Design a Board Game

Shell Centre for Mathematical Education

Joint Matriculation Board

TEACHER'S GUIDE
About this scheme . . .

This scheme for the teaching and learning of numeracy through problem solving consists of a series of modules which provide effective support for teachers of mathematics who wish to introduce into the curriculum a component which enables their students to link their mathematics to the real world in which they live.

It has been developed with students of all abilities in the age range 13–16, and their teachers.

Each module package provides comprehensive materials for both teaching and assessment, related to a practical context which has proved interesting and enjoyable to the students who have taken part in its development. It is accessible to those who normally find mathematics difficult, while at the same time it provides a challenge for the most able.
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## 1 Classroom materials

This chapter contains detailed suggestions and hints on the use of the module in the classroom. It begins with information about preparation, including lists of equipment needed and classroom organisation. It then gives a detailed commentary, with teaching suggestions, on the Student’s Booklet. Some suggested assessment tasks are also included at the end of each stage.

## 2 Developing the mathematics

This chapter looks in more detail at various ways of making use of the mathematical opportunities offered by the module. A collection of sample teaching materials is offered.

## 3 The role of assessment

This chapter contains a discussion of assessment issues, and offers examples of assessment tasks at different levels of difficulty.

## Checklist for the teacher

Please note:

Throughout this book, all references prefixed with the letter T refer to pages in the Teacher’s Guide, references prefixed M refer to the Masters for Photocopying and unprefixed references refer to the Student’s Booklet.
Authors

This series of module packages has been developed, as part of a joint project on the assessment of numeracy by the Shell Centre and the Joint Matriculation Board. Many teachers and their students have worked with the central team: Alan Bell, Hugh Burkhardt, Rosemary Fraser, Kevin Mansell, Jim Ridgway and Malcolm Swan together with Barbara Binns and John Gillespie who, assisted by Clare Trott, coordinated the project. Building on previous discussions involving the Shell Centre and the JMB, it was conceived and directed as part of the Testing Strategic Skills programme, by

Hugh Burkhardt

This module, Design a Board Game, has been written by

Malcolm Swan, Barbara Binns and John Gillespie

It is a result of successive revision through six versions on evidence collected from the comments and suggestions of the teachers and students involved, and through classroom observation by the team.

The assessment tasks owe much to the advice of John Pitts.

Many contributions to the work of the project have been made by staff and committee members of the Joint Matriculation Board – notably John Mathews, the Chairman of the JMB’s Steering Committee and Austin Fearnley, who has played a major role in the organisation of the operational trials.

Among the teachers to whom we are particularly indebted for the contributions to the early development of the module are David Cain, Joanne Cooper, Ray Crayton, Paul Davison, John Edwards, Mick Fitzgerald, Tansy Hardy, Aidan Harrington, Anne Haworth, Sue Marshall, Cath Mottram, Mary Robinson, Norbert Gajda, Bob Smith, Aileen Steven, Glenda Taylor, Margaret Tuck and Dave Wilson.

The later trials involved teachers and students in over 50 schools in many local authorities including Barnsley, Bradford, Bury, Calderdale, Cheshire, Cumbria, Derbyshire, Doncaster, Gateshead, Humberside, Kirklees, Knowsley, Lancashire, Leeds, Leicestershire, Manchester, Newcastle upon Tyne, Northumberland, North Tyneside, North Yorkshire, Nottinghamshire, Rochdale, Rotherham, Salford, Sheffield, Stockport, Sunderland, Tameside, Trafford, Wakefield and Wigan. Consultations with their Mathematics Advisers have made significant contributions to the development of the scheme.

The manuscript was prepared through many revisions by Susan Hatfield, Diane Jackson and Jenny Payne, and the staff of Burgess and Longman.

We are grateful to them all.
Numeracy through problem solving

Design a Board Game is one of a series of modules that have been designed to encourage a new approach to the teaching and learning of numeracy, understood in the original broad sense\(^1\)\(^2\) as

the ability to deploy mathematical and other skills in tackling problems of concern or situations of interest in everyday life.

There is now a general acceptance that people need to learn to use the knowledge and skills they acquire at school, and this requires a shift in the balance of the curriculum to include more real problem solving. This is particularly important for the mathematics curriculum, because the power of mathematics in helping people tackle real problems more effectively, is not often realised.

The Cockcroft Report says

'...most important of all is the need to have sufficient confidence to make effective use of whatever mathematical skill and understanding is possessed, whether this be little or much.' (paragraph 34)

and

'...our concern is that those who set out to make their pupils 'numerate' should pay attention to the wider aspects of numeracy and not be content merely to develop the skills of computation.' (paragraph 39)

TVEI and other recent curricular initiatives have similar aims, emphasising that curricula should contain a strong element concerned with the tackling of practical problems relevant to everyday life and work. The assessment criteria for the GCSE emphasise these aspects too. Employers say that they are primarily interested in people who can use their knowledge sensibly and effectively.

A curriculum component of this kind places new demands on teachers; it needs a broader range of teaching strategies than does the traditional mathematics curriculum, with some new roles for both teachers and students. The scheme has been developed to provide an introduction to such work in the classroom that is both effective and enjoyable for those involved.

What are the skills?

The modules are based on practical contexts which have been chosen to allow students of all abilities to develop general problem solving (or strategic) skills in areas of activity such as designing and making, planning and organising, and choosing.

These strategic skills include:

- understanding general ideas and details
- following instructions precisely
- distinguishing between essential constraints and desirable features
- identifying faults
- correcting faults
- generating and listing viable possibilities (brainstorming)
- developing a rough plan, including: reviewing the prepared suggestions; reaching and recording agreed decisions; maintaining a broad level of description, avoiding excessive detail; identifying needed information and materials; making estimates of quantity and cost; describing, testing and evaluating the plan
- making the final plan, product and/or detailed instructions with comprehensiveness, accuracy, clarity and quality
- implementing the activity with full preparation
- testing and evaluating the plan or product comprehensively.

Various tactical skills, more specific to each context, are involved in implementing these strategies; for example, different ways of collecting and recording information are appropriate if you are considering alternative products to buy, or alternative routes to follow.

Technical skills are, of course, required to carry through the solution of problems using the higher level skills described above. Technique is only useful for these purposes insofar as it is reliable. This implies much higher standards in this respect than are expected in the traditional curriculum, with a greater emphasis on thorough understanding and checking of whatever

techniques are used. Among the mathematical techniques and concepts, of importance in this scheme, are:

- the ability to:
  - carry through simple calculations with suitable accuracy, using a calculator where appropriate,
  - make estimates,
  - make measurements (including number, length and time),
  - draw accurately,
  - interpret and display data in a variety of representations (including graphs, maps, timetables and other tables).
- understanding and using some techniques of
  - probability and statistics,
  - ratio and proportion,
  - geometry in two and three dimensions.
- logical reasoning, including the ability to enumerate alternative possibilities and classify them in various ways.
- research skills, including the collection and evaluation of relevant data.

The relevant mathematical skills are discussed in more detail in each module package. There is also opportunity for the use of other parts of the mathematics curriculum which a student has mastered.

In addition skills from other curriculum areas, such as language and arts, are inevitably called upon, as these are necessary for the presentation of the reasoned arguments which are essential for real problem solving. Since group work is involved, social skills also play their part. Thus, though numeracy is focussed on the deployment of mathematical skills and reasoning in real problem solving, it has a broad cross-curricular aspect.

What is provided?

The scheme is implemented in a modular form, each module being designed to occupy between 10 and 20 hours of teaching time spread over 3 to 6 weeks. Five modules will be available in the first instance. A feature of each module is the importance attached to students working in groups, explaining their ideas and listening to each other, making their own decisions and living with the consequences, reflecting on their experience and learning from it, just as they do in life outside the classroom. While working through the modules, students themselves become responsible for setting and tackling their own problems, rather than simply responding to tasks set by the teacher. Modules are not necessarily staged nor are they dependent upon each other but the sequence which follows is recommended as providing an appropriate progression and a balance of different kinds of context.

The modules in the series are:

- **Design a Board Game**: in which students design and produce a board game which can be played and evaluated by other members of the class.
- **Produce a Quiz Show**: in which students devise, schedule, run and evaluate their own classroom quiz.
- **Plan a Trip**: in which students plan and undertake one or more class trips, and possibly some small group trips.
- **Be a Paper Engineer**: in which students design, make and evaluate 3-dimensional paper products, such as pop-up cards, envelopes and gift boxes.
- **Be a Shrewd Chooser**: in which students research and provide expert consumer advice for clients in their class.

Many contexts were considered and tried in the early stages of development, to see which led to the best balance of classroom activities and learned skills. Those that were chosen all have a practical outcome, interesting and relevant to the students' present circumstances. This corresponds with our observation that people best develop the strategic skills of numeracy in the course of solving problems which they see as realistic, stimulating and within their capabilities. The themes selected were found to have general appeal and to require the use of a wide range of skills, whilst not making unreasonable demands on classroom or school organisation.

Discussion with students and observation in the classroom support the expectation that students' problem-solving abilities improve as they work through the series of modules and that skills acquired in one area are subsequently applied in others. Students themselves maintain that they will be able to apply these strategic skills with advantage in tackling further problems as they arise in their lives outside the classroom. Groups of students also suggested many other interesting and worthwhile themes, each of which could form the basis for a further module. These include:

- planning and running a jumble sale; raising money for charity by sponsored events; planning and running a magazine; setting up a small business; planning a party; designing a bedroom; planning a youth group weekend; making a garden; orienteering; designing and marketing T-shirts.

The scheme provides classroom materials and assessment tasks, together with further support materials to help teachers explore in greater depth the issues and teaching strategies involved. Suggestions for further mathematical development are also included.

**Classroom materials**, including detailed teaching suggestions, have been developed to offer a proven approach that has worked well for a representative...
group of teachers, new to this kind of work, without imposing on them excessive demands of design or implementation. We recognise that, of course, each teacher works in his or her own way in the classroom but most have been found to appreciate detailed, explicit suggestions which they can use, and adapt, in the knowledge that they have worked well for others. Such materials are provided in each module package.

Assessment tasks play an important role in the curriculum, providing targets that help students and teachers recognise objectives more clearly and help them to progress towards them. (The effect of assessment on the curriculum has often been to narrow and distort its aims but, equally, assessment can be used to enhance what is achieved.) In a new curriculum component like this one, assessment is particularly important. Thus assessment tasks are provided throughout these materials.

The suggestions for further mathematical development provide a variety of ideas, together with discussion on how and when they might be introduced and linked to the more traditional teaching of mathematical techniques.

