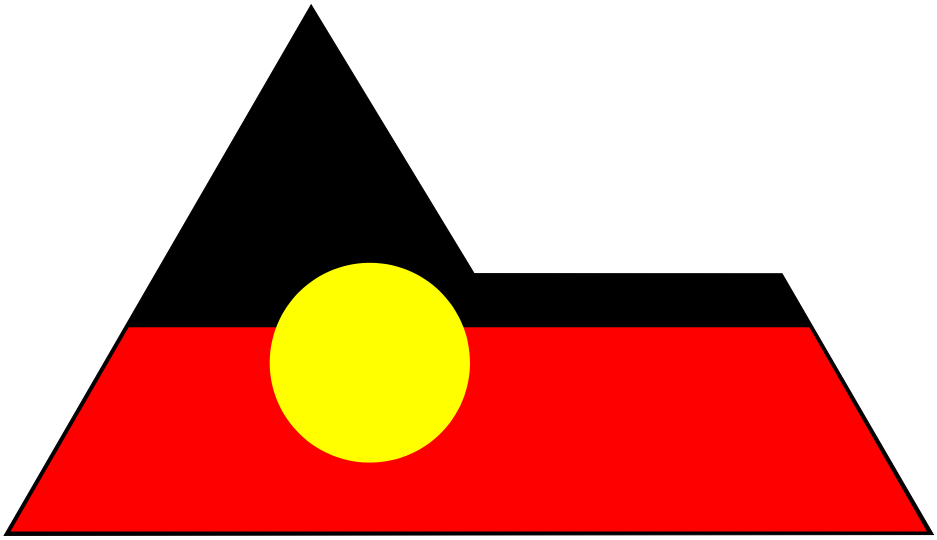
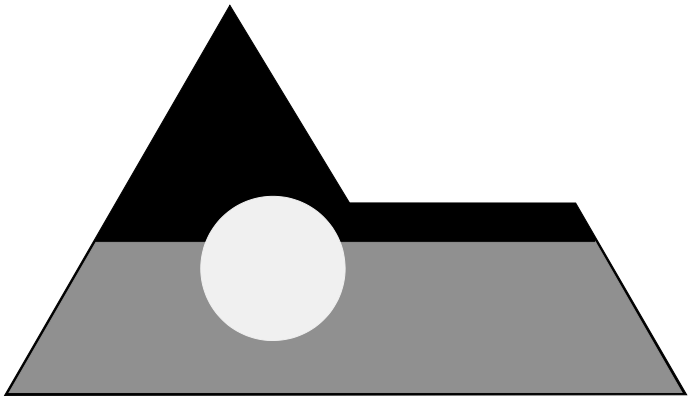


Mathematics Task Centre

TEACHERS' HANDBOOK

Hands-on Problem Solving Tasks
and
Professional Development

www.mathematicscentre.com
Mathematics Task Centre is a division of Mathematics Centre which is managed by
Black Douglas Professional Education Services, 4/71 Greenhill Road, Bayswater North, Australia 3153



Mathematics Task Centre

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Manual revised 2017

Charles Lovitt & Doug. Williams

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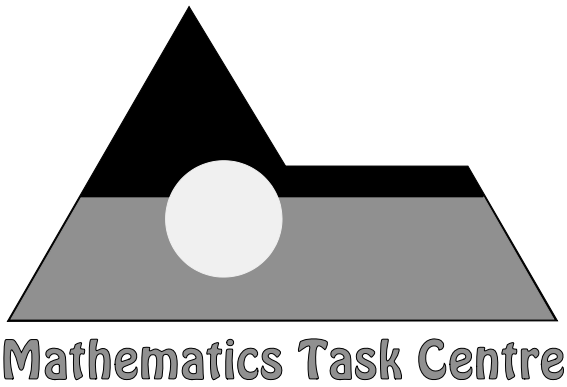
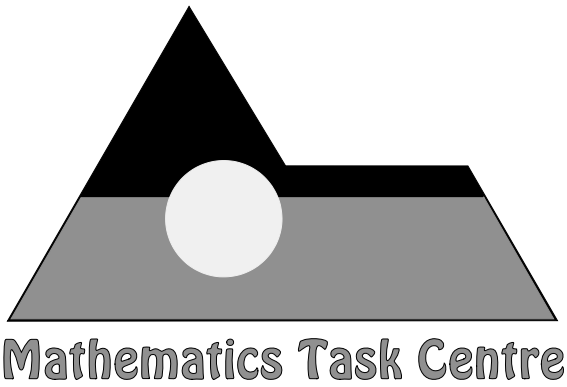


Section A

TASK CENTRES IN SUMMARY



Introduction

Problem solving task centres have much to offer a school mathematics program. They are an important component of the overall mathematics education picture.

Tasks offer the invitation to pairs of students to work like a mathematician.

When tasks are used in partnership with lessons in which:

- the process of Working Mathematically is modelled in a whole class investigation
- the skills of a mathematician are practised

all students can learn to work like a mathematician.

To support the establishment and integration of tasks into the school's mathematics program, this Handbook provides some thoughts on:

- background and history of tasks
- purposes and potential advantages
- experiences and opinions of others
- implementation strategies

Section A (p.1) may be used by your consultant to guide the professional development day which is available to support the introduction of tasks. However, Task Centres are multi-dimensional entities and becoming comfortable with tasks and their use is an on-going growth process.

Section B (p.21) supports this growth with more extensive detail.

Many schools and teachers contributed to the compilation of the original form of this handbook. In particular, thanks to the many schools in the Northern Territory which participated in generation of early drafts and to:

- Steve Flavel
- Kim Leech
- Charles Lovitt
- Lucy Nin
- Faith Hill
- Michael Richards
- Gina Silis
- Anneliese Vogl
- Doug Williams
- Michael Ymer

Other teachers and schools since have continued to add to this knowledge. You can keep up to date by registering for Mathematics Centre eNews:

- mathematicscentre.com/news.htm

We also welcome your contribution to the knowledge stored on site.

What Is A Task Centre?

For additional information visit:
mathematicscentre.com/taskcentre/what.htm

Physical Description

A Task Centre is a collection of individually housed mathematics problems (or tasks) that require the use of concrete materials (housed with the problem) to solve or make a start to the problem. Some students may not need the materials to solve the problem; but if the materials are not present many students would be prevented from accepting the challenge.

Multiple Intelligence theory tells us there is a range of preferred learning styles in any classroom. Tasks are tactile, kinaesthetic, visual and encourage interpersonal skills, therefore they encourage many more students to become excited about mathematical challenges than is the case through a curriculum embedded in text and exposition.

A Task Centre is a special room in the school, or a designated section of an individual classroom, that displays a selection of tasks. It is more than a storeroom. It is an access centre which allows the tasks to become part of the curriculum in an integrated and purposeful way. A Task Centre may offer a library of several hundred tasks.

Originally tasks were made by teachers, either individually, or in teams. The Mathematics Task Centre Project (1992-2011) encouraged teachers to continue that tradition wherever possible, but over this time it also developed a collection of 241 prepared tasks so that teachers' attention could be more on the teaching craft related to using them than on the labour of preparing them. These tasks were completely rewritten by Mathematics Task Centre in 2011 to encourage teachers to engage even further with professional growth aspects of improving learning. The Mathematics Task Centre is therefore 100% focussed on professional development.

In 2017 tasks were adapted to be delivered through the web as eTasks. All print materials were supplied in an eTask Package. Teachers added materials to create each task, mainly from the stock expected in a reasonably resourced maths department. In a sense this was the wheel turning full circle, but the Mathematics Centre web site now provided 40+ years of support information that wasn't originally available - solutions, task cameos, teacher stories, research, assessment information, support documentation, Cube Tube videos and more. The reasons for this development were:

- Expanding the use of the Internet and computer-based technology.
- Increasing material costs and especially labour costs.
- Increasing freight costs.

Storing Tasks

Whether in a designated room, or in a section of a classroom, tasks are commonly stored in sturdy, press-seal bags, or in small plastic boxes. The guiding principle in this decision tends to be whether the tasks are to be moved around the school. Press-seal bags involve less volume if tasks have to be moved. Twenty or more of these can be easily carried to class in a plastic crate. Plastic tubs look better on shelves if the tasks 'have a home'.

Another occasional alternative is hanging bags of the sort often used in libraries. The handles which form part of the hanging design make them easy to carry in handfuls, or hanging from a rod like clothes in a wardrobe.

Tasks are often coded on their container by a sticker system (explained later). Teachers use this as a ready reference to the curriculum strand(s) involved in the task and their connection with Maths300.

How Are Tasks Used?

Task Centres have been established in mainstream primary, secondary and tertiary institutions across the world, in remote Aboriginal schools and in a range of special school environments such as Distance Learning Centres, a school for the deaf and hospital schools.

Tasks are used by pupils from Years K-12 in a variety of settings which vary from school to school. However, any scheme for integrating them has the two-fold purpose of helping teachers continue to develop:

- happy, healthy, cheerful, productive, inspiring classrooms, and
- students who are learning to work like a mathematician

One strategy for integrating tasks includes:

- a regular task time each week
- sessions which begin with a short problem for the whole class
- students choosing the tasks they wish to work on
- students working co-operatively (usually in pairs)
- keeping a record of the investigation which may take several sessions
- teacher and student recording satisfactory completion

Task Centres often include computers to take advantage of Maths300 software which extends many of the tasks. Maths300 offers over 190 stories of investigations in the form of lesson plans which support teachers in modelling how a mathematician works.

Mathematics Centre offers professional development programs to support all of this work and more. A summary of programs can be found at:

- mathematicscentre.com/taskcentre/partners.htm

To build a professional development partnership contact Doug Williams:

- See fly leaf for contact details

Photo Gallery

For more photographs visit:
mathematicscentre.com/taskcentre/photos.htm

A brand new purpose built task centre ready to roll. Lots of storage space.

Lots of flat top space for spreading materials. Even the windows at the back are a problem.

Room too for computers and video and a whiteboard area for tutorials.

A well established centre with hundreds of tasks. Organised and colourful.

A creative teacher with a space problem has solved it with these hang bags.

A task centre on a trolley. Students comfortably working on the floor.

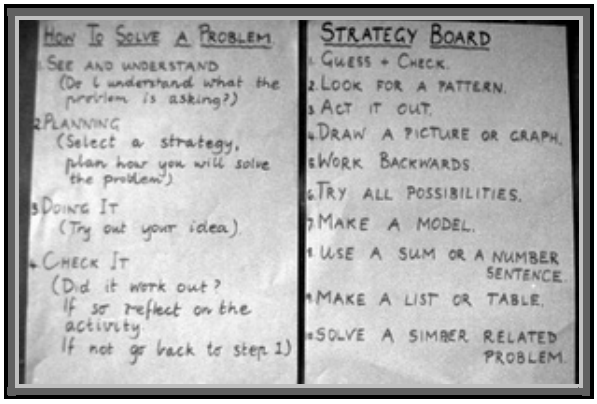
There is a place for photos of the way you use tasks. Please contribute to:
mathematicscentre.com/taskcentre/photos.htm

These are all the pieces. Now we only have to put them together to make a cube.

Infants can use tasks too. Check Infant Tasks:
http://mathematicscentre.com/taskcentre/infant.pdf.

Okay, tell me what you have been doing. How do you know when you have solved it?

The card tells us what the rules are then we write here in our journal.



A mathematician plays with a problem to gather data then dips into a strategy toolbox.

We love our maths tasks. They help us learn to work like a mathematician.

Principles

More information can be found at:
mathematicscentre.com/taskcentre/prin.htm
mathematicscentre.com/taskcentre/iceberg.htm
mathematicscentre.com/taskcentre/icesphinx.htm

Learning From Colleagues

All tasks in the collection have been well trialed in the classroom; some for three decades or more. They *are* fun, but that is not a sufficient condition for including them in the collection. Selection of a good task requires balancing the following principles:

- the task is intrinsically motivating
- the task requires hands-on materials to support its solution
- the intellectual challenge is likely to result in a first level of success in 15 - 20 minutes
- the problem on the card is the *tip of an iceberg*; the beginning of a deeper investigation
- the task has *three lives*:
  - as an invitation for two students to work like a mathematician
  - as a whole class investigation
  - as a deeper investigation guided by an investigation sheet
- the task can be used to illustrate the process of *Working Mathematically*

Hands-on materials are what set tasks apart. The same problem may appear in a text book, but when presented as a task the materials invite students to become involved. Some students (and teachers) may choose to tackle the problem without using the materials; however, many students (and teachers) may not be able to begin the problem at all *unless* the materials are present. In this way tasks contribute to an inclusive atmosphere in the classroom and broaden access to mathematics.

Iceberg Information

Swedish teachers refer to tasks as *Mattegömmor*, which means 'a place where mathematics is hidden'. Teachers need to become familiar with this depth, and are supported to do so. Task 166, Sphinx, has been extensively documented to illustrate these principles (see link above). It highlights the process of working like a mathematician, which is a successful framework for planning, implementing and assessing a mathematics curriculum.

Every task has additional Task Cameo information (see the iceberg link above) and Maths300 offers more in its whole class investigations. Membership of Maths300 is recommended to support the use of tasks.

- maths300.com

Working Mathematically

For more information visit:
mathematicscentre.com/taskcentre/work.htm

First give me an interesting problem.

When mathematicians become interested in a problem they:

- Play with the problem to collect & organise data about it.
- Discuss & record notes and diagrams.
- Seek & see patterns or connections in the organised data.
- Make & test hypotheses based on the patterns or connections.
- Look in their strategy toolbox for problem solving strategies which could help.
- Look in their skill toolbox for mathematical skills which could help.
- Check their answer and think about what else they can learn from it.
- Publish their results.

Questions which help mathematicians learn more are:

- Can I check this another way?
- What happens if...?
- How many solutions are there?
- How will I know when I have found them all?

When mathematicians have a problem they:

- Read and understand the problem.
- Plan a strategy to start the problem.
- Carry out their plan.
- Check the results.

A mathematician's strategy toolbox includes:

- Do I know a similar problem?
- Guess, check and improve
- Try a simpler problem
- Write an equation
- Make a list or table
- Work backwards
- Break the problem into smaller parts
- Act it out
- Draw a picture or graph
- Make a model
- Look for a pattern
- Try all possibilities
- Seek an exception
- ...

If one way doesn't work I just start again another way.

Mathematics Task Centre

Task Centre History

Task Centre history:
mathematicscentre.com/taskcentre/what.htm
mathematicscentre.com/taskcentre/tenth.htm

Beginnings

No account of task centres could begin without considering the rise of two related developments in mathematics education, namely activity based learning and problem solving.

- 1970s: Activity based learning
- 1980s: Problem solving

Task centres blend these two teaching/learning strategies.

In the early 1970s, influenced by Piaget and Dienes, and also the UK Nuffield Project, much effort and energy went into exploring activity based learning coupled with the uses and benefits of concrete materials. Groups such as SGML (Study Group for Mathematics Learning) ran workshops around Australia.

One outcome was a stage of developing and running the 'mathematics laboratory'. These were special sessions run in a special room of the school where the exploratory instincts of learners could be encouraged. Attempts were made to integrate laboratory work with the 'real stuff' that took place in regular classes. However the system was not ready for the full integration of these approaches because the supportive theory of learning was not fully articulated and insufficient opportunities were created for enough teachers to experience these laboratory sessions. Yet the learning was not lost and many aspects of these endeavours have slowly permeated regular teaching.

In Melbourne, several schools were very active in these approaches. Yarra Valley Anglican School and Elwood, Ferntree Gully, and Pembroke High schools were leaders in this field. Much of the work of their staffs is recorded in the December Conference books of the Mathematical Association of Victoria (MAV) from this decade.

Another useful reference is:

A Mathematical Obstacle Course
Neville de Mestre
The Australian Mathematics Teacher, Vol 31, No 1 (1975)

In the early 1980s, the problem solving thrust gained momentum and respectability through such policy documents as the Cockcroft Report (UK, 1982), The NCTM Agenda For Action (USA, 1989), and the Australian Mathematics Education Program (AMEP). Each of these promoted, with theoretical and system support, the virtues of problem solving as part of a

well rounded comprehensive education. This emphasis developed from a growing conviction that rote learning of algorithms and skill oriented curricula would not adequately provide pupils with necessary basic learning and preparation for adult life and further studies. 'Learning how to learn' gained a place in the newly defined set of basic skills.

These two emphases come together in the characteristics of problem solving task centres. From 1992-2011, the Mathematics Task Centre Project strengthened this work further by presenting tasks as an invitation to students to work like a mathematician.

