newVOICES

Using Geoboards in Primary Mathematics

GOING... GOING... GONE?

HILARY SCANDRETT

reminds us of geoboards and asks whether or not they still have a place in today's classrooms.

Until recently, I had forgotten what a geoboard was and how it was used. Upon reintroduction, fond memories of using it as an investigative tool in primary school, were triggered. It seems that geoboards have also been forgotten by mathematics educators and there is little reference to them in recent literature. This led me to question: Are geoboards a forgotten tool? Are they still relevant in today's classrooms? Has modern technology replaced geoboards and made them obsolete?

For those of us who have forgotten, what is a geoboard?

Invented by English mathematician and pedagogist, Caleb Gattegno (1911–1988), the geoboard was designed as a manipulative tool for teaching primary geometry in schools (Williams, 1999). Traditionally made out of plywood and nails, geoboards today are usually made out of plastic and come in a variety of different sizes and colours. Rubber bands are placed around the nails or pegs to form different shapes (see Figure 1). As a learning tool, it provides a means to act upon the world and can be used as a cognitive scaffold that facilitates the extension of knowledge (Salomon & Perkins, 1998, in McInerney & McInerney, 2002).

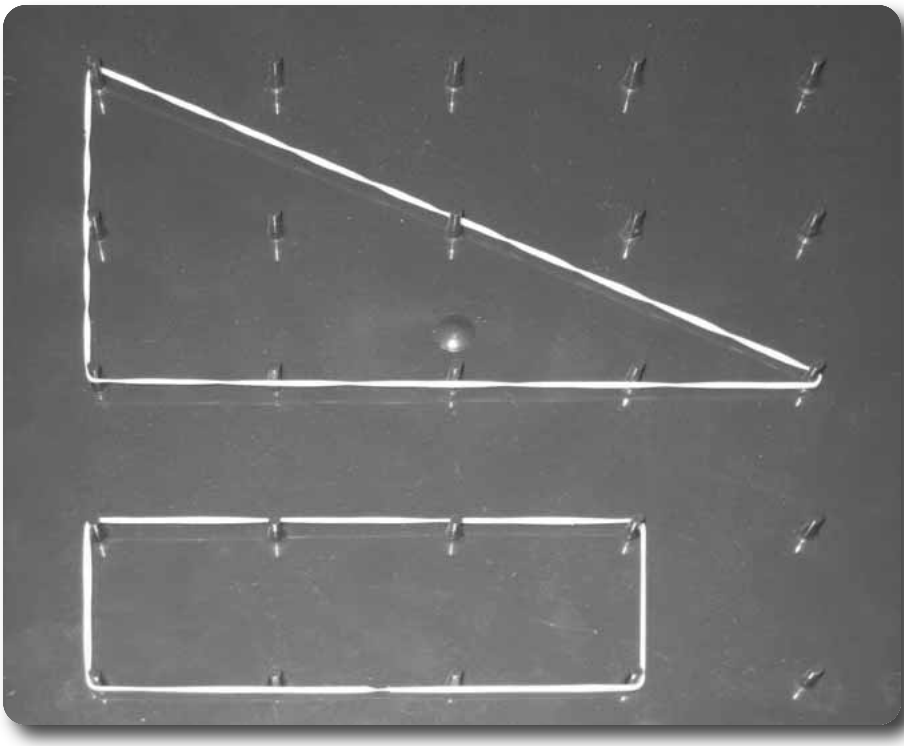

Figure 1. Photo of a geoboard.

and work can be recorded easily. The areas of mathematics in which geoboards can be used in include:

- plane shapes
- translation
- rotation
- reflection
- similarity
- co-ordination
- counting
- right angles
- pattern
- classification
- scaling
- position
- congruence
- area
- perimeter.

How can geoboards be used in teaching?

The geoboard is versatile and can be used at all levels for teaching and learning about different areas of mathematics. It has been found to be a particularly useful aid for investigational and problem solving approaches (Carroll, 1992). There is no set sequence to use with geoboards when using them to teach a mathematical concept and so, is an easy tool to incorporate into mathematic units and learning sequences. Like every tool, however, time needs to be allowed for free play, so that students have the opportunity to explore and experiment with new equipment. Another advantage of the geoboard is its design, as it allows for even young children, and those who may experience difficulty in drawing shapes, to construct and investigate the properties of plane shapes (Carroll, 1992).