Support materials are designed to help teachers with the new aspects of classroom activity and teaching style that this work involves. The materials relate to the three principal differences between this work and the traditional mathematics curriculum – the broader range of skills involved, the practical priorities of numeracy, and the much greater responsibility of the students for their own work. In the traditional curriculum students are largely imitative, here they are autonomous in deciding on and carrying through their approach to the task. The primary support is provided by the teaching suggestions in the classroom materials and elsewhere in each Teacher’s Guide. The support materials, which form a separate package, take this further, sharpening awareness and tackling more fully and deeply the teaching and assessment issues and skills involved. They may be regarded as a do-it-yourself in-service course, designed to be used either on a distance-learning basis by teachers in a school or within LEA or college courses. This material, which is linked particularly to the ‘Be a Paper Engineer’ module, includes a video of the modules in use, together with comments from teachers and students on the work, its challenges and its benefits.
Introduction to Design a Board Game

Design is an important area of real problem solving that many people face regularly in their lives at home and at work. The context of ‘the design of board games’ fits well in a mathematics classroom. Board game designers face a wide variety of problems which have to be solved before a game is complete. These problems involve them in the deployment of a range of strategic skills and a variety of different mathematical techniques if the end product is to be a success. In this module students face and solve such problems in designing their own board games.

The classroom activities are arranged in four stages that are typical of the design process. These are outlined below, together with the main strategic skills that are being developed.

1. **Looking at examples.** Students play a number of games which have been devised by someone else, discover faults and shortcomings and suggest improvements. (This involves the strategic skills of ‘understanding a situation’ and ‘identifying relevant factors in it’.)

2. **Developing your own ideas.** Students share their ideas within groups, then decide on a rough plan for their own game. (This involves ‘listing alternatives’, ‘estimating resources required’, ‘making decisions’ and ‘detailed planning’.)

3. **Making your game.** Each group of students produces a detailed design, then makes it up and checks the finished version. (This involves ‘implementing a plan’, ‘selecting and using appropriate mathematical techniques’ and ‘checking and testing’.)

4. **Testing and Evaluating.** The groups exchange games and test them. When they are returned, each group re-assesses its own game in the light of another group’s comments. (This involves ‘evaluating the outcome of a plan in action’.)

Chapter 1 provides classroom materials and teaching suggestions for the sequence of activities.

The range of mathematical techniques required will depend on the students’ abilities and the demands made by their chosen design. However, the range is likely to include:

- carrying out simple whole number and length calculations,
- estimating,
- drawing simple figures, using drawing instruments appropriately,
- understanding and using ideas of angle and parallelism,
- using simple tessellations to create original board designs,
- writing clear, concise and complete instructions,
- appreciating and using ideas of fairness and bias, randomness and variability.

This aspect is discussed further in Chapter 2, while Chapter 3 is concerned with assessment.
Classroom materials

Introduction

Summary of activities

Preparation

Stage 1  Looking at examples
Student’s Booklet with comments
Assessment tasks

Stage 2  Developing your own ideas
Student’s Booklet with comments
Assessment tasks

Stage 3  Making your game
Student’s Booklet with comments
Assessment tasks

Stage 4  Testing and evaluating
Student’s Booklet with comments
Assessment task

Using the board games
Classroom materials

Introduction

This chapter provides a detailed guide to the classroom materials. The lesson outlines are offered in the recognition that every teacher has an individual style in which he or she prefers to work. However, many teachers have found it helpful to be given detailed suggestions which they can then adapt to meet their own needs. This has also enabled us to offer an approach which we have seen working well in a representative range of classrooms.

The classroom materials are centred around the Student’s Booklet. This Booklet is important for several reasons:

- It provides students with a coherent structure for their work. At any point, it should help students to have an overview of what they have achieved and where they are going.

- Students who are inexperienced in designing a product often latch on to an idea that seems superficially attractive, without carefully considering implications or alternatives. The booklet will help to slow down and stimulate the more impatient or less imaginative students by, for example, inviting them to criticise a range of different designs before embarking upon their own.

Much of this work involves students working collaboratively in small groups. It is often difficult to assess an individual’s contribution to a group’s product, so we have also included a number of short assessment tasks which may be given to students at the end of each stage. These should provide further evidence of what a particular student can do on his or her own.

This kind of real problem solving in the classroom demands a different balance of teaching styles and strategies from the traditional mathematics curriculum. For some teachers, the emphasis on student-led decision making will be unfamiliar. In this case, we offer the following suggestions which have been found helpful.

Your role will involve rather less task setting and explaining than you may be used to. Instead, you will be acting more as an adviser and resource, responding to the class rather than directing them. As you tour the room, it is helpful if you can

- Listen to students and ask questions which may help them to clarify their own thinking and move beyond superficial discussions.

- Encourage students to listen to one another, making sure that the less forceful or articulate are given a fair chance to express their views.

- Help students to pace their work, by agreeing target dates by which phases of their work should be completed.

- Encourage students to take a pride in their work and aim for a product which is both imaginative and polished.

- Avoid ‘taking over’ by suggesting your ideas and making decisions for them. If you do this, students may feel that they are no longer working on their board game and become disenchanted. Intervention is particularly tempting when it is clear to you that a student is using a particularly inappropriate or time-consuming method, but hold back if you possibly can until the students realise for themselves that their method is unsuitable.

These suggestions are summarised on the final page of this book for ease of reference.
Stage 1  Looking at examples

To begin with, you will play some games that were invented by other people, to see what you can learn from them. Later on, you will invent your own game. Will you be able to make better games than these?

The games are called:

- The Great Horse Race 1 to 12 players 4
- Bugs 2 players 6
- Goal 2 players 8
- Treasure Island 2, 3 or 4 players 10
- Honeycomb 2 players 12

You will also be asked to think about other games you have played.

Stage 2  Developing your own ideas

It’s easy to spot mistakes in other people’s games, but it’s quite hard to avoid making them yourself. In this section your group will invent a new, original game.

This will involve:

- Brainstorming,
- Reaching agreement,
- Drawing up a rough plan,
- Testing and improving your plan,
- Getting everything ready.

Summary of activities

Time needed
About 2 to 3 hours is sufficient, though you may choose to spend longer.

Students’ activities

- Playing and criticising games with inbuilt faults, in order to identify features which may be taken into account when designing their own game. A group activity with some class discussion.
- Writing about other games, and considering why they like or dislike them. This could be an individual activity, possibly as homework, or it could form the basis for discussion.

The teacher’s role

- Facilitating the sharing of ideas.
- Encouraging groups to get beyond a superficial analysis of a game.
- Encouraging groups to suggest and try out improvements to the games.

Time needed
About 2 hours.

Students’ activities

- Brainstorming ideas about different aspects of board games. Mainly an individual activity.
- Reaching agreement on which idea to use for the group’s game.
- Drawing up a rough plan for the game, including rules and board design.
- Testing and improving the plan to make sure it works well.
- Making lists of what will be needed to make the game.

These are all group activities.

The teacher’s role

- Encouraging groups to work through each activity thoroughly, rather than opting for one idea without considering alternatives.
SUMMARY OF ACTIVITIES

**Stage 3  Making your game**

In this stage, your group will be involved in
- Making the board,
- Collecting and making any extra bits,
- Writing the final version of the rules.

**Time needed**
About 3 to 4 hours, though students may wish to spend longer. You may wish to set a finishing deadline.

**Students’ activities**
- Making the board accurately and neatly using suitable geometrical techniques and other ‘artistic devices’.
- Writing the final version of the rules so that someone else could play their game.
These activities are shared amongst the members of the groups.

**The teacher’s role**
- Making sure necessary equipment is available and organising its use.
- Making sure that all members of each group are involved in some aspect of the production of the game.
- Encouraging and helping students to use mathematical techniques where appropriate.

**Stage 4  Testing and evaluating**

When several games are finished, swap your game with one from another group.
You will then
- test their game to see how well it works,
- see what the other group thinks of your game.

**Time needed**
About 1 hour, but you may wish to spend longer.

**Students’ activities**
- Testing the game produced by another group, and making constructive criticisms. A group activity.
- Responding to another group’s comments about their own game, perhaps by improving it still further. A group activity followed by an individual reflective activity.

**The teacher’s role**
- Organising the exchanging of games.
- Encouraging students to criticise in a constructive, positive manner.
Preparation

This module requires students to work in groups on practical activities. In order for this work to run smoothly, it is advisable to make sure that all the necessary equipment is accessible and to consider the best way of organising the classroom.

Equipment required

<table>
<thead>
<tr>
<th>When needed</th>
<th>Item</th>
<th>Quantity</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughout the module</td>
<td>Student’s Booklets</td>
<td>1 for each student</td>
<td>supplied</td>
</tr>
<tr>
<td></td>
<td>Envelopes or folders in which to keep work</td>
<td>1 for each student</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rough paper</td>
<td>a plentiful supply</td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td>Sets of the five board games with equipment</td>
<td>3 sets for a class of 30</td>
<td>supplied</td>
</tr>
<tr>
<td></td>
<td>‘Comments’ sheets</td>
<td>at least 3 for each student</td>
<td>master supplied</td>
</tr>
<tr>
<td></td>
<td>‘Looking at other games’ sheet</td>
<td>1 for each student</td>
<td>master supplied</td>
</tr>
<tr>
<td></td>
<td>Assessment tasks (if required)</td>
<td>1 for each student</td>
<td>masters supplied</td>
</tr>
<tr>
<td>Stage 2</td>
<td>‘Brainstorming’ sheets</td>
<td>1 for each student</td>
<td>masters supplied</td>
</tr>
<tr>
<td></td>
<td>‘Rough Plan’ sheets</td>
<td>1 for each student</td>
<td>master supplied</td>
</tr>
<tr>
<td></td>
<td>Assessment tasks (if required)</td>
<td>1 for each student</td>
<td>masters supplied</td>
</tr>
<tr>
<td></td>
<td>A variety of different grid paper e.g. squared, isometric, dotty, etc.</td>
<td>a plentiful supply</td>
<td>some masters supplied</td>
</tr>
<tr>
<td>Stage 3</td>
<td>‘Rough Plan’ sheets</td>
<td>several for each group</td>
<td>master supplied</td>
</tr>
<tr>
<td></td>
<td>Assessment tasks (if required)</td>
<td>1 for each student</td>
<td>masters supplied</td>
</tr>
<tr>
<td></td>
<td>Equipment listed on students’ own lists (see facing page).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>‘Comments’ sheets</td>
<td>several for each group</td>
<td>masters supplied</td>
</tr>
<tr>
<td></td>
<td>‘Evaluating your own game’ sheets (this is also used for assessment)</td>
<td>1 for each student</td>
<td>masters supplied</td>
</tr>
</tbody>
</table>
By the end of Stage 2, students are required to write out their own equipment lists, which apply to their own designs. The following list includes items that students have often asked for. Not all of these items are essential, but most will be found useful:

- pencils
- felt tipped pens in assorted colours, including a few broad liners
- rulers
- set squares
- protractors
- compasses
- rubbers
- scissors
- glue, especially glue sticks
- sellotape
- coloured paper in various sizes, including some large sheets
- gummed paper
- tracing paper
- grid paper
- card in various sizes, including some large sheets
- counters in various colours
- dice
- a guillotine
- headless matches or cocktail sticks (for making spinners)
- some ‘Transpaseal’, ‘Fablon’, or an alternative method of laminating the board with transparent plastic
- a tape recorder (to help some students write their rules)
- a stapler
- a box for each group to store things in.
Classroom organisation

While using this module, it is helpful if the classroom furniture is arranged so that students can comfortably
- work and discuss in small groups,
- collect equipment,
- see the blackboard, which may be used for class discussions.