From Special Centre to Individual Classroom

After at least a year of planning and preparation, the first Task Centre opened its doors to its first class of eight year olds in March 1977. The ACT Mathematics Task Centre, Canberra, Australia was the brain-child of Neville de Mestre, who chose Bea Duncan as the first 'task centre teacher'. (Read more at: mathematicscentre.com/taskcentre/tc_begin.htm)

Success breeds success, and during the 1980s many Task Centres were started across Australia. Some were within a school as a special room; in other cases special regional centres were established. One centre in Brunswick, Melbourne, had hundreds of boxes and full time specialist staff. District centres transported children in for regular timetabled mathematics sessions, again a derivation of the ACT Task Centre experience.

The separation of such centres from regular classes impeded the integration of the learning benefits into the regular program. Since the arrival of the Mathematics Task Centre Project, and now continuing through Mathematics Centre, the momentum has been towards planned use of tasks and whole class investigations to help students learn to work mathematically. When offered to a pair of students the tasks are an invitation to work like a mathematician. When a teacher 'pops one under their arm' and takes it to class to generate a whole class investigation, the process of working like a mathematician is modelled.

The ACT centre closed in 1990, but most of its activities survive within the National Science and Technology Centre exhibitions. At times these have been 'on the road' travelling Australia within the Questacon Maths Squad.

Cameos & Task Dossiers

More information in the Task Cameo link at:
mathematicscentre.com/taskcentre/iceberg.htm

The purpose of a collection of tasks is to encourage deeper mathematical investigation. Using them is certainly not a race to 'do' every task. To support teachers in encouraging students to work like a mathematician, Mathematics Centre provides an expanding collection of information about particular tasks through the Task Cameos link.

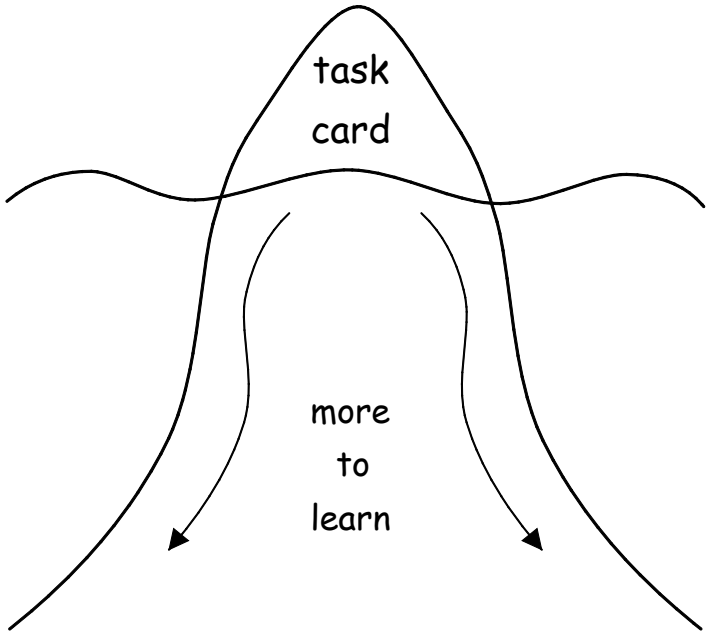
- mathematicscentre.com/taskcentre/iceberg.htm

Staff-developed dossiers which start from Cameos and add local knowledge and experience will be vital to successfully using tasks. The Library Kit link (which encourages maths around the kitchen table) and Maths300 have additional information about some tasks.

- mathematicscentre.com/taskcentre/library.htm
- maths300.com

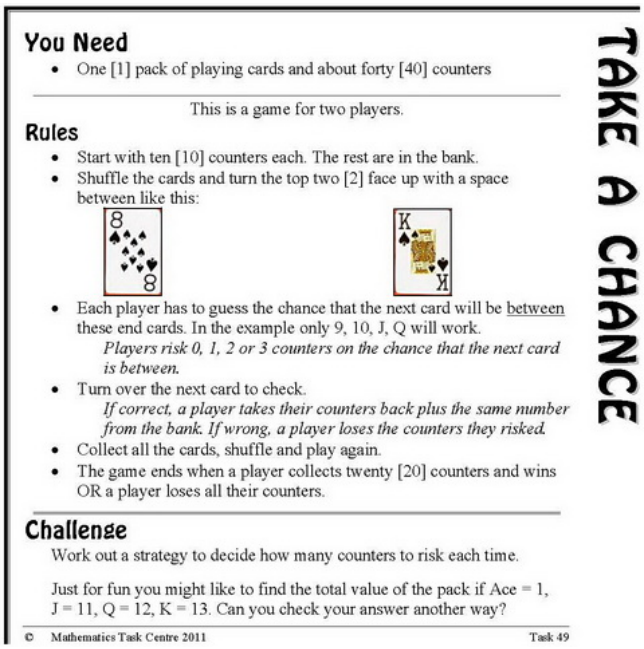
Given broadband web access, the most efficient way to build these dossiers may be electronically on the school Intranet with live links to the sites mentioned. Staff (and students?) can then readily access from their desktop or wireless laptop computer.

Sample dossier notes for *Take A Chance* appear on Pages 12 - 13. A Word document with this format is also available at the Iceberg Information link above. In this form the document can be edited, so it may be a starting point for your own dossier files. Alternatively, use the model of the Cameos and link directly to each one in your set from your Intranet. Add comments on your site, or if they might be useful others, contribute to the cameo.



TAKE A CHANCE

Because this is a game, the students take to it readily. As they play, they make judgements based on their intuitions of what is likely. The task then becomes an introduction to a discussion of probability.



TAKE A CHANCE

You Need

- One [1] pack of playing cards and about forty [40] counters

This is a game for two players.

Rules

- Start with ten [10] counters each. The rest are in the bank.
- Shuffle the cards and turn the top two [2] face up with a space between like this:

- Each player has to guess the chance that the next card will be between these end cards. In the example only 9, 10, J, Q will work.
  Players risk 0, 1, 2 or 3 counters on the chance that the next card is between.
- Turn over the next card to check.
  If correct, a player takes their counters back plus the same number from the bank. If wrong, a player loses the counters they risked.
- Collect all the cards, shuffle and play again.
- The game ends when a player collects twenty [20] counters and wins OR a player loses all their counters.

Challenge

Work out a strategy to decide how many counters to risk each time.

Just for fun you might like to find the total value of the pack if Ace = 1, J = 11, Q = 12, K = 13. Can you check your answer another way?

© Mathematics Task Centre 2011 Task 49

MATHEMATICS CONTENT

- Recognise and use patterns in number.
- Make statements about likelihood.
- Estimate and calculate probabilities in a practical situation.
- Systematically list possible outcomes, deduce probability and test predictions experimentally.

LEARNING FEATURES

- Game situation.
- Intuitive concept development.
- Language of chance.
- Prediction based on past events.
- Connecting with many homes through the use of a deck of cards.

ANSWER

- The total value of the deck is 364, but the interest is in the counting strategies the students use to arrive at this answer. For example, who pairs the cards to make fourteens (A/K, 2/Q, 3/J) etc.)? Who adds the terms of the sequence 4, 8, 12, ..., 52? Who adds one suit, then multiplies by four? Who uses a calculator? But, perhaps most of all, who asks and applies the mathematician's question, *Can I check this another way?*.

- The second part of the task is a game and has no actual answer. Its value is in the intuitive use of the language and concepts of chance which it generates, and in following the student's experiences with a discussion.

  A proven method of promoting this discussion is to play the game with the teacher as dealer for everyone. Discs or counters can still be used , but if there are insufficient, a points system can be used. The children work in pairs, checking each other, until one person scores 20 points.

  Scoring could be one point for a win, and zero for a loss. This is also an alternative procedure if it is believed that the use of discs is too closely allied to gambling.

TEACHERS' COMMENTS

- *Playing with cards reminds my children of things they do to relax when they are on holidays or staying at their grandparents'.*
- *Students soon develop a notion of a 'good chance'. When this becomes evident I ask them about the clues which help them decide.*
- *This is a fun activity and by the time I use it to generate a class investigation, it has already helped to develop a positive attitude to the use of mathematics.*
- *Although the students are really playing against the card pack rather than a person, I always pair them up to play this game because using the counters generates so much discussion.*

EVALUATION / ASSESSMENT

- Ask students to explain the 'betweens' they would definitely bet on and the ones they wouldn't.

EXTENSIONS

- In class discussion the teacher can set up any of the situations ranging from 'zero possible cards between' to 'eleven possible cards between'. The students can then be surveyed for the number of discs they would risk in the given situation, This produces interesting first hand data. These intuitive responses can then be checked against the calculated probabilities. For example if the two end cards are 4 and 10, there are 20 cards in the remaining 50 which could produce a win. This is a chance of 2 in 5 of winning. How many students are prepared to take a risk against those odds?

- Another form of investigation involves fixing one 'between' situation, eg: (4, 10) as above, and running many trials to compare the experimental probability with the calculated probability. How many trials does it take before the experimental probability approaches the theoretical value?

- Some children at one school fete set up a 'Between' stall. They used the cards 5 and Queen as the 'ends' all the time. The deck was always shuffled before each play. Players paid 50¢ to turn up the top card. If it was between they got their money back. If it was not between they lost their money. Do you think the stall would have made money for the school?

RELATED TASKS / REFERENCES

- Dice Differences , Task 34
- Diamonds & Rectangles, Task 40
- First Down The Mountain, Task 87
- Crazy Animals, Task 102
- 12 Counters, Task 117
- Highest Number 1, Task 127
- Highest Number 2, Task 128
- Win At The Fair, Task 133
- Game Show, Task 162

Teacher Stories 1

Many more stories in the Research & Stories link at:
mathematicscentre.com/taskcentre/do.htm

Lynn Patterson, USA

- Lynn has used the tasks for many years and sometimes runs task centre workshops for colleagues.

Upon reflection, I am amazed at just how universal the tasks are; that they can indeed meet the math needs of such a variety of grade levels and cultures.

In a conversation regarding the workshop I was asked the following questions:

> Question*: Who was the workshop for?*
>
> Answer: *High school and middle school teachers.*
>
> Question: *Don't you teach elementary?*
>
> Answer: *Yes, but the tasks reach all grade levels and have different depths of understanding depending upon the developmental or academic needs of the group. They provide extensions and challenges for all grade levels.*
>
> Question*: Did you say the workshop was for Native American students and don't you teach average middle income socio-economic students?*
>
> Answer: *Well, the tasks have been proven to work with Aboriginal students in Australia ... so they work in all cultures including Native American math students in Wisconsin. That is why the teachers are interested in learning how to use the tasks ... for motivation and connections and to, of course, simply improve mathematical understanding for their students. And the tasks are just so engaging!*

Isn't this fascinating?? I am in awe of the 'power of tasks'; the way they can engage and connect the learner.

Gerry Harkins, Scotland

- Gerry returned to Scotland from exchange in Australia full of enthusiasm and has since established a Task Centre in his own school, run conference sessions and published about tasks.

(I) ... looked at a number of developments which have taken place in mathematical teaching within Australian classrooms over the last ten years and which are now being used within countries all around the world.

Students are now taking a very active role in their mathematical learning and are consequently obtaining a much deeper understanding of the mathematics

involved in their lesson. Teachers have been looking for a new direction in their mathematical teaching and have found a way to both motivate their students and engage them within the classroom.

I experienced this for myself whilst on Teacher Exchange within Victoria, Australia. As I remember with delight my various adventures from Perth to Sydney and from Darwin to Alice Springs to Adelaide, I also recall observing a class of S2 students (Grade 8) becoming totally engrossed in their problem solving tasks one Friday afternoon in Springtime temperatures of 29°C. Period 6 on a Friday has that same gut feeling for everyone around the world and yet these students were enthusiastically involved in their hands on learning and weren't going to stop until they had found the solution to their particular tasks.

Sally Collins, USA

- Sally is a District Math Coordinator in Colorado. She has five elementary schools in her district and has introduced tasks to each through workshops led by Australian consultants.

We had our first study group on Monday. The session will be repeated again on Thursday. I had 15 teachers attend. We looked at the Task 129, *Farmyard Friends*. We extended it out like the questions from the companion Maths300 lesson suggested, and talked for quite a while about the concept of a factorial. This is exactly the type of dialog that I feel is essential for our elementary teachers to support the development of their math background. So anytime we can use the tasks to extend the teacher's math knowledge we are ahead of the game.

Andy Martin, England

- Andy's full report of this Home Lending Project based on tasks can be found at the Research & Stories link above.

This approach to mathematics problem solving continues to surprise me in terms of pupil achievement. ... The work with these pupils, and the outcomes of the parent workshop when we launched the Home Lending Project (using Task 33, *Dominoes*), has inspired me to write an article about the use of dominoes in the classroom. Here for the first time I can include contributions from parents. When working with their child some parents had discovered solutions of which I was unaware. These solutions prompted many pupils to continue to search for answers when they might otherwise have given up.

... pupils did feel quite strongly that their parents ... were learning more from them than they were from their parents! All pupils ... stated that the e-mail buddy aspect kept them interested in the problem once they had reached the frustration phase. ... When the pupils received these from Sweden (with photos attached) it caused greater interest and amazement at the fact that the same equipment was being used somewhere else in the world!

Task Centre or Tasks in Classrooms?

Each school must make this decision for itself. We have seen tasks successfully used in many circumstances. A 'separate room', should it be available, has attracted some criticism for taking maths away from the regular program and classroom (which sometimes is not such a bad idea!).

An argument for a special room is that a place where the whole school collection is housed can be cared for more easily and is available to all. Security and storage areas are factors to consider; a Task Centre room certainly makes it easier to manage these issues. Also, a central location can become a place for teacher workshops, including constructing new tasks, and a place for parents or other helpers to assist in maintenance and preparation.

The most successful of these rooms are an integral part (rather than a separate part) of the school's mathematics agenda. With appropriate display, newsletter input, maths club meetings and parent nights, such a room can provide a focus and an identity for mathematics in the school.

Whether there is a Task Centre room, or tasks used in the classroom, a key element in the integrated use of the tasks seems to be the frequency with which staff deliberately 'pop a task under their arm' and take it to class to generate a whole class investigation.

> *Some of you have worked on this task in the Task Centre. What can you tell me about it?*
>
> ... (List responses.)
>
> *Okay let's work together as mathematicians and see what else we can learn from it.*

This process validates the experiences the students have had with the task; validates the Task Centre as a source of the type of work mathematicians do; validates the tasks as having an 'iceberg'; and models the depth of investigation you want students to eventually reach for themselves. Students come to see tasks more and more as worthy intellectual challenges and less and less as games.

Whatever arrangements are necessary in a particular environment, the important things are that the tasks are accessible.

Many schools have started with a special room until pupils and teachers are comfortable with the concept and then aspects of the centre begin to merge into regular classrooms.

Why Use Tasks?

For additional information visit:
mathematicscentre.com/taskcentre/why.htm

Advantages

Teachers have reported the following range of possible benefits:

- Introduces problem solving to pupils in a light, open, active and enjoyable manner.
- The concrete, active and puzzle features provide encouragement and enjoyment to pupils, creating an enthusiasm for mathematics.
- Creates an environment which encourages verbalisation and discussion of mathematical ideas, both between pupils and between pupil and teacher.
- The range of choice allows pupils to select, or be subtly directed towards, tasks relative to their interest and ability levels without the stigma of competition.
- Systematic development of pupils' problem solving skills.
- The ease with which a true mixed ability group can be taught. This is due to the collection and classification of tasks into a wide coverage of mathematical concepts and difficulty levels.
- Improves co-operation between students when doing maths. The complementary skills of listening, discussing, making decisions and sharing are all valued and encouraged.
- The integral use of concrete materials makes ideas more 'real' and less abstract.
- The deliberate use of physical, tactile and visual experiences enriches the learning environment.
- The alternative teaching style for teachers can be advantageous. Anecdotal evidence strongly suggests that once well organised they are very involving and satisfying experiences for teachers. Certainly the stress related to being 'up front', 'on show' and presumably 'in control' can be greatly diminished. The increased responsibility required of pupils makes the room more of a partnership in learning than a presumed 'expert to non- expert' model.

Some Comments From Evaluations

What I like best about the approach

- Open-ended approach. Discussion generates a lot of language - mathematical and not. Enables children to work at their own pace, promotes group work.

- The enthusiastic parental involvement that has occurred. The increase in the children's confidence. The verbal retelling and co-operation between children.
- New and exciting. Lots of colour and concrete aids. Children's positive attitudes.
- Motivates students. Once they are used to the routine they can work unsupervised. Some problems are unanswerable which is great when students discover this themselves. Enhances divergent thinking.
- They can be used as extra challenges for children who need extension. Benefit of co-operation and communication.
- Students really get involved, it gives them opportunities to work together in a positive setting. Suits all children. They really get excited when they find the solution. Great for parents to join in 'hands on'.
- Self-motivating - pupils give a very positive response. I enjoy watching and listening to students working. Ideal for gifted pupils as well as the mainstream.
- Great stimulus material for children. Excellent for verbalising thought processes. Caters for all children.

