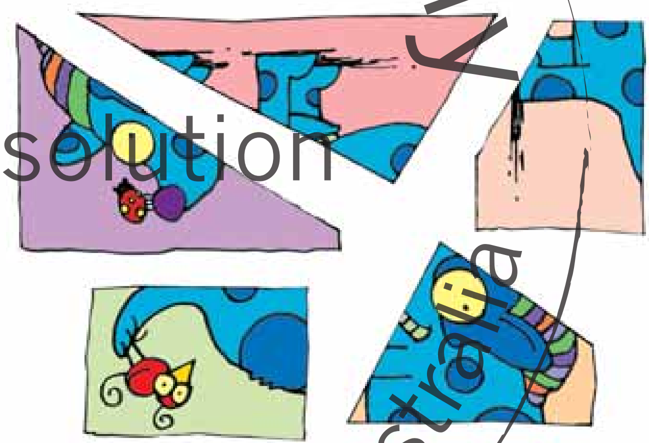
AGES 8–10

PROBLEM SOLVING

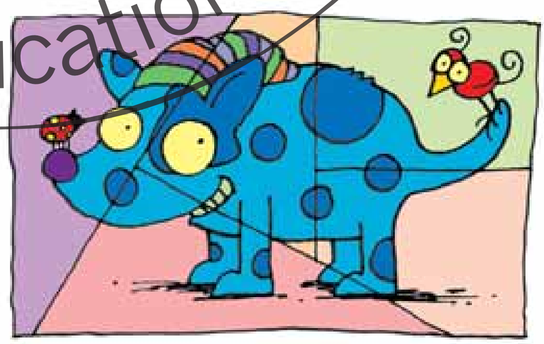
All you need to TEACH...

PROBLEM SOLVING

Turning problems



into solutions



Peter Maher

MACMILLAN

All you need to TEACH...

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Ages 8-10

Turning problems into solutions

Peter Maher

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DEDICATION:

To Tom and Frieda, who taught me that no problem is too difficult to overcome.

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Contents

How to Use This Book

All You Need to Teach Problem Solving Ages 8–10 is the second in a series of three books designed to help teachers develop the capabilities to strengthen logical and creative thinking skills in the students under their care. This book caters for teachers of students in the fourth and fifth years of schooling and is in four parts.

All The Teaching Tips You Need presents the strategies and techniques that need to be developed and applied by students to solve the range of problems in the books. It also suggests ways to implement a successful problem-solving program in the classroom.

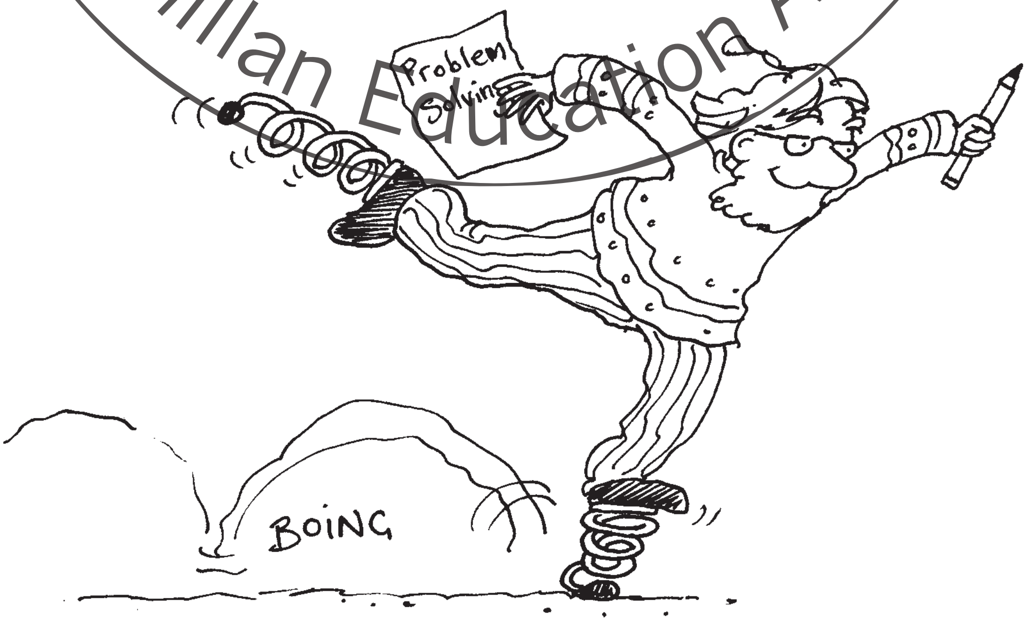
All The Lesson Plans and Worksheets You Need contains 16 lesson plans with accompanying blackline masters. The lesson plans outline the theoretical background of the problems and suggest the best manner to present them to the students. The blackline masters give students the opportunity to draw and describe the strategies and working they used to solve problems.

All The Task Cards You Need contains 16 task cards designed to be photocopied and laminated. Each card presents a variation or extension of the problem found on the blackline master of the same number. The task cards provide an ideal way to assess the development of each student's problem solving capabilities.

All The Answers You Need offers solutions to both the blackline masters and the task cards.

These lesson plans, blackline masters and task cards are designed to be practical, intellectually stimulating and to contain high motivational appeal.

As your own problem solving capabilities grow, your ability to successfully teach problem solving will be similarly enhanced. Problem solving also offers the opportunity to have an enormous amount of fun in the classroom. Mathematics is a discipline that offers a number of opportunities for excitement and stimulation. The *All You Need to Teach Problem Solving* series offers the potential to clearly demonstrate this fact.



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Locate key words	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
Look for a pattern	◎	◎	◎	◎		◎				◎		◎	◎		◎	
Assume a solution						◎						◎		◎		◎
Create a table or chart			◎			◎										◎
Make a drawing	◎								◎					◎		
Work in reverse								◎								
Find a similar but simpler problem	◎							◎								
Make a model									◎		◎					
Think logically			◎	◎	◎		◎				◎	◎	◎	◎	◎	◎

All the Teaching Tips You Need

WHAT IS PROBLEM SOLVING?

Problem solving is the application of previously acquired skills and knowledge to an unfamiliar situation. Numerical equations presented as story or worded problems are often mistaken for problem solving. A typical example of what is not problem solving would be the transference of 5 cents + 5 cents + 10 cents + 10 cents into:

> Four children emptied out their pockets. Kate found five cents. Jake found five cents. Jason found ten cents and Sarah found ten cents. How much money did the four children find altogether?

This is not problem solving because the technique required to solve this story problem (addition) is easily identified and requires little creative thought.

Questions that transfer numerical problems into a practical context are an essential part of any effective mathematics program. It is vital that students are constantly shown why they are learning mathematical skills.

A related problem-solving question could be:

> In how many different ways can 30 cents be made in our money system?

This question requires the student, in a logical manner, to search for a strategy to solve the problem and to apply the previously acquired skill of addition and their knowledge of the coin denominations available in Australian currency. The story problem offers a context. The problem solving exercises the student's ability to work flexibly, creatively and logically.

WHY TEACH PROBLEM SOLVING?

It can be argued that problem solving should be the most effective and significant aspect of any mathematics course. As adults, both at work and at home, our everyday lives are filled with situations that demand flexible thinking and creativity. The role of both parents and teachers is to turn dependent children into independent people who are capable of functioning in a society that demands resilience, intelligence, a high emotional quotient and tractability. Such traits are best fostered through the development of an ability to problem solve.

It therefore follows that all students will benefit from regular exposure to problem solving in schools. Problem solving should not lie solely in the domain of the most intelligent and capable students, which is, regrettably, often the case. Although the more intelligent students may achieve best on problem solving tasks, regular problem solving should feature strongly in every student's learning experiences.

Classroom Atmosphere

It is essential for students to believe in their own capabilities and to have healthy self-esteem. They need to understand that to have a go, even if their attempt is wrong, is far preferable to not attempting a question at all. Making mistakes plays a vital role in the learning process.

Encourage students to view intellectual challenges as opportunities to demonstrate how much they have learned and how bright they are becoming. Problem solving should come to be seen by students as not just important, but a great source of fun.

This positive atmosphere can best be engendered by teachers who are confident in their own ability to teach problem solving. It is as true for the teacher as for the student: Practice may not necessarily make perfect, but it will lead to improvement. Improvement leads to increased success and greater self-confidence. Success leads to enjoyment!

Raising the Bar

The capabilities of young students are often quite remarkable. They come to school today with far greater confidence and knowledge than any previous generation. In a classroom with a positive atmosphere and a school that celebrates learning, students will not only rise to intellectual challenges, they will thrive on them.

The concept of raising the bar refers to the idea that students should be extended until their full intellectual capabilities are reached, regardless of supposed appropriate year level standards. Every student deserves the opportunity to strive for his or her intellectual best. Problem solving is an excellent adjunct for the teacher to assess such potential. Present the students with challenges and step back to observe the outcomes. I can assure you that, in the appropriate learning environment, most students will exceed expectations.

Timetabling Problem Solving

A problem solving approach to teaching mathematics should be adhered to in each classroom for the reasons outlined on page 7. Whenever lessons involving 'core material' are conducted, every attempt to include open-ended questions should be taken.

If, for example, in a Year 3 classroom the concept of 3 + 3 digit column addition is being taught, the following question should be introduced to extend the concept:

Given six different digits, say 2, 4, 7, 9, 8 and 1, what is the biggest possible sum?

I believe that it can be strongly argued for a lesson a week to be devoted to strengthening problem solving skills. This four day a week core material, one day a week problem solving ratio would complement each component of the mathematics course very well. This is especially the case if the questions posed for the problem solving sessions could be related to the core material topic under review at the time.

Structuring the Lessons

Each problem to be solved should be preceded, where appropriate, by a background discussion concerning the context of the problem and the previously acquired skills or knowledge necessary to successfully complete the task. For example, a question asking ‘How many rectangles can be found on a four-square court?’ could prompt a discussion of the structure of the game and then move on to the concept of a rectangle and how a rectangle can be formed by using pre-existing rectangles. Point out that a square is merely a special type of rectangle (opposite sides equal and four right angles).

The problem should be read aloud, by either the teacher or a competent student. Ask students to select key words, underline them and write them down. At this point some of the brightest will be eager to get into the problem. Let them do so. For others in the class, a discussion of appropriate strategies that could be employed is valuable. Soon, many other students will be ready to begin.

For those still in need of guidance, it may be necessary to commence an appropriate strategy together. It may take some time, but by following this ploy, each student will be on the right track.

Not all will finish the problem – some may only make a start. However, this is a step in the right direction and should be praised.

Some students prefer to problem solve individually, some enjoy the cut and thrust that cooperative group learning brings. Either approach is suitable, providing that within the group, each participant has a role to play.

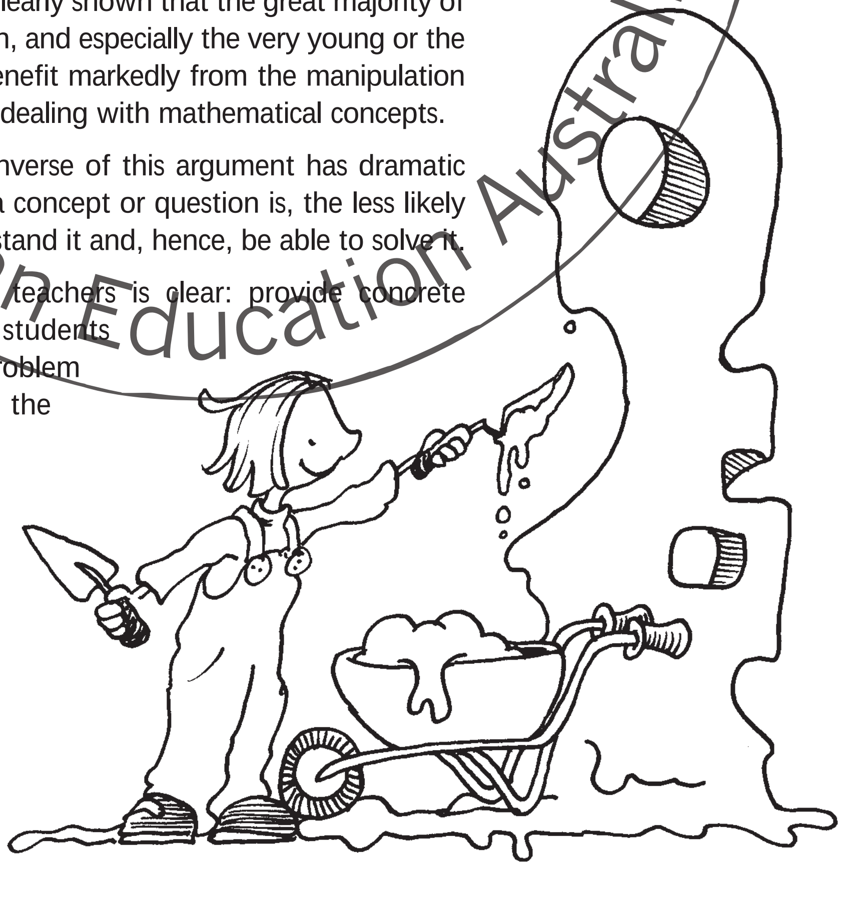
Some problems lend themselves better to group work. Fermi problems such as ‘How many pies will be eaten in Australia today?’ are best ‘solved’ by sharing ideas, estimates and general knowledge.

The Student as a Concrete Operator

Developmental theory has clearly shown that the great majority of primary school aged children, and especially the very young or the mathematically less able, benefit markedly from the manipulation of concrete materials when dealing with mathematical concepts.

For many students, the converse of this argument has dramatic results. The more abstract a concept or question is, the less likely that such a child will understand it and, hence, be able to solve it.

The message for primary teachers is clear: provide concrete materials whenever the students under your care attempt problem solving tasks to achieve the best possible results.



Reflection

Following the completion of each blackline master, gather the class for shared reflection. Encourage students to describe the strategies they have used and to outline the mathematics contained in their technique. Many problems can be solved with more than one strategy, as this reflection will demonstrate. This time will be especially valuable when problems were solved in a hit and miss fashion by students who were unable to recognise a pattern. Celebrating differences is a very healthy classroom activity and should be highlighted at this time.

This will also enable you to offer students praise and encouragement for their efforts. Keep their self confidence and mathematical self-esteem as high as possible. Praise their attempts at all times, even if they may be misdirected. Bear in mind that problem solving is intellectually challenging both for children and adults alike. Remember that any attempt is far preferable to no attempt at all.

Ask students the following types of questions:

- What helped you understand what the question was asking you to do?
- What strategy or strategies did you use in attempting to solve the problem?
- Have we used this/these strategies anywhere before?
- When else might you use this strategy?
- How did you feel when you solved the problem?
- Do you think that your problem solving skills are getting better?
- Do you think Mum or Dad might be able to solve the problem with your help?
- Did you find it useful to work with a partner on the problem?
- Could you make up a problem of your own like this one?
- Was the problem as difficult as it first appeared?

You may also consider encouraging students to record their progress in a journal. As well as providing a useful teacher reference, this can help students to see what they have learned.