For example,

change this .....  

![Diagram of classroom organisation](image1)

Stage 1 may be easier to manage if the games are allocated to tables before the lesson, then when a
group has finished playing one game, they move to a
different table to play the next. This avoids having to
pass the game boards and pieces around the room.

into this .....  

![Diagram of classroom organisation](image2)
Stage 1  Looking at examples

Introduction
In this stage, students are expected to play at least three games, evaluate and identify any faults in them, and then offer constructive comments on how they may be improved. The games are carefully chosen to offer variety in board design, equipment used, and skill required. They also embody a number of serious design faults. We hope that students will find that they both stimulate ideas and illustrate the kind of mistakes that should be avoided.

Total time needed
About 2 to 3 hours, though you may choose to spend longer.

Organisation and equipment required
The students will need to work in small groups, according to the number required for each game. All the games may be played with two players, although ‘Treasure Island’ is designed for four players.

Each student will need:
• one Booklet,
• some ‘Comments’ sheets (one for each game played),
• one ‘Other Games’ sheet,
• an envelope or folder in which to keep his or her work.

Related assessment criteria
This stage offers students the opportunity to show that they can:
(i) follow a set of rules,
(ii) evaluate a design and identify faults in it,
(iii) devise and evaluate improvements to a design.

Note: assessment tasks are included at the end of each stage and the role of assessment is discussed more fully in Chapter 3.
Stage 1 Looking at examples

To begin with, you will play some games that were invented by other people, to see what you can learn from them. Later on, you will invent your own game. Will you be able to make better games than these?

The games are called:

• The Great Horse Race
• Bugs
• Goal
• Treasure Island
• Honeycomb

You will also be asked to think about other games you have played.

Purpose

To introduce the module, to explain the purpose of Stage 1, and to involve the students in playing and criticising at least 3 games.

Presentation

An introductory discussion, followed by group work, and concluded with a reflective discussion.

Suggestions and comments

You may wish to introduce the module with a general discussion about board games, perhaps asking for responses to questions like:

- Who enjoys playing board games?
- Which ones do you like?
- What is good about them?
- Name a game you find boring.
- Why is it boring?

Read through page 1 of the booklet and explain the processes that the students will work through during the next few weeks.

Now look at pages 2 and 3.

Emphasise that

- the games have faults,
- students should note down any criticisms they have, using a ‘Comments’ sheet,
- students should move beyond superficial comments like ‘it’s boring’ ‘it’s hard to understand’ and explain why and suggest ways of improving the games,
- a different ‘Comments’ sheet should be used for each game.

You may like to go through the comments that have already been started (on page 3), asking students to complete them orally with reference to particular games they know.
STAGE 1

THE GREAT HORSE RACE
A game for 1 to 12 players.

What you need
The board, two dice and twelve counters to represent the horses.

Aim of the game
Twelve horses enter a race. The first one to pass the finishing line wins.

Rules
How to start
- Put the horses on their starting squares, labelled 1 to 12.
- Each player chooses a different horse.
  (If there are only a few players, then each player can choose two or three horses.) The remaining horses are still in the race — but no one owns them.

How to play
- Throw the two dice, and add the scores (e.g. 2 + 3 gives the number 5).
- The horse with that number moves one square forward.
- Keep throwing the dice.
  The horse which is first past FINISH is the winner.

- Play this game a few times.
- Each time you play, write down, on the back of your ‘Comments’ sheet, which horse comes 1st, 2nd, 3rd, and so on.

Throughout the stage, you will need to encourage students to reflect on the games and write constructive comments.

Here are some ideas which promote this:
- Play and discuss one game with the whole class. ‘The Great Horse Race’ is recommended for this.
- Discuss specific aspects of a game e.g. context, board design, rules, skill or luck factor, fairness. Write these headings on the blackboard and suggest that students comment under each.
- Hang large sheets of paper on the wall – one for each game. As each group completes a game they add their comments to the sheet. When several groups have done this, the sheets may be used as a focus for a class discussion.
- When a group has suggested improvements to a game ask them to play the game again, incorporating their changes.
- As you go round the class, ask each group to point out and describe the faults they have found. Listen as if you know nothing about the game! If they appear to have misread the rules, ask them to explain each rule and demonstrate its effect. Encourage students to tell you about the game.

Below, we offer a few detailed comments on each game.

Comments on ‘The Great Horse Race’
- A simple game of pure chance.
- The game is unfair as it favours the horses in the middle. It is worth asking students to explain why this is the case.
- Horse number 1 never moves!
BUGS
A game for 2 players.

What you need
A board, a dice and two counters to act as bugs.

What it's about
The apple has two tunnels leading to the core in the middle. Each bug follows one tunnel.

Aim of the game
To reach the core first.

Rules
How to start
- Put the bugs on the two bug pictures.

How to play
- Take it in turns to throw the dice.
- Move your bug along your tunnel the number of spaces shown by the dice.
- If you land on an M (mouldy) space - miss a go.
- If you land on an E (edible) space - have an extra go.

Play this game a few times.
Each time you play, write down, on the back of your 'Comments' sheet, whether Winston or Catherine wins.

Comments on 'Bugs'
- A simple game of pure chance. No skill is involved.
- It is unfair. Winston worm has further to travel and has more mouldy bits and fewer edible bits to pass through.
- As the game progresses, the counters have to be placed on smaller and smaller spaces. Near the centre this becomes almost impossible!
STAGE 1 LOOKING AT EXAMPLES

STAGE 1

GOAL
A game for 2 players.

What you need
The board, a counter for the ball, a pack of playing cards.

STAGE 1

GOAL
A game for 2 players.

What you need
The board, a counter for the ball, a pack of playing cards.

Aim of the game
To score more goals than your opponent before time runs out.

This game is rather like hockey or football.

Rules

How to start

• Place the ball in the centre circle.

• Give one player a red Ace, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

• Give the other player a black Ace, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

(The rest of the cards are not used.)

How to move the ball

• Look at your cards.

• Now each choose a card and put it face down on the table.

• Both of you turn your cards over at the same time.

• If you have the higher value, move the ball one step towards your opponent’s goal.

• Now each choose another card and put it face down on the table. Compare them as before.

Scoring goals

• You score when the ball reaches your opponent’s goal. Then you replace the ball in the centre circle.

• Time runs out when both players have used up their ten cards. The person who has scored the most goals is the winner.

• Play the game a few times.

• Each time you play, write down, on the back of your “Comments” sheet, whether the red or black team wins.

Comments on ‘Goal’

• A boring game because it rarely finishes in a result, and if it does, then no more than one goal is usually scored.

• The structure of the board is very simple. The rest is merely for decoration.

• The rules are fairly complex, and are sometimes misinterpreted by students.

• Although the game requires little skill, it is worth trying to remember which cards have been played, and some students enjoy the ‘mind reading’ element.
STAGE 1

TREASURE ISLAND
A game for 2, 3 or 4 players.

What you need
The board, a dice, four boats, twelve treasure rings, pack of 'Fight' cards.

What it's about
The board shows the sea with four ports and a Treasure Island. You have to sail to the Island Harbour and collect treasure. You can attack other ships as well.

Aim of the game
To collect three treasure rings from Treasure Island and land them at your port.

Rules
How to start
• Start with your boats in your ports and the treasure on the island.
• Shuffle the 'Fight' pack and put the cards face down.
• Each player takes a card, but keeps the number on the card secret.

How to make a move
• Throw the dice in turns.
• You can move your boat any number of triangles up to the number on the dice.
• You collect treasure when you arrive at the HARBOUR on the island, but your boat can only carry one treasure ring at a time.
• If you land on a triangle next to a boat carrying treasure, you fight. You both show your 'Fight' card. The player with the highest score takes the treasure, the loser gets a free move of two triangles. Then put your cards to the bottom of the pack and take new ones.

• Play the game a few times.
• Each time you play, write down, on the back of your 'Comments' sheet, the name of the winning Pirate.

Comments on 'Treasure Island'
• The triangles on the board and the pieces are too small.
• The 'Fight' cards are badly numbered.
• The rules are incomplete. There is no indication of what should happen if the cards drawn in a fight have the same value.
• The rule for moving is ambiguous.
• The rule which restricts a boat to carrying one treasure ring at a time is unfortunate. It prevents two boats which are carrying treasure from engaging in a 'fight'.
• The board is drawn unfairly. 'Peg-Leg Pete' is nearer to the harbour than the other players.
STAGE 1 LOOKING AT EXAMPLES

STAGE 1

HONEYCOMB
A game for 2 players.

What you need
The board, and a set of counters in two colours, one for the 'Worker' bees and one for the 'Drones'. 13 of each colour will be needed.

Aim of the game
The 'Drones' must try to make a connected path from the top to the bottom of the board. The 'Workers' must try to make a path from side to side.

What it's about
Two kinds of bee are trying to control a hive - the 'Workers' and the 'Drones'.

Rules
- Take turns to put a counter on any empty hexagon. (You need not put your first counter at the edge; you need not put your counter next to the one before.)
- The examples show two winning paths.
- Each time you play, write down, on the back of your 'Comments' sheet, whether the 'Workers' or 'Drones' win.

Comments on 'Honeycomb'
- This is a game of strategy which never ends in a draw.
- The board is unfair. The Drones have further to go to create a path when they are blocked. The game thus favours the Workers.
The final activity in this Stage invites the students to think reflectively about other games they have played. This may be used in several ways, for example:

- as homework,
- for the last 5 minutes of a lesson while the equipment is being collected and checked,
- to ease pressure on particular games (this may occur with large classes),
- as the focus for a short lesson, when students could bring into school for discussion some games which are commercially available.
Assessment tasks for Stage 1

On the following pages we offer two assessment tasks which may be helpful when deciding whether or not students can satisfy the Stage 1 criteria.

Assessment task 1 helps to assess whether or not a student can
   (i) follow a set of rules,
   (ii) evaluate a design and identify faults.

Assessment task 2 also relates to these criteria but, in addition, it helps to assess whether or not a student can
   (iii) devise and evaluate improvements to a design.
The Great Horse Race

Turn to pages 4 and 5 of your Student’s Booklet.

The ‘Great Horse Race’ is being played.