Children's comments

- It's not just 2D - you can move 3D things around. You feel you are doing something good.
- It's a fun way of doing maths - if you're stuck on one, you can quit or think harder - or ask someone to help.
- I was doing a really hard one - I felt mad because I couldn't do it. It didn't put me off. I chose another one.
- They're fun - better than the blackboard.
- Some are challenging, interesting, fun. Some are really hard, almost impossible. I'll do them in Year 7.
- My confidence has certainly grown. If you get stuck it won't put you off for life. There's always more.
- We sat down for a whole hour and we had to get help. We booked the same one for next time.

Teachers' comments

- Make sure language is simple and tasks can be read by all children.
- After using the boxes at first, I now need to put more structure by choosing particular tasks to suit a particular maths concept.
- A list of tasks which complement the different topics of the curriculum would be helpful.
- Students must be familiar with working in small groups.
- Matching pupils to the right difficulty level of task.
- It is hard getting pupils to discuss what and how they are doing.
- I had the greatest success with the poster problems - all the class tossing around the same problem.
- Makes teaching maths *lots* more fun - it is a lot more child centred.

- Children are keen to work. They get great satisfaction and their attitudes to maths have improved. The tasks are great for those who previously disliked maths.
- In my class we have a daily group rotation of five sections. Pupils do a different section each day. The maths task centre fits in perfectly with this rotation. One group does maths tasks, one does reading with the teacher, one uses the reading laboratory, one plays maths games, and one does measuring activities.
- I would like more suggestions from other teachers on how to 'sell' the idea to the rest of the staff.
- Tasks that need too much teacher intervention are a problem - I use these for Poster Problems.
- It promotes sharing with colleagues - we've started putting problems into newsletters - we lend tasks out for home use - it has promoted staff thought towards the variety of teaching and learning strategies we could employ.
- When I first started using tasks I found many students were resistant to being pushed into the iceberg of the task. "I've done what the card says." seemed to be the order of the day. But I persisted with the tasks and the whole class investigations that can grow from them and these students began to change. It took about a term though.

Additional Information

Some years ago a study was done to collect the attitudes of teachers who had been involved with Task Centres for various lengths of time; from just beginning to think about it to as much as a decade or more. You can find this paper at:

- mathematicscentre.com/taskcentre/tcreport.htm

which can be also be accessed directly from the Research & Stories link. Some other relevant stories at this link are:

- Marita Miesen, *What Worked. What Did Not?*
- Professor Richard Evans, *An American Experience*
- Damian Howison, *Starting a Task Centre & Creating a Working Mathematically Curriculum*

Professional Development

More information about these professional services is available at:
mathematicscentre.com/taskcentre/pdfrommc.htm

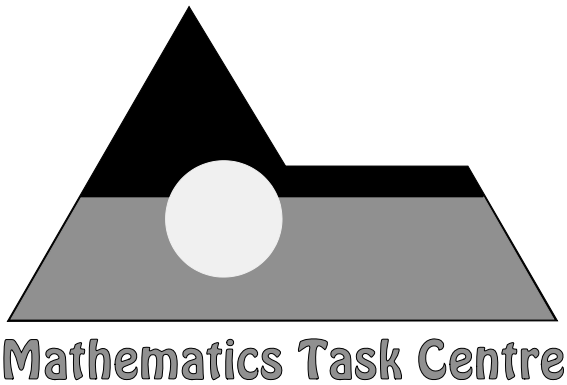
For many schools wishing to break away from a text book approach, a task centre has been a very valuable first step. Each task, because it allows access to a problem with no immediate answer, invites its users to take the role of a professional mathematician. In a Task Centre workshop context uncountable numbers of teachers have accepted that invitation. Once they have appreciated the exciting possibilities offered by tasks, they are often prepared to further develop these features in their teaching. In our turn, we have developed Task Cameos and Maths300, to support that growth.

Gradually, the more holistic view of mathematics education as learning to work like a mathematician, rather than endlessly refining the skill toolbox of a mathematician, is able to evolve.

However, to cement this process into the school curriculum requires effort and vigilance. Teachers have found that to make a curriculum shift such as this a permanent feature they must address issues which include:

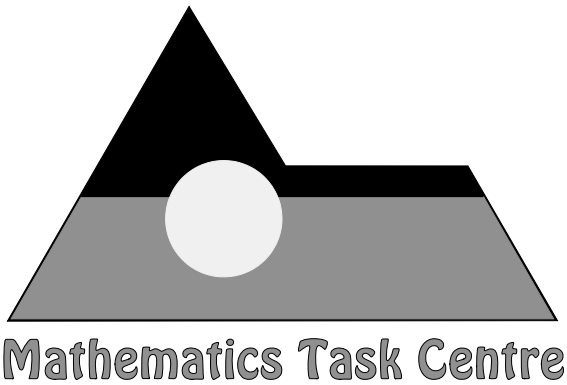
- Are parents and students included in the development of the new direction?
- How are the tasks documented in the school curriculum?
- Does the documentation link to official district, state or national documentation?
- How do the assessment and reporting procedures reflect the Working Mathematically focus?
- Is professional development in learning to work like a mathematician an on-going feature of faculty life? This seems to be especially important because teachers have often been 'brought up' with a different view of their professional role.
- Are the administrative procedures, especially timetabling, regularly reviewed as changes occur in the wider life of the school?
- Are the responsibilities associated with developing and maintaining this curriculum shift, which are arguably more extensive (and rewarding!) than those associated with a text book curriculum, equitably shared?
- How are new staff inducted into what, for them, may be a new approach, structure, expectation and documentation?

Through ***PD from MC*** (Professional Development from Mathematics Centre) a wide range of workshop sessions is available to support schools as they journey towards a more holistic, problem solving curriculum.



Section B

TASK CENTRES IN DEPTH



Successfully Using Tasks

Practical points and principles about using task at:
mathematicscentre.com/taskcentre/prin.htm
Research and teacher stories proving successful learning at:
mathematicscentre.com/taskcentre/do.htm

Task Centres, Problem Solving & Official Documents

Each country has its own official document detailing the structure of what will be taught in mathematics. Each of these addresses the importance of problem solving in one way or another. Some place this content in the context of working or thinking like a mathematician, or other reference to higher order thinking skills. Some include objectives in the affective domain such as working in groups, independent learning, enjoyment of learning and so on. A Task Centre resource has the potential to address all these objectives.

However simply placing tasks in front of students is the least effective way of doing so. It is teachers who make the difference, not the tasks. Over decades teachers from many places have contributed to the knowledge of what makes the difference between success and failure when using tasks.

Teaching & Learning Issues

Tasks can work well or they can work badly.

Working well means paying attention to all those things we know about creating an effective learning environment. If these are implemented, a task centre approach can indeed be a theoretically sound and successful learning environment for all pupils.

Working badly may come from:

- Teacher expectation that tasks are 'the solution' to the school's learning problems. They are not, but they are a rich resource which will support teachers in responding to student needs.
- Using the tasks as 'play things' only. Yes they are play things, and a mathematician does need to play with a problem to make headway, but if students are allowed to 'butterfly' from task to task superficially they will not be challenged at the deeper intellectual level which leads to learning how to learn.
- Insufficient bridge building from one form of mathematics education to another. Usually tasks are introduced to help teachers move away from a text and talk approach. However, even if they are not succeeding at it, students may be comfortable with this approach because it is all they know. Under these circumstances the 'new' approach may seem suspicious.

- Using the tasks in a way that allows students to think that there is the 'real maths' and the 'task maths'. One is seen as what is assessed; and one is seen as 'fun in mathematics' and consequently less important.

The research papers in the web page above (especially those from INISSS and Marsden High School) provide irrefutable evidence that mathematics learning can be better for more students. Such reports provide the vision. Each school still has to provide its own effort to obtain similar results. Tasks can, and should, exploit the potential of all the following aspects of good practice.

Group work

Pupils learning from each other and expressing ideas in their own words are just two of the benefits that have much appeal. Mathematical conversation is natural in a task centre environment.

> *Pupils usually work in pairs. I find friendship groups the best, but sometimes deliberately set up variations on this if I have a reason and can explain it to pupils.*

The value of choice

This is related to mixed ability teaching. If the range of available problems is sufficiently broad, then pupil responsibility is enhanced by allowing them maximum room to select their own pathway through the options.

> *The length of time on a particular task is variable, but I feel it is important to let pupils decide and take responsibility. Too much interference and instruction from me simply makes them dependent and overly needing approval and instruction.*

The nature of problem solving

Clearly this is usually the most sought after outcome from a task centre - that pupils have an overview of the problem solving process and have a range of strategies they have been exposed to and can employ. The range of problems or tasks (and poster problems) used should create opportunities for pupils to understand strategies such as:

- look for key words or phrases
- check for hidden assumptions
- look for a pattern (or an exception or contradiction)
- use or make a model, picture or a graph
- guess and check
- restate the problem in another way
- work backwards
- solve a similar problem first
- summarise important (and irrelevant) information
- experiment or act out the problem
- try an exhaustive solution by trying every possibility
- formalise the problem eg: into algebra

Degree of guidance

Teacher 1

There is often a terrible tendency (born of past experience) for pupils to 'get the answer' (any way they can!). Breaking this pattern is a slow process which needs reinforcement. I constantly share with pupils and have them explain the things they are learning about problem solving. Seeing that an answer is sometimes less important than the process of achieving it is a major step.

Teacher 2

Their first reaction to a problem is often Tell me what to do!. *To encourage them to work through it themselves, I use the following checklist to help me focus on the problem solving aspects and to avoid the tendency to celebrate my own expertise by doing all the work for the pupil. It is a tendency that is very hard to resist!!!*

- Have the pupils attempted the task?
  Tell me about the task.
  Show me what you have done so far.
- Ask them to compare what they have done to the instructions.
  Have you looked for patterns or connections?
  Is this like any other problem you have tried?
- Give the smallest possible hint if necessary.
- Is the problem inappropriate for the students at this time?

Teacher 3

I often use Newman's Five Point Error Analysis and ask these five questions when pupils are experiencing difficulty.

- Please read the question to me. If you don't know a word leave it out.
- Tell me what the question is asking you to do.
- Tell me how you are going to find the answer.
- Show me what to do to get the answer. Tell me what you are doing as you work.
- Now write down the answer to the question.

Technology

We know technology used wisely has much to offer. Exploiting this challenge can enrich the learning environment. Hence the choice between software presenting trivial low level use and tasks which use the computer's potential is a pedagogical challenge for the teacher. Using tasks in partnership with the whole class investigations on the Maths300 site supports teachers to accept this challenge. Around half the Maths300 lessons are built on tasks from Mathematics Task Centre and about one third of the lessons have companion software to help dig even further into the iceberg.

♦ maths300.com

Mixed ability teaching

A major advantage of the variety of choice and range of difficulty in the tasks is the ability to cater for the full range of interests and abilities in the class. All pupils can be usefully engaged on tasks appropriate to themselves without the stigma of being 'labelled'. Both less able and very capable pupils can, assuming the tasks have been chosen to accommodate this, work comfortably within the one setting. As such, tasks can be a powerful way of realistically differentiating teaching.

Concrete aids

All tasks involve manipulation of concrete materials. Containers are not filled with pencil and paper tasks but present challenges which require tactile/ visual/ kinaesthetic experiences designed to support the learning in the task. This is deliberately based on research indicating the value of concrete experiences as a stepping stone to abstract understanding.

Visual and spatial thinking

This is closely related to the use of concrete aids. Concrete tasks can promote and enhance the visual and spatial aspects of learning. Symbolic, analytical textbook approaches sometimes inhibit or deny these aspects. In fact, there is clearly some mismatch when, for example, three dimensional geometry is presented on a two dimensional page, even if supported by picturesque coded diagrams. Tasks can offer the same mathematical challenges in real 3D, and in doing so add a kinaesthetic learning component.

Equity

A variety of barriers may exist for some pupils. To assist these students to achieve their best, teachers need to consider adapting the tasks.

Special language needs

Cultural background may not only provide a barrier in humanities subjects, but also in many areas of mathematics. Language skills can present learning difficulties, as can maths problems that have no basis in previous experience. For example immigrant students may have no knowledge of the rules of football, or of a deck of cards, and both of these contexts are involved in some of the tasks. Other learning barriers are the difficulties students experience in reading and decoding the task card.

The following are some of the strategies teachers have used to address these issues:

- identify tasks which require little or no reading
- select tasks appropriate to cultural background and experience
- group students to include a competent reader
- use a buddy system between older and younger classes where the older students learn a task first, then take a facilitating role in presenting it to a pair of younger students

- tackle unusual or wordy problems in a whole class situation
- actively seek out 'culturally specific' problems to be shared with the class by appropriate students
- invite parents to the maths classroom as 'supporters' - if possible provide a training session for parents, which might include how to assist students to write a journal entry.

Gender issues

It is well documented that girls generally have less confidence in their mathematical ability than boys. Particularly, in a mixed classroom, girls are less likely to initiate using concrete materials and may sit back and be a passive member of a practical maths or science class.

Also at some ages, eg: early teenage years, it is quite common in whole class investigations for boys to 'push to the front' and girls to seem to 'allow this to happen'.

To some extent the non-traditional nature of a task lesson overcomes these problems, but additional successful strategies teachers have used are:

- *Offering appropriate tasks*: Teachers have found that the language and logic contexts of some tasks are more likely to draw the interest of girls.

  To start a group of girls I am more likely to use Police Line-up or Who Owns The Monkey? in preference to, say, Cube Nets or Painted Cubes. These are good tasks for girls to start on in order to build their confidence in using the tasks.

- *Pupil groupings*: Teachers suggest that girls paired together allows for greater access and less inhibited use of concrete materials. In many instances, girls friendship groups also assisted this.
- *Variety in expressing solutions/findings*: If students are encouraged to choose from a variety of ways to present their solution(s) - eg: diagrams, pictures, traditional mathematical form, paragraphs, or oral explanation - then learners who are apprehensive about mathematical symbolism have a choice.
- *Non-competitive setting***:** Working within a strict time limit with maths tasks can be threatening, especially for girls. Time to discuss starting points and explore strategies for problem solving without a strict time frame encourages confidence in approaching and working through a task. A professional mathematician does not usually have to solve a problem in a set time frame. However, in practical terms, schools are governed by timetables. Therefore it is important to encourage students to 'pick up a task where they left off'.
- *Positive discrimination*: Look for opportunities to 'push the boys back' and encourage and compliment the girls. Of course this strategy is important for any learners who somehow have an inequitable place in the classroom.

Management Issues

Storage

Sturdy press-seal bags work well if the tasks are being moved from room to room, but if they are used in a Task Centre, the most commonly used container is a transparent, plastic 'lunch box' with a coloured lid. Alternative containers include plastic hang-up bags or inexpensive ice-cream containers.

The plastic boxes are excellent if the task centre is in a fixed place and the students come to the tasks. They can be readily stacked and their attractive contents are very motivating. However, boxes are bulky to move around the school if the tasks must go to the students, in which case bags are preferable.

Task Cards

The instruction card and any concrete materials necessary for the task are stored inside each container. Usually the card will have a double line ruled across it just before the Challenge section which tells the students that they *must* bring their work to a teacher, aide, or helper to be checked before continuing. There may be more than one double line on a card.

Teachers use these opportunities to:

- ask students to explain what they have been doing
- highlight aspects of the Working Mathematically process which have been, or could be used
- establish whether the students are in a position to move on to the next part of the card, or whether they could put the task aside for now having reached one level of success.

Care of equipment

Teachers will no doubt recognise this dilemma. Who is responsible for checking all equipment is returned, damaged or lost pieces replaced, equipment for new tasks purchased etc. etc.? Parents have proved to be a very valuable resource in this respect. Pupils themselves being given and trusted with this responsibility have also proved invaluable. Some schools designate a particular teacher as co-ordinator, but the centre definitely needs to be seen as belonging to all.

Of course, it is a standard procedure that the equipment for a task is checked by the students before and after using it. If the task is missing pieces before the children use it, they immediately inform the teacher, who follows the school's established process for replacement.

Mathematics Task Centre supplies replacement parts for all of its tasks. In addition, the Distribution Manager may be able to arrange a 'service day' to refresh and replace tasks so that teacher time can be used in more professional pursuits.

Labelling tasks

- Any task can be used at a wide range of ability levels.
- Any task can be exited at a number of levels of success.
- Many tasks include mathematics from more than one curriculum strand.