Fast Finishers

The students who are likely to enjoy problem solving the most will be those who are more mathematically able. Because of their innate capabilities they will be the first to finish their work. Please do not give these students extra drill and practice examples to do! This is far more likely to dull their enjoyment of the subject and dim their creativity. Make space in your room for fast finishers and offer them a corner full of problem solving tasks, games or puzzles to do to encourage their love of challenges.

WHICH STRATEGY TO USE

There are relatively few types of problem solving questions. As a consequence, the more a student practises these strategies, the more comfortable they will become with problem solving in general. The strategies are similar across the three books in this series for a very sound reason – they are as relevant to a five-year old as they are to an adult. The two key strategies of problem solving are locating key words and looking for a pattern. These are fundamental to almost all problem solving tasks. The other strategies, while still relevant to all learners, are more question specific. The sooner key strategies can be exercised and practised, the better the problem solving skills will become.

For some questions, once students understand what needs to be done, just one strategy will be sufficient. For other questions, more than one strategy will need to be used. Sometimes a range of different strategies may be appropriate. In some instances, two totally different strategies may successfully solve the same problem in two logical and equally creative ways.

LOCATE KEY WORDS

The instructions involved in a problem must be understood before students can begin to attempt the question. Often a student will not attempt a problem because no strategy is immediately apparent. Getting started can often be the toughest part.

The technique of underlining and then writing down the key words in a question (committing something to the page) is an excellent way for students to gather their thoughts and to make a start. This strategy will be emphasised in every problem in this series.

Take the question: 'Five people meet at a party and shake each other's hands. How many handshakes are there altogether?'

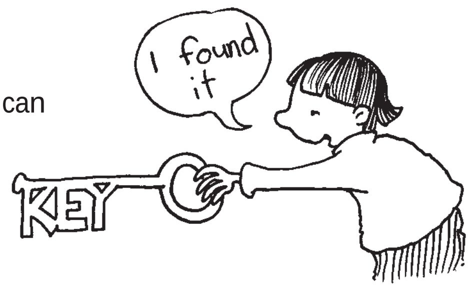
Underlining and then writing down 'Five people – how many handshakes?', can focus a student's thinking. This précis of the problem can also make it appear, from a psychological point of view, easier to handle.

Once they understand the problem, encourage students to work in a logical manner while offering suggestions for the students to build upon. Point out that a sensible way of commencing the problem would be to act out or model the problem by using five students and progressively counting the handshakes.

The technique of finding a similar, but simpler problem by using two then three then four and eventually five students as models will reveal the hidden pattern of handshakes equalling the previous number of people plus the previous number of possible handshakes.

This pattern would best be demonstrated with the creation of a table such as:

Number of people	2	3	4	5
Number of handshakes	1	3	6	10



This problem emphasises that often more than one strategy can be employed to solve a problem and that a combination of strategies may be used together.

This approach requires that students understand the question and can identify the problem's key components.

Look for a Pattern

This strategy, used effectively, is often the shortcut to success and can greatly simplify problems that may initially appear very difficult. Consider the following problem:

> Tess has an equal number of $2, $1 and 50 cent coins in her moneybox, adding up to $28. How many coins are in Tess's moneybox?

The most successful problem solvers would appreciate that each set of three coins equals $3.50 and, therefore, that eight lots of this total equals $28.

The discovery of this pattern has saved time and effort. It can be argued that pattern recognition is the most apparent trait in the brightest problem solvers. This fact is often frustrating for both teachers and students. Students who can't see patterns readily are the ones who most need short cuts.

Successful problem solvers will be the first to recognise the patterns in times tables. They see quickly that all numbers in the nine times table have their digits summing to nine or a multiple of nine (18 = 1 + 8 = 9, 234 = 2 + 3 + 4 = 9, 585 = 5 + 8 + 5 = 18 and 1 + 8 = 9 and so on). Students who appreciate this pattern will readily see that 17342 has its digits summing to 17, which is eight beyond a number in the nine times table and so is not a multiple of nine and will give a remainder of eight if divided by nine. These students will also recognise that the two closest numbers in the nine times table to 17342 must be 17343 and 17334, both adding up to 18.

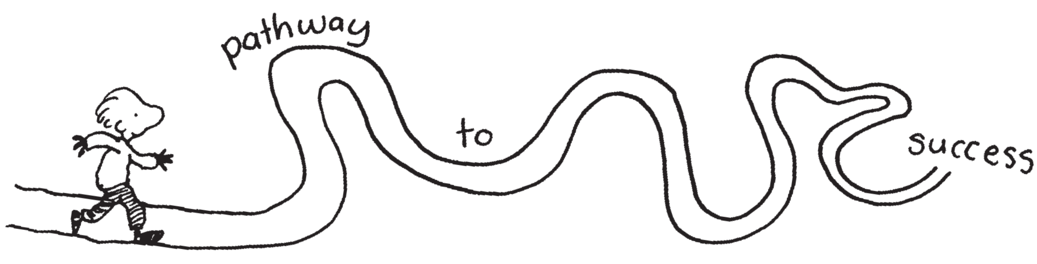
Assume a Solution (Guess and Check)

This approach encourages the student to have a go and is particularly useful in problems involving variables. By assuming a solution, patterns often appear, suggesting a suitable pathway to success. Using the problem:

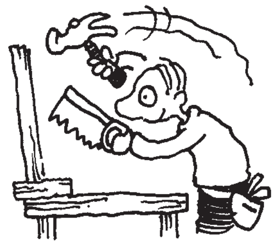
> Tess has an equal number of $2, $1 and 50 cent coins in her moneybox, adding up to $28. How many coins are in Tess's moneybox?

A first assumed solution might be that there are ten of each type of coin. By calculating the total, it can be seen that this solution is too large. Another attempt of five of each type of coin will be too small. Eventually, by this manner, the correct answer of eight of each type of coin (24 coins in total) will be reached.

Although this approach is not the easiest or the fastest way of solving the problem, at least the student who uses this technique is putting something on paper. Even if they don't get the right answer, at least they have made some progress.



Create a Table or Chart



Tables and charts can often be useful in making potential patterns more perceivable to students.

A question such as 'What is the 432nd odd number?' could be solved easily and quickly by using a chart in the following manner:

Ordinal number	Even number	Odd number
1st	2	1
2nd	4	3
3rd	6	5
4th	8	7
5th	10	9

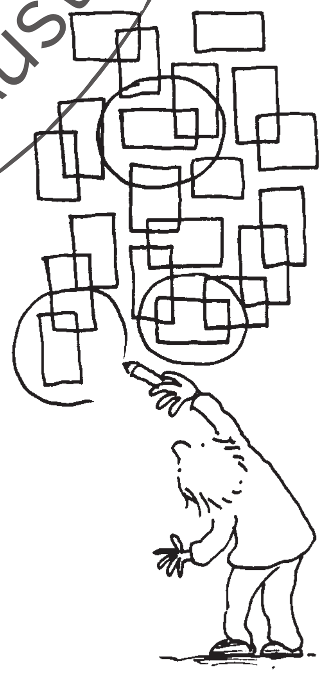
The pattern 2n – 1 (where 'n' = the ordinal number) may be recognised by many students using this technique. Thus, the 432nd odd number is 2 x 432 – 1, equalling 863.

For younger students, the table or the chart should be provided by the teacher. The student's task should be to fill it in rather than to create it. In later primary years when the students have had exposure to the structure and nature of a table, it is appropriate to ask them to form the structure themselves. In the middle years of primary school an interim approach is best. Encourage students' growing independence by helping them to create the required tables and charts.

Make a Drawing

Drawing is particularly useful for beginning problem solvers, for students who are visually oriented in their thinking and learning styles, or when applied to certain spatial questions. Take the following problem for example:

> I dealt out 20 playing cards face up. One half were red, seven twentieths were clubs and the rest were spades. How many cards were spades?



This can be solved effectively by drawing rectangular representations of the 20 cards and circling or crossing out the number of cards as required.

Making a drawing is also an excellent way of getting students started. In a similar way to verbalising and discussing the structure of a question, drawing helps to crystallise what needs to be done.

When asked to solve, for example, problems involving 2D or 3D shapes or questions regarding perimeter and area, it certainly helps to sketch the shape under review. As a result, dimensions, faces, vertices and edges become more apparent and often shed significant light on the problem.

Work in Reverse

This strategy is relevant to a specific type of problem, usually numerical and in many parts. Take the following problem for example:

> I dealt out 20 playing cards face up. One half were red, seven twentieths were clubs and the rest were spades. How many cards were spades?

This can be solved effectively by drawing rectangular representations of the 20 cards and circling or crossing out the number of cards as required.

This card problem could also be easily solved by working in reverse. The number of spades must equal the total of the clubs and the red cards subtracted from 20. Note how the inverse operation, addition, rather than subtraction, is used in this strategy.

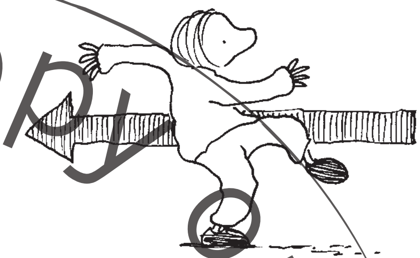
7/20 of 20 = 7

1/2 of 20 = 10

7 + 10 = 17

20 – 17 = 3

Therefore, three cards are spades.



Find a Similar but Simpler Problem

This is a particularly valuable strategy when applied to what can appear to be very complex problems. Take the following question:

> What day of the week will it be in 77 days from today?

This will almost certainly be met with stunned silence. The more adventurous students may begin to count on their fingers or write down dates in their books. Asking the students to consider what we already know about the number 77 and the number of days in a week should lead to the realisation that this is simply the same problem as seven days on, 11 times over. In seven days it will be the same day as today, therefore the same must be said for any multiple of seven days. It would be useful at this time to ask what day of the week it would be in, for example 64 days. What similar but simpler question does this remind us of?

Returning to the earlier cited problem of what is the 432nd odd number, the strategy of finding a similar but simpler problem has indeed been employed with the assistance of using a chart and a table. Rather than using the 432nd odd number, consider the 1st, 2nd, 3rd and so on. The pattern of 2n – 1 may well appear best in this format.

This example emphasises that a particular problem may well be solved in more than one way or even by using more than one strategy concurrently.

MAKE A MODEL

This strategy is often employed by concrete thinkers whose innate spatial sense may not lend itself to tackling geometric or space-oriented questions in any other way. Take the following question, for example:

> Two cubes of the same size are glued together to form a rectangular prism. The original two cubes each had 12 edges. How many edges will the new shape have?

Using connecting blocks to construct the rectangular prism should lead to the correct solution that the number of edges does not change.

Making a model is often time consuming, but it is far better to obtain a lengthy solution than no solution at all.

The fact that the youngest students are usually very concrete in their thinking means that the use of concrete material is not only useful, it is often essential. Until basic number facts develop to a near automatic level, concrete material in problem solving, such as connecting blocks, is a wonderful adjunct to learning. This enables the student to make a model related to the question and to see patterns far more readily.

THINK LOGICALLY

Many problems with numerous potential solutions can be solved by using deductive reasoning to identify and eliminate impossible options. Games like ‘Guess Who’, ‘20 Questions’ and ‘Mastermind’ are examples of activities that utilise this strategy. For example:

> I am a polygon. I have four sides. All of my sides are equal in length. I have no right angles. What shape am I?

This question requires a logical analysis that involves deduction and the elimination of impossible options until only one solution, rhombus, remains.

Step 1: A four-sided shape: quadrilateral, square, rectangle, parallelogram, trapezoid, rhombus and kite are all possible answers.

Step 2: Equal sides: square and rhombus remain.

Step 3: No right angles: Only the option of rhombus satisfies all of the criterion.

The game of ‘20 Questions’, when applied to numbers, is another excellent example of an activity that asks its participants to use logic to eliminate impossible answers.

Starting with the clue ‘I am a three digit number’, questions such as:

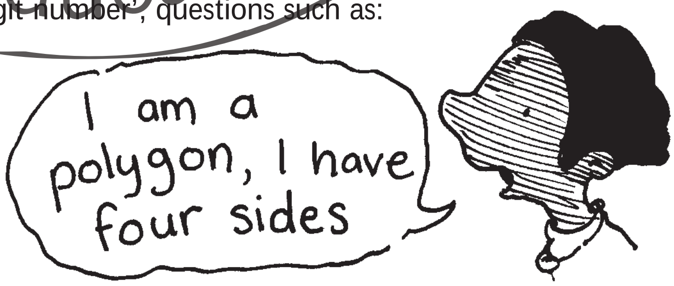
Am I even?

Am I bigger than 500?

Am I in the three times table?

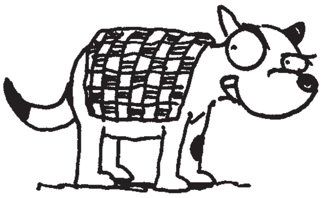
Do I have repeated digits?

Are all of my digits odd?



eliminate many of the initial 900 possible answers. By keeping a record of the questions that the students ask and the range of the possible answers, the teacher can focus the students’ attention on the task at hand as well as illuminate the power of this problem solving strategy.

THE NINE PROBLEM SOLVING STRATEGIES



1. Find the important words in the question

- Underline them.
- Write them down.
- Read them a few times.
- Make sure I know what I have to do.

2. Look for a pattern

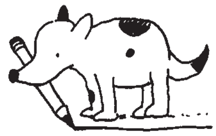
- Is there a similar thing happening over and over again?
- Will finding this help me solve the problem?

3. Guess and check

- Think of a possible answer.
- Try and see if it works.
- Does the answer make sense?

4. Make a table or chart

- Will something like this help me?
- Will it help me to see a pattern?



5. Make a drawing

- Can I draw about the problem in some way?
- Will a sketch help me see what needs to be done?

6. Work backwards

- If I start at the end of the problem and work backwards, will it help?
- When I do this, does my answer work?

7. Try a similar but easier problem

- What is the same about these two problems?
- Can I use this to help me with the harder problem?
- Can I see a pattern?

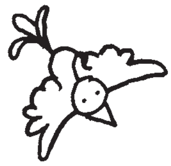
8. Make a model

- Will a model made out of paper help me to solve the problem?
- Will a model made from blocks help me to solve the problem?

9. Think clearly

- What do I already know about the possible answer?
- What must the answer look like?
- What answers obviously do not work?

WHEN I PROBLEM SOLVE I MUST REMEMBER THESE THINGS

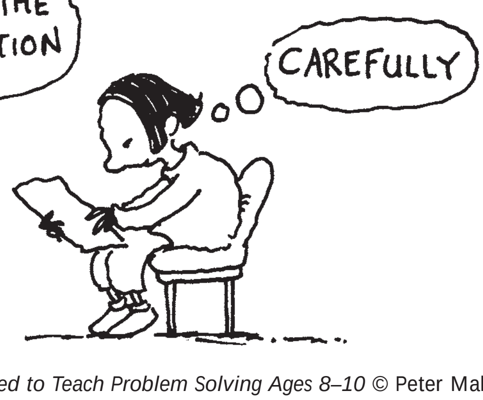


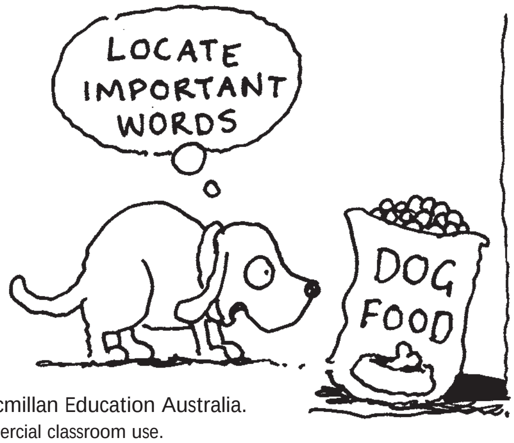
- Read the question carefully.