The scores on the first six throws of the dice are shown below:

<table>
<thead>
<tr>
<th>Throw 1</th>
<th>Throw 2</th>
<th>Throw 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

1. On a copy of this grid, mark the positions of the horses after the six throws.

2. Suppose you want to win the game.
   (a) Which horse would you not choose?
       Explain your answer.
   (b) Which horse would you choose?
       Explain your answer.
   (c) Do you think the game is fair?
       Explain your answer.
Snakes and Ladders

Read the following description of a game, and answer the questions which follow.

This is a game for 2 players. 
You will need a coin and two counters.

Rules

- Take it in turns to toss the coin. 
  If it is heads, move your counter 2 places forward. 
  If it is tails, move your counter 1 place forward. 
- If you reach the foot of a ladder, you must go up it. 
  If you reach the head of a snake, you must go down it. 
- The winner is the first player to reach ‘FINISH’.

1. Suppose you start by tossing a head, then a tail, then a head. 
   Where is your counter now?
2. List and describe all the faults you notice with the board.
3. Using 3 snakes and 3 ladders, design a good game on a copy of this blank board.
Stage 2  Developing your own ideas

Introduction

The activities contained in this stage develop a number of important strategic skills which may be applied to almost any design task. These skills include:

- exploring a wide range of alternatives before deciding on a particular solution,
- working through cycles of testing and improving rough designs before making a final version.

As we have already mentioned, such activities are unfamiliar to many students, who tend to embark upon the first idea they find attractive, without considering implications and alternatives.

Total time needed

About 2 hours.

Organisation and equipment required

While actually making the games, small groups of 2, 3 or 4 students will work together. These groups will be formed during the ‘reaching agreement’ phase.

Each student will need

- a ‘Brainstorming’ sheet
- a ‘Rough Plan’ sheet
- plenty of rough paper
- access to different kinds of grid paper. (e.g. isometric, dotty, etc)

Related assessment criteria

This stage offers students the opportunity to show that they can:

- list alternative ideas for design features,
- devise a satisfactory rough plan including spatial layout and instructions,
- sketch a design to fit given conditions,
- devise rules to fit given conditions.
STAGE 2 DEVELOPING YOUR OWN IDEAS

STAGE 2

Brainstorming

You will each need a copy of the 'Brainstorming' sheet. On your own, make lists and draw diagrams to show
• what your game could be about,
• what the board could look like,
• what the aim of the game could be,
• any special features your game could have.

Purpose
To give students the opportunity to think of alternatives before discussing their ideas with the group.

Presentation
Class discussion followed by individual work.

Time needed
10–15 minutes.

Suggestions and comments
You may like to begin this activity by asking a few members of the class to suggest one or two ideas for each of the different sections in the 'Brainstorming' sheet, and list these on the blackboard.

Encourage students to fill in all the spaces on the sheet on their own before discussing their ideas. This will ensure that every student has something to contribute to the group discussion which follows.

If students have difficulty with this activity you could ask them to think of games that they have at home, games from stage 1 or even computer games.

Reaching agreement

Look at all the different lists and drawings your group has produced. Give each person a chance to explain his or her ideas. Using your lists, try to agree on the details of a game that your group could make. If you cannot agree, then why not produce two games, or two versions of the same game?

Have you agreed on answers to the following questions?

Purpose
For everyone to share their ideas in a group, and to reach agreement on which ideas to develop.
For students to learn how to listen and discuss constructively with one another.

Presentation
Group discussion.

Time needed
About 10–30 minutes. (This will vary from group to group).

Suggestions and comments

1. This may need emphasising, as there is sometimes a tendency for one or two people in a group to dominate the discussion, by pushing their own ideas forward and ignoring those suggested by other students.

2. This is an option that can be taken up when negotiations fail, or if a group is too large. A group which contains more than four students will not be fully occupied in the making of a single game, so we suggest that such large groups are broken up at this point.

3. The decisions made at this stage are likely to change while the rough plan is being developed.
STAGE 2
Drawing up a rough plan
When your group has agreed on your game, each person should fill in the top half of a 'Rough plan' sheet.
Do not worry about writing the rules yet.

Rough plan

| Name: Barbara Prager, Mary Fisher, David Smith, Catherine Stone |
| Our game is called... Everest |
| Way it's for... Four players aged 10 upwards |
| What we need in order to play... Board, 2 dice, 4 counters, spinner |
| What it's about... You have to climb the mountain avoiding accidents |
| Area of the game... To be the first to reach the top |
| Rules... How to start... |
| How to make a move... |

Purpose
To allow each student the opportunity to record the decisions made by the group, to begin to consider possible spatial layouts for the board, and to write a first draft of the rules.

Presentation
Individual work, interspersed with short group discussions.

Time needed
About 30 minutes

Suggestions and comments
1. In order to involve everyone in the work, we have asked each student to record the group's decisions. Students will either discuss exactly what to write down and thus produce identical versions, or produce different versions and then decide on the best one.

2. Students should be encouraged to think about the board layout on their own before sharing their ideas within the group.

3. If extra features are designed (for example spinners, or 3-dimensional counters), then, as well as adding to the interest of the finished game, they will promote a wider variety of activities in Stage 3.
STAGE 2 DEVELOPING YOUR OWN IDEAS

STAGE 2

Write down some rules for your game on a spare piece of paper. Now try playing the game in your group. As you play, you will probably think of:
- new rules,
- changes to the board,
- ideas for new pieces.
Make a note of all these new ideas.

Other people have got to be able to play your game by just reading your rules. Each person should try to write out a good copy of them on the bottom of their ‘Rough plan’ sheet.

The work involved in this page could take much longer than the estimated time, depending on how much ideas are modified. Encourage groups to develop their ideas as much as possible.

Many students have difficulty when writing their rules. On this (and on page 21) we encourage students to write them out roughly, then test and refine them until they are complete and coherent.

You could help students to notice omissions or inconsistencies in their rules by reading them out and trying to interpret them.

Purpose
To check that all aspects of the plan work.

Presentation
Group (or possibly intergroup) work.

Time needed
15 minutes

Suggestions and comments
It is unlikely that all groups will reach this stage at the same time, but you may be able to arrange some swapping of games between groups that have reached approximately the same stage.
STAGE 2

Getting everything ready

Before you begin to make your game, you will need to collect things like
skissors, glue, counters, card, special paper,
an envelope to put bits in...

Make a list of the things you will need.
Make sure that everyone knows what they must bring, especially your teacher!

The following page may help.

Purpose

To encourage students to think about which resources are needed, where these can be obtained from, and
who will be responsible for collecting them.

Presentation

Group discussion.

Time needed

10 minutes

Suggestions and comments

This activity is particularly important if you do not have a permanent classroom base. In these circumstances it
may be easier if one member of each group arranges to see you before the next lesson to sort out a box of
equipment for his or her group. These people could then be responsible for collecting the boxes before
each lesson.
Assessment tasks for Stage 2

On the following pages, we offer four tasks which may help in deciding whether or not students can satisfy the Stage 2 assessment criteria. The first two should already have been completed by students during the normal course of their work, but the remaining two tasks are new, and may be completed at the end of Stage 2.

Stage 2 Assessment task 1

Each student should have completed a ‘Brainstorming’ sheet at the beginning of the stage (see pages 16 and 17). This may be used to assess whether or not students have shown that they can:

(iv) list alternative ideas for design features.

Stage 2 Assessment task 2

Each student should have completed a ‘Rough Plan’ sheet (see pages 18, 19 and 20). This may be used to assess whether or not students have shown that they can:

(v) devise a satisfactory rough plan, including spatial layout and instructions.
The remaining two tasks may be completed by a student when he or she has completed Stage 2.

Assessment task 3 assists in verifying that a student can:
(vi) sketch a design to fit given conditions.

Assessment task 4 assists in verifying that a student can:
(vii) devise rules to fit given conditions.

STAGE 2  ASSESSMENT TASK 3

Deep Sea Diving

One group have been discussing their plans for a board game.

Here are some of the things they have decided:

Our game will be about deep sea divers looking for treasure in a sunken shipwreck.

The game will be for 3 players.

The winner will be the first to bring the treasure to the surface.

You need to throw a dice to move around the board.

There are sharks and other dangers which make the task more difficult.

Your task is to design a board for this game.

Try to make your design interesting and fair.

(You do not need to draw it accurately.)
Treasure

The board drawn below was designed by a group of students, but they haven't written any rules.
Answer sheet for ‘Treasure’

Fill in the ‘Rough Plan’ sheet shown below, so that a young child could understand how to play this game.

### Rough plan

<table>
<thead>
<tr>
<th>Names</th>
<th>Our game is called...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who it’s for...</th>
<th>What you need in order to play...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What it’s about...</th>
<th>Aims of the game...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Rules

*How to start...*

*How to make a move...*

*Other rules...* Make sure you explain what happens if you land on a gun or a ship.
Stage 3  Making your game

Introduction
In this stage, the emphasis is on using mathematical and other skills to implement the students' own plans. Each group will need to:
- make the board and other accessories to the highest standard they can achieve,
- write a clear, concise and complete description of the rules of the game.

In addition, the group may also want to design a box to keep the game in.

Total time needed
About 3 to 4 hours.
This stage can take a long time, so you may wish to set a finishing deadline.

Organisation and equipment required
Students are likely to share out tasks according to the particular skills possessed by individuals. If this happens, you will need to ensure that everyone has a task to do and is kept fully involved.

Each group will need:
- several copies of the 'Rough plan' sheet,
- the equipment listed by the group at the end of Stage 2.

You may also need to ensure that a supply of basic equipment and a variety of paper and card is constantly available. A suggested list is given at the beginning of this chapter on page T15.

Related assessment criteria
This stage offers students the opportunity to show that they can:
- estimate the materials that they need to make a final product,
- draw a design accurately, following geometric and other specifications,
- take an active part in the production process.
In this stage, your group will be involved in:
- Making the board.
- Collecting and making any extra bits,
- Writing the final version of the rules.

Stage 3 Making your game

Making the board
You now have to make a large, neat, final version of your board.
Before you start, discuss these three questions:

What shape will your board be?

How big will your board need to be?

We could keep the game in an old shirt box.
It could fold in half.
Shall we put the rules on the board?

How will you make your board?

Let's draw the board in felt-tipped pen.
But suppose we mess it up?

Could we draw parts of the board onto bits of coloured paper and paste them on?

There are some more ideas over the page...

Purpose
To encourage students to make a product of which they may justifiably be proud.

Presentation
Group work.

Suggestions and comments
Groups are likely to complete stage 2 at different times. It may therefore be necessary to start each group off on Stage 3 separately.

It is important that throughout this stage, jobs are shared out within groups so that everyone is fully occupied.

If possible ensure that everyone has a task that involves using geometrical techniques. For example, a group of four could divide up the jobs as follows:
- two people draw the board,
- one person makes a spinner and counters,
- one person cuts up a set of cards and makes a box to keep all the bits in.

Alternatively, a group could perhaps make two copies of the same game.

At the end of each lesson make sure that everyone is aware of the progress that has been made by their group, otherwise unforeseen absence can cause problems. For the same reason, it is better that all the games are kept in school.