Therefore, over time, the labelling of tasks has moved towards guiding teachers to select tasks which support current curriculum objectives and away from any structure which might suggest certain students are excluded from using certain tasks. Further, it is now most common that tasks are core resources in the daily classroom rather than occasional resources used in a task centre. Consequently clear plastic bags are more common for storage.

When using bags, stickers to indicate curriculum strand seem to work best when affixed to the back of each card and board. Then it doesn't matter which bag the materials are returned to and teachers can easily see the curriculum information through the bag.

The following (historic) colour code is recommended:

- CHANCE & DATA orange
- LANGUAGE & LOGIC red
- MEASUREMENT green
- NUMBER blue
- PATTERN & ALGEBRA black
- SPACE yellow

If you decide to label your tasks, you will need dot stickers (about 2cm diameter) of each colour. White rectangular label stickers may also needed to label the face, especially if using boxes, as described below.

Since 2000, Maths300 has provided additional teacher support. About half of the Maths300 lessons grow from the iceberg of tasks. So, as a simple reminder of this, some schools have taken to adding another sticker:

- MATHS300 gold

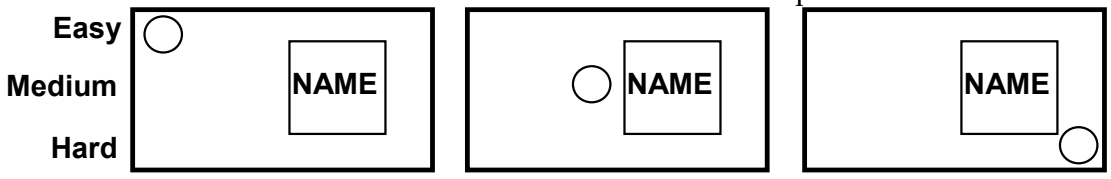
The Task Catalogue lists the strands addressed by each task and the Tasks & Maths300 list shows which tasks have a companion Maths300 lesson.

- mathematicscentre.com/taskcentre/tc_catal.pdf
- mathematicscentre.com/taskcentre/taskm300.pdf

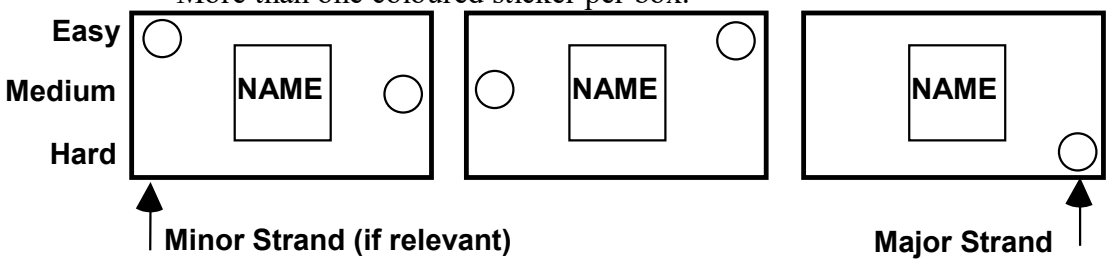
Historically, from 1977, task boxes were labelled with:

- A white sticker showing task number and name.
- Coloured stickers to indicate curriculum strand.

These were arranged on the front face of the box to indicate strand and difficulty in one of the following ways. Three different box fronts are shown in each case. The first used one coloured sticker per box



More than one coloured sticker per box:



Historically, the Australian Task Centre Network (pre-1992) used these strands and colours:

- LOGIC red
- MEASUREMENT green
- NUMBER blue
- PROBABILITY orange
- SPACE yellow

With easy access to computers in schools, office personnel can now prepare laser printed labels reasonably easily. This is an option you might explore instead of using the white stickers provided for task names. It produces uniformly neat labels in an interesting font - in colour too if a colour printer is available.

Taking all these aspects into account, and recognising that each school can certainly choose any system it wishes, the objective is that teachers can readily identify curriculum strands and the availability of Maths300 support information. Using the Task Cameo Library offers even more support and it shows which tasks have a Maths300 lesson and which of these has software support.

Teacher placement: One position or circulating?

I find that pupil independence is sometimes greater if I remain seated. They know they will only obtain assistance when they come to the front of the room. However, I get to see more, ie: observe their progress, by circulating.

Whichever approach I use, a major objective is to value and build up a sense of independence in pupils. This does much for smooth running and lessens unimportant demands on my time.

*I thoroughly enjoy my task lessons because I can sit with a pair and with a simple prod like **Tell me what you have been doing**, can open up a mathematical chat that often tells me heaps about the students' abilities. When I move around the room and get involved with the groups I find so many ways I can compliment kids for working like a mathematician.*

Availability of answer lists

I do keep a list of answers, including the way(s) of working out the problem. Certainly the list is not available at all times, but I do find it useful for pupils to check their process against the records - it sometimes saves me a lot of time by selectively letting pupils reference the list (and letting them add to it).

- Such a list can be built up from the Task Cameo Library. Each Cameo provides answers to the task and much more.

Table arrangements

I prefer scattered tables for 4 pupils, being 2 groups of 2, but I have seen a U-shaped set up work very well.

Pupils are constantly moving around the Task Centre - to obtain or return tasks, to use the computer, to go to the teacher's desk. Work tables must be placed in consideration of this need for freedom of movement.

I make sure there is no obvious board focus in the layout.

Assessment

Considerable assessment information is available at:
mathematicscentre.com/taskcentre/assess.htm

If students are learning to work like a mathematician then all aspects of that process must be assessed, rather than just assessing proficiency with skills. Therefore assessment is critical in successful use of tasks.

The consequences of pupils or teachers not keeping records is to promote a casual 'butterfly' approach where pupils wander aimlessly from task to task, often giving the illusion of working but really seeking unproductive entertainment. If the teacher allows this to happen, pupils will not see the task centre as legitimate and valued learning and will eventually subvert its real purposes.

Similarly assessment must be up front for pupils. They must know what they are accomplishing and why this form of learning is being made available. We show pupils what we value by what we assess. Not to assess is to subtly reinforce an impression of no real value. Assessment allows both teachers and students to see how problem solving skills and the overall Working Mathematically process are developing.

Many a Task Centre has gone adrift for failing to pay attention to these important items.

The above 'warnings' do not mean the Centre has to have all the appearances of a harsh authoritarian environment. Both assessment and record keeping can enhance not detract from the friendly, non-threatening environment which is part of the appeal of Task Centres.

Assessment of tasks can be done in a number of ways. The way in which a task will be assessed is determined by the function that the task is to serve. Whilst the development of problem solving skills, including group and individual working skills is a major component, tasks fit into all strands of the mathematics curriculum. Therefore if a teacher is seeking to develop the skills of a particular strand, the assessment process needs will be a reflection of this.

Assessment should be done by both the teacher and the student. In this way the 'why' of the assessment process becomes obvious, and therefore meaningful, to both and gives legitimacy to the task. Tasks are then more than 'time-fillers' and it is vital that they be appreciated as such if they are to add richness to the learning environment.

Reflection by pupils

Theorists value and promote metacognition, the notion that learning is more permanent if pupils deliberately and consciously analyse their own learning. The deliberate teaching strategy of oral questioning and the way pupils record their work is an attempt to manifest this philosophy in action. The alternative is the very tempting 'butterfly' approach by pupils which is to madly do as many activities as possible, mostly superficially, in the mistaken belief that quantity equates to quality. Teachers report having to work quite hard to overcome these previously entrenched habits of just getting the answer, any answer, and moving on to the next task.

Teachers' comments on assessment

Teacher 1

In trying to guide pupils I use this set of structured questions known as Newman's Five Point Error Analysis:

- Please read the question to me. If you don't know a word leave it out.
- Tell me what the question is asking you to do.
- Tell me how you are going to find the answer.
- Show me what to do to get the answer. Tell me what you are doing as you work.
- Now write down the answer to the question.

They help focus on finding where a blockage or difficulty may be occurring. It is illuminating that just by asking these simple standard questions, pupils often unravel and solve their own dilemmas.

Teacher 2

Both oral and written recording help me monitor pupil performance. The purpose of the double line on the instruction card is to recognise an important or critical moment to pause and reflect on progress thus far. Having pupils verbally describe in their own words what they have achieved provides me with valuable informal information on which to base advice about what to do next. But a written record is also valuable for my files.

Teacher 3

I use a version of written reports, sometimes called journal writing. The headings I use are: Task Name, Task Number, What is the task?, My plan, How I solved the task, Looking back.

I don't want to bury kids in documentation, so each of the sections is short. However, it is tempting for pupils to bypass the critical reflection phase of thinking what they did and what they learned from it. I constantly reinforce the value and need for this summary of their work.

I particularly like the 'What is the task?' section. Encouraging pupils to use words other than those on the instruction card is one way of ensuring that they understand the problem.

Assessment approaches

Examples of assessment approaches are:

- simple recording
- journal writing
- written question and answer assessment form (for the student to complete)
- anecdotal note taking
- discussion (individual and group)
- a basic checklist

Where these assessment procedures involve students writing, teachers will need to ensure that the writing does not become too onerous. Students who get bogged down in doing the writing will lose interest in doing the tasks.

Increasingly popular, perhaps because it is consistent with the way a mathematician works, is a two-tier recording/reporting system. Every task tackled is entered into a journal or diary with the date, task name and number. Beyond that the recordings are personal 'scribbles' and drawings. Students learn that to record sufficient information reminding them of what they did - successful or otherwise - and what understanding developed. Rough as this first tier might be, teachers frequently find these journals give useful assessment information.

The second tier happens less frequently - perhaps only once a term. The student chooses a task to investigate in depth, perhaps with the assistance of a teacher prepared Investigation Guide, and is expected to publish a report of their investigation. Students have to be taught to write a such a report. It is not something that can simply be 'expected'. Notes for a model lesson titled *Learning to Write a Maths Report*, which is based on Task 45, Eric The Sheep, can be found at:

- mathematicscentre.com/taskcentre/report.htm

Of course, this level of publishing need not always be a writing assignment. In literacy terms a text could be presented as an oral report, a video, a wall display, a Power Point display, a drama, or a range of other forms which could simultaneously achieve learning outcomes in curriculum strands other than mathematics.

Journal writing

Journal writing is a way of determining whether the task has been understood by the student. The pupil can comment on such things as:

- What I learned in this task.
- What strategies I tried.
- What went wrong.
- How I fixed it.

- Jottings - ie: any special thoughts or observations.

A sample journal page might look like the following. Imagine the page folded vertically down the middle.

Task Name:	Date: ..... Task Number: .....
My Working Space	My Diary Notes

Assessment form

An assessment form using questions helps students to reflect upon specific issues in connection with their specific task. See samples Pages 36 - 41.

Anecdotal records

Some teachers keep on-going records about how students are tackling the tasks. These would include jottings on whether students were showing initiative, whether they were working co-operatively, whether they could explain ideas clearly, whether they showed perseverance. Such records can also be scaffolded against the steps of the Working Mathematically process.

Checklists

A simple approach is giving pupils a catalogue of the available tasks. They keep this at the front of their journal. There is a check box next to each activity. Satisfactory completion of the task can be acknowledged by the teacher initialling the check box after administering a simple informal assessment of the pupil's work. This can take just a few seconds and be based on observation of pupils notes or simple oral questioning.

One effective question is:

What did you learn from this task?

Such a question places emphasis on the learning and not the specific answer to the task, and also assists the pupil's reflective processes. The growing list of completed tasks, duly acknowledged by the teacher is a growing and visible record of accomplishments.

On the other hand, some checklists detail all the qualities valued in the activities and teachers assess pupils against these. However the burden of record keeping can take away from valuable time supporting pupils' work. After all:

No one ever grew by being measured

A healthy compromise seems to be a list such as the one below which is used on occasion as one instrument of assessment.

Name:		**Class: .....**	**Date: .....**
Shows initiative	☐	Explains ideas clearly	☐
Adaptable/Flexible	☐	Organises well	☐
Works co-operatively	☐	Shows perseverance	☐

Assessment & Official Documents

All tasks from Mathematics Task Centre can be directly linked with learning outcomes expressed in the official documents of any country. All tasks offer both content and process outcomes. All tasks can support the development of these outcomes at more than one age/ability level.

However, the local school, cluster, district or system must make those links for themselves. Using information from the Task Cameo Library, which has been gathered for each task into the Task Cameo Content Finder, makes it easier to build those links.

The one task can be used to achieve a range of learning outcomes. Equally, schools will find that a collection of different tasks can be used to achieve the same outcomes. This richness offers flexibility to the teacher and choice to the student. These characteristics improve the teaching and learning environment for both parties.

If teachers develop checklists related to the outcomes in official documents, and correlate this to a range of tasks from which students can choose, students can become responsible for recording their own perceived learning as one component of the assessment picture. Some students may attempt one or more tasks before achieving a specific learning outcome.

TASK CENTRE PROBLEMS RECORDING SHEET

NAME:

PROBLEM: **No:**

WHAT I/WE DID TO FIND THE SOLUTION TO THE PROBLEM:

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DIAGRAM:

WHAT I/WE FOUND OUT:

TASK CENTRE PROBLEMS RECORDING SHEET

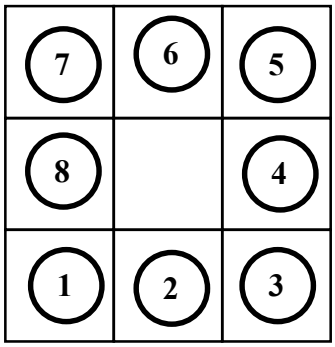
NAME: Lisa Robinson

PROBLEM: No Diagonal Move **No:** 66

WHAT I/WE DID TO FIND THE SOLUTION TO THE PROBLEM:

I moved counter 2 up, then moved counter 3 across, number 4 counter down, 5th counter down, 6th counter across, 7th counter across, 8th counter up, number 2 counter across, number 3 counter up, counter 1 across, counter 2 down and number 3 counter across.

DIAGRAM:



WHAT I/WE FOUND OUT:

I found out that I was excellent at this game because the sheet said if you could do it in 12 moves you were excellent at the game and I did it in 12 moves. I liked this game because it was fun.

TASK CENTRE PROBLEMS RECORDING SHEET

NAME:

PROBLEM: **No:**

REWRITE THE PROBLEM IN YOUR OWN WORDS:

WHAT I/WE DID TO FIND THE SOLUTION TO THE PROBLEM:

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DIAGRAM:

A PATTERN I/WE OBSERVED: (IF APPLICABLE)

WHAT I/WE FOUND OUT:

WHAT I/WE THOUGHT OF THE PROBLEM:

HOW HARD WAS THE PROBLEM?

Place a cross on the line below to show the difficulty level of the problem.)

TASK CENTRE PROBLEMS
RECORDING SHEET

NAME: *Rebecca Schmit/Paul Crennan/Daniele Hughes*

PROBLEM: *THE SWITCH* **No:** *11*

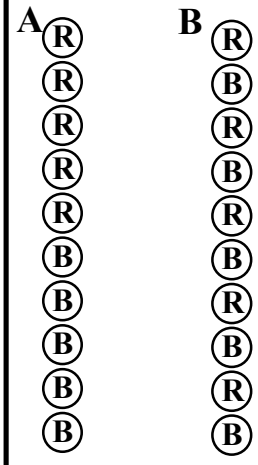
REWRITE THE PROBLEM IN YOUR OWN WORDS:

The problem was to alternate the 5 red counters and the 5 blue counters. You started with a line that had 5 red and 5 blue and you had to make it 1 red and 1 blue and 1 red and 1 blue etc.

WHAT I/WE DID TO FIND THE SOLUTION TO THE PROBLEM:

We just changed the counters around and counted how many times we changed them. We changed them 10 times.

DIAGRAM:



From diagram A to diagram B

A PATTERN I/WE OBSERVED: (IF APPLICABLE)

There was no obvious pattern that occurred.

WHAT I/WE FOUND OUT:

Trial and error is a good start to a confusing problem.

WHAT I/WE THOUGHT OF THE PROBLEM:

It was easy.

HOW HARD WAS THE PROBLEM?

Place a cross on the line below to show the difficulty level of the problem.)

Integrating Tasks

More information, including Unit Plan models at:
mathematicscentre.com/taskcentre/plans.htm

This web page details several well-trialed unit plans and other structures used by both Primary and Secondary schools. As schools develop and submit more experiences they will be added to the page. Therefore, the examples below are offered as starting points for thinking about integration.