- Locate the important words.

- Make sure I know what to do.
- Look for a strategy to help solve the problem.

- See if my answer works.
- Tell someone about what I have discovered.





All the

Lesson Plans and Worksheets

You Need

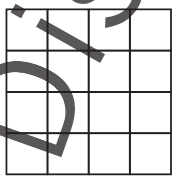
Squares in Squares in Squares

Strategies

- Locate key words
- Look for a pattern
- Make a drawing
- Find a similar but simpler problem

Background

When a number is squared it is multiplied by itself. Four squared equals 16 because 4 x 4 = 16. Although this fact is generally known, it is less well understood that perfect squares, such as 16, are so called because it is possible to create a square from 16 squares of the same size.



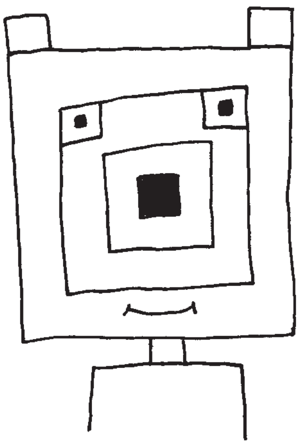
The task of finding squares within squares illustrates this point very well to students.

Resources:

- access to a foursquare court
- access to a tennis court, or drawing of a tennis court

Orientation

Begin the lesson by taking students outside to a foursquare court in the playground. Encourage students to discover that not only does the court contain four squares, but that the entire court itself is a square. If a tennis court is available, point out that the court is a rectangle. Then have students look closely and observe that there are many rectangles contained within the court.



Guided Discovery with BLM 1

Read the question with students and help them to locate the key words: squares on 3 x 3 square.

This problem can best be tackled by working slowly through a series of simpler problems contained within the question itself. The first obvious point is that the square contains a series of 1 x 1 squares, nine in all. Ask students if the square contains any other types of smaller squares. Point out that there is a series of 2 x 2 squares that can also be seen. How can we count these so that we don't miss any? Encourage students to use coloured pencils to overlap the 2 x 2 squares. There are four, or 2 x 2 of these types of squares. Can we see any other squares? Of course, the entire 3 x 3 square is a square as well.

At this point the three solutions of nine, four and one should be considered. What can we say about these numbers? They are, of course, perfect squares in themselves. The solution of 14 is the sum of each of the perfect squares from one to three.

Further Exploration

Task Card 1

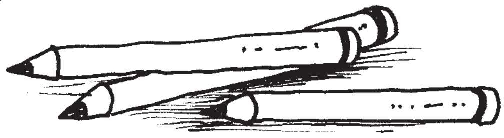
Read the question with the class: 'How many squares can be found on this 4 x 4 square?'

Remind students to locate the key words: Squares on a 4 x 4 square.

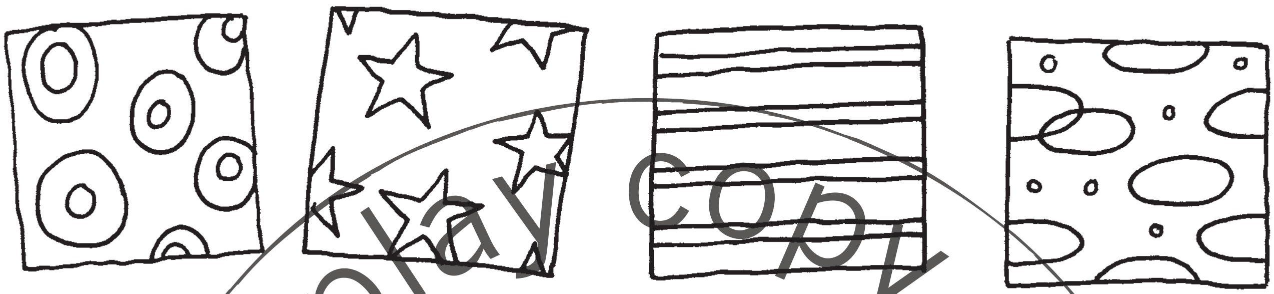
Observe the way students attempt to solve the problem. Can they see the similarity to **BLM 1**? Are they able, with your assistance if necessary, to count all of the 1 x 1, 2 x 2, 3 x 3 and the one 4 x 4 square? Can they appreciate that the solution follows a pattern? It simply adds on the number of 1 x 1 squares found on the 4 x 4 square to those found on the 3 x 3 square studied in **BLM 1**.

Name Date BLM 1

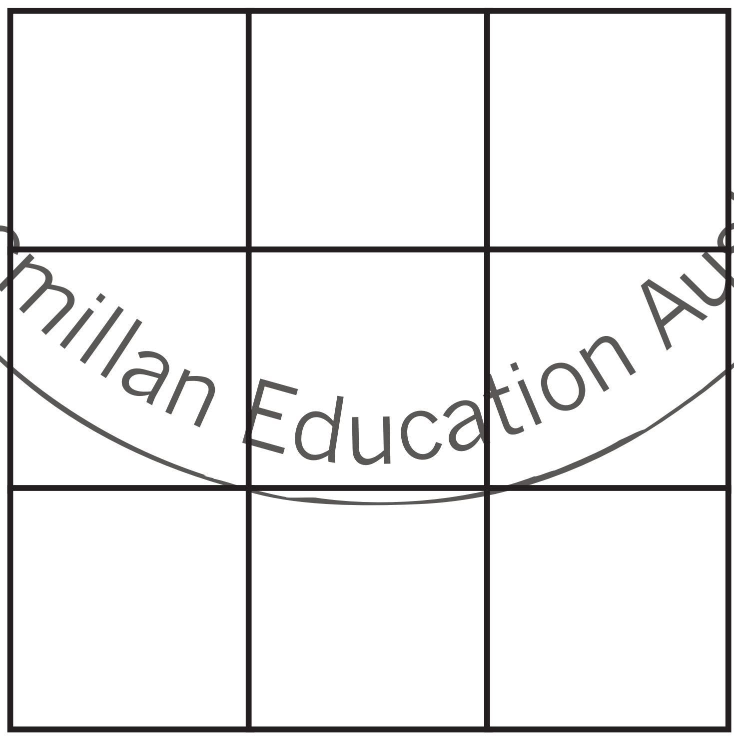
Squares in Squares in Squares



What you need: coloured pencils



How many squares can you see on this 3 x 3 square?
Use coloured pencils to fill in all the squares.



Strategies @ Locate key words @ Look for a pattern @ Make a drawing @ Find a similar but simpler problem

Good Thinking, 99

Strategies
- Locate key words
- Look for a pattern

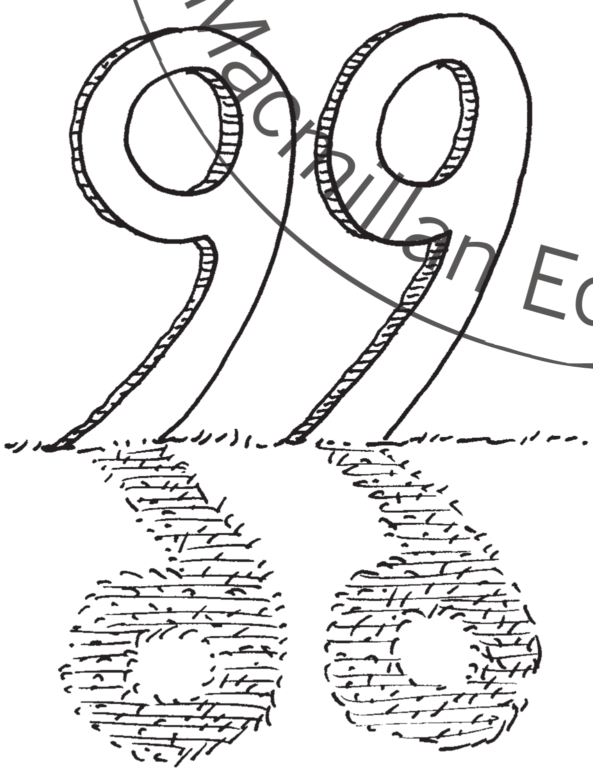
Background

As stated previously in this book, the ability to readily see a pattern is a consistent trait in the best problem solvers. 'Good Thinking, 99' demonstrates the power of finding a pattern and draws on students' knowledge of times tables.

Resources:
- 1–100 number board

Orientation

Begin the lesson by introducing students to a standard one to 100 number board. Show them some of the patterns contained within the numbers, such as the fact that the far right column displays numbers in the ten times table, that every second column is odd, that numbers in the nine times table form a diagonal, and so on. Utilise these patterns and ask students to make predictions regarding where numbers beyond 100 might be found on an imaginary extended grid.



Guided Discovery with BLM 2

Read the question with the class, then help students to locate the key words: In which column will 99, 100 and 98 be found?

Show students that the strategies of assume a solution or trial and error will, eventually, get them to the correct answer, providing they don't lose their place along the way. Then explain that there is a much faster way of finding the answers – to locate a pattern. Can they see a pattern? What about in column D?

Once students appreciate that this is where the numbers in the nine times table can be found, ask them what we know about the numbers 100 and 98 in relation to the nine times table. Can we now see any other patterns?

For confident students, this can be extended in a multitude of ways to numbers two, three and four away from a multiple of nine. Where can 91 be found? What about 110?

Further Exploration

Task Card 2

This activity reinforces the skills developed in **BLM 2** and helps students appreciate that most numbers have many factors.

Read the question with the class: 'This is a new way of showing numbers on a grid. Can you see which column 99, 100 and 98 can be found in?'

Help students to locate the key words: Which column 99, 100 and 98?

This time, encourage students to work more independently. They should begin by looking for a pattern. Ensure students have a sufficient understanding of the 11 times table. Once the column that contains the multiples of 11 is found, the other two parts of the question should be relatively easy to complete. Again, extension for the better students is obvious. Where will 999 be found? Where will 997 be found?

Good Thinking, 99

Look at the way these numbers have been placed in this chart.

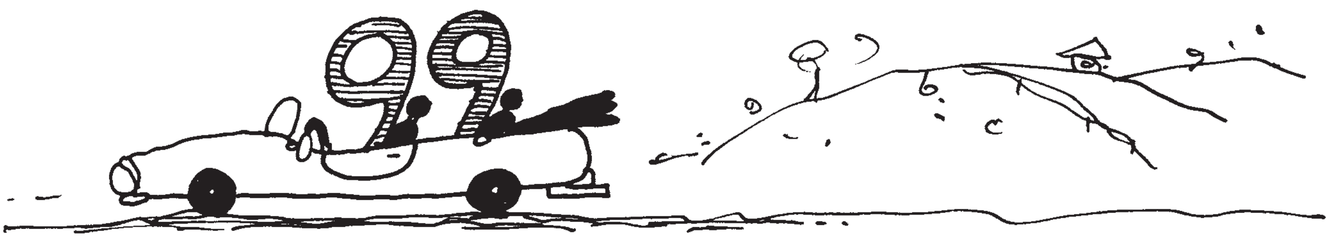
Can you see a quick way of finding the column in which 99 can be found?

Where will 100 be found? Column ___________

Where will 98 be found? Column ___________

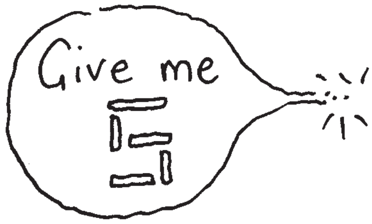
Fill in the chart.

A	B	C	D	E	F	G	H	I
2	7	4	9	1	8	3	5	6
11	16	13	18	10	17	12	14	15
20	25	22	27	19	26	21	23	24



Strategies Locate key words Look for a pattern

Digital Fives



Strategies

- Locate key words
- Look for a pattern
- Create a table or chart
- Think logically

Background

Being able to work logically through a problem that has many parts or contains numerous answers is essential if all of the possible solutions to this type of problem are to be found. 'Digital Fives' is a problem of this type requiring logic and structure to be successfully solved.

Prior to the presentation of this problem, the students should be made aware of the manner in which a digital clock displays the time. They need to appreciate that a colon separates the hours from the minutes and that the column to the right of the colon represents the tens of minutes and that the far right column represents the units of minutes. Show students the similarity of this structure to the Hindu-Arabic system of numeration (our Base 10 system of counting).

Resources:

- calculators
- sweep-hand clock

Orientation

Show students that devices with digital displays use light bars to represent numbers. Have students use their calculators to discover how many light bars are used in the representations of the digits 0–9. Then use a sweep-hand clock to calculate the current time, transfer it into a digital format and then ask students to calculate the number of light bars needed to show this time.

Guided Discovery with BLM 3

Read the question with the class, then remind students to locate the key words: Fives on a digital clock between two and three o'clock.

Remind students that there are three columns on this clock that need to be considered when attempting to solve the problem. Can a five appear in all three places? Why not?

Encourage students to write down the first time that a five will appear on the clock (2:05). Point out that this five is in the units of minutes place. What other times will have a five appearing in the units of minutes place? (2:15, 2:25. 2:35, 2:45 and 2:55) Why won't a five appear for 2:65, 2:75, 2:85 and 2:95?

Will a five appear in the tens of minutes place? If so, how many times? Now add up all of the times that a five appeared. At 2:55, what did you notice?

Further Exploration

Task Card 3

This problem extends the concept under review by introducing the hour column to the problem.

Read the question: 'How many times would the digit 3 appear on a digital clock between the hours of 2:59 and 4:00?'

Locate the key words: Digital 3s between 2:59 and 4:00.

Explain that, for this question, students need to consider three columns. They need to work through the problem systematically, column by column. How many times will the three appear in the units of hours place?

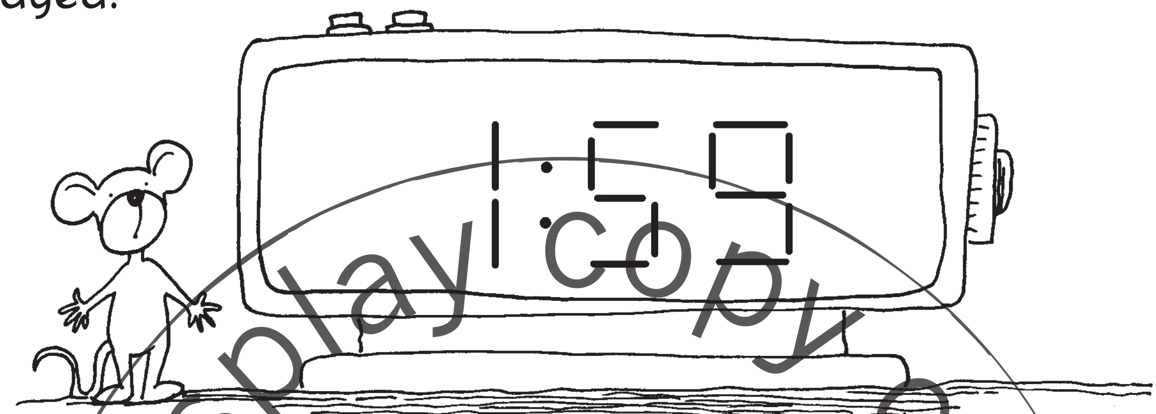
How many times in the tens of minutes place?