Making the board
Before a group shares out tasks, students should discuss the three questions on page 25. It may help some groups if you actually ask the questions and encourage ideas from each student.
Here are some ideas which may help you make your board.

If your board contains a lot of shapes all the same, try making a template from tracing paper...

1. Draw the shape accurately on tracing paper.
2. Place the tracing paper on the cardboard base.
3. Prick through with a pin.
4. Lift off the tracing paper and draw between pin pricks.
5. Re-position the tracing paper on the base and repeat...
   ... until the design is complete.

You could also try making a mosaic board.

1. Draw parts of your board on pieces of coloured paper, using a template.
2. Cut these pieces out and paste them into place.
3. Prick through the tracing paper with a pin, and finish the board.

The ideas on these two pages suggest ways of reducing the time and labour involved in drawing and colouring repeated designs on the board, while at the same time making it more attractive and accurate. Students should be encouraged to look carefully at these ideas and choose any which are appropriate for their games.

While students are working through this stage, they may request advice on how to draw particular geometrical shapes (e.g. ‘How do you draw a spiral, sir?’). You may also wish to make everyone aware of techniques and equipment that would be particularly helpful.

More help on how to prepare for this is offered in Chapter 2.

Encourage students to make the board look as professionally finished as possible. It may, for example, be covered with some kind of self adhesive transparent plastic.
Collecting and making extra bits

1. It is not always easy to make a fair spinner (or a fair dice). A tally chart, for example, could be used to test whether the numbers generated by a spinner occur in a truly random way. It may then prove possible to alter it slightly or incorporate the bias into the design of the game.

Hexagonal pencil pieces which may be rolled along the table provide cheap alternatives to spinners or dice.

2. Counters do not need to be 2-dimensional!

3. Students tend to cut their cards from the middle of a sheet thus causing wastage. They should be encouraged to think about the best way of cutting a certain number of cards of given measurement from a large sheet of card.

Writing the final version of the rules

4. Although the rules were well tested in Stage 2, some students may wish to amend them still further in the light of their finished board. If this happens, then the rules will need to be checked again.

5. The rules could be written
   - on the sheets provided,
   - on the actual board,
   - on a separate piece of card,
   - using a typewriter (if a member of the group can type)
   - using a word processor if one is available.
Assessment tasks for Stage 3

The following three tasks may assist you in deciding whether or not students can satisfy the Stage 3 assessment criteria.

Assessment tasks 1 and 2 help you to verify whether a student can
(viii) estimate the materials needed for a final product.

Assessment task 3 helps you to verify whether a student can
(ix) draw a design accurately, following geometric and other specifications.

Note that criterion (x) which states that students have shown that they can 'take an active part in the production process', may only be assessed by observation of the students during their work in Stages 2 and 3.

Assessment task 1

Show each student a finished board game. It may be a game that has been completed by another group in the class, or it may be a commercially-produced game.

Ask the student to imagine that she is going to make this game at school. Ask her to write out a list showing all the equipment and materials she would need in order to make the game. The student should assume that every item apart from the dice, the counters and the box must be made from paper or card. She should include quantities and dimensions wherever possible.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity or dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scissors</td>
<td>1 pair</td>
</tr>
<tr>
<td>Sheet of cardboard</td>
<td>40 cm x 60 cm</td>
</tr>
</tbody>
</table>
Chasing Packs

Here is part of a rough plan for a game called ‘Chasing Packs’.

Rough plan

<table>
<thead>
<tr>
<th>Names</th>
<th>Philip Smith  Colette Beaulieu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our game is called</td>
<td>Chasing Packs</td>
</tr>
<tr>
<td>Who it's for</td>
<td>Four Players</td>
</tr>
<tr>
<td>What you need in order to play</td>
<td>Board, pack of playing cards, 6 counters for each player</td>
</tr>
<tr>
<td>What it's about</td>
<td>The players chase each other round the board and try to capture each other cards</td>
</tr>
<tr>
<td>Aims of the game</td>
<td>To win the most cards</td>
</tr>
</tbody>
</table>

Rules

How to start... Start by dealing out all 52 cards
Each player places one counter on the board

Rough Board Design

Each of these small squares will be 2cm by 2cm
Chasing Packs

Two students are about to make this game.

1. How many counters will be needed altogether?

2. They are going to make a full-size version of the board. Work out how big the large cardboard base should be (use the measurements on the rough plan).

The students have found this scrap of black paper

3. They could cut out the black squares on the board from it and then paste them on.
   How many 2 cm by 2 cm squares can be cut from this piece?
   (Find the largest number you can make).
Chuck-a-Luck

A group of students have designed a board for a game called 'Chuck-a-Luck'.
Draw the board full size, as accurately as you can.
Make sure you follow the instructions in the bubbles.

This circle should have a radius of 8 cm.

These squares should all be 4 cm by 4 cm.
Stage 4  Testing and evaluating

Introduction
This stage completes the cycle of the design process by inviting students to play and comment on each other’s games, using the same method as in Stage 1. They are then asked to react to the comments other groups have made about their game, and encouraged to incorporate any worthwhile suggestions that are practicable.

Total time needed
It is only necessary to spend about an hour on this stage, ensuring that each game is played at least twice, although you may wish to spend longer.

Organisation and equipment required
It may prove possible to organise the exchanging of games in a systematic way, but more often, this is governed by the order in which groups finish.

Each group will need:
- a ‘Comments’ sheet for each game they play,
- an ‘Evaluating your own game’ sheet.

Related assessment criterion
This stage offers students the opportunity to show that they can:
(xi) take part in testing and evaluating their product.
STAGE 4

Testing another group’s game

Be a fair tester!
- Take time to read and understand the rules, but . . . do not ask the other group to explain them!
- Play their game.
- Say what was good about their game and what they could improve.

This game would be better if the board were coloured.

[Image of students playing a game]

Hey, this is good. I like the idea of the spinner.

If you change this rule it works much better.

Comments
- Date
- Comments

1. When other groups have played your game, read through their ‘Comments’ sheets.
2. Compare their comments against your game; make any changes you can which will improve your game (including rule changes).

Then, each person should fill in the ‘Evaluating your own game’ sheet.

Purpose
To encourage students to make helpful comments about a game so that the inventors can improve it still further.

Presentation
A group activity.

Time needed
About 45 minutes

Suggestions and comments
1. Students should attempt to understand the rules without asking for help. If they do need help they should note down the extra explanation that was needed.
2. Students should be encouraged to offer only constructive criticism, and no negative comments should be made without a corresponding suggestion for improvement.

Purpose
To incorporate other people’s ideas where possible.

Presentation
Group discussion followed by individual work.

Time needed
15 to 20 minutes

Suggestions and comments
1. The group should consider other people’s comments carefully and make any changes possible to the final version.
2. The ‘Evaluating your own game’ sheet should be filled in by every student. You may wish to make students do this on their own, especially if the work is being used for assessment.
Assessment task for Stage 4

There is only one assessment criterion for stage 4, which states that the student has shown that he or she can

(xi) take part in testing and evaluating the product.

This may be assessed by classroom observation, and by how well each student has completed an ‘Evaluating your own game’ sheet (see page 31).

Evaluating your own game

Name of the game

Filed in by

Read through the Comments sheets.

1. What did other people say about your game?

Tick the points you agree with.

2. These are the good points of the game:

3. These are weak points of the game:
Using the board games

The aim of the classroom material is to produce a game that other people can play. There are, however, ways that the work may be further developed.

Here are some ideas that have been tried.

- Present the games to people outside the class. For example some groups have taken games designed for younger people into local primary schools.

- Look into the possibility of mass producing and selling a game, maybe at a school fête, or even at a local community volunteer shop. This could become a springboard for the consideration of all kinds of manufacturing and marketing issues. For example, the students could look at reprographics, costs, cash flow, materials, production lines, advertising and so on.
Developing the mathematics

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Developing the mathematics

Introduction

‘Design a Board Game’ is a rich theme for generating mathematical activity. While students are working on the module, their main objective is to design an attractive, exciting board game – not to develop particular mathematical techniques. However, as a teacher, you may wish to use the module to motivate the learning of mathematics in a more explicit way. This chapter offers some ideas on how this may be achieved without destroying the essential flow of activities contained in the module.

Which skills may be developed?

The table below illustrates some of the mathematical topics related to the context of board games. This list is by no means complete. A group of students may want to design a game within a particular context, and this context may in itself provide opportunities for mathematical development. A game about buying and selling may offer practice at handling money, simple percentages and use of a calculator. An abstract 3-dimensional game will offer more demanding geometrical challenges. A game about the school day may involve using simple timetables and so on.

<table>
<thead>
<tr>
<th>Mathematical topics</th>
<th>Examples from the module</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number</strong></td>
<td>‘How do I combine the scores on these two dice?’</td>
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<tr>
<td>• Counting, ordering and combining whole numbers in various ways.</td>
<td>‘Commercial counters are 1½ cm in diameter, so let’s make each square on the board 2 cm by 2 cm. My cardboard base is 29.6 cm wide . . . so I could fit 12 squares in with a space of 2.8 cm each end . . . .’</td>
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<tr>
<td>• Understanding and using fractional measurement.</td>
<td>‘How many ‘hazard’ cards will I need to make? Roughly how big will my board be? How long will the game take on average?’</td>
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<td>• Making estimates.</td>
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<tr>
<td><strong>Spatial Concepts</strong></td>
<td>‘How can I make a hexagon template, where each side is 3 cm?’</td>
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<tr>
<td>• Drawing simple figures to given specifications, and using drawing instruments appropriately</td>
<td>‘Maybe my board could consist of hexagons, squares and equilateral triangles!’</td>
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<td>• Using tessellations to create original designs.</td>
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<td><strong>Logic</strong></td>
<td>‘Are my rules clear and complete?’</td>
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<tr>
<td>• Reading and writing instructions</td>
<td>‘How can I play this game well?’</td>
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<tr>
<td>• Reasoning</td>
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<tr>
<td><strong>Statistical concepts</strong></td>
<td>‘How can I make my game fair?’</td>
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<tr>
<td>Understanding and using</td>
<td>‘Is it harder to throw a 6 or a 3?’</td>
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<tr>
<td>• ideas of fairness and bias</td>
<td>‘Which horse is most likely to win ‘The Great Horse Race’? Why?’</td>
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<tr>
<td>• ideas of randomness and variability</td>
<td>Is this what happens in practice?’</td>
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<tr>
<td>• simple theoretical and experimental probabilities</td>
<td>‘How long does the average length game last? Does this vary much?’</td>
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<tr>
<td>• measures of average and spread</td>
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How and when may they be introduced?

Mathematical activity may be initiated either by the student or by the teacher. For example:

- a group of students may become aware of their need to acquire a particular skill in order to carry through their own plan. ‘How do you draw spirals, Miss?’
- you may wish to use some of the materials to support a more intensive piece of work on a particular topic. ‘Today, we're going to do some work on probability, using a game from the ‘Design a Board Game’ module’.