Learning to Work Like a Mathematician

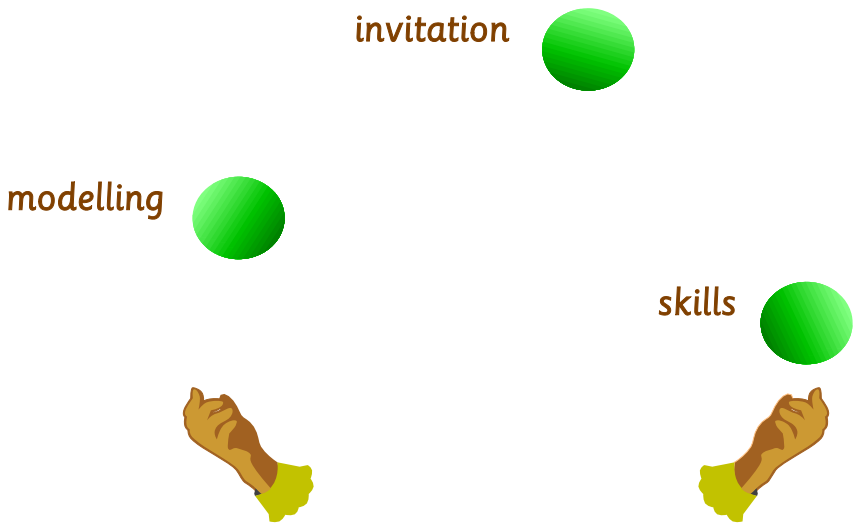
When professional mathematicians are asked what they do, the response is:

First give me an interesting problem.

Tasks offer interesting problems, but using tasks in pairs is only one aspect of the overall objective of learning to work like a mathematician. Tasks offer students an invitation to put the Working Mathematically process into action for themselves, but how do they learn what this process involves?

Through whole class investigations, often built on the iceberg of a task, teachers model how a mathematician works. One step of that process is to look into a toolbox of mathematical skills for tools which might help solve the problem. Therefore a Working Mathematically curriculum also includes lessons which practise and refresh the skills of a mathematician.

Integrating tasks into the curriculum involves developing a balance which reflects these three aspects of the work of a professional mathematician.



A primary school's approach

Many teachers take a holistic approach to their delivery of curriculum. A topic or theme provides a focus and generates learning in many areas. In an integrated curriculum classroom the tasks from the Task Centre are brought into the 'normal' classroom. Experience shows that the more often teachers can make links for children between a task from the Centre and the regular classroom program, the more likely are children to view the tasks as involving worthwhile learning.

Our teachers operate using an integrated curriculum. Everything was planned for specific learning outcomes. In this unit we wanted to focus on specific problem solving skills but also felt the need for the 'content' of the tasks to be linked to our focus theme. We found and selected tasks that linked and compiled a 'contract' for the weeks of theme which included tasks for students to attempt.

Depending on the focus, our maths content varies. Sometimes we do an investigation or project, where students, individually or in pairs investigate, research and extend a problem. Interaction or conferencing with the teacher provides time to question, clarify and give direction. They work on this project for a couple of weeks and present their findings to the class. Many develop new problems or games from the tasks. Others find out the history and involve the family, eg: card or match stick problems. Others add a cultural focus.

This approach allows the depth of the investigation to become valued and diminishes attitudes of 'getting an answer - any answer' or 'getting it correct' or 'finishing quickly'.

Sometimes the students' work becomes our own Poster Problem (see later) to laminate, display and shared with other classes. The projects provide very clear information to assist teachers with assessment and profiling data. We receive an insight into thinking and approaches when we allow the students to interact with the task at their own level.

A secondary school's approach

Tasks provide an innovative and interesting way to introduce concepts of a new topic.

We like to use Protons & Anti-Protons with the students before we begin a more formal look at the arithmetic of integers. When the students have all had a chance to use the task, we begin a class lesson with the students themselves becoming the Proton and Anti-Proton objects. We choose exercises for the students to act out which highlight the importance of zero. Zero is created by combining opposites, but also zero can be split up to create opposites. It is then a small step to

link these activities with the opposite senses of positive and negative numbers.

The tasks also provide a challenging method of revisiting learning outcomes at the end of a topic. An example is Crazy Animals which introduces, and provides practice in, selections and arrangements and concepts in probability. How Many Squares challenges pupils to use concepts in algebra to find an equation.

Unit Plans

Knowledge about the mathematical and pedagogical depth of tasks, such as that recorded in cameos and dossiers, is the platform for constructing curriculum units which integrate all aspects of learning to work like a mathematician. The Integrating Tasks link details several of these models:

- mathematicscentre.com/taskcentre/plans.htm

This link leads off with Maths With Attitude which is available as eManuals to support the eTasks package. Maths With Attitude offers 20 weeks of pre-planned core investigative work integrating tasks and Maths300 for each year level from 3 to 10.

More on Maths With Attitude which includes various structures and unit plans built into its Planners at each level, can be found at:

- mathematicscentre.com/taskcentre/mwa.htm

Latest information on Task Centre products and services is available at:

- mathematicscentre.com/taskcentre/resource.htm

To stimulate initial discussion, outlines of some unit plan models follow.

Graft-on Model

This model can be useful if the staff want to 'dip their toe' in the Task Centre ocean without moving too far from the comfort of the land they know. Computation is a good strand to begin such a unit. It is well known territory at a range of levels so, at the same time as basic skills are being included, the focus can more easily shift to how problem solving and Working Mathematically outcomes are addressed within the unit..

The model aims to support teachers to change from an exclusively text book driven 'Before' model to one that covers the same ground, but includes a clear, and clearly assessed, problem solving component. Before the unit, the published curriculum document (if it exists at all!) usually looks like this:

Before

Year 7 Topic 1 Basic Skills & Calculators 4 weeks

Textbook Name: ... Chapter: ...

- Whole numbers - adding, subtracting, multiplying, dividing
- Order of operations
- Fractions - adding, subtracting, multiplying, dividing, ordering

- Decimals - adding, subtracting, multiplying, dividing, rounding
- Converting Fractions to Decimals
- Number properties - commutative, associative and distributive laws
- Factors, primes, composites, multiples
- Squares & square roots

After staff agree that they could 'push the kids' through the text material in three weeks, rather than four, the curriculum document looks more like the one below. Multiple copies of a limited number of relevant tasks are purchased to support the experiment (tasks cannot be photocopied). In this way, the staff only have to learn something deeper about five new things, and to most this seems like a manageable challenge. In fact, the unit can develop an in-house professional development focus.

After

Year 7 Topic 1 Basic Skills & Calculators 4 weeks

Part A: SKILLS *3 weeks*

Textbook Name: ... Chapter: ... Assessment: Topic Test

- Whole numbers - adding, subtracting, multiplying, dividing
- Order of operations
- Fractions - adding, subtracting, multiplying, dividing, ordering
- Decimals - adding, subtracting, multiplying, dividing, rounding
- Converting Fractions to Decimals
- Number properties - commutative, associative and distributive laws
- Factors, primes, composites, multiples
- Squares & square roots

Part B: INVESTIGATIONS *1 week*

Task Resource Assessment: Project Report

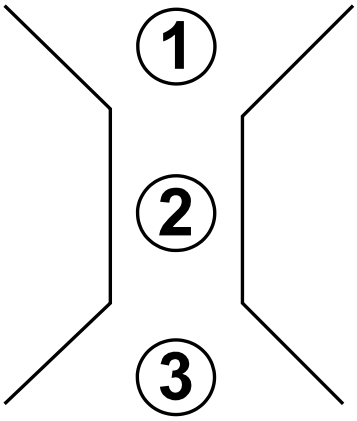
- Number Tiles as whole class investigation including modelling report writing.
- Students select one of the following to investigate and report. (Multiple copies of each task are available)

  ☐ Eric The Sheep ☐ Dominoes

  ☐ Snail Trail ☐ Doctor Dart

At first glance it may seem that the teachers have agreed to compress the original four weeks unrealistically. However as teachers get to know the tasks they realise they do involve the required practise (and application) of skills, in this case, basic operations, factors and multiples. More importantly the skills are being called on purposefully within higher order challenges. Further, the two forms of teaching practice now included in the unit have required the staff to think about appropriate assessment procedures for each style of presentation. Consequently assessment information will be broader and deeper.

Replacement Unit (3-Part) Plan



This model is based in a menu of 20 tasks related to a particular theme (see example below) and a teacher-prepared Investigation Guide to extend each one. Twenty tasks seems about the right number for students working in pairs in a class of up to thirty students. There are always sufficient tasks for each pair and some left to allow for differences in the rates students work through them.

Week Zero - Planning

Staff familiarise themselves with the material and jointly plan the unit. This is not a model that can be 'planned on the way to class'. When preparation of the Investigation Guides is shared among perhaps four staff, then each only has to become familiar with five new things, and to most this seems like a manageable challenge.

> *Getting together turned out to be great professional development for our group.*

Week 1 - Introduction

If your students are not used to this more open way of learning in mathematics, trial teachers suggest you present the unit as an experiment intended to improve maths learning for them. Indicate that you will be wanting to hear their evaluations of the approach, but that this unit will substitute for, or replace, the more usual way of teaching this area.

> *We gave the kids an 'encouragement talk' first about joining us in an experiment in ways of learning maths and then gave out the tasks. The response was intelligent and there was quite a buzz in the room.*

In this week:

- Students explore the 20 tasks listed on a printed menu.
- They choose their own tasks and the order in which they tackle tasks.
- Students explore the tip of the task, as on the card.
- Students move to the next task to task when ready, but not before a questioning session with the teacher which indicates there is more to the task than the tip shown on the card.

The teacher's role is as facilitator. An advantage is that in discussion with students, teachers gather informal assessment information which guides lesson planning for the following week.

Week 2 - Formalisation

This week returns to the more traditional classroom structure. It is a series of lessons identifying key concepts, formal language and rules of the unit which,

through conversation in the previous week, have been identified by the teacher as being in need of review. In preparation for Week 3, a lesson modelling how to write a Maths Report is usually included.

> *It was good for both us and the students that the lessons in this week were a bit more traditional. However, they weren't text book based. We used whole class lessons based on the tasks they had been exploring in Week 1 and taught the Working Mathematically process, content and report writing. Our Maths300 membership was a great support here.*
>
> *Assessment was via standard teacher-designed tests, quizzes and homework.*

Week 3 - Investigations

> *We were most delighted with Week 3. Each student chose one task from the menu and carried out an in-depth investigation into the iceberg guided by an investigation sheet. They had to publish a report of their investigation and we were quite surprised at the outcomes. It was clear that the first two weeks had lifted the image of mathematics from 'boring repetition' to a higher level of intellectual activity.*

Report writing in this form can include:

- initial drafts
- discussion with the teacher to check the draft against expected performance standards
- redrafting of the final product to be assessed and included in the student's portfolio

Interestingly, some schools are now accepting reports in formats such as oral presentation (often with aids in the manner sometimes expected in the commercial world), Power Point, wall displays. This Multiple Intelligences approach offers the opportunity to simultaneously address learning outcomes across subject boundaries.

Language & Logic Replacement Unit

In addition to other advantages of the Replacement Model itself, a language & logic unit potentially has other advantages:

- Cross-curricula links which allow the unit to be taught outside the mathematics course.
- This type of task often appear in books in pencil and paper form. Putting them in the more concrete form of a task makes them more accessible to a wider range of students.
- This type of task is well documented in puzzle-type books so, by consulting these references, the unit can easily be extended.
- The tasks are relatively straightforward to grade from easy (*Farmyard Friends*) to challenging (*Who Owns The Monkey?*).
- The tasks are particularly valuable for drawing out problem solving strategies such as *working backwards*, *elimination* or *if-then reasoning* in a context unthreatened by more numeric or algebraic skills.

- In some, the language is provided by the task. In others, such as *Back To Back Building*, *Hearts & Loops* and *Leading The Blind*, the students need to invent the language. Personal language can then be trawled for its links to more precise mathematical language.
- Some tasks, such as *Who Lives Where?* and *Police Line Up* can take the students beyond the solution of the puzzle into the structure of the puzzle itself, thereby empowering them to create their own puzzles. Achieving this leads to a valuable sense of ownership and control.

Sample Menu for a Language & Logic Unit

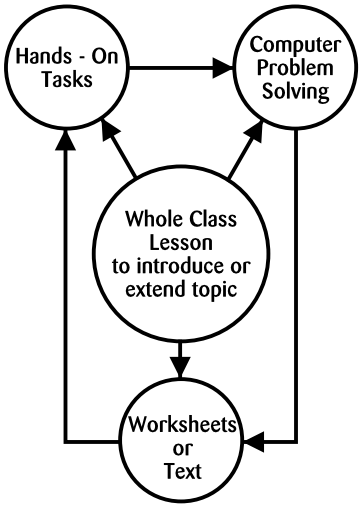
WORKING MATHEMATICALLY

in

LANGUAGE & LOGIC

☐ Back To Back Building	☐ Farmyard Views
☐ Chess Queens	☐ Hearts & Loops
☐ Choosing Beads	☐ Land of ET
☐ Coloured Cubes	☐ Leading The Blind
☐ Crossing The Desert	☐ Police Line Up
☐ Diamonds & Rectangles	☐ Red To Blue
☐ Eight Queens	☐ Sliding Tiles
☐ Famous Mathematicians	☐ Squound
☐ Farmyard Friends	☐ Who Lives Where?
☐ Farmyard Race Day	☐ Who Owns The Monkey?

Mixed Media Model



This is a work station model which is built on choosing a topic for which there are ten related tasks and appropriate problem solving software. Maths300 is often the source of the software. Picture Puzzles is also a possibility for this station

- mathematicscentre.com/picturepuzzles/

The week begins with a whole class investigation on the topic. During the other three lessons in the week, students spend one lesson at each of the work stations. The structure is repeated in the second week, with a new class investigation to start things off.

> *It was our staff discussion on Gardner's theory of Multiple Intelligences that led us into creating mixed media units. That and the access you have provided to tasks and Maths300 software.*
>
> *We felt challenged to integrate these resources into our syllabus. There was really no excuse for a text book diet that favours the formal learners. We now often use four different modes of learning in the work station structure shown. It can be easily managed by one teacher, but it is better when we plan and execute it together.*

Assessment involves informal anecdotal evidence as the teacher visits each station, and the written records students are asked to keep at each station. Towards the end of the unit a class discussion developing from the question:

> *What do you know now that you didn't know when we started this unit?*

and

> *How did you learn it?*

can add further assessment information, especially if the class discussion is followed by a request that students now write their personal answer to the questions.

Some teachers find there is no need to add a further layer of formal testing to this information.

Poster Problem Clinic

Additional Poster Problem Clinic information can be found at:

- mathematicscentre.com/taskcentre/poster.htm

Getting started

Many Task Centre lessons have the following format:

- Presentation of a whole class problem and some initial discussion.
- Organisation, housekeeping, setting targets for the session.
- Task time.
- Discussion of the class problem and review session.

A whole class problem displayed on a poster (or slide) is one approach to getting the class started in the Task Centre and giving it a sense of direction and purpose. Teachers also find this technique can be used when teaching in rooms away from the maths area as a way of linking the curriculum by keeping problem solving, the work of a professional mathematician, as the focus. This method fosters class discussion and thought about problem solving strategies. One teacher describes the session like this:

> *I like starting with a class problem - for only a few minutes - it focuses the class attention, and often allows me to introduce a particular strategy that is new or needs emphasis.*
>
> *We call these 'poster problems'. Being displayed on large cardboard posters at the front of the class means they are visible to all.*
>
> *If we don't collectively solve the problem in five minutes, I will leave the problem 'hanging' and it gives a purpose to the class review session at the end.*
>
> *It only takes about five minutes to introduce and get some initial ideas going. It gets kids in the way of thinking. It allows class members to hear and learn from their peers about problem solving strategies that work for them.*
>
> *Then just prior to liberating them into the task session, they are all together to allow me to make any short general observations about classroom organisation etc.*
>
> *Sometimes I require everyone to work out and write down their solution to the whole class problem. The staggered finishing time for this allows me to get organised and help students get started on tasks without being besieged.*
>
> *I try to never interrupt the task session, but all pupils know we have a five minute review session at the end to allow them to comment on such things as an activity they particularly liked. We often close then with an agreed answer to our whole class problem.*

A Clinic in Action

The aims of the weekly clinic are:

- to provide children with the opportunity to learn a variety of strategies
- to familiarise children with a process for solving problems.

The following example illustrates a structure which many teachers have found successful when running a clinic. If your school is a member of Maths300 you can also find a clinic modelled in Lesson 14, *The Farmer's Puzzle*.

