 0PQ

ITV Associations Ltd,
6 Paul Street,
London
EC2A 4JH

Logotron Ltd,
Dales Brewery,
Gwydir Street,
Cambridge
CB1 2LJ

Mathematical Association,
259 London Road,
Leicester
LE2 3BE

NCET,
Sir William Lyons Road,
The Science Park,
University of Warwick,
Coventry
CV4 7EZ

Newman College Technology Centre,
Genners Lane,
Bartley Green,
Birmingham,
B32 3NT

Panthera,
5 Cedar Avenue,
Beeston,
Nottingham

Research Machines Ltd,
PO Box 75,
Mill Street,
Oxford
OX2 0BW

Resource,
Exeter Road,
Doncaster
DN2 4PY

Resources for Learning
Development Unit,
Bishop Road,
Bishopston,
Bristol
BS7 8LS

SMILE Centre,
Middle Row School,
Kensal Road,
London
W10 5DB

Tarquin Publications,
Stradbroke,
Diss,
Norfolk
IP21 5JP