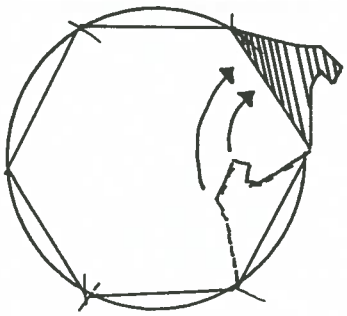
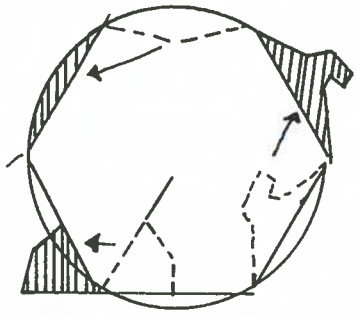
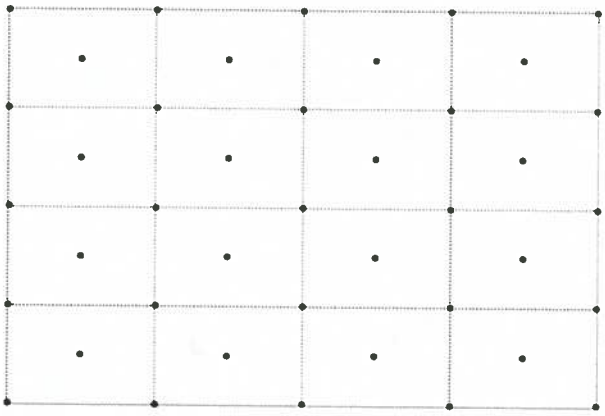


Whatever shape is cut out is just rotated round to the side next to it.



Other shapes were 'cut and added' to form a bear ... that tessellates!!!

All that was left to do now was to transfer the bears onto the grid pattern ... tricky!



Hexagons fit nicely onto isometric paper so I had to make the grid into an isometric pattern.

I soon discovered that isometric fits into a grid like this, so I made my grid into isometric (in perspective). Then I made up hexagons over it and drew in the bears. I coloured them in black, grey and white to give a finished effect of rotating bears disappearing into the swirling distance. ■

Year 9 student,
Belper School, Derbyshire

Another poster, designed by Sarah Griffiths, Belper School, will appear in the next colour issue of MT along with instructions for drawing it – Eds

TESTING VERSUS ASSESSMENT

Mike Ollerton

In recent years mathematics education has seen some positive moves away from tight didactic teaching methods, where children were taught concepts without an understanding of what they were doing, or without a context on which to base their learning, to a problem solving approach. Because this latter type of approach parallels the way learning takes place in the 'real world' it therefore should underpin the way that children learn mathematics effectively.

The changes that have happened in the classroom must also have consequences for the way that a child's performance is measured. The kind of changes to which I refer support the aims of mathematics education which were first recognised at a national level through Cockcroft in 1981, supported and encouraged in 1985 by HMI *(Mathematics from 5 – 16)*, developed in schools through the introduction of coursework in some GCSE syllabi since 1986, and institutionalised by the National Curriculum NSG in 1990.

Teachers of mathematics are currently striving to incorporate these ideals into their teaching methodology. Unfortunately our confidence as teachers to enhance and enrich our students learning of mathematics is often met by ignorance, prejudice, rhetoric and contradiction.

Because the National Curriculum document for Mathematics has been written at 10 levels over 14 Attainment Targets, there is a fundamental danger that teaching methods will focus on narrow pieces of content:

> *Much of the mathematical experience of most pupils is extremely fragemented ... Indeed because of the commonly held view that 'many pupils cannot concentrate for any length of time' many text books are planned to provide this rapidly changing experience. However provided that topics which interest them are selected it is possible to encourage most if not all pupils to pursue a study in some depth ... An in-depth study is of potential value for all pupils, not only mathematically but also in terms of development of personal qualities such as commitment and persistence.*
>
> Mathematics from 5 – 16, HMI

Consequently the assessment of the students' responses may be narrow and fragmented and something that happens only at the end of a piece of work, usually through an end of topic test. I

believe that a more holistic approach is necessary and more valuable. I want teachers to develop problem solving attitudes in their students so that assessment of the content described in Attainment Targets 2 – 8 and 10 – 14 is made by applying the level related criteria of the process based Attainment Targets 1 and 9. This can be achieved by focusing on assessment using broad criteria across a range of content. The type of project work undertaken in secondary schools through GCSE coursework assessment needs highlighting as examples of good practice.

The mathematics department at Orleton Park School has begun to develop similar techniques enabling children in the 11 to 14 age range to produce 'coursework' type responses, and then make appropriate comments back to the student as an ongoing part of the assessment.