Preparation

The focus of these clinics is the Working Mathematically process on Page 8. In particular, a clinic emphasises the steps of:

- Read and understand the problem.
- Plan a strategy to start the problem.
- Carry out their plan.
- Check the results.

which is sometimes displayed in a chart like this:

HOW TO SOLVE A PROBLEM

SEE & UNDERSTAND	Do I understand what the problem is asking? Discuss
PLANNING	Select a strategy or strategies from the board. Plan how you intend solving the problem.
DOING IT	Try out your idea.
CHECK IT	Did it work out? If so reflect on the activity. If not, go back to step one.

The other major emphasis of a Poster Problem Clinic is the toolbox of strategies which is often displayed on a separate Strategy Board like this:

STRATEGY BOARD

DO I KNOW A SIMILAR PROBLEM?	LOOK FOR A PATTERN
GUESS, CHECK & IMPROVE	DRAW A PICTURE OR A GRAPH
ACT IT OUT	WRITE AN EQUATION
SOLVE A SIMPLER RELATED PROBLEM	MAKE A LIST OR A TABLE
MAKE A MODEL	WORK BACKWARDS
BREAK INTO MANAGEABLE PARTS	SEEK AN EXCEPTION
TRY ALL POSSIBILITIES	...

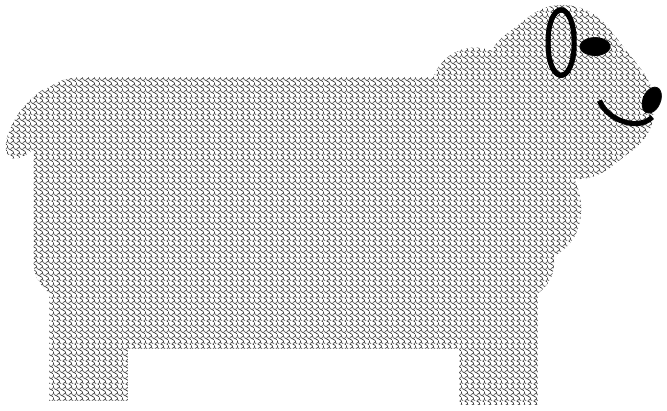
The Strategy Board can be prepared in advance as a reference for the children, or may be developed *with* the children as they explore problem solving and suggest their own versions of the strategies.

The problem can be chosen from a book or from the task collection. The *Professor Morris Puzzles*, listed in the Resources link of the Mathematics Centre are a set of Poster Problems presented in rhyme. It is one of these which is the focus of Lesson 14, *The Farmer's Puzzle*.

The example which follows is from the task collection. The teacher copied it out on to a large sheet of paper and asked some children to illustrate it. *The teacher also changed the number of sheep to sixty* to make the poster a little different from the challenge in the task collection.

ERIC THE SHEEP

Eric the Sheep is lining up to be shorn before the hot summer ahead. There are sixty [60] sheep in front of him. Eric can't be bothered waiting in the queue properly, so he decides to sneak towards the front.



Every time 1 sheep is taken to be shorn, Eric then sneaks past 2 sheep.
How many sheep will be shorn before Eric?

Step 1

Tell the children that we are at Stage 1 of our four stage plan:

... See & Understand ...

Point to it! Read the problem to/with the class. Discuss the problem and clarify any misunderstandings.

If children do not clearly understand what the problem is asking, they will not cope with the next stage. A good way of checking this stage is to hide the problem and ask the class to collectively retell its main points in their own words.

Allow time for questions - approximately 3 to 5 minutes.

Step 2

Tell the children that we are at Stage 2 of our four stage plan:

... Planning ...

In groups children select one or more strategies from the Strategy Board and discuss/organise how to go about solving the problem.

Without guidance, children will often skip this step and go straight to 'Doing It'. It is vital to emphasise that this stage is simply planning, not solving, the problem.

After about 3 minutes, ask the children to share their plans.

Plan 1

> *Well we're drawing a picture and sort of making a model.*
>
> *Can you give me more information please Brigid?*
>
> *We're putting 60 crosses on our paper for sheep and the pen top will be Eric. Then Claire will circle one from that end, and I will pass two crosses with my pen top.*

Plan 2

> *Our strategy is Guess and Check.*
>
> *That's good Nick, but how are you going to check your guess?*
>
> *Oh, we're making a model.*
>
> *Go on ...*
>
> *John's getting MAB smalls to be sheep and I'm getting a domino to be Eric and the chalk box to be the shed for shearing.*

I have found this sharing of strategies invaluable as it provides children who would normally feel lost in this type of activity with an opportunity to listen to their peers and make sense out of strategy selection. Note that such children are not given the answer. Rather they are assisted with understanding the power of selecting and applying strategies.

Step 3

Tell the children that we are at Stage 3 of our four stage plan:

... Doing It ...

Children collect what they need and carry out their plan.

Step 4

Tell the children that we are at Stage 4 of our four stage plan:

... Check It ...

We come together as a class and different groups share their findings. Again emphasis is on strategies.

> *We used the drawing strategy, but we changed while we were doing it because we saw a pattern.*
>
> *So Jake, you used the Look For A Pattern strategy. What was it?*
>
> *We found that when Eric passed 10 sheep, 5 had been shorn, so 20 sheep meant 10 had been shorn ... and that means when Eric passes 40 sheep, 20 were shorn and that makes the 60 altogether.*

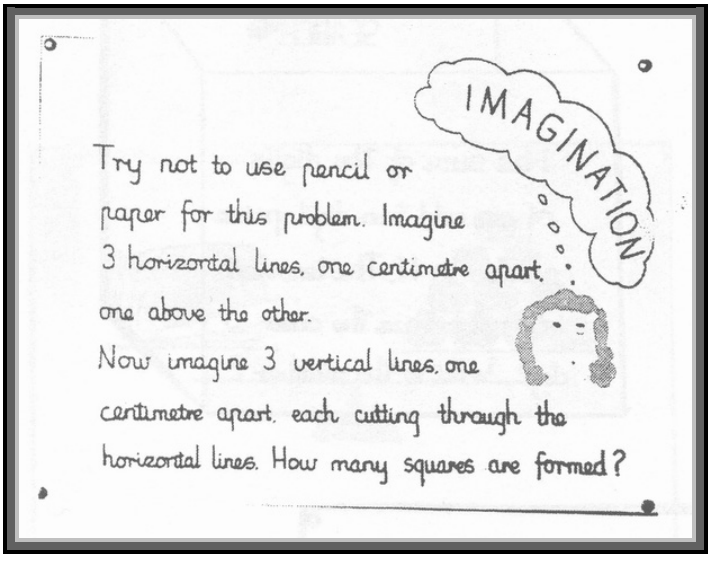
Sometimes there is a conflict in the answers presented by the different groups. Then some serious checking has to happen. This sharing time is also a good opportunity to add in a strategy which no one used. For example:

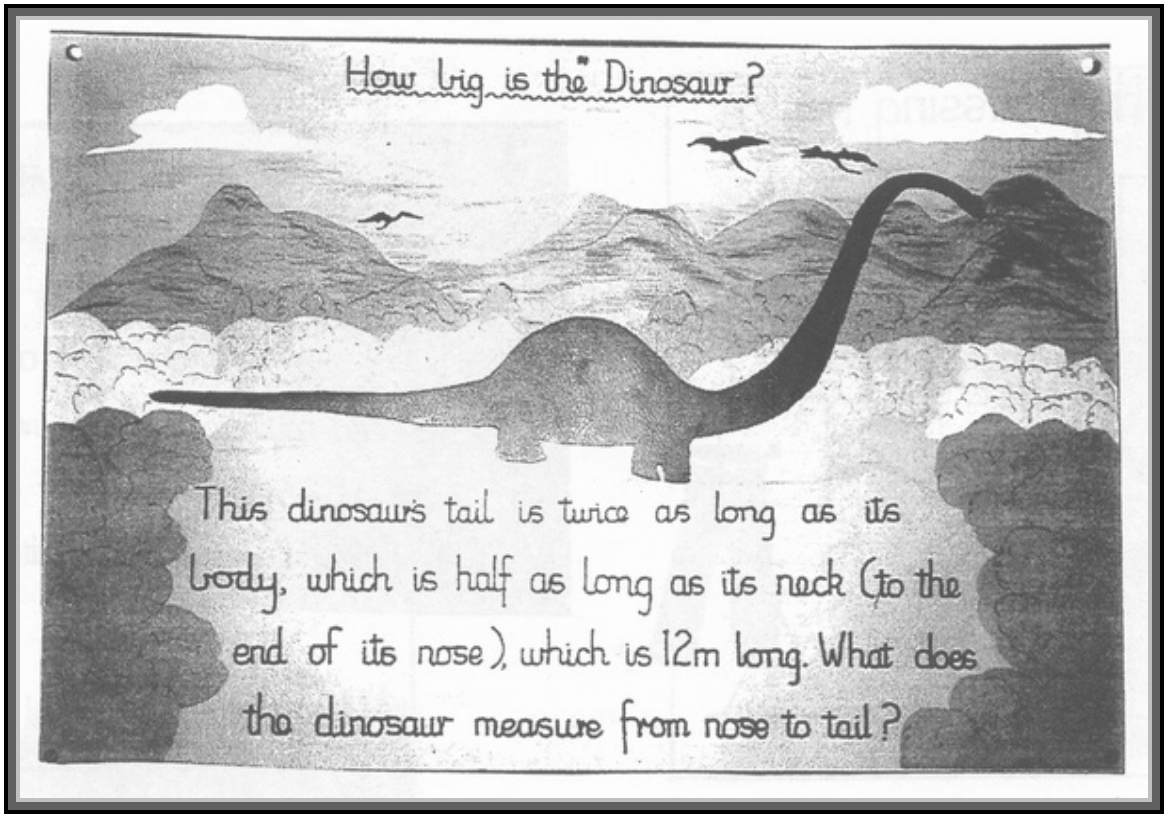
> *Perhaps we could've used the Number Sentence strategy. I mean, one sheep goes to be shorn and Eric passes two sheep. That's 3 sheep , so perhaps, 60 divided into groups of 3, or 60 ÷ 3 gives the answer.*

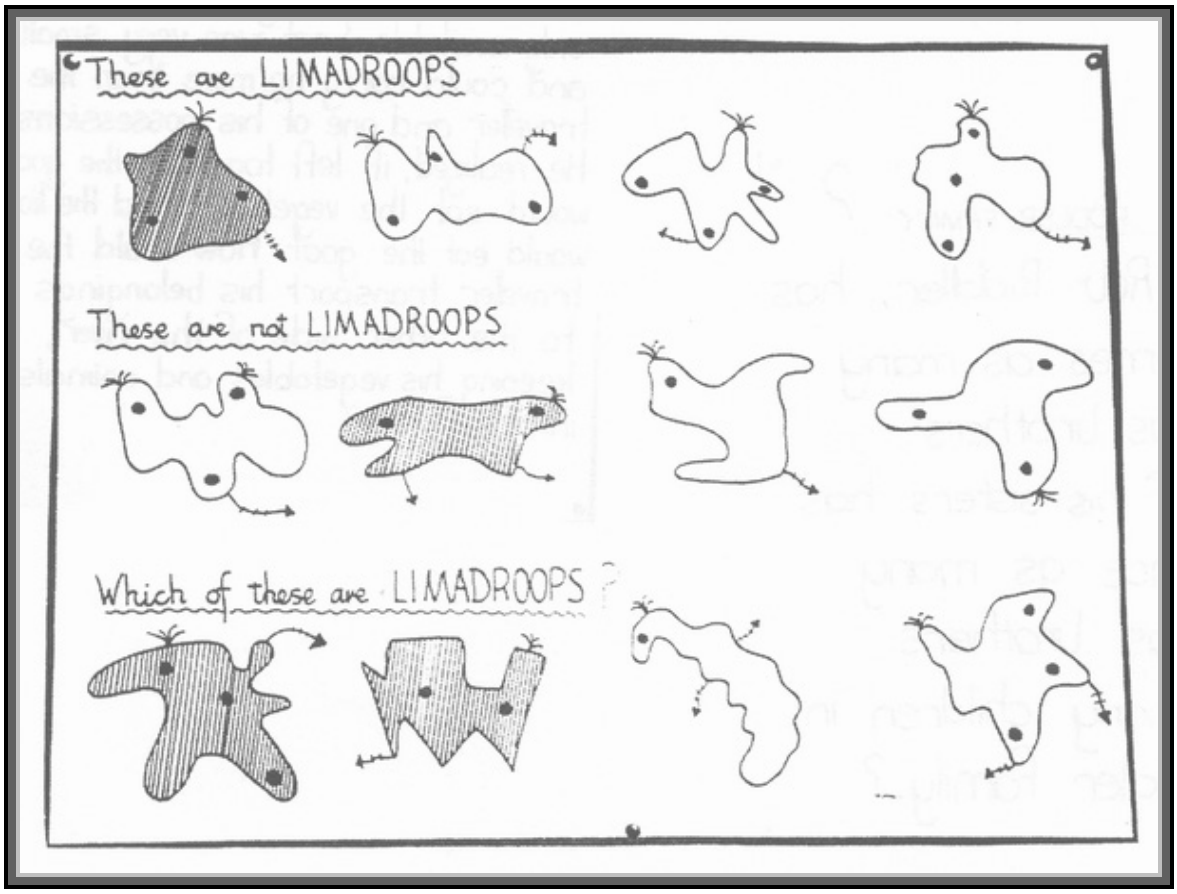
I always like to round off the clinic with a suggestion that there could be more to the problem. With Eric, that's easy. *What happens if there were 59 sheep in front of Eric?*

Sample Posters

Start your own collection of Poster Problems.




How big is the Dinosaur?
This dinosaur's tail is twice as long as its body, which is half as long as its neck (to the end of its nose), which is 12m long. What does the dinosaur measure from nose to tail?


These are LIMADROOPS
These are not LIMADROOPS
Which of these are LIMADROOPS?

THE RIDDLER FAMILY

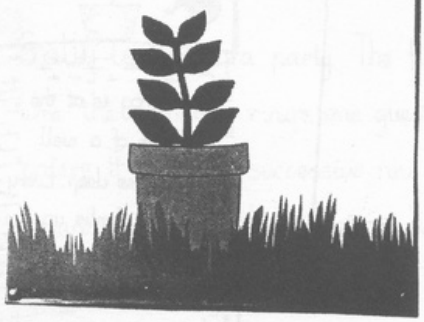
Young Rob Riddler has three times as many sisters as brothers

Each of his sisters has only twice as many sisters as brothers

How many children in the Riddler family?

MAGIC PLANT

On Friday, a magic plant is 2 cm high. Each day the plant doubles its height from the day before. How high will it be on Monday?



Getting five litres of water:

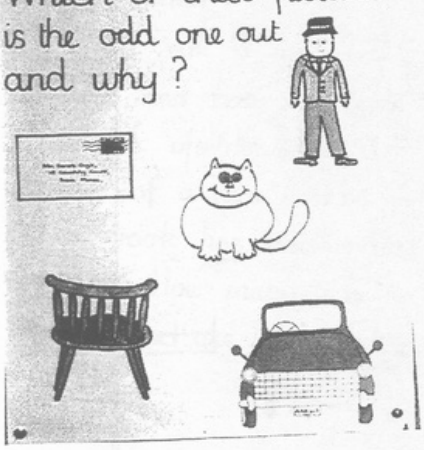
A man with a seven-litre bucket and a four-litre bucket goes to a well to get exactly five litres of water. He has no container other than the buckets. How can he do it?

PRIME SEARCH

The sum of the digits of an odd two-digit prime number is 11. The tens digit is greater than the ones digit. What is the number?

ODD PICTURE

Which of these pictures is the odd one out and why?



The Chair Puzzle.