How many times in the units of minutes place?

Tackling the problem in this logical and systematic way should improve the randomness that some students bring to problem solving. Encourage students to make use of the table provided and to look for patterns as they emerge. This will help them to identify short cuts and save time.

Digital Fives

This digital clock shows how one minute to two o'clock is displayed.



How many times will the digit 5 appear on this digital clock between two o'clock and three o'clock? ____________

Write all the times here.

Strategies Locate key words Look for a pattern Create a table or chart Think logically

Two Dice Roll

Strategies

- Locate key words
- Look for a pattern
- Think logically

Background

Rolling two dice can give 36 outcomes, rolling one die, only six. The possible totals of the two dice, if added, lie anywhere from two to 12. However, the chances of the 11 possible totals are not equal. **Two Dice Roll** asks students to base their judgements upon this fact.

Prior to playing the game, students need to roll two dice, adding up the totals that emerge and recording results. This will demonstrate that the 36 combinations are more likely to produce some totals than others. For example, there is only one combination that will add up to two, but there are six combinations that can give a total of seven.

Resources:

- two dice

Orientation

Teach students to play **Two Dice Roll**. Have students stand on either your left or right, forming two lines with a corridor between them for you to roll the dice. Each line represents an outcome. The students stay in the game as long as their predicted outcome is the actual outcome.

For example, before rolling the dice, say:

'Stand on my left if you think the total of the two dice will be seven. Stand on my right if you say that the total will not be seven.'

Some other directives could be:

Left = a total between 2 and 7. Right = a total between 8 and 12.

Left = a total that is even. Right = a total that is odd.

For many directives, you can roll one die at a time and ask students what the chance is of the next die being 'on your side'. For example, if the directive was to decide if the total would be under six or six or greater, if the first roll was a four, some students have a 2/6 chance of staying in the game and others a 4/6 chance. The winner is the last to stay in the game.

Guided Discovery with BLM 4

This blackline master offers students the opportunity to demonstrate their understandings of chance via the medium of a mock game of **Two Dice Roll**.

Read the question with the class then help students locate the key words: Tick A or B column.

Ensure that the students reflect before each judgement is made. The use of a pencil and a piece of paper will assist with considered decision making. Many students will prefer to write down the possible outcomes and the numbers that will determine their choice on each occasion. Other students will be satisfied to consider the comparative probabilities mentally. Both options should be seen as equally appropriate.

Further Exploration

Task Card 4

The task card exercises students' abilities to think creatively by asking them to formulate their own instructions as though they were conducting the game themselves.

Read the question with the class: 'Pretend that you are the teacher in a game of **Two Dice Roll**. Write down three instructions that will give both sides of the room the same chance. Write down three instructions that will be in favour of one side of the room over the other. Write down three instructions that will only give one side of the room a chance of winning.'

Locate the key words: Three instructions both sides the same chance, three favouring one side and three giving only one side a chance.

Encourage students to draw on their understanding of probability to determine which instructions are most likely to achieve the desired result.

Name Date **BLM 4**

Two Dice Roll

What you need: two dice

Pretend that you are rolling two dice. Each row of this chart has two possible outcomes for each roll. Tick what you think is more likely to happen.

Outcome A		Outcome B	
1. a total less than 7		a total of 7 or higher	
2. a total of 7		a total that is not 7	
3. two odd numbers		two even numbers or an even and an odd number	
4. an even and an odd number		two even or two odd numbers	
5. an even total		an odd total	
6. a total of 5, 6 or 7		a total not 5, 6 or 7	
7. a single-digit total		a two-digit total	
8. at least one number bigger than 4		both numbers smaller than 5	
9. a 1 and a 5		not a 1 and a 5	

Strategies Locate key words Look for a pattern Think logically

Lesson Plan **5**

What Number Am I?

Strategies

- Locate key words
- Think logically

Background

Games demanding clarity of thought are excellent ways to improve logical thinking. **What Number Am I?** requires structure and contemplation to be played successfully and, with guidance, will improve clear thinking.

Resources:

- paper
- blackboard or whiteboard

Orientation

Teach students to play **What Number Am I?** Choose a three-digit number for example, 378. Tell the class how many digits are in the number. On the board, draw three lines to represent the hundreds, tens and ones places. Ask the class what the range of the number could be. On the board, write: 'Range: 100–999'. Then write: 'Number of possible answers: 900'. Discuss this point at length.

Ask students to pose sensible questions regarding the number. Tell the class that about 20 questions should be enough to narrow down the answer.

Questions such as 'Is the number bigger than 500?' will be useful because either yes or no will narrow many of the options. Summarise this in numerical form on the board: >500?

'No' usually elicits a poor response from students until they are reminded that this changes the range and the number of possible answers. Now the power of the first question becomes apparent. The range: 100–500. Number of possible answers: 401.

Call for further questions until the answer becomes obvious, or until a guess is appropriate because so few options remain. When the correct question of 'Is the number 378?' is asked, the number is revealed.

Encourage the students to be creative with their questions:

'Is the number in the _ times table/even/a multiple of 3?'

'Does the number have repeated digits/do they add up to >10?', and so on.

Guided Discovery with BLM 5

BLM 5 presents a mock game of **What Number Am I?**, giving questions posed and the teacher's answers. Students are then asked to write the range and number of possible answers on each occasion. The clue given is 'I am a three-digit number'.

The questions should be read out one at a time and answers written down.

Read the questions and help the students to find the key words. Encourage students to analyse each question to ascertain its appropriateness and value. Why is the question 'Is the number bigger than 500?' so useful? Is the answer of 'Yes' to be expected from the point of view of probability? Once we knew that the number was smaller than 750 and that the hundreds place was not a five or a six, why didn't we ask if the hundreds place was a 7?

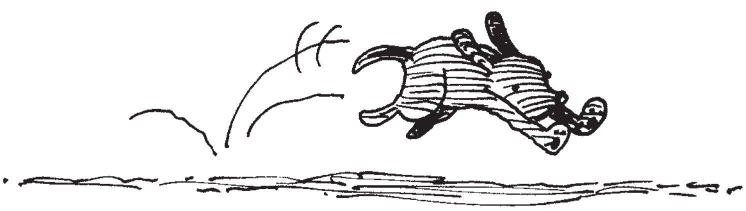
Further Exploration

Task Card 5

Read the question with the class: 'You are the teacher in a game of **What Number Am I?** Write down a three-digit number, and then take questions from the class. See how quickly the number can be found.'

Help students to locate the key words: You are the teacher in **What Number Am I?** Three-digit number. Take questions.

Assist the student leading the lesson by ensuring that the range and the number of possible answers are correctly written on the board and that questions posed are correctly answered. Encourage the students to record the questions, responses, range and number of possible answers in their books. Keep records of the class performances over the year. What will their class record be? Are they game to challenge other classes in a school-wide contest?



Name Date BLM 5

What Number Am I?

Here is a game of **What Number Am I?**
The answer has three digits.

The questions are given, and the answers too.

Write down the range and the number of possible answers for each question.

QUESTION	ANSWER	RANGE	POSSIBLE ANSWERS
Do I have three digits?	Yes		
Am I bigger than 500?	Yes		
Am I smaller than 750?	Yes		
Am I in the 500s?	No		
Is my hundreds place a six?	No		
Is my tens place an even number?	Yes		
Is my tens place a 0 or a 2?	No		
Am I bigger than 745?	No		
Are all of my digits different?	Yes		
Am I an odd number?	Yes		
Do my digits add up to 12?	Yes		
What number am I?			

Strategies Locate key words Think logically

Hooptime

Strategies
- Locate key words
- Look for a pattern
- Assume a solution
- Create a table or chart

Background

Questions that involve variables ask to be solved either by trial and error using the assume a solution strategy, or by looking for a pattern. It is essential that these questions are read very carefully by students. It is often the case that they will satisfy one of the criteria contained in this type of problem but not others, and yet will be satisfied with the result.

Orientation

Discuss the different scoring systems used in different sports. In cricket scores can be one, two, three, four or six. In Australian football a goal is worth six points and a behind one point. In basketball there are three types of goals that can be scored, each with a different value. What are they? Can the students suggest other sports with different types of scoring systems? Explore these mathematically.

Guided Discovery with BLM 6

Read the question with the class and remind students to locate the key words: 42 points. Won by six. Same number of three-, two- and one-point goals.

Encourage students to use the table provided to assume a solution and test it. Ask students why an attempt of, for example, 40 of each type of goal is not really sensible.

Once an answer has been ruled out, ask students to estimate another one and try it out. Was it closer to the mark? If so, what does this teach us for our next attempt?

Once the solution has been found, ask students how the question was related to the six times table. Why did each attempt give a multiple of six as an answer? Now ask students how we could have found the answer after the first unsuccessful attempt. If the first assumed solution was four of each type of goal this is 18 points below the correct answer, therefore three sets of goals too few.

Was it possible to see the pattern and to get to the answer (7 x 6 = 42) straight away?

Now encourage students to apply this reasoning to answer the second part of the question.

Further Exploration

Task Card 6

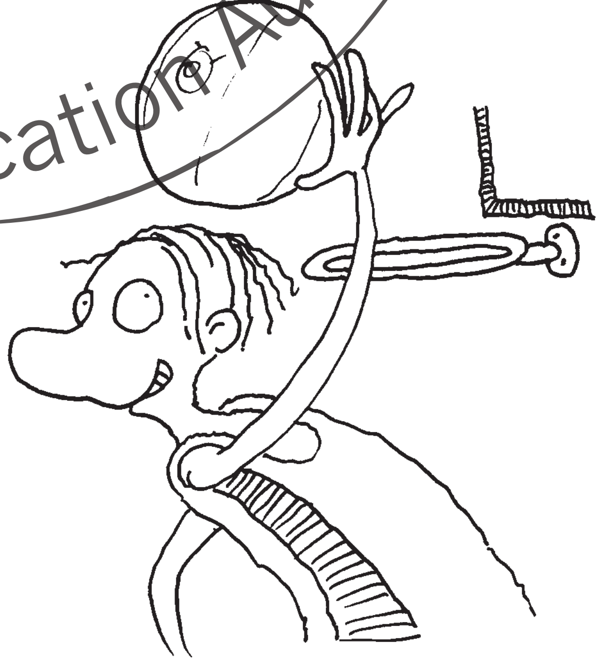
This question demands a more systematic approach than **BLM 6**.

Read the question with the class: 'In a recent cricket match, Basher Bullman scored 66 runs, all in sixes and fours. He made only 12 scoring shots. How many sixes and how many fours did Basher score?

Remind students to locate the key words: 66 runs. 12 scoring shots, all sixes or fours.

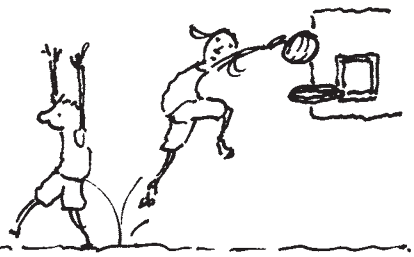
Again, encourage the students to have a go. The most sensible first attempt would be six of each. This is incorrect – does this mean that too many fours or too many sixes were selected? Can we see a pattern whenever a four is exchanged for a six?

No table is provided for this question for students to use. Challenge them to draw one up themselves.



Name Date **BLM 6**

Hooptime



In their basketball final, the Sunnyvale Swifts scored 42 points and won by six points. Sunnyvale scored the same number of three-point goals, two-point goals and one-point goals.

How many of each type of goal did Sunnyvale score? Use this table to assume a solution and test it.

THREE-POINT GOALS	TWO-POINT GOALS	ONE-POINT GOALS	TOTAL SCORE

How many points did their opponent score? If they scored the same number of three-point, two-point and one-point goals, how many of each type of goal did they score?

THREE-POINT GOALS	TWO-POINT GOALS	ONE-POINT GOALS	TOTAL SCORE

Strategies Locate key words · Look for a pattern · Assume a solution · Use a table or a chart

Lesson Plan 7

Where Do I Live?

Strategies

- Locate key words
- Think logically

Background

This question is related to the skills developed in Lesson Plan 5, emphasising the need for the students to work logically and systematically, eliminating unwanted and impossible solutions. In this task, students are given clues and must use them to isolate the solution. They need to draw upon their knowledge of basic number facts and use it in an unfamiliar and challenging manner.

Resources:

- class of students

Orientation

Explain to students that it can often take a number of clues before an answer to a problem can be identified. Each clue will narrow the field of possible answers nonetheless. Play a game of 'Guess Who' with the class. Ask everyone to stand up and give clues such as 'My person is female', 'My person is wearing a red piece of clothing', 'My person has a name starting with the 18th letter of the alphabet'. Ask them to sit down if they do not match the clues given until only one remains.

Guided Discovery with BLM 7

Read the question with the class, and remind students to locate the key words: Use clues to find my house number. Write down what we know after each clue.

After each clue, ensure that students write down what they have learned about the house number. Guide students through the clues, helping them narrow down the size and characteristics of the number. When they have enough clues and have put them all together, they will reach the solution. Ask them which clue did not help (knowing that the number was even after being told that it was in the four times table).

Once a solution has been found, encourage students to transpose their answer back into the question, clue by clue, to ensure that it is correct and fulfils all the given details.

Further Exploration

Task Card 7

The task card extends students' abilities in logical thinking but leaves open more than one possibility at the final clue. It should be tackled in a similar fashion to **BLM 7**, with students writing down what they discover after each clue is provided.

Read the question with the class: 'Olivia's collection of stickers is growing very large. She won't tell how many stickers she has. Here are some clues she gave.

The number has three digits. All the digits are odd. The tens digit is a one. The ones and the hundreds differ by four. How many stickers could Olivia own?'

Help students to locate the key words: Three digits, all odd, tens place one, ones and hundreds differ by four.

After each clue, ensure that students write down how it narrows down the potential number of solutions.

Once any of the four potential answers are worked out, ask students to transpose their answer back into the problem, clue by clue, to check its validity. By the time students reach the middle years of primary school they can become more responsible for their own solutions. This checking technique fosters such growing independence.

Where Do I Live?

My house number has two digits in it. ______________________

____

Both of the digits are different. ______________________

____

The number is in the four-times table. ______________________

____

It is an even number. ______________________

____

My house number is bigger than 50. ______________________

____

The digits in my house number add up to nine. ______________________

____

What number in Hillview Crescent is my house? ______________________

____

Strategies Locate key words Think logically

Domino Delight

Strategies

- Locate key words
- Work in reverse
- Find a similar but simpler problem

Background

This task utilises the problem solving strategy of working in reverse and exercises students' capabilities in using mathematical operations. The tasks could also be solved by assuming a solution, but this is not the best way of solving the questions. The strategy of working in reverse is very effective when used in the correct circumstances and should be strongly encouraged where appropriate.