The first type of situation can lead to valuable learning experiences, because the student wants to know something. You can actually ‘scratch where they itch’! Such opportunities occur rather unpredictably however and it is difficult to spend a great deal of time helping one group if you have a large class to supervise. One possible solution is to write a few simple ‘How to...’ sheets, like the example shown opposite. These may then be used to deal with some of the more common requests for help. Alternatively, a member of the group could describe the group’s problem to the whole class and invite help and advice from other students.

Do not expect students to use, autonomously, mathematics that they have only recently been taught. There is a gap, typically of several years, between ‘learning’ a skill and being able to adapt and use it with flexibility and fluency. Students will only tend to use knowledge or apply those technical skills that they have mastered. Narrowing this gap requires a more ‘rounded’ approach to learning, with a variety of applications and non-routine problem solving to supplement and give meaning to technical exercises.

More intensive work on mathematical techniques relating to the theme of board games may occur before, during or after working on the module:

Before: ‘I'll do some work on tessellations now, and then my class will be more able to use tessellations later, when they come on to designing their game.’

This timing has the advantage that the students will have their techniques polished and ready to be used, but it does seem artificial to learn a new technique before seeing a need for it. Students may tend to assume that the module is merely a vehicle for practising these techniques, rather than to develop individual autonomy.

During: ‘They don’t seem to be able to draw as well as I thought. I’ll break off for a lesson or two and give them more practice at using rulers and compasses.’

‘I’ll prepare some problem sheets for my class so that I can keep them together. So if one group finishes a stage early, they can do problem sheets until the rest of the class have caught up.’

This timing enables you to respond to needs as they arise, but if students always expect you to produce the method or solution when the going gets difficult, you may reinforce dependence and undermine autonomy.

After: ‘When we finish the module, we will spend the rest of the term working on two topics which relate to board games, accurate drawing and probability.’

‘Now we’ve finished the module, I’m going to encourage my class to look in depth at one or two simple strategy games. They could explore the effects of changing rules and so on. Maybe they could write up their investigations for GCSE coursework.’

The experience of working on the module may motivate and enable students to perceive the value of techniques when they are taught. However, in this case the techniques still need to be related to a real problem solving activity.

Whatever you decide, it is important to be vigilant about preserving the students’ autonomy and strategic control of the problem; it is only too easy to allow them to revert to the imitative role that the traditional curriculum encourages. On the following pages we offer a few resources for developing mathematical techniques on non-routine problems. You may like to devise some more of your own.
How to . . . draw a spiral

You will need: Pencil, ruler, compasses, scissors, glue, rubber.

1. Draw some concentric semi-circles, with diameters of 2, 4, 6, 8 . . . units.

![Diagram of concentric semi-circles with diameters 2, 4, 6 units.]

2. Now draw some more, with diameters of 3, 5, 7, 9 . . . units.

![Diagram of additional concentric semi-circles with diameters 3, 5, 7 units.]

3. Now join the two halves together:
1. In one particular game of Goal,
   the red team put down: Ace, then 4, 6, 3, 2, 10, 9, 7, 5, 8
   the black team put down: 8, then 3, 2, Ace, 10, 5, 4, 6, 9, 7
   What was the final score?

2. Write down all the other possible final scores.
   Describe one way in which the cards could be laid to give each of these final scores.

3. When you played ‘Goal’, you may have found it boring . . . maybe no-one scored!
   - Change the rules to make it more exciting
   - Write down your new rules
   - Play your new version.

4. Suppose you keep all the rules the same as on page 9, apart from the rule which says:

   ‘If you have the higher value, move the ball one step towards your opponent’s goal.’

   - Change this rule to

   ‘If your card is one higher than your opponent’s, move the ball one step towards his/her goal;
    If your card is two higher, move the ball two steps . . . and so on’

   - Play the game using this new rule.
   - What final scores are possible now?
   - Describe a game which ends in a score of 6–3.

5. Make up some similar questions of your own, which refer to your own rules for question 3.
   Give them to a friend to solve.
‘Honeycomb’ problems

(See pages 12 and 13 in Stage 1)

1. This diagram shows how the board looked after 8 moves in one game.
   (a) Imagine that you are playing 'Drones' in this game. It is your turn.
       Where would you put your next Drone counter?
       Explain why you would do this.
   (b) Using the same board, now imagine that you are playing 'Workers'. It is your turn.
       Where would you put your next Worker counter?
       Explain why you would do this.

2. Do you think that the game of 'Honeycomb' is fair?
   Does it make any difference who goes first?
   Explain your answers as fully as you can.

3. If you start first, and you are playing 'Workers', where would be bad places to go? Explain why.
   If 'Drones' were to start first, where would be a bad move for them?

4. Can the game of 'Honeycomb' ever end in a draw?
   Either: show how the game can end in a draw
   or: explain why the game can never end in a draw.

5. Try changing the rules to ‘Honeycomb’ and play your new version of the game.
Making and playing board games

Choose a game from those described below.
Draw the board, full size, as accurately as you can.
Play the game with a friend and comment on it.
Now try changing the rules . . .

Ashi – a game for 2 players from Ghana.
What you need: 8 counters, 4 of one colour, 4 of another.
Aim of the game: To get 3 counters of your colour in a straight line, before your opponent does.
How to play
Take turns to put a counter on the board, like Noughts and Crosses.
When all the counters are on the board, take turns to move a counter to a neighbouring empty position along the lines.
(You can only move a counter of your own colour).

Lau-Kati-Kata – a game for 2 players from Bengal.
What you need: 12 counters, 6 of one colour, 6 of another.
Aim of the game: To ‘take’ all your opponent’s counters.
How to start: Put your 6 counters on the dots to the left of the centre. Your opponent puts her counters on the dots to the right. The central dot is left empty.
How to play
Take turns to move a counter to a neighbouring empty dot along a line.
You capture a counter by hopping over it to an empty position beyond. (This is a bit like ‘Draughts’).
As in ‘Draughts’, you can make more than one hop in a move.
If you can hop over one of your opponent’s counters, then you must do so.

Drawing the board
Draw the circle with a diameter of 18 cm.

Drawing the board
Make all dots 4 cm apart (measured along the straight lines)
All the angles are 45° or 90°
Making and playing board games (continued)

**Mu-Torere** – a game for 2 players from New Zealand.

**What you need:** 4 black counters and 4 white counters.

**Aim of the game:** To block your opponent's counters so that he cannot move.

**How to start:** Each player puts his pieces on four neighbouring points of the star.

**How to play**
Black starts, and players take it in turns to move their counters.

There are 3 kinds of move.
(a) A counter may be moved to the centre circle if one or both of the neighbouring points on the star are occupied.
(b) A counter may move from one point to a neighbouring point if it is empty.
(c) A counter may move from the centre circle to a point.

Only one piece is allowed on each point or in the centre circle.
Jumping is not allowed.

**Drawing the board**
Diameter of large circle = 16 cm
Diameter of small circle = 2 cm
The points on the star are equally spaced, 6 cm from the centre.

**Sixteen Soldiers** – a game for 2 players from Sri Lanka.

**What you need:** 32 counters, 16 black and 16 white.

**Aim of the game:** To capture all your opponent's counters.

**How to start:** Put the counters on the board as shown below:

**How to play**
Take turns to move a counter to a neighbouring empty dot along a line.
You capture a counter by hopping over it to an empty position beyond. (This is a bit like ‘Draughts’).
As in Draughts, you can make more than one hop in a move.
If you can hop over one of your opponent's counters then you must do so.

**Drawing the board**
Make the circle 20 cm in diameter
Looking for winning strategies

Make one of the following games and play it.

In each game, one player can make sure that he or she always wins.
- Try to find this winning strategy
- Try changing the rules, and see what happens

Now try playing a different game.

**The Spiral Game**

This is a game for 2 players.
Place a counter on the dot marked ‘\( \downarrow S \)'.
Take it in turns to move the counter inwards, along the spiral.
On your turn you can only move the counter 1, 2, 3, 4, 5 or 6 dots.
The first player to reach the dot marked ‘\( \downarrow F \)' wins.

**Pin them down!**

A game for 2 players.
Place the counters on the board as shown.
The players take it in turns to slide one of their counters up or down the board *any* number of spaces.
No jumping is allowed.
The aim is to stop your opponent from being able to move, by pinning all her counters to the wall.
Looking for winning strategies (*continued*)

**First one home**
This game is for 2 players.
Place the counter on any square of the grid.
Now take it in turns to slide the counter any number of squares due West, South or Southwest (like the dotted arrows).
The winner is the player who moves the counter to "Finish".

**Domino square**
This is a game for 2 players.
You will need a supply of 8 dominoes or 8 paper rectangles.
Each player in turn places a domino on the square grid, so that it covers two squares.
After a domino has been placed, it cannot be moved.
If you cannot place a domino on the grid, you lose the game.

For example:
This board shows the first five moves in one game.
It is the second player's turn.
How can she win with her next move?
Games and probability

Read through the games described below.

Before you play a game, try to answer the following questions:

- Is the game fair?
- If the game is played a lot of times, who would you expect to win most often? Who do you expect to come second, third, ... last? Explain your reasoning.

Now play the game and see if your predictions are correct! Try to explain what you notice.

### Double-toss – a game for 3 players.

**What you need:** 3 counters, 2 coins and a large copy of the board.

**Aim of the game:** To be the first to get your counter past the finishing line.

**How to start**
- Place the 3 counters on their starting squares, labelled 0, 1, and 2.
- Each player chooses a different counter.

**How to play**
- Toss the coins.
- If you toss 0 heads, then move counter number 0 one square forward.
- 1 head, then move counter number 1 one square forward.
- 2 heads, then move counter number 2 one square forward.
- Keep tossing until one counter wins.

### Take-away – a game for 2 or 3 players.

**What you need:** 5 counters, 2 dice and a large copy of the board.

**Aim of the game:** To be the first to get your counter past the finishing line.

**How to start**
- Place the 6 counters on their starting squares, labelled 0 to 5.
- Each player chooses 2 or 3 counters (depending on the number of players).

**How to play**
- Roll the dice.
- Find the difference between the numbers you roll.
  (e.g. 5 2 gives a difference of 3)
- Move the counter which is labelled with this difference, one square forward.
  (e.g. 3 1 would mean that you move counter number 3 one square forward)
A few solutions to the sample worksheets

‘Goal’ problems (page T54)

1. The final score was red team 1, black team 0.
2. Other possible final scores are 0–0, 1–0, 0–1, 1–1, 2–0, or 0–2.
4. If the red team play 5, 6, 7, 8, 9, 10, 4, 3, 2, Ace and the black team play Ace, 2, 3, 4, 5, 6, 7, 8, 9, 10, then the final score is red team 6, black team 3.