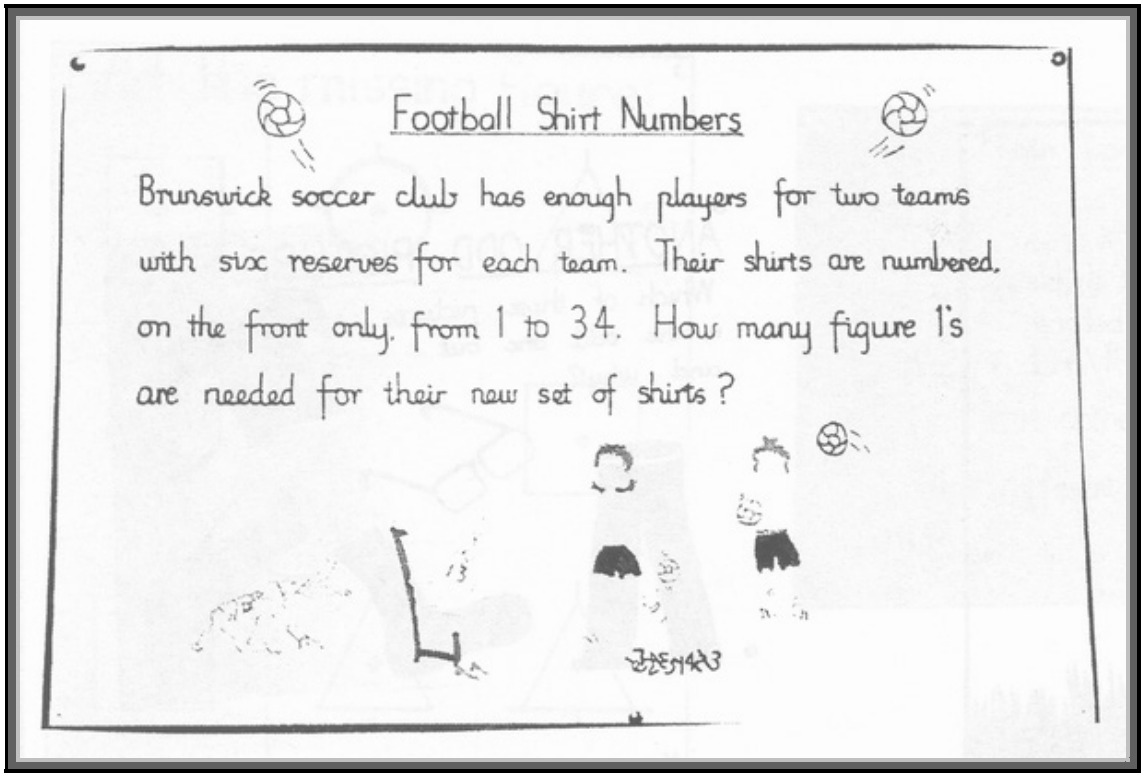
The grade 4 children put rows of chairs in the room so that there were 5 chairs in a row on each side of the centre aisle.

Jim sat in a chair in the row which was third from the front and second from the back

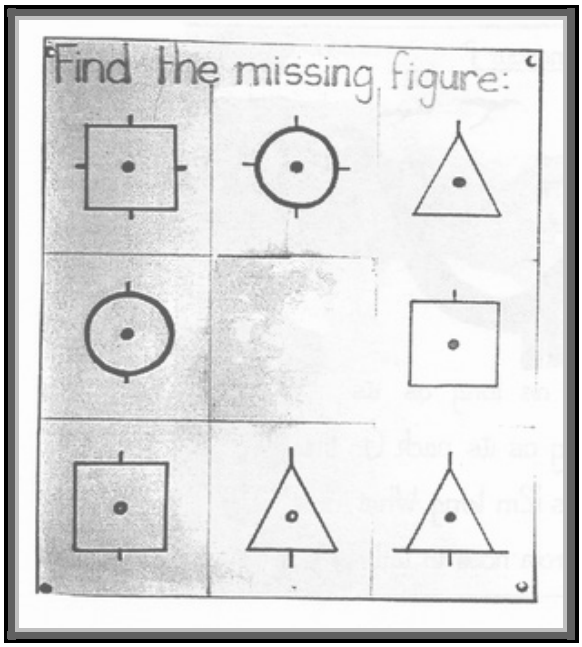
How many chairs are in each row?

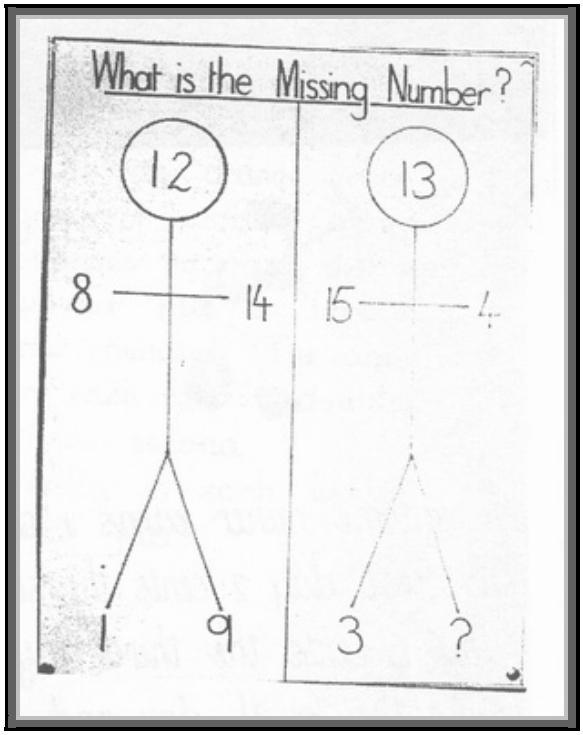
How many rows are there?

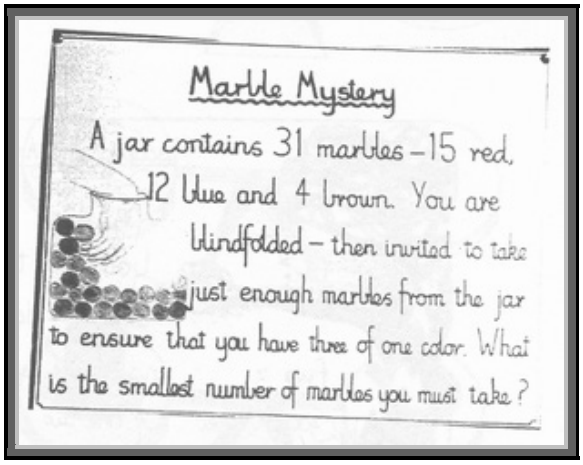
How many chairs altogether?

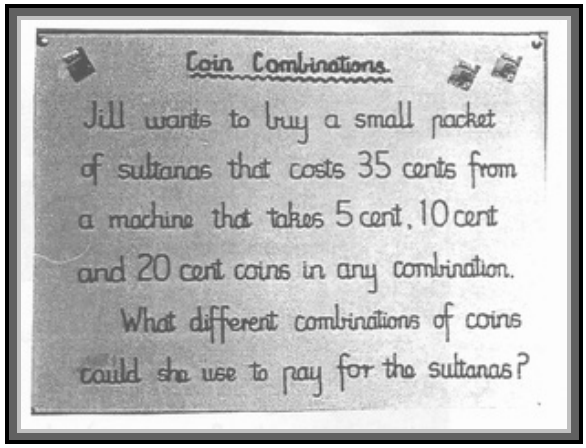


These sample posters were donated by Brunswick Primary School Task Centre.

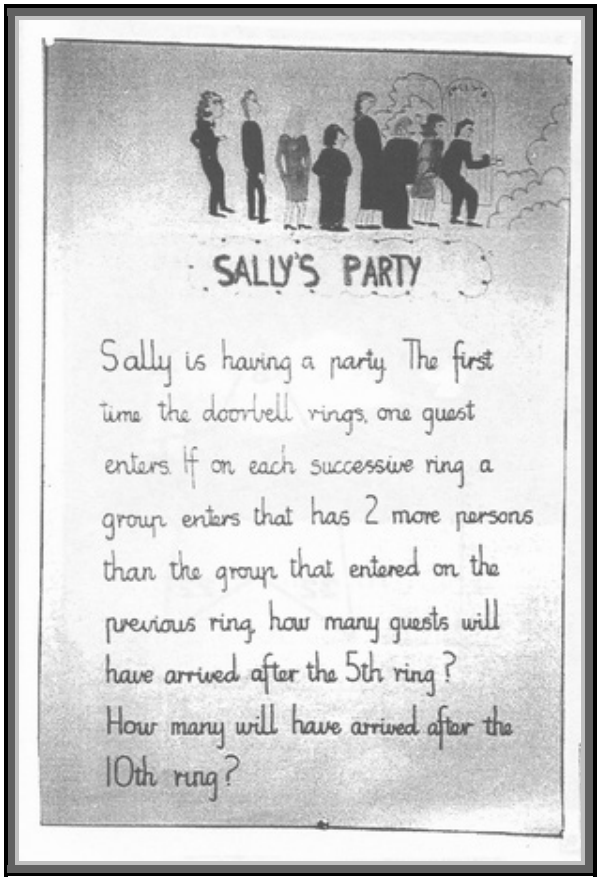


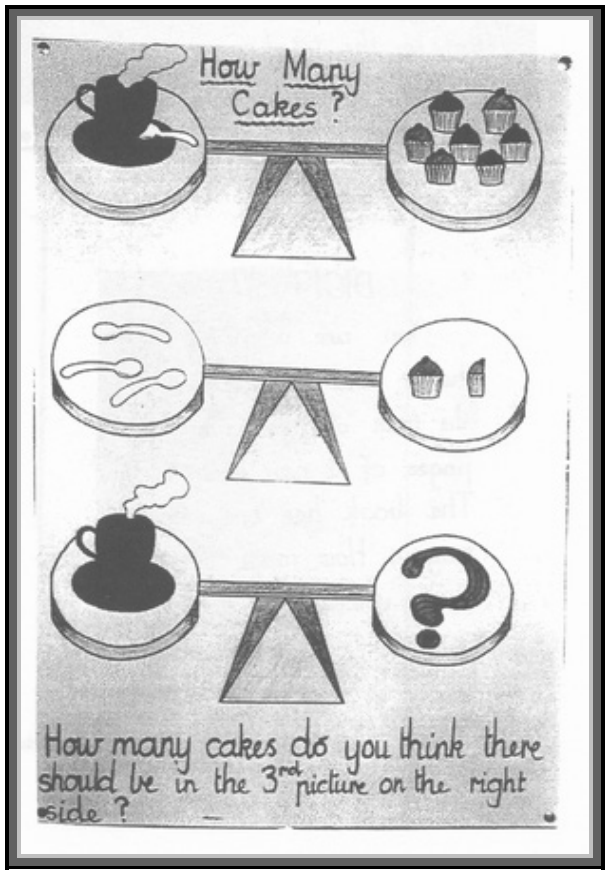


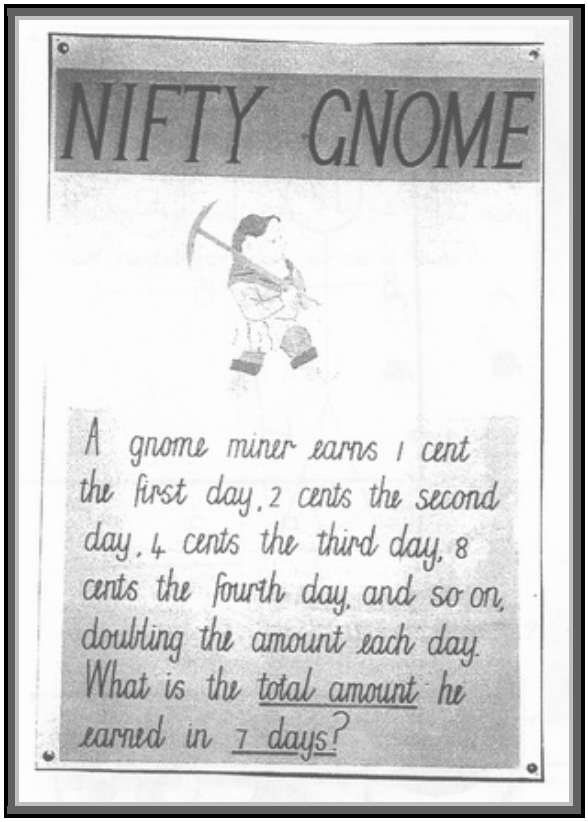


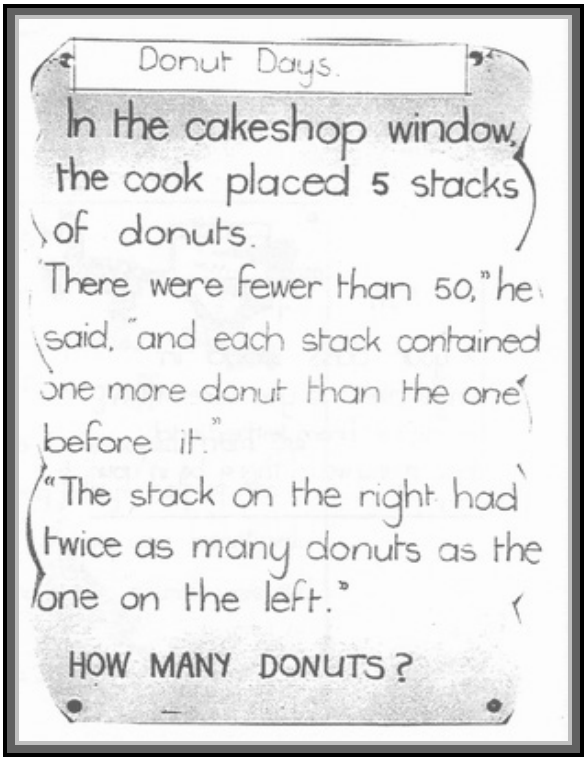


Parents and students can be involved in collecting and preparing the posters as large, colourful, laminated sheets.

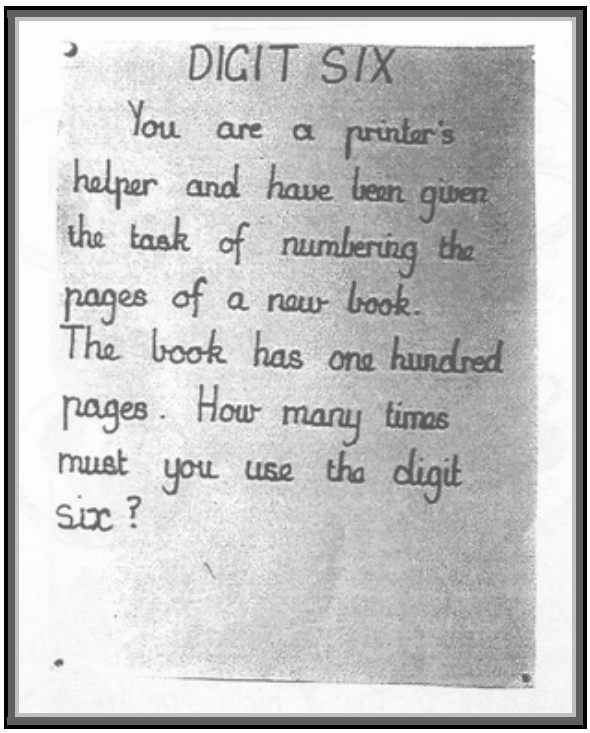


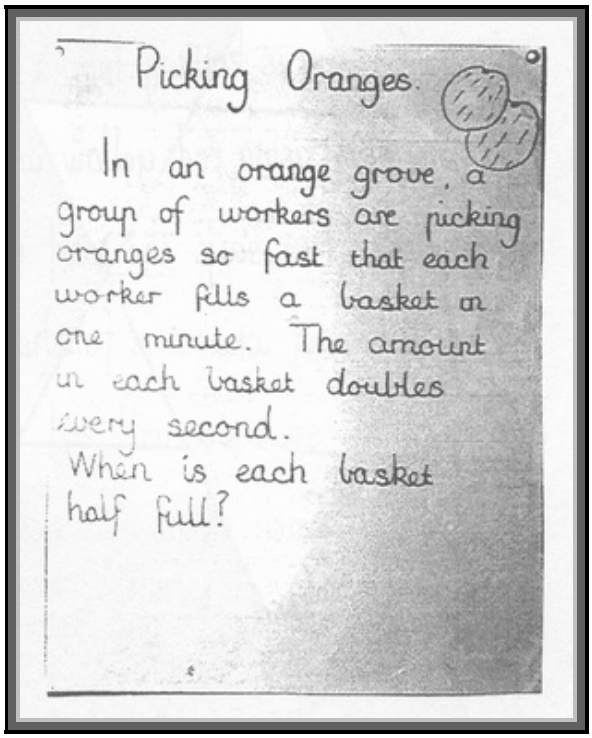






How will you store your Posters so they are easily accessible
when a teacher wants to take one to class?





Burning Problem

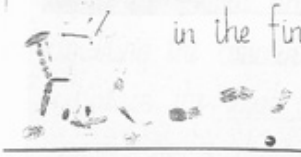
A fireman stood on the middle rung of his ladder spraying water into a burning building. As the blaze lessened he climbed up 5 rungs. A sudden flare sent him down 10 rungs. When it died down he moved back up 12 rungs. When the fire was out he climbed the remaining 10 rungs to the top.

