

Product v. process: A bright or tarnished idea for planning?

- Product v. process
- Schematic v. rote learning
- Conceptual v. procedural knowledge

personal history

Some References

Ploger and Rooney (2005) - outlined an approach to the teaching of common fractions that emphasises reason rather than just memorising the processes involved.

Cady, Meier & Lubinski, (2006) - young teachers to revert to the way they were taught when things get a little tough

Davis (2005) - claims that students can apply both procedural and conceptual knowledge to the solution of problems.

Heuser (2005) - employed a game situation to develop both understanding and competence in computations

The Cockcroft Report

240 *The Review of research* points out that in the teaching of mathematics it is possible to distinguish between three elements – facts and skills, conceptual structures and general strategies and appreciation. (Cockcroft, 1982, p. 70)

241 Research shows that these three elements – facts and skills, conceptual structures, general strategies and appreciation – involve distinct aspects of teaching and require separate attention. It follows that effective mathematics teaching must pay attention to all three.

An example

Stage 1. SGES1.2 Outcome from the NSW K-6 Mathematics Syllabus states:

Manipulates, sorts and describes representations of two dimensional shapes using everyday language.

Facts and skills

- the difference between straight and curved lines
- what is meant by closed shapes
- a closed shape with three straight sides is called a triangle
- triangles can be different shapes depending on the lengths of their sides.

Mathematics 7-8 Syllabus, e.g.

G4.1 manipulates, describes and sketches two-dimensional and three-dimensional shapes and classifies them in terms of their mathematical properties, using common terminology and conventions. (p. 19)

Conceptual structure

Table 1. Triangles classified according to the lengths of the sides

All sides equal	Two sides equal	All sides different
Equilateral triangle	Isosceles triangle	Scalene triangle

Table 2. Triangles classified according to the size of their angles (Table 2)

All angles acute	One angle obtuse	One angle right angled
Acute angled triangle	Obtuse angled triangle	Right angled triangle

The external structure to which triangles belong is that of polygons (Table 3). A triangle is the closed shape that can be formed with the least number of sides, i.e.

Table 3. Polygons

3 straight sides	4 straight sides	5 straight sides	6 straight sides	7 straight sides
Triangle	Quadrilateral	Pentagon	Hexagon	Septagon or Heptagon

General Strategies and Appreciation: General strategies are ‘the procedures which guide the choice of which skills to use or what knowledge to draw upon at each stage in the course of solving a problem or carrying out an investigation’ (Cockcroft, 1982, p. 71). The *Working Mathematically* column in the K-6 Mathematics Syllabus gives several suggestions for this aspect. For example,

- *Predict the results of putting together or separating two dimensional (in this case, triangular) shapes.*

Stage 2

Paragraph 243. Mathematics teaching at all levels should include opportunities for

- exposition by the teacher;
- discussion between the teacher and pupils and between pupils themselves;
- appropriate practical work;
- consolidation and practice of fundamental skills and routines;
- problem solving, including the application of mathematics to everyday situations;
- investigational work. (Cockcroft, 1982, p. 71)

A possible sequence might be:

- 1 Investigation and practical work 1 – pupils sort a set of shapes into triangles, quadrilaterals and others and, in groups, decide on the distinguishing features of triangles.
- 2 Discussion will have taken place in groups as pupils come to decisions about triangles in general.
- 3 Investigation and practical work 2 – pupils sort triangular shapes (a) according to their sides, (b) according to their angles
- 4 Discussion will have taken place in groups and can be followed by some discussion between the teacher and the pupils to ensure there is a common understanding of the classification of triangles.
- 5 Facts and skills – a card sort (see Appendix B) may be a good way to consolidate the facts and skills related to triangles. This could be a group activity with accompanying discussion.
- 6 Practical work – Finding what new shapes can be found by putting two or more triangular shapes together by matching sides.
- 7 Exposition – Teacher and pupils develop a systematic display, e.g. what shapes can be formed by putting 2 equilateral triangles together? Two isosceles triangles? Two right-angled triangles? Etc.
- 8 Problem solving – Which types of triangles tessellate? This is another investigation which emphasises the pupils' understanding of triangles and the various characteristics of each type.

The benefits of a structured approach

- structured
- topic is considered holistically
- ensures complete coverage of topic
- can be a checklist to monitor teaching
- lends itself to the inclusion of all six teaching strategies
- ensures teacher's background knowledge is sound

Difficulties and how to overcome them

- time needed
 - collegial planning
 - depends on the teacher's knowledge of the mathematics concerned .
 - planning can be reused
 - every second or third topic