Resources:

- dominoes

Orientation

Dominoes can be a source of both fun and mathematical adventure. Ask students to sort dominoes into groups adding up to values of between 0 and 12. Suggest that they consider each tile as a two-digit number. Put two or more together to form four- and six-digit numbers.

Guided Discovery with BLM 8

Read the question with the class, and encourage students to locate the key words: Twice as many as Sam. Sam seven more than Sean. Sean 33.

If students don't recognise it as the appropriate strategy, prompt them to try working in reverse.

It is a good idea at this point to apply this technique to a similar but simpler problem, such as 'I made five less fall than Sam. I made 10 fall. How many did Sam knock over?' Students will quickly come up with the answer of 15 and, hopefully, appreciate that this was calculated by working in reverse.

Now encourage students to return to the original problem and work in reverse to solve it.

Further Exploration

Task Card 8

This task card also requires students to work in reverse, but with a greater number of steps involved. Again, this could be solved by trial and error or assuming a solution and transposing it into the problem, but students need to be told which strategy is appropriate for this type of question.

Read the question with the class: 'Last time I played 40-Card Shuffle:

I won twice as many cards as Emma.

Emma won twice as many cards as Paris.

Paris won one more card than Liam.

Liam won three more cards than Michael.

Michael won one card.

How many cards did each player in the game win?'

Help students to locate the key words: 40 cards. Me twice Emma. Emma twice Paris. Paris one more than Liam. Liam three more than Michael. Michael one.

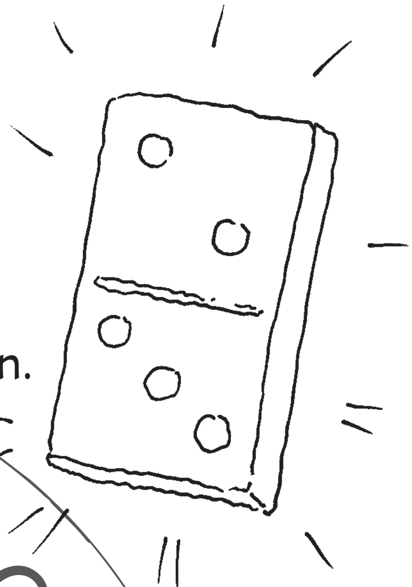
Concrete materials will assist many students in solving this problem. Once an answer has been achieved, it should be checked in a number of ways.

Does the total of the cards sum to 40?

Do all of the answers satisfy the given information?

Name Date BLM 8

Domino Delight



What you need: dominoes

I love to play Domino Fall with my friends. We line up our dominoes and see who can make the most fall at a time.

Last time we played, I made the most fall down.

I made twice as many fall as Sam.

Sam beat Sean by seven.

Sean made 33 fall.

How many fell for me? ____________________

Show your working here.

Now make up a problem of your own. Write it on the lines, then ask a friend to try and solve it.

____

____

____

____

Strategies Locate key words Work in reverse Find a similar but simpler problem

Quadley Quest

Strategies
- Locate key words
- Make a drawing
- Make a model

Background

The ability to think in a spatial context varies enormously from student to student. Some find it very easy to manipulate 2D and 3D shapes and to locate direction and orientation, whilst others find relatively simple spatial tasks quite difficult. Even for some adults, the delineation of left from right is not automatic.

These factors are due to the innate nature of our spatial sense. We are not all born with strength in this area. As a consequence, some of us need to work hard to develop and make the best of our abilities.

However, like all mathematical traits, our ability to think spatially can be improved. The task of 'Quadley Quest' will exercise students' capabilities in this area and explore the strategic use of drawing and making a model in the process.

Resources:
- connecting blocks

Orientation

Explain to students that a Quadley is a machine made on the planet Quad, located four light years from Earth. Each Quadley is made up of four connecting blocks created in such a way as to be able to lie flat on a surface. Direct students to **BLM 9** and explain that the connecting blocks on their table are to be used to form Quadleys. Make a line of four connected blocks to show the simplest Quadley, called 'the line'. This is used to measure things on the planet Quad. Demonstrate how, no matter how this Quadley is rotated or flipped, it remains the same type of Quadley.

Guided Discovery with BLM 9

Read the question with the class, and help students identify the key words: Make as many Quadleys as you can. Draw, name and write down their uses.

As you check students' work, make sure that the shapes they create are flat and ensure that shapes are not repeated in a differently oriented format.

Further Exploration

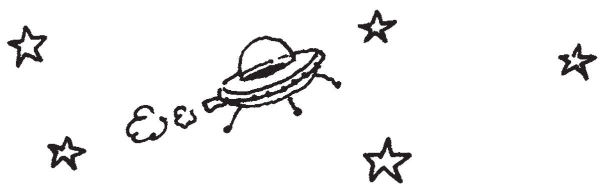
Task Card 9

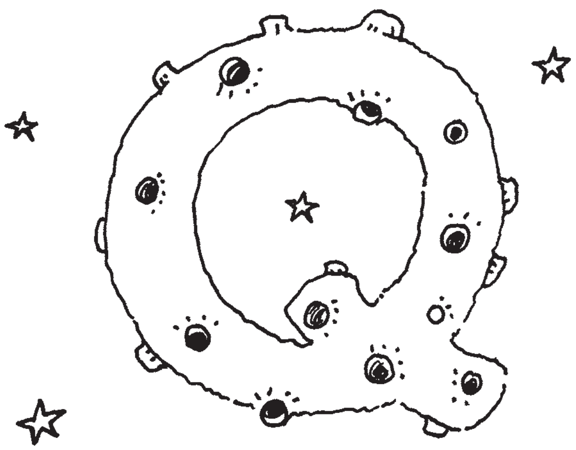
This task introduces students to the pentomino, which is comprised of five connected blocks. The instructions for this activity remain the same as for the previous task.

Read the question with the class: 'When five blocks are connected, they are called a pentomino. Like Quadleys, pentominoes are flat. There are 12 pentominoes in the complete set. Use connecting blocks to see how many you can make.'

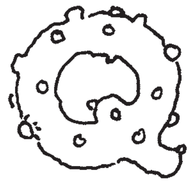
Help students to locate the key words: Connect five blocks together to make flat shapes. Make all 12 possible pentominoes.

Ensure that students are creating flat constructions and that they are not repeating pentominoes. Many look quite different when flipped or rotated. You might like to ask the students to name each pentomino as they make it, such as 'the cross', 'the axe' or 'the Z'.



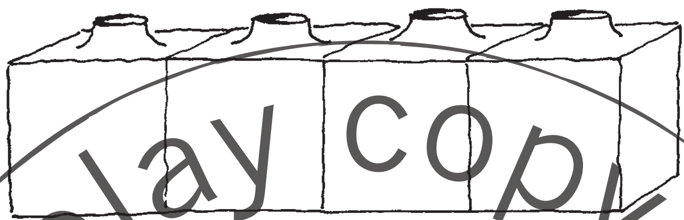


Quadley Quest



What you need: connecting blocks

This Quadley is called 'The Line'. It is used for measuring on the planet Quad.



How many Quadleys can you make?

Draw each one, name it and then write down its job on the planet Quad.

Strategies Locate key words Make a drawing Make a model

Lesson Plan **10**

Multiplying Big Time

Strategies

- Locate key words
- Look for a pattern

Background

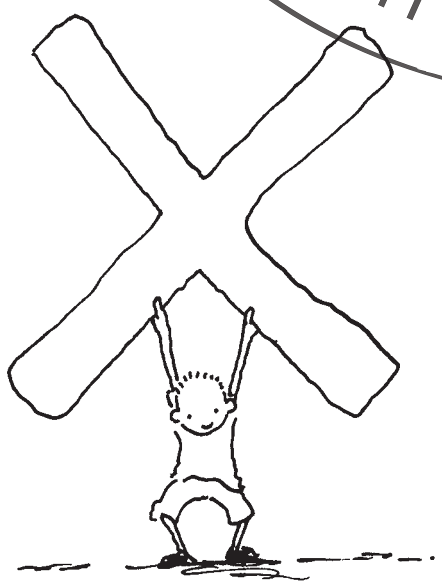
One of the major objectives of number work in the middle primary years is to improve students' mental arithmetic skills. Learning the times tables is an essential prerequisite for being introduced to the formal multiplication algorithm. By the end of the fifth year at school, many students will have the ability to multiply by at least a single digit number to an impressive degree. The tasks found in this unit deal with multiplication, invoke the use of a calculator and ask students to search for patterns that will enable them, hopefully, to draw general valid conclusions.

Resources:

- calculators

Orientation

Explain to students that a calculator is a machine that has a multiplication button, but cannot multiply. Calculators are programmed to turn multiplication problems into addition sums that are solved very quickly. Thus, the problem 32 x 5 will be solved by a calculator by adding 5 together, 32 times. Ask the students to do this and then to attempt the problem in the standard multiplication manner. This demonstrates that multiplication is simply a very quick way of adding up the same number over and over again.



Guided Discovery with BLM 10

Read the question with the class, and help students identify key words: Use 3, 7 and 9 to make six 2 x 1 digit sums and find the answers. Which is the biggest?

Correct each answer before moving on.

Read the next question and locate the key words: Use 2, 8 and 4 to do the same thing. Is there a pattern?

At this point in the lesson, predictions of a pattern and a general rule will begin to emerge. These should be tested for their validity.

Ask students what will happen to the rule if two of the three digits are the same, such as three, three and six. Encourage them to test this scenario.

Further Exploration

Task Card 10

Read the question with the class: 'Use the digits 3, 9, 8 and 2 to make as many 2 x 2 digit multiplication sums as you can. Use your calculator to find the answers to these questions. Which question gave you the biggest answer?'

Help students to locate the key words: Use 3, 9, 8 and 2 to make the biggest 2 x 2 digit multiplication sum.

Ask students to suggest a possible general rule for any 2 x 2 digit multiplication question.

Read the next part: 'Now use 1, 7, 3 and 5 to do the same thing. Do you see a pattern?'

Help students to locate the key words: 1, 7, 3 and 5 to do the same thing. Is there a pattern?

At this point it would be valuable to test students' suggestions and then write the general numbers on the board: Largest, second largest, second smallest and smallest numbers. Then ask which combination will give us the biggest product every time.

As an extension ask the students which combination will give the smallest answer each time.

Name Date BLM 10

Multiplying Big Time

The digits 3, 7 and 9 can be combined to make six 2 x 1 digit multiplication sums. 37 x 9 is one of them.

Write down all six possible sums and find their answers.

Which gave the biggest answer? ______________________

Now do the same thing for 2, 8 and 4.

Which gave the biggest answer? ______________________

Can you see a pattern? ______________________

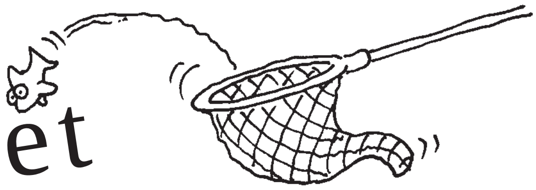
____

____

Strategies Locate key words Look for a pattern

Lesson Plan **11**

On the Net



Strategies

- Locate key words
- Make a model
- Think logically

Background

The ability to be able to transfer from a net to a solid is another task that will test the innate spatial capabilities of many students. Nonetheless, for all students, however strong their capabilities, practice will result in improvement.

Resources:

- examples of cubes and prisms
- tissue box
- one die

Orientation

Explain to students that 3D shapes are called polyhedra, a word that comes from the ancient Greek and translates to mean 'many faces'. The great majority of polyhedra contain many edges, faces and vertices. Offer examples of cubes and prisms to illustrate this point.

Show students that the blueprint of a polyhedra is called a net. Unfold a tissue box as an example. It is also a good idea to show a cube in the form of a die and to demonstrate the fact that the opposite faces of any die always add up to seven. Thus, three must be opposite four and two must be opposite five, and so on.

Guided Discovery with BLM 11

Read the question with the class, and help students to locate the key words: Which face opposite C?

Encourage students to have a go after reminding them of the earlier cited example of the die. Encourage them to test their ideas by actually making a model of the rectangular prism out of cardboard, after tracing the two squares and four rectangles onto a piece of paper.

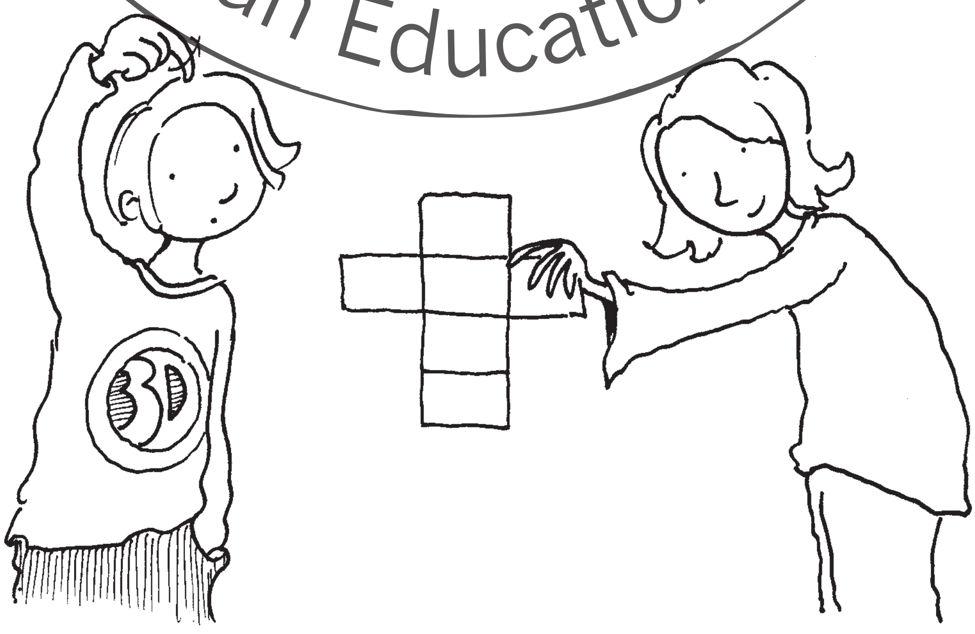
Further Exploration

Task Card 11

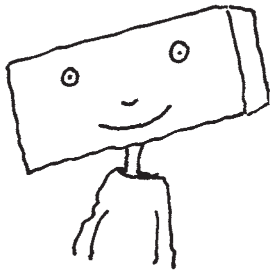
Before beginning this task card, ensure that students comprehend the meaning of the terms edge and vertice.

Read the question with the class: 'At each corner or vertice of any rectangular prism, three edges and three faces will always meet. Which three faces will meet at the point marked on this net when it is constructed?'

Again, call for a suggestion and ask for its justification. Then ask students to confirm their answer by making a model of the new rectangular prism.