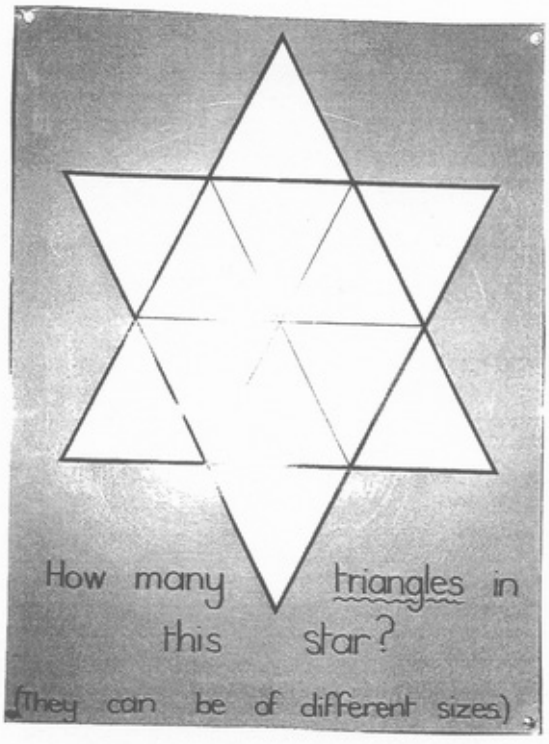
When he had reached the top of the ladder, he entered the building.

How many rungs did the ladder have?

Stripey Puzzle

Jim's Granny is knitting him a stripey scarf using red, yellow and blue wool. Jim says the scarf must be 140cm long when it is finished and Granny says she will end with a red stripe. Each stripe measures 5cm. How many blue stripes will there be in the finished scarf?





Teacher Stories 2

More stories in early editions of the eNews at:
mathematicscentre.com/taskcentre/news.htm
and in the history of the first 10 years of the Project at:
mathematicscentre.com/taskcentre/tenth.htm
and in the Research & Stories link at:
mathematicscentre.com/taskcentre/do.htm

Pack up your problems in an old kit bag

A new dimension to my experiences with problem solving - the task centre approach - came recently when I did a stint of emergency/relief teaching. I put together a collection of 30 - 40 tasks, each one in a separate plastic sleeve and all transported in a large A4 spring binder ... my travelling task centre.

I selected problems suited to many levels, which covered a wide range of types of problems, called on a variety of strategies and required a minimum of materials which were able to fit in the plastic sleeves (such as counters, dice, icy-pole sticks etc.), or which needed materials I would find in most classrooms (Unifix cubes, calculators, measuring equipment).

Although I had limited time with each class, and knowing their experience with problem solving in most cases was minimal, I still wanted each class to taste as far as possible the full value of the approach.

I likened each new task to a new game a child might receive for Christmas.

What do you do when you get a new game?

I listed their responses and linked these to a four-stage problem solving process (based on Polya):

GAME		MATHS TASK
Read the directions in box and look at equipment	**< SEE >**	Read the task card. Check the materials. Try to understand the problem.
Work out how to get started	**< PLAN >**	Think of a strategy that might work.
Have a go!	**< DO >**	Try out the plan, strategy or idea.
How did it go? Was it a good game? Did it work?	**< CHECK >**	Did your plan work? Does it seem right?

The children seemed to grasp straight away what was expected of them and set about tackling the tasks with confidence and enthusiasm.

Faith Hill

Tasks: Starting point for a problem solving curriculum

I always have somewhat mixed emotions when the topic of task centres arises. Many of my colleagues, whose opinions I greatly respect, express some reservations about the centres. Yet I also see the enthusiasm, enjoyment and success they can generate for both teachers and pupils. So I have to rationalise these two apparently contradictory viewpoints.

My conclusion is that I believe task centres to be the best entry point into problem solving that I have yet seen. They have the tremendous initial appeal of being self-contained, tangible, active, full of variety (and therefore cater for the range of pupil abilities and interests), easy to manage and overall an exciting step away from dull textbooks.

The reservation point of view, which I share, is that if a task centre is all a school does in the area of problem solving, then they have seriously misinterpreted the nature and potential of problem solving in a well balanced curriculum. The spectre of a task centre as the once-a-week reprieve from the 'real stuff' is not an appealing one. If the growth of a school stops at this stage then I share the concerns of some colleagues and withdraw my advocacy. The challenge is to ensure growth does not stop.

One personal case study is as follows. While working as a regional curriculum co-ordinator with a team of consultants, we tried to give a focus for one of the district pupil-free days. The schools in our district typically had about three or four such days a year and I feel these are not always used as effectively as they might be. So after negotiation, we instituted a half-day workshop, on site at each of four participating schools. A small grant was obtained and we were able to provide each school with the resources to make about 70 tasks. The workshop consisted of all the staff being involved in putting the tasks together, workshopping the problems as well as coding and labelling the boxes. They then committed themselves to trialing the tasks and the approach over the ensuing weeks. A follow up meeting was scheduled for reflection and review.

My enthusiasm is supported by the fact that at all four schools the experience proved to be the stimulus that led to on-going improvements. Each school made the task boxes 'their own' and integrated them into the school program. None of the schools 'stopped' just with the initial concept, perhaps because there was much discussion and on-going support from the district consultants, but most importantly because the whole idea was presented to, and accepted by, the schools as a starting point, not as a solution.

Charles Lovitt

- The idea of workshopping the tasks to initiate ownership among the staff is the cornerstone objective of the eTask Package workshop.

The On-Going Task

If you are using the Library Kit tasks:
mathematicscentre.com/taskcentre/library.htm
Parents can access solutions at:
mathematicscentre.com/taskcentre/library.htm

Involving Parents, School Councils, Community

Parents in the classroom

Many teachers report a task centre as being the best medium they have ever used for involving parents in mathematics. Parents easily adapt to the roles of preparation of materials or aide in the task session. They clearly enjoy helping pupils and are not 'threatened' by the tasks as they often are with processes and algorithms. Parents also see, and are a part of, an expanding view of school maths which is richer than they experienced at school.

As homework or support for sick children, tasks have been very popular. Being self contained, concrete and active, they are ideal as homework in which parents can assist in an enjoyable way. This is quite different to the use of homework as a form of punishment which sometimes occurs.

Disabled pupils or those with extended absences from school also greatly enjoy using the tasks to complement any text resources.

Once a comprehensive library of tasks is established, it is an easy procedure to select an appropriate subset for any child to work on at home. More information about Home/School Lending can be found at:

- mathematicscentre.com/taskcentre/library.htm

Funding

Task collections are, or should be, a growing, changing, adapting part of the school program. They are built from a lot of small investments, yet can add up to a significant resource over time. Parents who are enthused about the value of tasks for their children's learning are often willing to assist in raising additional funds, perhaps for the purchase of some new tasks, or additional storage boxes.

Tasks in the community

The self contained packaging of tasks makes them ideal to take to, and display at, community events. Perhaps during National Literacy & Numeracy Week, consider setting up a Maths Fair in the local shopping mall. Tasks are an excellent vehicle to introduce the public to the notions of activity style learning and problem solving. Engaging students as facilitators in this activity simultaneously builds a healthy reputation for the school and develops positive attitudes in students.

Extending The Task Collection

The Mathematics Task Centre collection has grown over decades and we encourage schools to do the same with their collection. The first major step in this direction is usually to complete the set of 241 eTasks. However, sometimes you will come across good tasks so make your own. Schools have a community to call on which can easily and economically supply the needed material. For example for the first two tasks below there will likely be homes where these toys are no longer in full-time use.

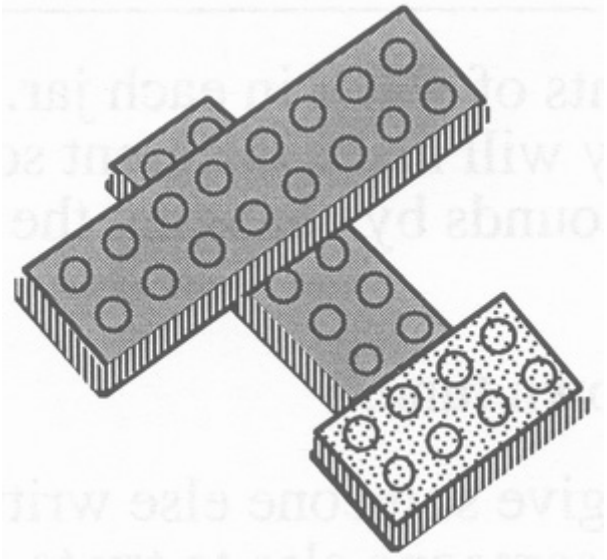
Design your own task card template based on the eTask model and you have a new task in the making. Consider contributing it to the site with photos and comments which reflect student responses to it.

SQUADRON

MATERIALS

Twenty [20] building bricks with sixteen [16] studs. (Ten each of 2 colours.)
Ten [10] building bricks with eight [8] studs. (Five each of the same 2 colours.)
Three [3] extra building bricks, two [2] large and one [1] small in a third colour.
One [1] dice.

An aeroplane is made of three [3] pieces as shown.



1. Using two colours only, how many different planes can be made?
   Make each one and record it in your journal.
2. How can you be sure you have found all possible planes?

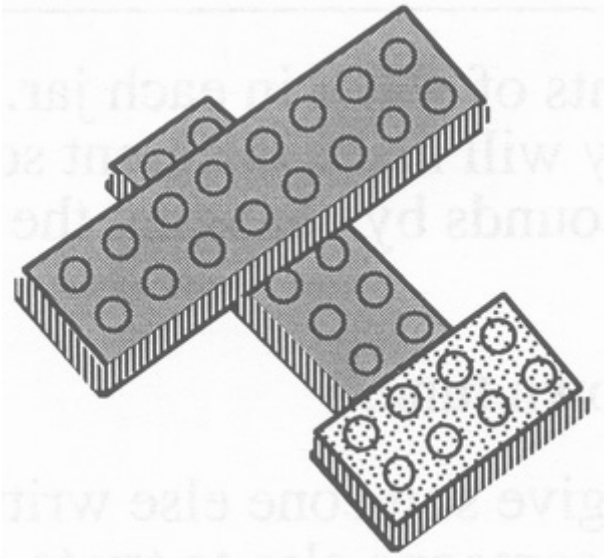
3. Make some planes by rolling the dice. Body first, then front wing, then back wing.
   1, 2, 3 means use colour A. 4, 5, 6 means use colour B
4. How many rolls until you make a plane which is all the same colour?
5. If a third colour is now available, how many planes can be made?

FLYING IN FORMATION

MATERIALS

Twenty-four [24] building bricks with sixteen [16] studs.
Twelve [12] building bricks with eight [8] studs.

Use the equipment to build twelve [12] planes like this one:



The pilots of these planes like flying in formation.

1. Arrange the twelve planes so that they make a square formation.
   Sketch your formation.
2. Arrange the twelve planes so that they make a triangle formation.
   Sketch your formation.

3. Can you make them into a hexagon formation.
4. What other patterns can you make with your planes?

A school could easily collect its own set of jars for this next task.

PLAY A TUNE

MATERIALS

Five [5] jars. A quantity of water will be put into each one.
One [1]spoon.

1. Put different amounts of water in each jar. Tap each jar with the spoon.
   Experiment with changing the sounds by changing the water levels.
2. Try to invent your own tune.
3. Work out a way to give someone else written instructions to play the same tune.
   Ask some one to play your written tune.

Networking

One of the most powerful components of a task centre resource is that it works best when it is worked by a team of teachers. The resource encourages teachers to explore their teaching styles and yet, because of the many ways it can be used, it doesn't impose a particular style. Therefore, teachers from disparate backgrounds and with divers approaches to teaching have frequently found that by developing or joining a local network based around the task centre concept, they are stimulated by their colleagues and saved a great deal of research time.

Perhaps the most appreciated feature is the opportunity to 'talk tasks', but the benefits of sharing organisational details and discussing and annotating problems also ranks highly. Further, when new information is developed it can be shared across the world through Mathematics Centre, which is freely accessible to all

Local Network

Having a general library of tasks obviously means greater variety for each teacher, but brings with it the need for co-ordination and clarification of responsibilities. In some schools, making new tasks, or digging into the iceberg of tasks in the current collection is a regular feature of staff meetings. Teachers often report the value this adds to faculty meetings compared with meetings which focus on administrative issues. Engaging as a team in the tasks refreshes and consolidates enthusiasm for their integrated use throughout the curriculum.

As the iceberg information about a task becomes known teachers realise that, in one of its three lives (see Page 7), it could be used at several levels in the school. This leads to discussion about assigning particular tasks to particular levels and documenting their learning potential at that level.

Regional Network

Many networks have started when a group of schools collectively decide to initiate a task centre approach. Apart from the benefits of sharing pedagogical and mathematical knowledge other potential benefits are:

- increased likelihood of joint funding,
- sharing the costs of access to outside expertise,
- the comfort of a 'shared risk',
- a larger collegiate to attract the support of regional administrators,
- a larger collegiate to interpret and make links to district, state or national documentation.

International network

Mathematic Centre and Mathematics Task Centre:

- mathematicscentre.com
- mathematicscentre.com/taskcentre

are frequently refreshed. The easiest way to know what has been added or changed at the site is to register your email on the eNews list. In return you will receive a brief eNews every 4-6 weeks which will invite you to revisit the News page. Any number of staff members can register and there is no fee at all. This is our contribution to the international flow of information between teachers with a common interest in students learning to work like a mathematician. Your input to the site is always welcome.

You can register you email address by sending an email to:

- doug@blackdouglas.com.au

Tasks for Infants

The specific benefits of considering the use of tasks with Infants (K-2) include:

- mathematical concepts are presented in a practical context
- the problems are open ended
- tasks encourage experimentation
- tasks introduce mathematical concepts in a variety of ways
- various methods of recording and representing are possible
- usual barriers to mathematics learning are not present

Tasks in the eTask collection are designed for Years 2-10 because the reading level requirement for most task cards is usually not acquired until some time in Year 2. However, teachers have adapted several of these to younger (and older) students. More information, including a current list of tasks which have been adapted, is available at:

- mathematicscentre.com/taskcentre/infant.pdf

In addition, to create their own tasks, staff can turn to activities they have found successful with children of this age, and ask *Can these be changed into a task format?* (See Principles on Page 7.)

Frequently, the challenge in producing task cards for infants is to 'get the language right'. Some teachers have developed visual, rather than textual problem cards, and others have developed cards as big as posters so that small groups can gather on the floor around the task to explore and discuss.

It is important to make these efforts, but many teachers also supplement this work with a modified approach to using tasks in their classrooms. For example schools have modified the concept so that there is sufficient material for as many as one half, or all, of the class to work on the same problem simultaneously. Teachers then supplement the written language with spoken language and class demonstration in an attempt to build access to the

mathematics in a manner which is less dependent on the language proficiency of individuals.

This process also provides lots of opportunity for the teacher to model how a mathematician works. Even at this level, there is proven value in using the language and attitudes of the Working Mathematically process on Page 8.

Adapting and developing this approach with young children is well supported by the resource *Working Mathematically with Infants* from the Calculating Changes division of Mathematics Centre:

- mathematicscentre.com/calchange/#wmi

The introduction of maths tasks to young children should support their naturally inquisitive approach. Problem solving strategies can be easily introduced incidentally and informally if we work with the rich body of knowledge and experience young children bring to school.

For young children it is important that maths tasks have a 'context' either as an everyday story or problem. For example, Task 110, *Who Lives Where?*, becomes 'real' if you use children and family names from within the class, toy cars, and model 'houses'. The students can 'act it out' and then minor adaptations can include other 'families' in similar settings to reinforce the problem solving strategies.

Questioning and conference techniques are used to draw out discussion, probe thinking, seek explanations and prompt exploration. Students are encouraged to record in their own way using their own language. Later when they report and share findings they relive the learning and consolidate the mathematical understanding. These approaches promote oral language and these young students quickly learn to test, justify and express their theories.

> *By allowing the students plenty of time to estimate, develop an approximation, test and check, the focus remains on the learning and what we have discovered rather than shifting to getting it right. Instead of arbitrary figures on sheets of paper or in their books, their recordings become more detailed and comprehensive. The Task Centre allows me to develop risk takers, problem solvers and thinkers.*

Look for more stories about Working Mathematically with the youngest children in Calculating Changes Stories:

- mathematicscentre.com/calchange/stories.htm

and in particular about the resource *Working Mathematically with Infants* at Boroondara Park Primary School at:

- mathematicscentre.com/calchange/boroon.htm

Bibliography

There are many sources of ideas and materials for task centres. Your library is a good place to start looking for them. This bibliography was prepared by Margarita Pavlou and Doug Clarke of the Australian Catholic University, Victoria, Australia in the 1990s. We include it here because:

- It reminds us of the long history surrounding the use of tasks.
- The articles are predominantly classroom level experiences.
- The articles are largely housed in volumes of teacher associations and therefore are likely to be accessible.

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