‘Honeycomb’ problems (page T55)

1. (a) If ‘Drones’ play their next counter on hexagon A, then the ‘Workers’ cannot prevent the ‘Drones’ from winning.
(b) Similarly, if ‘Workers’ have the next move, they should play on hexagon A.
2. The game is biased in favour of the ‘Workers’.
4. The game cannot ever end in a draw.

Looking for winning strategies (page T58)

The Spiral Game
If the first player moves to position 4 then, whatever the second player does, the first player can always land on 11, 18 and 25.

Pin them down!
This game should result in a win for the player who moves first. If white moves the centre piece as far forward as possible, then whatever piece black moves on one side of this column, white can imitate on the other side (e.g. if black moves to X then white can imitate with Y). This kind of symmetrical play will ensure that white will have the last forward move, and then go on to win.
First one home
The player who can first move the counter onto a shaded (●) square must win. Whatever the other player does, he cannot prevent this player from moving from shaded square to shaded square and eventually into the bottom left hand corner.

Domino square
Player 2 can always ensure a win on a $4 \times 4$ board by placing his dominoes in such a way that the pattern of dominoes is always kept rotationally symmetrical about the centre point of the board.

For example, if player 1 puts her domino in position A, player 2 should respond by placing his at B; player 1 puts hers at C then player 2 should put his at D etc.

Games and probability (page T60)

Double toss
Theoretically, in this game, you would expect one head to occur twice as often as no heads or two heads.

If this happened the board would appear as shown.

Take-away
In this game, the counter labelled ‘1’ is the most likely to win.

Again, the theoretical distribution has been illustrated on the board.
The role of assessment

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The role of assessment

Introduction

You may wish to assess your students’ work for a variety of reasons. These range from using the module in the context of an externally administered assessment scheme (e.g. GCSE) to using it to measure the students’ performance and to make them more aware of their own progress.

This module encourages the development of many different types of skill. These include (with examples)

- technical skills (the ability to measure accurately),
- strategic skills (the ability to plan and design),
- social skills (the ability to discuss and listen).

Each of these poses a very different assessment challenge. In this chapter, we will focus on ways of assessing and recording

- a student’s contribution to the work of a group,
- the strategic and technical skills which we have identified in the introduction (pages T5 and T6), and which are described in terms of criteria to be satisfied.

Illustrations will be drawn from the collection of assessment tasks that followed each stage of the material in Chapter 1. In addition, we provide examples of two written examination papers, at different levels of difficulty, which may be used to assess the students’ retention and ability to transfer their skills to fresh situations within the same context.

Assessing a student’s contribution to the work of a group

The teaching material encourages group work. This is mainly done to develop each student’s ability to discuss, listen and cooperate with his or her peers. In addition, a group which works well together will often design a more imaginative product than its individual members would produce in isolation.

However, for most assessment purposes, you are likely to be interested in an individual’s contributions to, and understanding of, the work of the group. Two extreme ways of assessing these are:

- through one-to-one discussions with each individual student, possibly using a checklist of some kind. This method is time-consuming, particularly with larger classes, and it is difficult to carry out an interview while you are simultaneously trying to supervise the whole class,
- through students completing a number of written tasks, on their own, at various stages of the work, these tasks reflecting the work that they have done in the group. However, some skills cannot be assessed in this way, and since students have difficulty in expressing themselves in writing, their responses may not fully reflect their capabilities.

A combination of these methods may provide an optimum solution. Some written tasks may be used, where appropriate, and some follow-up interviews may be conducted to clarify incomplete or confusing responses. With a class of very low attainers, where the numbers are often small, you may prefer to assess using only oral methods.

Assessing with reference to criteria

The following criteria have been used throughout the classroom materials. Students are given the opportunity to show that they can

(i) follow a set of rules,
(ii) evaluate a design and identify faults in it,
(iii) devise and evaluate improvements to a design,
(iv) list alternative ideas for design features,
(v) devise a satisfactory rough plan including spatial layout and instructions,
(vi) sketch a design to fit given conditions,
(vii) devise rules to fit given conditions,
(viii) estimate the materials that they need to make a final product,
(ix) draw a design accurately, following geometric and other specifications,
(x) take an active part in the production process,
(xi) take part in testing and evaluating their product.

Such criteria are useful in giving both the teacher and the student a useful profile of relative strengths and weaknesses, but what does it mean to ‘satisfy’ a particular criterion in any absolute sense? A statement such as ‘the student can follow a set of rules’ is unhelpful without specifying

- the context. Following a set of rules for playing a game is very different from following a set of rules for assembling a car.

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THE ROLE OF ASSESSMENT

- **the complexity within the context.** Following the rules for playing ‘noughts and crosses’ is very different from following the rules for playing ‘chess’.

- **the frequency of success.** Has the student ‘satisfied’ the criterion on many occasions or only once? Has the criterion been satisfied at every attempt or only on a small proportion of the attempts?

- **the amount of help that was given.** Did the student receive help from others in the group, or from the teacher, or did he or she perform the task completely alone?

- **the occasion.** When has the student been asked to do the task? Did the student have any recent experience of a similar situation, or was the task administered in isolation?

- **the mode of response.** Has the student demonstrated that he or she can satisfy the criterion in writing, or do you have only oral evidence?

If students work through several modules in this series, they will be required to demonstrate similar strategic skills in a variety of different contexts. In this event you will be able to make more general statements about a student’s ability to satisfy certain criteria. From the assessment of this module alone, you will only be able to make statements like ‘the student has shown the ability to follow the rules for a variety of simple board games’.

### Recording students’ achievements

You may find it helpful to record your students’ successes on a grid like the one shown opposite. The criteria associated with this particular module have been listed horizontally across the top, and there are spaces for students’ names to be filled in vertically down the side. There are many ways of filling in the cells in this grid. You may wish to record only that a student has satisfied or ‘passed’ a criterion (for example, by entering a P), or you may wish to qualify this by recording, for example, the amount of help that was given and the frequency of success. Thus,

- **P** may mean ‘pass with no help’
- **Ph** may mean a ‘pass with a little help’
- **PH** may mean a ‘pass with a lot of help’
- **PP** may mean that a student has ‘passed’ the criterion on more than one occasion

If a student has not yet shown that he or she can pass a criterion, the cell should be left blank, and the student given a further opportunity to pass it at a later date. We suggest that only positive achievement is recorded and that no cells are labelled with an F (for failure).

An alternative would be to use a numbering system on a three or five point scale. There is always the temptation to add up such numbers so that a single result can be obtained for each student. Although such results are convenient, they are meaningless and miss the whole point of criterion referenced assessment.
### Record sheet

#### Criteria satisfied

<table>
<thead>
<tr>
<th>Name</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(i) follow a set of rules.</td>
<td>(ii) devise and evaluate improvements to a design.</td>
<td>(v) devise a design to fit given conditions.</td>
<td>(ix) take an active part in testing and evaluating their product.</td>
</tr>
<tr>
<td></td>
<td>(ii) evaluate a design and identify faults in it.</td>
<td>(iii) devise a satisfactory rough layout and instructions.</td>
<td>(vi) devise rules to fit given conditions.</td>
<td>(x) take part in testing and evaluating their product.</td>
</tr>
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<td></td>
<td>(iv) list alternative ideas for design features.</td>
<td>(vii) estimate the materials needed to make a final product.</td>
<td>(viii) draw a design accurately, following geometric and other specifications.</td>
<td>(ii) follow a set of rules.</td>
</tr>
<tr>
<td></td>
<td>(v) sketch a design to fit given conditions.</td>
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A student has shown that he or she can:
Some sample assessment tasks

We will now illustrate some of these ideas, using sample assessment tasks from each stage of the classroom materials. With each task, we give

- the related assessment criteria,
- the type of response which will ‘satisfy’ the criteria, annotated with examples of students’ work. These ‘satisfactory’ responses are those that we believe are achievable by a substantial majority of the school population. You may wish to set more demanding standards for more able students. (Throughout, we have used the P, Ph or PH notation as defined in the introduction (page T66)).

The tasks included here are:

Stage 1, Assessment task 1 ‘The Great Horse Race’
Stage 2, Assessment task 3 ‘The Deep Sea Diving game’
Stage 3, Assessment task 3 ‘The Chuck-a-Luck game’
Stage 4, Assessment task The ‘Evaluation sheet’.

We follow this by offering two written examination papers, which may serve as a useful resource in assessing a student’s ability to retain and transfer the skills to fresh situations in the same context. Paper 1 is intended for nearly all students while paper 2 is intended for approximately the top 30% of students.
The Great Horse Race

Turn to pages 4 and 5 of your Student’s Booklet.

The ‘Great Horse Race’ is being played.

The scores on the first six throws of the dice are shown below:

<table>
<thead>
<tr>
<th>Throw 1</th>
<th>Throw 2</th>
<th>Throw 3</th>
</tr>
</thead>
<tbody>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>Throw 4</th>
<th>Throw 5</th>
<th>Throw 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

1. On a copy of this grid, mark the positions of the horses after the six throws.

2. Suppose you want to win the game.
   (a) Which horse would you not choose? Explain your answer.
   (b) Which horse would you choose? Explain your answer.
   (c) Do you think the game is fair? Explain your answer.
Stage 1  Assessment task 1 question 1

Related criterion: (i) A student can follow a set of rules.

Response required
The correct response is:

```
   X   X  X   X
1  2  3  4  5  6  7  8  9 10 11 12
START
```

However, if just one or two Xs are omitted or incorrectly positioned, it may still be the case that the student does understand the rules and, if prompted, he or she would be able to correct the error. (Ph could then be entered on the grid.)

Lee’s work, reproduced below, provides one such example.

```
   X   X
1  2  3  4  5  6  7  8  9 10 11 12
START
```

‘What is wrong here?’
‘I just slipped up on my adding.’

If more than two Xs are incorrectly positioned, then it is likely that the student has not understood the rules. Mandy provides one such example.

```
   ✓   ✓   ✓
1  2  3  4  5  6  7  8  9 10 11 12
START
```

‘Tell me how you got this.’
‘There are two 1s on the dice, one 2, two 3s . . . .’

If when asked to re-read the rules, Mandy is able to revise the response satisfactorily, then Ph would be a suitable entry. If more help is needed then PH would be suitable.
Stage 1  Assessment task 1 question 2

Related criterion: (ii) A student can evaluate a design and identify faults.

Response required

2. (a) Either 1, because this number is impossible to throw, or 2, 3, 11 or 12, because these numbers are harder to throw.
   (Answers of 4, 5, 9 or 10 may need to be followed up with an interview.)
(b) 6, 7 or 8, because these numbers are likely to occur most often.
(c) The game is unfair because it favours the middle horses. (You may wish to demand a more complete explanation from more able students.)
   To pass the criterion there must be some indication that the fault (given in the answer to part (c)) is understood. Although Richard has not answered part (c) in a satisfactory way, he has indicated that he understands the fault in his answer to part (a). He should be asked to expand on that answer, and a P, Ph or PH awarded accordingly.