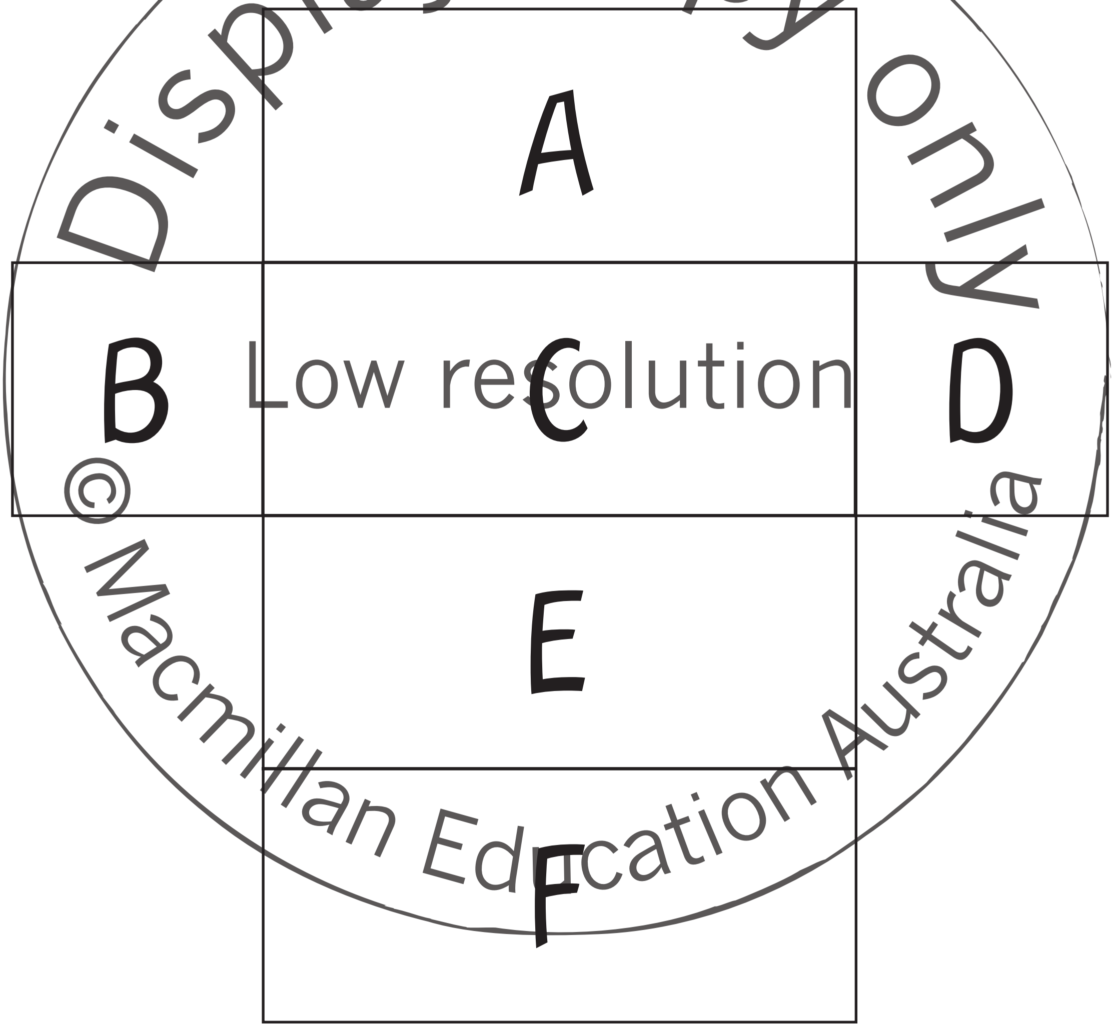
On the Net



What you need: coloured pencils; scissors

Here is the net of a rectangular prism.

If it were to be put together, which face would be opposite C? Colour in that face.



Cut out the net and fold it together to see if you were correct.

1, 2, 3, 4

Strategies
- Locate key words
- Look for a pattern
- Assume a solution
- Think logically

Background

'Mucking around' with numbers is an excellent way in which creativity and acquired skills can be combined in a fruitful manner. This activity exercises some of the most powerful problem solving strategies available.

Orientation

Advise the class that an equation is a term that refers to a number sentence. Just like in English, a sentence in maths must make sense.

The equation 2 + 3 = 5, like all equations, uses mathematical signs or symbols to show that the left side of the equal sign equals the right side of the equal sign.

Advise students that there are many signs and symbols used in maths. Have students brainstorm as many as they can come up with and don't be surprised if signs such as square root or squared and other symbols normally associated with more complex mathematics arise. If and when they do, these should be celebrated and discussed at length. Some of the best mathematical lessons are generated incidentally, and often from a chance remark or question from a student.

Advise the class that they will now be able to use any of the maths signs they understand to help complete **BLM 12**.

Guided Discovery with BLM 12

Read the question with the class. Due to the brevity of the question, it is not really appropriate to isolate the key words, but it is valuable to write out the question nonetheless.

Advise students that it doesn't matter where you start and that there may well be more than one answer for any numerical value.

Encourage students to have a go, and remind them that it doesn't matter if all solutions are not found. Once a solution is found, it can often lead to another one.

Call for suggestions from the class and then let them loose on the problem.

Further Exploration

Task Card 12

Similar to **BLM 12**, this task card encourages the strategies of assuming a solution, thinking logically and looking for patterns. It uses the number four exclusively, due to the fact that four is a perfect square. This is an ideal opportunity to show students the value of the square root sign. Don't be afraid to extend the students – they love being told that they are 'doing really hard maths from further up the school!'

Advise the students that 44 is a very clever way of making a big value by using only two fours.

Read the question with the class: 'Use the number 4 four times, and any maths signs you know, to make equations that equal 0, 4, 5, 8, 14, 16, 24, 44, 52 and 88.'

As with **BLM 12**, the question is already in précis form, so rather than identifying key words, encourage students to copy it down.

A useful extension would be to ask students to make up any other equation values that they can. Encourage the use of calculators where required.

1, 2, 3, 4

What you need: calculator

Take the numbers one, two, three and four, in that order. Use any maths signs you know to make equations that equal from 0–10.

0 = ______________________________

1 = ______________________________

2 = ______________________________

3 = ______________________________

4 = ______________________________

5 = ______________________________

6 = ______________________________

7 = ______________________________

8 = ______________________________

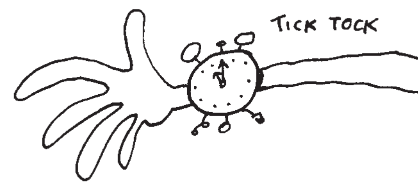
9 = ______________________________

10 = ______________________________

Strategies Locate key words Look for a pattern Assume a solution Think logically

Lesson Plan **13**

A Testing Time



Strategies

- Locate key words
- Look for a pattern
- Think logically

Background

When encountering problems with numerous possible solutions, it is essential to work logically and systematically. Finding a pattern is of vital significance and increases the chance of locating all available answers.

Orientation

Before attempting the blackline master, students should be advised that in maths tests often questions are not just marked as wrong or right. For many problems, especially those containing numerous steps, part marks can be given for the working and part for the answer. This becomes increasingly the case as the students move through school. A question worth ten marks on a test could have eight marks allocated to the working and only two to the answer. Explain to students that while this may appear to be a little strange, it is very much in their favour. Even if they get the answer to a problem wrong, they can still get part marks if they were on the right track.

Guided Discovery with BLM 13

Read the question with the class, and help identify the key words: Three questions. Two, one or zero for each. How many ways of scoring four out of six?

Suggest that students name the three questions, such as A, B and C.

Now call for a suggestion as to how a score of four might be obtained. Write this on the board. Then ask if there might be a totally different way of scoring four out of six on the test. Write this method on the board. (The two ways are two twos and a zero or one two and two ones.)

Tell students that we need to come up with a strategy to help us to get all of the possible answers. Suggest that students think of each answer as though it were a separate three-digit number. Thus, the solution of two, two, zero might be seen as 220. If the students work in this fashion numerically from, say, 220 to 022 and from 211 to 112, they will be able more easily to recognise a pattern and find all of the possible solutions.

Further Exploration

Task Card 13

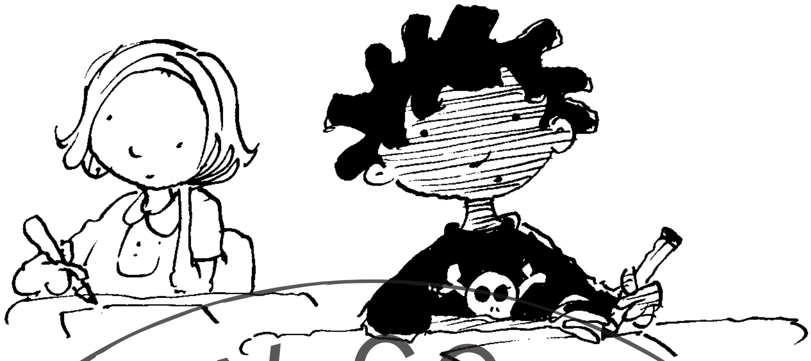
Read the question with the class: 'Mr Smith marks projects out of ten points. This year John completed four projects and scored 38 out of a possible 40 points. On a piece of paper, list ten ways that John's projects could have been marked.'

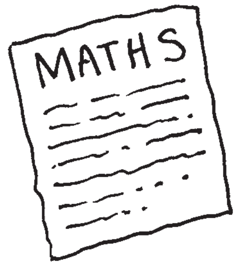
Help students to locate the key words: Four projects. 38 out of 40.

Advise students that there are two ways of scoring 38 out of 40. Can they find them?

Once this has been achieved, ask the students to work through the problem in a systematic manner, finding all of the ten, ten, ten, eight combinations before trying to find the ten, ten, nine, nine combinations. Ask them to look for the obvious patterns that emerge.

A Testing Time





On a maths test, questions are marked as follows:

2/2 if both the working and the answers are correct.

1/2 if the answer is wrong but most of the working is correct.

0/2 if both the answer and the working are wrong.

There were three questions on the test. John scored four marks out of a possible six. How might John have gained his marks?

Method 1: ______________________

Method 2: ______________________

Method 3: ______________________

Method 4: ______________________

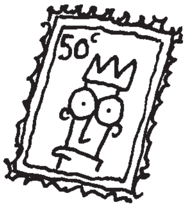
Method 5: ______________________

Method 6: ______________________

Strategies Locate key words · Look for a pattern · Think logically

Lesson Plan **14**

Splitting the Dial



Strategies

- Locate key words
- Assume a solution
- Make a drawing
- Think logically

Background

This lesson exercises students' abilities to apply their addition and bonding skills to the problem solving strategies of assuming a solution and thinking logically. The inclusion of a drawing enables them to visualise the task and to appreciate the power of an iconic representation.

Resources:

- blackboard or whiteboard
- calculators

Orientation

Explain that sometimes collections of objects or numbers can vary in quantity and yet be as valuable as each other. A stamp that may have cost 50 cents 20 years ago might be worth the equivalent of 20, 50-cent stamps today. The total of a large group of numbers could equal the total of a much smaller group of numbers with higher values.

Write the numbers from one to 13 on the board, placing them on a number line. Show the class that if we split the line at the number seven, the totals of the two half lines will not be anything like equal. Where will a split need to be made to make near equal totals on both sides of the line? A split between the nine and the ten will result in totals of 45 and 46.

Guided Discovery with BLM 14

Advise students that this task will enable them to use trial and error and common sense. The picture on the blackline master will help and should be used. Ask them to use a pencil as they work through the task because it is quite likely that the correct answer may not be found on the first attempt.

With students, read the question and identify the key words: Draw a line so that the two parts add up to the same number.

Although trial and error will eventually lead to the correct solution, logic suggests that some attempts will not be correct. For example, why isn't it sensible to cut the clock from 12 to 7 or 1 to 6?

Further Exploration

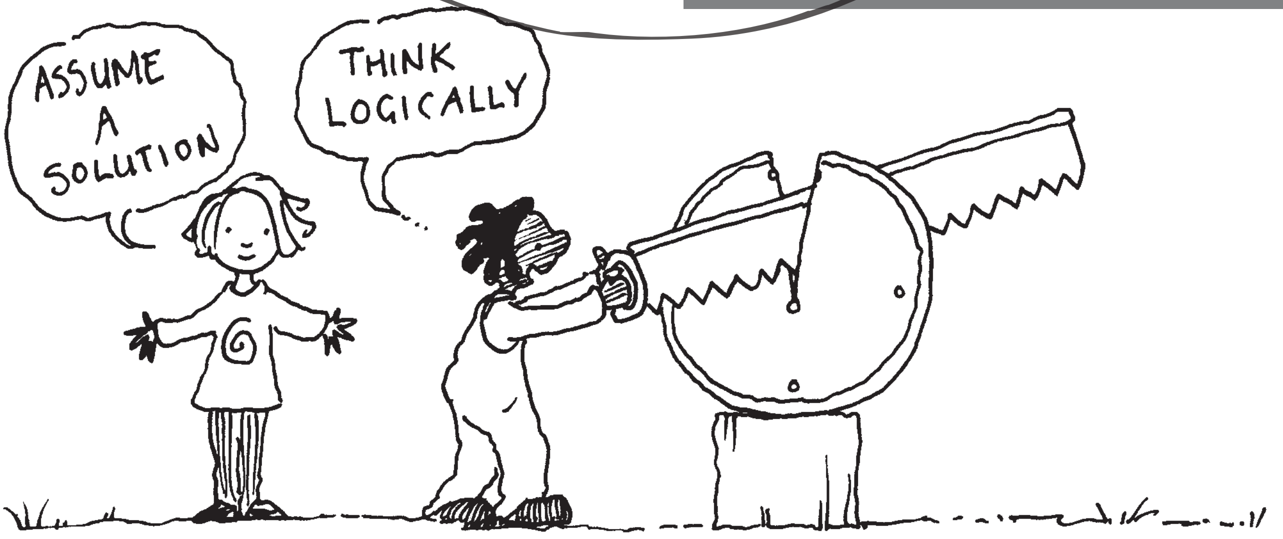
Task Card 14

Read the question with the class: 'This unusual clock face has to be divided into two parts with a straight line so that the two parts, when added up, are as close as possible in value. How can this be done?'

Help students to locate the key words: Divide the face with a straight line so that the two parts add up as closely as possible.

Encourage students to think in a logical, common sense fashion and then to have a go.

They then need to test their totals and tinker with their answers until they are satisfied that the closest divide has been obtained.