> *The easiest objectives to assess are facts and skills but any assessment is inadequate if these are all that are assessed. Due attention needs to be given to the assessment of conceptual structures and general strategies because these objectives are more indicative of pupils' mathematical abilities.*
>
> Mathematics from 5 – 16, HMI

> *It is relatively easy to access facts and skills out of context, but this has little value. With regard to a particular skill it is not enough to ask whether the pupils can perform the skill; we must also ask whether they can use it in a variety of contexts, whether they understand it ...*
>
> Mathematics from 5 –16, HMI

It is neither possible nor desirable to teach in one fashion and then test the students in a different way. I believe that narrow testing of the kind prevalent in GCSE end of course examinations can only assess narrow mathematical skills; it will not assess any of the richer areas of mathematics which are fundemental to good practice, such as:

- *appreciation of relationships within mathematics*
- *imagination, initiative and flexibility of mind in mathematics*
- *working in a systematic way*
- *discussion*
- *problem solving*
- *appropriate practical work*
- *investigational work*

Mathematics from 5 –16, HMI

I would add to this list the following set of skills that also cannot be tested in the traditional manner; these are the ability to:

- *communicate an extended piece of mathematics*
- *implement ideas behind an extended piece of mathematics*
- *process and interpret information requiring skills such as classifying, generalising, hypothesising and proving.*

The result from a narrow content without context test does not reveal information about whether a student could achieve the same result a day, a week or a month later. It would not tell the teacher that the student could apply the tested knowledge in a variety of different contexts outside the sterile environment of the examination room. All that such a test will inform anybody is that at a particular moment in time the student was, or was not able to respond to particular questions written by someone else. There are of course dangerous consequences, such as what the teacher then does with this information. Do they re-teach the skills from the test that the student has already failed to get to grips with? Does the teaching method revert back to a narrow skills based technique so that the student can answer a similar test question (but with different numbers) on the next occasion?

> *At present (July 1985) undue importance is often attached to termly or yearly tests. If these produce any major surprises for the teacher it reveals that the assessment aspect of the teaching approach is inadequate* 'because effective teaching can only take place with continuing assessment of pupils' responses.'
>
> Mathematics from 5 – 16, HMI

A test cannot assess the way an individual carries out mathematical activity that draws upon the student's autonomy, or mathematical attitude or their ability to evaluate the work they do; as putting the student in a test situation defeats autonomous action and denies opportunities to display either a spirit of enquiry or reflect upon a piece of mathematics.

> *These (Objectives 23 and 24) need to be assessed but mainly in an informal way... If these personal qualities are missing then there is something fundamentally wrong with the mathematics curriculum whatever the levels of achievement attained by the pupils.*
>
> Mathematics from 5 – 16, HMI

A test in itself does not raise standards. At its worse a test will undermine confidence in all but the most able and will therefore reinforce failure amongst the majority. A test can however prevent and therefore undermine a student's opportunities to demonstrate their ability to function as a mathematician.

If students are actively encouraged to perceive that the important aspects of mathematics are narrow skills that are immediatley testable, it will inhibit their confidence to recognise the value of and therefore participate more actively and willingly in

the broader aspects of mathematics, as listed above. This will in turn have a retrograde effect upon students' mathematical aspirations.

> *At various points in this document comments are made about the undesirability of overemphasising the practising and testing of skills out of context; the ability to carry out operations is important but there is a danger that skills come to be seen as ends in themselves. If mathematics is only about 'computational skills out of context' it cannot be justified as a subject in the curriculum.*
>
> Mathematics from 5 – 16, HMI

For many years, mathematics has largely been taught in 'bits', usually in a linear fashion. The difficulty that arose from this kind of learning experience is that the student did not often have the facility or the understandings that are required to join the bits together. Testing will foster the re-introduction of 'bit-teaching' and deny developing understanding as a whole.

> *When presented with a mathematical task pupils should be encouraged to find their own method of carrying it out even though there may be a standard more streamlined method which they might ultimately learn... Many textbooks present 'problems' which use words and give the exact amount of information required for solution. These questions require pupils to make direct use of a skill which has just been learnt, but they provide relatively little real challenge. Opportunities need to be given to pupils to use their expertise to find their own way through problems and investigations ... The aim should be to show mathematics as a process, as a creative activity in which pupils can be fully involved, not as an imposed body of knowledge immune to any change or development.*
>
> Mathematics from 5 – 16, HMI

It is essential that as the students progress through the school they take evermore responsibility for their learning in order to achieve independence. To achieve this, tasks should be both open-ended problems or investigations and content-based courseworks, thus enabling differentiation by outcome. Investigatory ways of working are not just restricted to open-ended problems; these skills are constantly encouraged throughout the more directly content based components of the mathematics syllabus, such as trigonometry and Pythagoras.

> *Pupils should have opportunities to explore and appreciate the structure of mathematics itself ... Mathematics is not only taught because it is useful. It should also be a source of delight and wonder, offering pupils intellectual excitement and an appreciation of its essential creativity.*
>
> Mathematics – The NCC NSG

> *Learning in mathematics does not neceassrily take place in completely predetermined sequences. Mathematics is a structure composed of a whole network of concepts and relationships, and, when being used, mathematics becomes a living process of creative activity.*
>
> Mathematics – The NCC NSG

For the past 5 years I have worked in a school that has been developing assessment of coursework through a GCSE syllabus written by members of the Association of Teachers of Mathematics, and certificated through the Southern Examining Group. There are six other schools operating the same syllabus. The style of teaching and learning that this syllabus encourages has produced some interesting developments, such as paving the way for mixed ability teaching groups through to age 16. There has also been a noticeable improvement in the performance of girls in mathematics. Students are encouraged to behave as mathematicians, working on problems which offer them opportunities to explore and research ideas that help them understand and work with traditional mathematical concepts. Because a high expectation is placed upon the students their responses to the ideas that they work on is of a high standard. This work is then assessed using meaningful criteria. Accordingly the students motivation is higher, their learning is enhanced, and I firmly believe that they raise their own standards. The type of teaching and learning experiences that have proved to be succesful for helping to record assessments for the GCSE are now being developed in the lower school in preparation for a KS3 assessment model.

This experience leads me to the conclusion that useful assessment must be of a continuous nature and not by simple testing. ■

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