Richard
Suppose you want to win the game.

(a) Which horse would you not choose?  I would not choose 10
   Explain your answer.
   10 is always harder to get on a throw than 7
(b) Which horse would you choose?
   Explain your answer.
   I would choose horse number 7.
(c) Do you think the game is fair?
   Explain your answer.
   No it is not a fair game.
Deep Sea Diving

One group has been discussing their plans for a board game. Here are some of the things they have decided:

- Our game will be about deep sea divers looking for treasure in a sunken shipwreck.
- The game will be for 3 players.
- The winner will be the first to bring the treasure to the surface.
- You need to throw a dice to move around the board.
- There are sharks and other dangers which make the task more difficult.

Your task is to design a board for this game. Try to make your design interesting and fair. (You do not need to draw it accurately.)
Stage 2  Assessment task 3

Related criterion: (vi) A student can sketch a design to fit given conditions.

Response required

In order to satisfy the criterion, a student must take all the conditions (given in the speech bubbles) into account. Alex and Stephen have both failed to do this.

Alex has not shown 'sharks and other dangers', although he may have intended the shaded squares to represent these. Stephen has not taken account of the fact that 'the winner will be the first to bring the treasure to the surface'. Both students need to be asked to check their boards against the conditions, and make the necessary changes, before they can be awarded a Ph or PH.

Karen’s design is much clearer, except for the discontinuity at square 26. She would almost certainly be able to correct her mistake if she were asked, and so a P should be recorded.
**Chuck-a-Luck**

A group of students have designed a board for a game called 'Chuck-a-Luck'.
Draw the board full size, as accurately as you can.
Make sure you follow the instructions in the bubbles.

- This circle should have a radius of 8 cm.
- These squares should all be 4 cm by 4 cm.
Stage 3 Assessment task 3

Related criterion: (ix) A student can draw a design accurately, following geometric and other specifications.

Required response
A minimum requirement may be that
- the radius of the circle must be 8 cm (± 2 mm)
- the rectangle must measure 12 cm by 8 cm (± 2 mm on each dimension)
- the board is complete and numbered correctly.

However, for more able students you may also wish to assess the accuracy of
- the subdivisions of the rectangle
- the location of the rectangle within the circle.

Both Basharit’s and Craig’s boards satisfy our minimum requirements, but Basharit has not centred the rectangle and Craig has not subdivided the rectangle accurately. (Note that these drawings have been reduced from the original size.) It would be helpful to discuss these problems with the students and allow them to attempt the task again.
**Stage 4 Assessment task**

**Related criterion:** (xi) A student has taken part in testing and evaluating his or her own product.

**Response required**

At least four of the questions on the 'Evaluating your own game' sheet should be answered in a reasonable manner consistent with the student's own game.

In the examples shown below, Rasak and Marie have both given very brief answers, but have nonetheless shown that they were involved in the testing and evaluating process. They should both be encouraged to expand upon their answers, either orally or in writing, before a P is entered on the record sheet.

### STAGE 4 Evaluating your own game

<table>
<thead>
<tr>
<th>Name of the game</th>
<th>Grand Prix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filled in by</td>
<td>RAZAK</td>
</tr>
</tbody>
</table>

1. What did other people say about your game?

   *It was well set up. It did not take so long to play. The shapes are not the right size for the cars and it is not very good for the board.*

2. These are the good points of the game:

   *It was well set up and fair*

3. These are weak points of the game:

   *none*

4. I could improve it by changing the rules like this ....

   *none*

5. I could improve it by changing the board like this ....

   *do a different design but still keep it straight-forward.*

6. Next time I design a board game, I will ....

   *I would get the idea first and write a set of rules then draw the design and the numbers.*

7. If a friend asked my advice about designing a board game, I'd say ....

   *I enjoyed doing it and learned something about that.*

8. Space for further points

   *Turn over*
Evaluating your own game

Name of the game: Horse Race
Filled in by: Marie

Read through the Comments sheets.

1. What did other people say about your game?

   It was fast

   Tick the points you agree with.

2. These are the good points of the game:

   It was fast

3. These are weak points of the game:

   It did not have any playing cards

4. I could improve it by changing the rules like this ....

5. I could improve it by changing the board like this ....

6. Next time I design a board game, I will ....

   think more carefully about all the points of the game and try not to make it a flop.

7. If a friend asked my advice about designing a board game, I'd say ....

   try and find an idea which most people will enjoy and make it so it was not complicated because it spoils the game if it's hard to understand. Good luck!

8. Space for further points
Overtaking

Here is the description of a game called 'Overtaking'.
Read it through and answer the questions which follow.

This is a game for 4 players.

What it is about
Each player has a counter.
Players take it in turn to throw a dice.
Each player moves his or her counter around the track the number of squares shown on the dice, in the direction of the arrows.

How to win
The first player to complete the circuit back to their ‘home’ square is the winner.

Rules
1. Red starts first, then Yellow, then Green, then Blue.
2. If a counter lands on the same square as another, both counters are removed and those two players are out of the game.
   The remaining players continue to play in the same order as before.
Overtaking

Using counters if you wish, become familiar with the game. Then answer the questions.
The first 4 throws of the dice give these numbers:

<table>
<thead>
<tr>
<th>Red</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>🟠</td>
<td>🟠</td>
</tr>
<tr>
<td>🟠</td>
<td>🟠</td>
</tr>
</tbody>
</table>

1. On a copy of the diagram, show the position of each counter after the matching moves.

The next three throws give 🟠 🟠 🟠

2. Show the final positions of the counters after all the moves.

3. Which counter has moved the furthest round the track?

4. ‘Now look what’s happened! No-one can win this game!’
   Explain how this situation could happen in the next move.

5. Change one of the rules so that there will always be a winner. Write down the changed rule.
Arcade

This is the rough plan of a board for the game of 'Arcade'.

continued
## Arcade

Complete this rough plan for ‘Arcade’

### Rough plan

<table>
<thead>
<tr>
<th>Names</th>
<th>Our game is called ... <strong>Arcade</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Who it’s for ... 2-4 players</td>
</tr>
<tr>
<td></td>
<td>What you need in order to play ...</td>
</tr>
<tr>
<td></td>
<td>a counter for each player, a dice</td>
</tr>
<tr>
<td></td>
<td>What it’s about ... going round an</td>
</tr>
<tr>
<td></td>
<td>amusement arcade</td>
</tr>
<tr>
<td></td>
<td>Aims of the game ...</td>
</tr>
</tbody>
</table>

### Rules

*How to start ...*

*How to make a move ...*

*Other rules ...* (make sure you explain what happens at the [ ] and the [ ] )
Nsolo

Nsolo is a game for 2 players. Many versions of the game are found in parts of Africa and India with different names.

A small picture of part of the board is shown here, with a row of 3 equal-sized circles inside a rectangle.

All circles are equally spaced.
The circle centres are 5 cm from the sides of the rectangle.
All circles are 4 cm diameter.
The rectangle is 10 cm by 20 cm.

1. Draw this part of the board accurately and full-size.

2. Using the same spacing as in question 1, how long would the rectangle be if the row had 5 circles instead of 3? (You do not need to draw this.)
Star

The diagram below shows a small board design for playing a game called ‘Star’.

The game will be played with circular counters, 2 cm in diameter. The counters will be placed on the 18 black blobs (marked ●) on the board. The board must be large enough so that when the counters are placed on adjacent ‘blobs’, there is a 1 cm gap between them, and no counter is ever less than 1 cm from the edge of the board.

This distance must be 1 cm.

Draw an accurate board which will satisfy these conditions.
Build a Pyramid

This is a game for 2 players

Aim
The first player to build a pyramid with 15 counters, wins the game.

Equipment
One board for each player
15 counters for each player
2 dice, one black and one white.

Preparation
Each player fills her board with numbers. A number from the set \( \{1, 2, 3, 4, 5\} \) must be written in each square. A player can choose to place some or all of these numbers in any position. For example, here are three possible ways:

![Diagram of possible boards]

Rules
- Decide which player will be 'BLACK' and which will be 'WHITE'.
- Throw the two dice.
- If the number on the black dice is greater than the number on the white dice, then BLACK calculates the difference between the two numbers on the dice and covers any correspondingly numbered square on her board with a counter.

For example, \( \text{\includegraphics{black_dice.png}} \) means that BLACK covers a square containing the number 4, if one is available.

- Similarly, if the number on the white dice is greater than the number on the black dice, then WHITE calculates the difference and covers a corresponding square on her board.
- If both numbers on the dice are equal, neither player covers a number.
- The first player to cover all 15 squares and complete the pyramid wins the game.
**Build a Pyramid**

Suppose that the two boards are filled in like this:

![Diagram of a pyramid filled with dice numbers]

1. The first four throws of the dice are:

   ![Dice throws images]

   On copies of the boards, show clearly which numbers have been covered.

2. Which player do you think is most likely to win?

   (If you think that both players are equally likely to win, write ‘You can’t tell’).

   Give a reason to support your answer.

3. Now suppose that you were playing the game.

   (a) Show how you would number your board to give the best chance of winning.

   (b) Explain why you think this would give you the best chance of winning.

4. Suppose that the game is to be adapted for 3 players using 3 dice and 3 boards.

   Describe how you would adapt the rules, so that the game will still work.
THE ROLE OF ASSESSMENT

PAPER 2 ASSESSMENT TASK 3

Underground

continued
# Underground

A group is making up a game for 2 players. It is about travelling on the London Underground. The group want to make up rules so that the winner is the first person to travel through or change trains at every station on the map. Make up a complete workable set of instructions for their game. You can put extra details on the board if you wish.

<table>
<thead>
<tr>
<th>Who it’s for ...</th>
<th>What you need in order to play ...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tbody>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

## Rules

*How to start...*

*How to make a move...*

*Other rules...*
Checklist for the teacher

Real problem solving demands a different balance of teaching styles and strategies from the traditional curriculum. Students need to learn how to

- assume more control of and responsibility for their work
- share and develop ideas with each other
- give and accept constructive criticism
- turn their own ideas into actions, and learn from the consequences of their own decisions.

To effect this change of roles, it is helpful if the teacher can:

**Frequently**

- praise achievement
  
  Those seem to be really good ideas.

- encourage groups to think further and deeper
  
  Can you make a game that uses all your ideas?

- ask clarifying questions
  
  Can you explain that to me again? I didn’t quite understand.

- agree targets

- encourage students who lack confidence
  
  I’m sure you can do it; I’ll come back and see you in a little while.

**Occasionally**

- make a suggestion if a group is running out of ideas
  
  Have you thought about using something other than dice?

- divert a group from a particularly unhelpful idea
  
  Are you sure a game that needs 20 players is a good idea?

**Avoid**

- taking over a problem
  
  Why don’t you try doing it like this?

- making negative comments

- determining whose view is accepted.

  Sarinda’s idea seems to be the best.