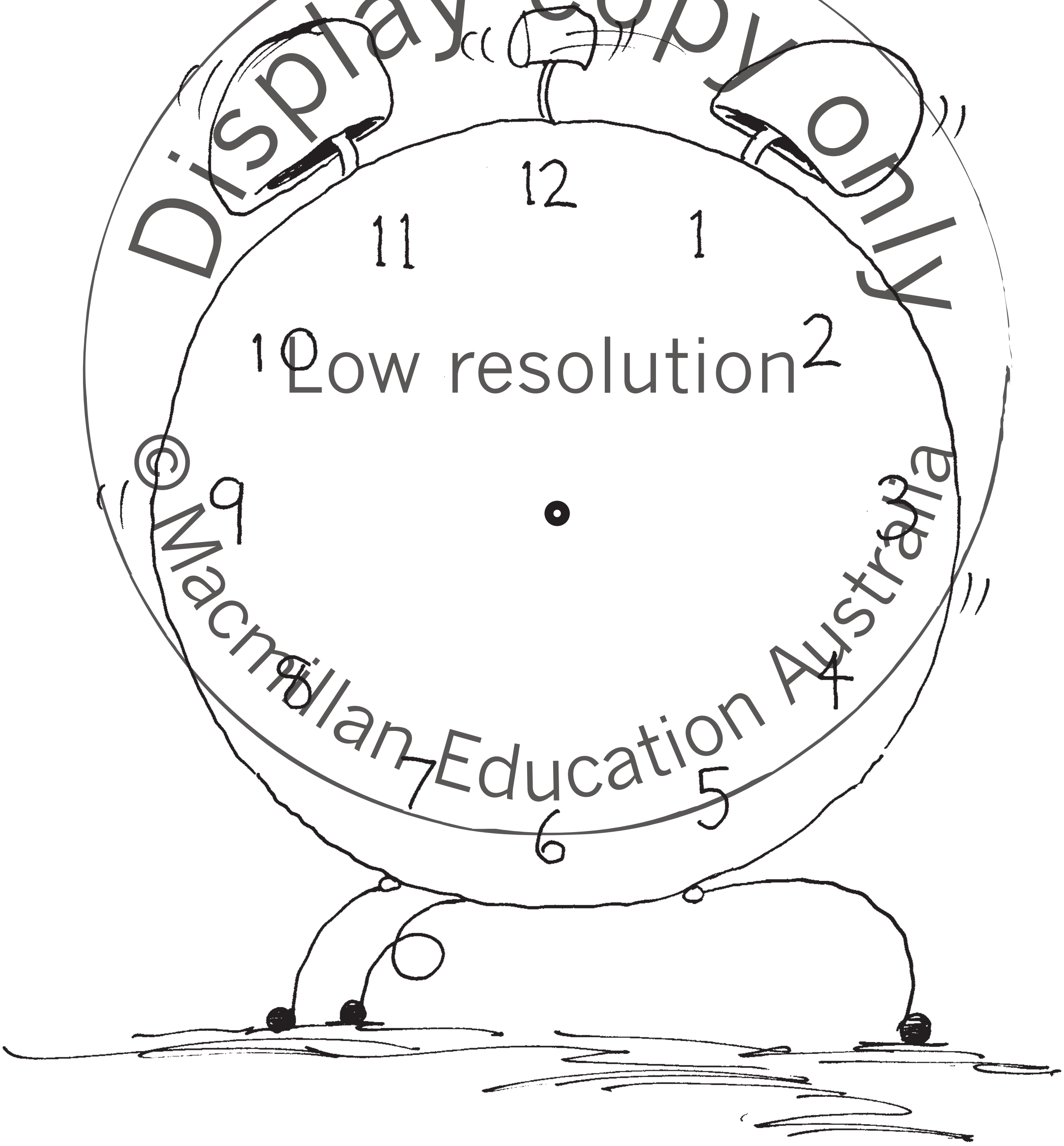


Splitting the Dial

What you need: a ruler and a pencil

Here is a standard clock face.

Use a ruler and a pencil to draw a straight line across the face. Make sure that the sum of the two parts will add up to be exactly the same.



Strategies Locate key words · Assume a solution · Make a drawing · Think logically

Lesson Plan **15**

Group Work

Strategies

- Locate key words
- Look for a pattern
- Think logically

Background

The strategies exercised in Lesson Plan 14 need to be employed again in this numerical example. Students' abilities to bond to the number ten, an essential prerequisite for success in addition, play a vital role in 'Group Work'.

Resources:

- paper
- calculators

Orientation

Write the numbers from one to nine on the board. Have students cut out nine pieces of paper with the numerals from one to nine written on them. Ask students to add up the total of the nine numbers. Then ask them to find as many creative ways of finding the total as possible (bonding to ten, bonding to nine, and so on). Once students understand grouping and that the same number can be grouped in many different ways, introduce **BLM 15**.

Guided Discovery with BLM 15

Read the question with the class, then help students locate the key words: Use the nine cards to make three equal groups.

It is likely that most students will begin the task in a fairly random fashion. After a short time, ask them to recall what we already know about the sum of the nine numbers. Can we use this information to help us work out what the total of the three individual groups must be? How can we do this? Once we know this, how can we use logic to assist in creating the three groups? Now ask them to apply this logic to the next question, using only the cards numbered from 1–6.

Further Exploration

Task Card 15

The task card extends students' capabilities in this area and encourages them to look for a pattern. The use of numeral cards similar to those used earlier in the lesson is highly recommended.

Read the first part of the question with the class: 'Use the numbers 2–10 to make three groups of three numbers that add up to the same total.'

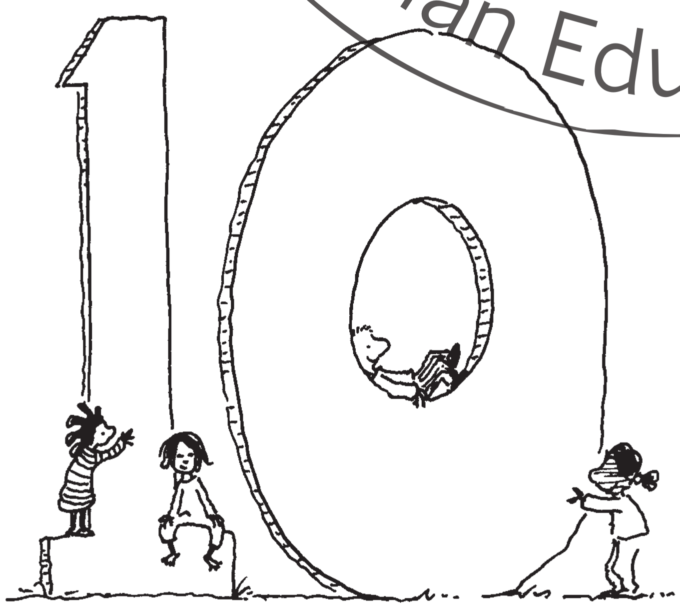
Help students to locate the key words: Two to ten. Three groups adding up to the same total.

Ask students if they can see a similarity to the question asked in **BLM 15**. Can they use this similarity to assist them with this task?

Read the second part of the problem: 'Do the same thing for the numbers 3–11.'

Locate the key words: Three to 11. Three groups of three numbers with the same total.

Again, ask students to use the information from the previous task to help find a pattern.



BONDING TO THE NUMBER 10

Group Work

What you need: nine numeral cards

Use your numeral cards numbered from 1–9 to make three groups of three numbers that will add up to the same total.

	+		+		=
	+		+		=
	+		+		=

Now take away the 7, 8 and 9 cards. Can you make three equal groups with the remaining cards? List the groups here.

	+		=
	+		=
	+		=

Strategies Locate key words Look for a pattern Think logically

99 or Bust

Strategies

- Locate key words
- Assume a solution
- Create a table or chart
- Think logically

Background

Games and an activity-based approach to teaching maths are both highly recommended. They add much needed motivational appeal to the subject and research has clearly demonstrated that primary school students learn very effectively through this process.

The game of **99 or Bust** relies upon previously acquired skills of addition and the ability to multiply by ten, and utilises several problem solving strategies.

Resources:

- one six-sided die
- calculators

Orientation

Teach students how to play **99 or Bust**. The students take turns to roll a standard six-sided die seven times. The numbers that are rolled can be taken as either face value or ten times face value at any time. For example, if a three is rolled, it can be taken as either three or 30.

The winner of the game is the player who, after all seven rolls, is the closest to 99. If a player goes over 99, they lose the game. Encourage students to record their results on a table and to use a calculator if necessary.

Challenge a student to a game of **99 or Bust** in front of the class. This will allow you to demonstrate the structure of the game, to ensure that all students understand the rules and, most importantly, to explore the invaluable mathematics that arise. When one of the players is, for example, on 94 with one roll to go, ask what the chance is of reaching 99.

If you are on 91 after your seven rolls and your opponent is on 84 with one roll left, ask which number your opponent will need to win. What is the chance of this number being rolled?

Ask students if they think that this game is one of pure luck, pure skill or a combination of the two. Why do they think so?

Let students play in pairs until they understand the game thoroughly.

Guided Discovery with BLM 16

BLM 16 presents students with a mock game of **99 or Bust** and asks them to make judgements concerning the rolls that have taken place.

Read the question with the class, then help students to locate the key words: Fill in the totals to make 99.

The strategy of assuming a solution should be employed at this point and logic applied. Ask the students, roll by roll, which decision is the more sensible from the point of view of probability. If, for example, the first roll of six is taken as 60, why is it not sensible to take the next roll of three as 30? If the first three rolls are taken as six, three and two, is it possible to end up with 99?

Further Exploration

Task Card 16

This task card further develops the skills used in **BLM 16** and presents students with a variation and a challenge that will enable them to form conclusions based on pattern recognition.

Read the question with the class: 'Here is a slightly new way of playing **99 or Bust**. It uses a ten-sided die. How could Elisa score 99 from these rolls? There is more than one way of reaching 99. See if you can find more than one answer.'

Locate the key words: 10-sided die. Score 99. More than one way.

Encourage students to use trial and error as well as logical thinking when completing this task. After each roll, ask the students why they have made their decisions. Why must the first roll be taken as ten and not 100? If the first four rolls are taken as ten, seven, two and eight, equalling 27, why can't 99 be achieved?

Name Date **BLM 16**

Here is a table showing Felicity's game of **99 or Bust**.

She scored the perfect 99.

Can you fill in her totals to see how she made 99?

ROLL	RUNNING TOTAL
6	
3	
2	
6	
4	
5	
1	99

Here is another table showing the next game Felicity played.
Can you see how she made 99 this time?

ROLL	RUNNING TOTAL
4	
6	
5	
2	
3	
5	
2	99

Strategies Locate key words · Assume a solution · Create a table or chart · Think logically

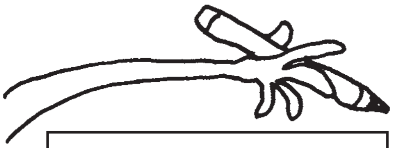
All the

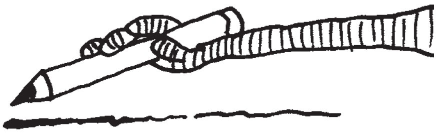
Task Cards

You Need

Problem Solving Task Card 1

Gridlock



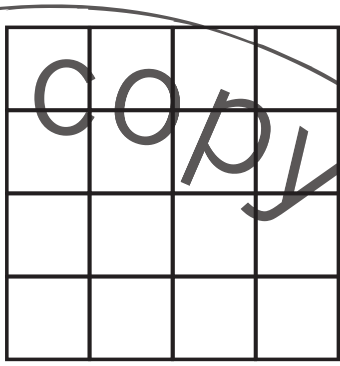


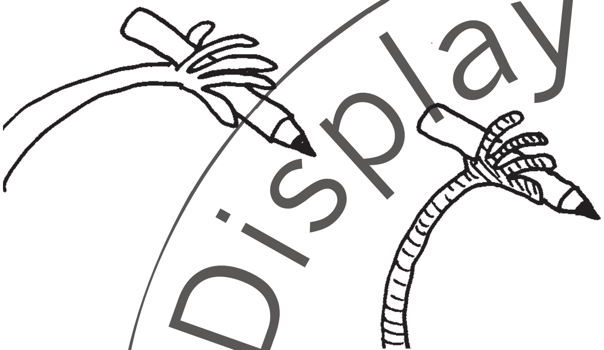
What you need:

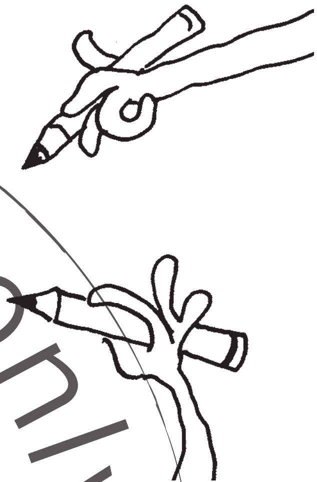
- paper
- coloured pencils

How many squares can be found on this 4 x 4 square?

Copy this onto a piece of paper and highlight the different squares.







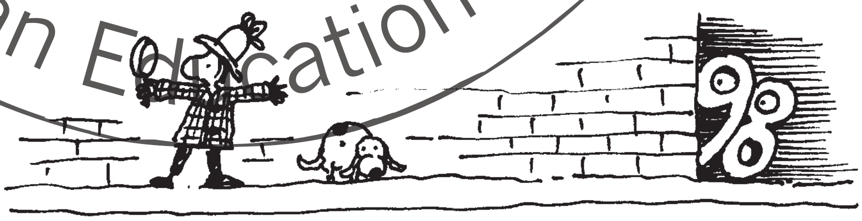
Problem Solving Task Card 2

Number Hunt

What you need:

- pencil and paper to record your results

This is a new way of showing numbers on a grid. Can you see which column 99, 100 and 98 will be found in?



A	B	C	D	E	F	G	H	I	J	K
5	8	10	3	9	1	4	6	2	11	7
16	19	21	14	20	12	15	17	13	22	18
27	30	32	25	31	23	26	28	24	33	29

Problem Solving Task Card 3

Three's a Crowd

What you need:

- pencil
- paper

How many times would the digit 3 appear on a digital clock between the hours of 2:59 and 4:00? Draw up a table like this one to help you work it out.

UNITS OF HOURS	TENS OF MINUTES	UNITS OF MINUTES

Problem Solving Task Card 4

Dicey Chances

What you need:

- pencil
- paper

Pretend that you are the teacher in a game of **Two Dice Roll**.

Write down three instructions that will give both sides of the room the same chance.

Write down three instructions that will be in favour of one side of the room over the other.

Write down three instructions that will only give one side of the room a chance of winning.

PROBLEM SOLVING TASK CARD 5

Secret Numbers

WHAT YOU NEED:

- pencil
- paper

Pretend you are the teacher in a game of **What Number Am I?**

Write down a three-digit number, and then take questions from the class. See how quickly they can find the number.

PROBLEM SOLVING TASK CARD 6

Scoring Shots

WHAT YOU NEED:

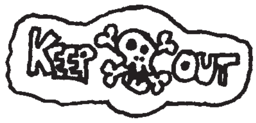
- calculator
- pencil and paper

In a recent cricket match, Basher Bullman scored 66 runs, all in sixes and fours. He made only 12 scoring shots.

How many sixes and how many fours did Basher score?

Problem Solving Task Card 7

Stupendous Stickers



What you need:

- pencil
- paper

Olivia's collection of stickers is growing very large. She won't tell how many stickers she has. Here are some clues she gave.

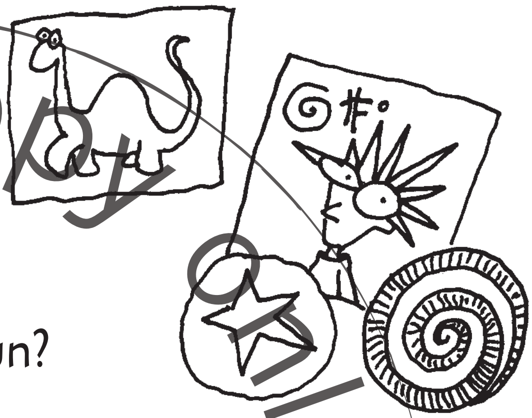
The number has three digits.