Carroll (1992) suggests that geoboards can be used in different areas of mathematics. It is suggested that geoboards be used in conjunction with isometric dot paper, so that exploration can be furthered

From this it can be seen that geoboards, can particularly support learning in the measurement, space and geometry strands of the primary mathematics curriculum. The following example illustrates the versatility of geoboards and how they can be used to develop students' understanding in the strands of space and geometry.

The K–6 mathematics syllabus document (Board of Studies New South Wales, 2002) classifies space and geometry as the study of spatial forms and is organised into three sub-strands: three-dimensional space, two-dimensional space and position. It considers recognising, visualising and drawing shapes, and describing the features and properties of three and two-dimensional objects, as important and critical skills for students to acquire. The development of geometric understanding as set out by the syllabus document, incorporates the first three levels of van Hiele's theory (Clements & Battista, 1992). Table 1 describes these three levels and provides examples of activities which can be used to assist students' progress through the levels.

From Table 1, it can be seen that geoboards can be used to support all three levels of geometric thought and of course

Table 1. Activities appropriate to van Hiele's levels of geometric thought.

LEVEL	DESCRIPTION	ACTIVITIES
One: Visualisation	• Identifies and operates on shapes and other geometric configurations according to their appearance • Reasoning is dominated by perception • Objects are recognised visually "as the same shape"	• Making shapes on the geoboard, followed by discussion • Make as many as you can of the same shape on the geoboard, differing in size and position • Ask students to follow instructions and then ask them what shape they have made
Two: Descriptive/Analytic	• Recognises and characterises shapes by their properties • See figures as wholes, but now as collections of properties rather visual gestalts • Properties are established experimentally by observing, measuring, drawing and modelling	• Present differing shapes on the geoboard discuss the ways in which in which the shapes are similar and different • Ask students to make a shape with a certain property; e.g., four sides and discuss the similarities and differences in the shapes made
Three: Abstract/Relational	• Forms abstract definitions • Distinguishes between necessary and sufficient sets of conditions for a concept • Reasons with the properties of classes of figures • Reorganises ideas by interrelating properties of figures and classes of figures	• Ask students to sort shapes on the geoboard according to their properties (allow children to select the criteria) • Reflecting and rotating shapes • Investigating the symmetry of shapes, using mirrors

there are many other activities that could be done. Furthermore, through using geoboards, students can not only work towards space and geometry outcomes, but also be engaged in working mathematically (Board of Studies New South Wales, 2002).

Have computers made geoboards obsolete?

The National Council of Teachers of Mathematics (NCTM) in their *Principles and Standards for School Mathematics* (2000) provide insight into the ways that calculators and computers are reshaping the mathematical landscape. They suggest that the appropriate and responsible use of technology can enhance student learning. Bobis, Mulligan and Lowrie (2004), support this view and further suggest that, with appropriate software, the computer can become a very powerful tool that enables students to manipulate spatial arrangements and construct visual images that would be usually limited by their drawing capabilities. Many of the activities in Table 1, for example, could be undertaken using software or websites which feature geoboards as a virtual manipulative.

Technology, however, cannot replace the mathematics teacher, nor can it be used as the sole resource for developing basic understandings and intuitions. Instead the teacher must make prudent decisions about when and how to use technology and should ensure that the technology is enhancing students' mathematical thinking (NCTM, 2000). This view is endorsed by Way (2006) who recommends that hands-on activities should be used to help students form mental images before commencing abstract tasks on the computer.

Conclusions

Overall geoboards have the potential to develop students' understandings in the mathematical strands of measurement, space and geometry. This learning can be further enhanced when students, under the guidance of their teacher, have the opportunity to engage in the hands-on experience of using geoboards, followed up by the more abstract experiences accessible through technology. Geoboards should not be forgotten in the mathematics classroom, but like other tools, should be used to engage students and facilitate their learning.

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Hilary Scandrett
University of Sydney (student)
<hsca8836@mail.usyd.edu.au>

APMC