All the digits are odd.

The tens digit is a one.

The ones and the hundreds differ by four.

How many stickers could Olivia own?



Problem Solving Task Card 8

40-Card Shuffle

What you need:

- 40 playing cards
- pencil and paper

Last time I played 40-Card Shuffle I won twice as many cards as Emma.

Emma won twice as many cards as Paris.

Paris won one more card than Liam.

Liam won three more cards than Michael.

Michael won one card.

How many cards did each player win?

Problem Solving Task Card 9

Perfect Pentominoes

What you need:

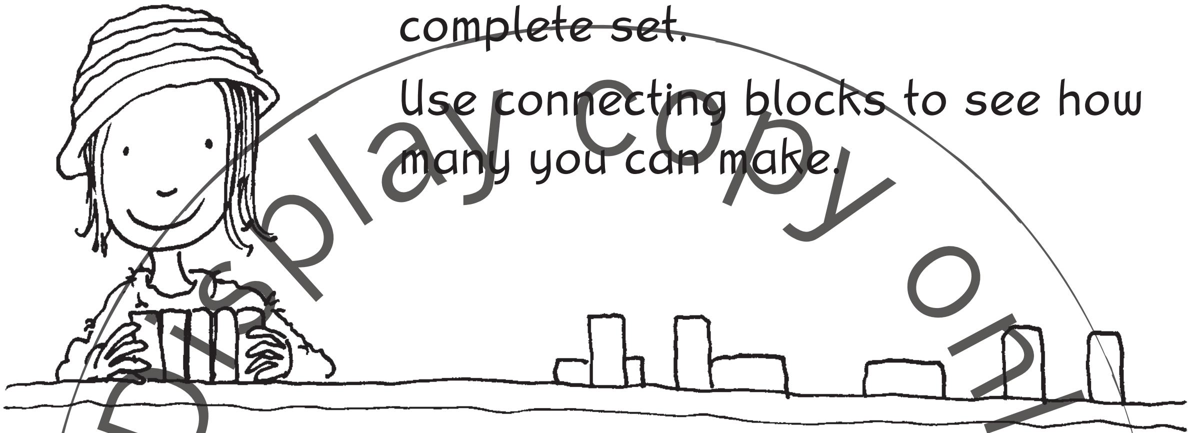
- 60 connecting blocks

When five blocks are connected together, they are called a pentomino.

Like Quadleys, pentominoes are flat.

There are 12 pentominoes in the complete set.

Use connecting blocks to see how many you can make.



Problem Solving Task Card 10

Multiple Multiplications

What you need:

- calculator
- pencil and paper

Use the digits 3, 9, 8 and 2 to make as many different 2 × 2 digit multiplication sums as you can.

Use your calculator to find the answers to these questions.

Which question gave you the biggest answer?

Now use 1, 7, 3 and 5 to do the same thing.

Is there a pattern?

Problem Solving Task Card 11

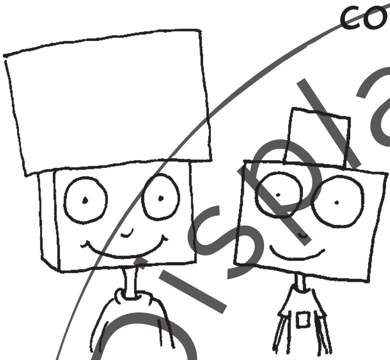
Face to Face

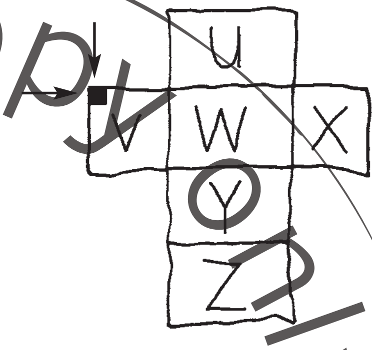
What you need:

- pencil and paper
- ruler

At each corner or vertice of any rectangular prism, three edges and three faces will always meet.

Which three faces will meet at the point marked on this net when it is constructed?





Problem Solving Task Card 12

Four Signs

What you need:

- calculator
- pencil and paper

Use the number 4 four times, and any maths signs you know, to make equations that equal these amounts. Write your equations on a separate piece of paper.

0 =	16 =
4 =	24 =
5 =	44 =
8 =	52 =
14 =	88 =

PROBLEM SOLVING TASK CARD 13

On Your Marks...

WHAT YOU NEED:

- pencil and paper

Mr Smith marks projects out of ten points.

This year John completed four projects and scored 38 out of a possible 40 points.

On a piece of paper, list ten ways that John's projects could have been marked.

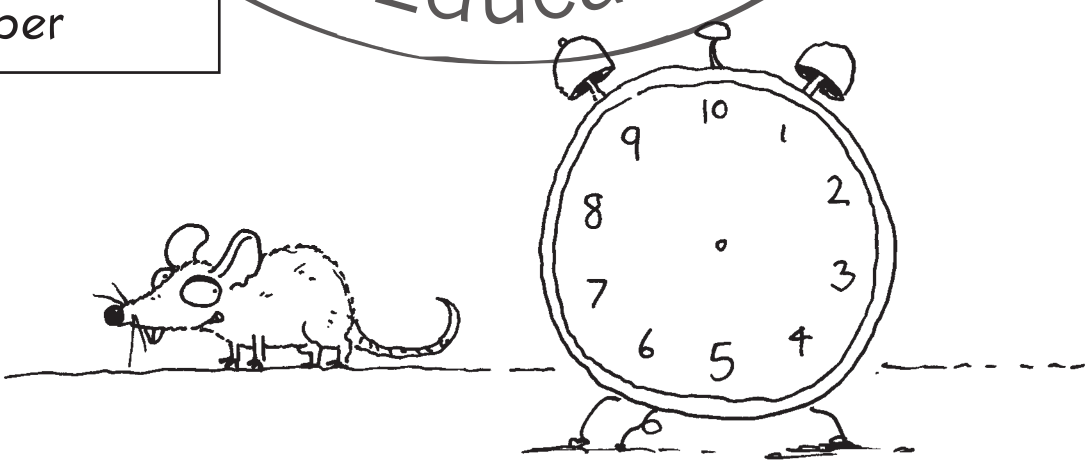
PROBLEM SOLVING TASK CARD 14

Half Time

WHAT YOU NEED:

- ruler
- calculator
- pencil and paper

This unusual clock face has to be divided into two parts with a straight line. The line must be placed so that the two parts, when added up, are as close as possible in value. How can this be done?



Problem Solving Task Card 15

Totally Equal

What you need:

- 10 small pieces of paper numbered from 2–11

Use the numbers 2–10 to make three groups of three numbers that add up to the same total.

Do the same for the numbers 3–11.

Problem Solving Task Card 16

Clever Rolls!

Here is a slightly new way of playing **99 or Bust**. It uses a ten-sided die.

How could Elisa score 99 from these rolls?

There is more than one way of reaching 99.

See if you can find more than one answer.

ROLL
10
7
2
8
4
4
1

What you need:

- pencil and paper to record the running totals

All the ANSWERS You Need

Blackline Masters

BLM 1: Squares in Squares in Squares

1 + 4 + 9 = 14 squares

BLM 2: Good Thinking, 99

A	B	C	D	E	F	G	H	I
2	7	4	9	1	8	3	5	6
11	16	13	18	10	17	12	14	15
20	25	22	27	19	26	21	23	24
29	34	31	36	28	35	30	32	33
38	43	40	45	37	44	39	41	42
47	52	49	54	46	53	48	50	51
56	61	58	63	55	62	57	59	60
65	70	67	72	64	71	66	68	69
74	79	76	81	73	80	75	77	78
83	88	85	90	82	89	84	86	87
92	97	94	99	91	98	93	95	96
101	106	103	108	100	107	102	104	105

BLM 3: Digital Fives

5 will appear 16 times : 2:05, 2:15, 2:25, 2:35, 2:45, 2:50, 2:51, 2:52, 2:53, 2:54, 2:55 (two appearances), 2:56, 2:57, 2:58, 2:59

BLM 4: Two Dice Roll

1. B (21/36 chance)
2. B (30/36 chance)
3. B (27/36 chance)
4. Either A or B.
5. Either A or B.
6. B (21/36 chance)
7. B (30/36 chance)
8. B (20/36 chance)
9. B (34/36 chance)

BLM 5: What Number Am I?

Range	Possible Answers
100–999	900
501–999	499
501–749	249
600–749	150
700–749	50
700–709, 720–729, 740–749	30
740–749	10
740–745	6
740, 741, 742, 743, 745	5
741, 743, 745	3
741	1

BLM 6: Hooptime

Sunnyvale scored 7 three-point, 7 two-point and 7 one-point goals.

Their opponents scored 6 three-point, 6 two-point and 6 one-point goals.

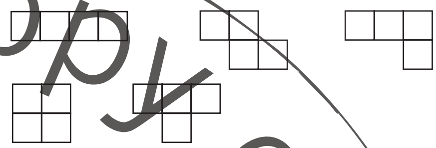
BLM 7: Where Do I Live?

I live at 72 Hillview Crescent.

BLM 8: Domino Delight

I made 80 dominoes fall.

BLM 9: Quadley Quest



Names and uses will vary.

BLM 10: Multiplying Big Time

Part 1

37 x 9 = 333

39 x 7 = 273

73 x 9 = 657

79 x 3 = 237

93 x 7 = 651

97 x 3 = 291

The biggest answer was to the question 73 x 9.

Part 2

24 x 8 = 192

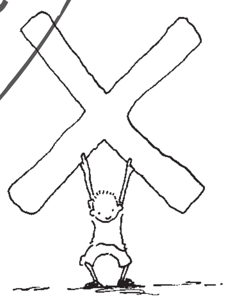
28 x 4 = 112

42 x 8 = 336

48 x 2 = 96

82 x 4 = 328

84 x 2 = 168



The biggest answer was to the question 42 x 8.

The pattern is that the biggest product will always be created by multiplying together the second and third largest digits by the largest.

BLM 11: On the Net

Face F.

BLM 12: 1, 2, 3, 4

Some answers could be:

0 = 1 + 2 – 3 x 4

1 = 1 x 2 + 3 – 4

2 = 1 + 2 + 3 – 4

3 = 1 + (2 x 3) – 4

4 = 1 + 2 – 3 + 4

5 = (1 + 2) x 3 – 4

6 = 1 – 2 + 3 + 4

7 = 1 x 2 + 3 + √4

8 = 1 x 2 x 3 + √4

9 = 1 x 2 + 3 + 4

10 = 1 + 2 + 3 + 4

BLM 13: A Testing Time

2 2 0

2 0 2

0 2 2

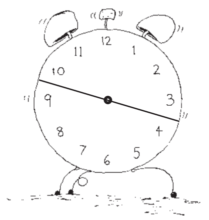
2 1 1

1 2 1

1 1 2

BLM 14: Splitting the Dial

The two halves add up to 39, which is half of the total of one to 12.



BLM 15: Group Work

7, 6, 2 = 15	6, 1 = 7
8, 4, 3 = 15	5, 2 = 7
9, 5, 1 = 15	3, 4 = 7

BLM 16: 99 or Bust

Roll	Running Total	Roll	Running Total
6	60	4	40
3	63	6	46
2	83	5	51
6	89	2	71
4	93	3	74
5	98	5	79
1	99	2	99

Task Cards

Task Card 1: Gridlock

1 + 4 + 9 + 16 = 30 squares

Task Card 2: Number Hunt

99 = column J

100 = column F

98 = column C

Task Card 3: Three's a Crowd

3 will appear on 76 occasions: 60 times in the units of hours place, ten times in the tens of minutes place and six times in the units of minutes place.

Task Card 4: Dicey Chances

Answers will vary

Task Card 5: Secret Numbers

Answers will vary

Task Card 6: Scoring Shots

Basher scored 3 fours and 9 sixes.

Task Card 7: Stupendous Stickers

Olivia could have 115, 317, 511, 519, 713 or 915 stickers in her collection.

Task Card 8: 40-Card Shuffle

I won 20 cards.

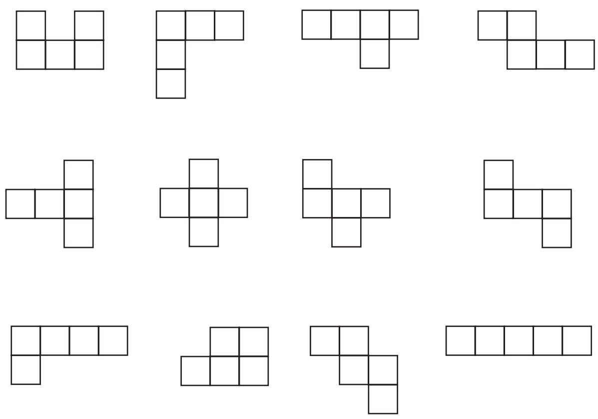
Emma won ten cards.

Paris won five cards.

Liam won four cards.

Michael won one card.

Task Card 9: Perfect Pentominoes



Task Card 10: Multiple Multiplications

Part 1

23 x 89 = 2047	32 x 89 = 2848
23 x 98 = 2254	32 x 98 = 3136
28 x 39 = 1092	82 x 39 = 3198
28 x 93 = 2604	82 x 93 = 7626
29 x 38 = 1102	92 x 38 = 3496
29 x 83 = 2407	92 x 83 = 7636

The biggest product was for 92 x 83.

Part 2

13 x 57 = 741	31 x 57 = 1767
13 x 75 = 975	31 x 75 = 2325
15 x 37 = 555	51 x 37 = 1887
15 x 73 = 1095	51 x 73 = 3723
17 x 35 = 595	71 x 35 = 2485
17 x 53 = 901	71 x 53 = 3763

71 x 53 gives the biggest product.

The general rule is that the biggest product will always be obtained by multiplying together the biggest and smallest digits by the second and third biggest digits.

Task Card 11: Face to Face

Faces U, V and Z.

Task Card 12: Four Signs

0 = 4 + 4 – 4 – 4

4 = 4 + 4 – √4 – √4

5 = $\frac{4}{4}$ + √4 + √4

8 = 4 x 4 – 4 – 4

14 = 4 + 4 + 4 + √4

16 = 4 + 4 + 4 + 4

24 = 4 x 4 + 4 + 4

44 = 44 + 4 – 4

52 = 44 + 4 + 4

88 = 44 + 44

Task Card 13: On Your Marks ...

8	10	10	10
10	8	10	10
10	10	8	10
10	10	10	8
9	9	10	10
9	10	9	10
9	10	10	9
10	9	9	10
10	9	10	9
10	10	9	9

Task Card 14: Half Time

There are two answers, both differing by five.

Task Card 15: Totally Equal

Part 1	Part 2
8, 7, 3 = 18	9, 8, 4 = 21
9, 5, 4 = 18	10, 6, 5 = 21
10, 6, 2 = 18	11, 7, 3 = 21

Task Card 16: Clever Rolls!

Roll	Running Total	Roll	Running Total
10	10	10	10
7	17	7	80
2	37	2	82
8	45	8	90
4	85	4	94
4	89	4	98
1	99	1	99

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