LAND SURVEYING FOR GM1&2 AND FM3&4

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This session demonstrates the possibilities of using land surveying techniques and their practical applications to teach and assess Geometry and Trigonometry to General Mathematics 1&2 and Further Mathematics 3&4.

Practical applications of measurement techniques

General Mathematics 1&2 (GM12) and Further Mathematics 3&4 (FM34) are traditionally taught to students who have not shown a strong affinity with mathematics and have often demonstrated an aversion to the aspects of mathematics that involve algebra.

Finding an idea that can be used to cover areas of the syllabus and be seen by students as both useful and manageable is valuable in encouraging them to learn.

The surveying techniques that can be introduced in GM12 are Offset (or Transverse) surveying, Radial surveying and Triangulation. The Offset surveying is no longer referred to in the Geometry and Trigonometry module of FM34, but Radial surveying, (and the associated considerations of contour lines) and Triangulation encompass much of the material that is to be taught in this module.

The different mathematical concepts that can be related to these surveying techniques are in Table 1:

Table 1: Concepts covered with different land surveying techniques

<table>
<tr><th>Offset surveys
(GM12 only)</th><th>Radial surveys
(GM12 and FM34)</th><th>Triangulation
(GM12 and FM34)</th></tr>
<tr><td rowspan="3">• Pythagoras' theorem
• Area of right angled triangles
• Area of trapezium
• Linear scaling
• Polygon angles
• Compass bearings
• Linear scaling
• Cosine rule
• Area of a triangle given 2 sides and the included angle
• Sine rule
• Geometry of parallel lines and triangles</td><td>• Compass bearings
• Linear scaling
• Cosine rule
• Area of a triangle given 2 sides and the included angle
• Heron's law
• Basic trigonometric ratios
• Angles of elevation and depression
• Horizontal and Vertical distances</td><td>• Linear scaling
• Compass bearings
• Geometry of parallel lines and triangles.
• Sine rule
• Cosine rule
• Basic trigonometric ratios
• Angles of elevation and depression
• Horizontal and Vertical distances</td></tr>
<tr><td>FM34 only</td><td>FM34 only</td></tr>
<tr><td>• Relative heights
• Similarity (for contour line positioning)</td><td>• Relative heights
• Similarity (for contour line positioning</td></tr>
</table>

Introduction and organization of ideas

Once any or all of the ideas behind the land surveying techniques have been introduced it is then possible to start developing mathematical processes that enable a student to:

Firstly: be trained in the different ways in which the measuring could be effectively carried out (i.e. how to actually carry out such Offset surveys or Radial surveys or Triangulation) and,

Secondly: calculate various measures that are intrinsic to the physical features of what has been mapped

- its area
- its perimeter
- internal distances
- positions of features within the boundaries – trees etc
- distance between features that were sighted but not visited
- angles at vertices
- heights of each vertex relative to the lowest point of the area surveyed
- positions of the contour lines on the boundary and internally

The development of these above mentioned skills through their applications to surveying techniques mean that students are constantly aware of the usefulness of a particular concept and that the skills learnt are immediately applicable to the related problems that they are challenged with.

Practical applications and Assessment

Upon the completion of the classroom aspects of the topic it is then most suitable to have the students carry out:

1. practical exercises of measuring using some or all of the three techniques
2. the production scaled maps of the area that they have surveyed.

This can be done with reasonably basic equipment. Trundle wheels, cones, compasses and 'school' theodolites are all available through the usual catalogues that teachers are bombarded with throughout the year. For a modest annual outlay a school can accumulate enough equipment to allow classes to work on small groups of 2 or 3. Schools in close proximity could share equipment as it would only be required by each school for a short period of time each year.

If appropriate areas are identified a school could then hold excursions where the measurements are taken with this equipment and Application Tasks can be set based around the work that the students have done out in the field. Again schools in the same region could share their use of such venues, even scheduling excursions over sequential days so that shared equipment could be suitably stored and used as each group attended the site.

Metropolitan areas that, with permission, could be suitable venues for such excursions will be identified along with sample Application Tasks and ideas for their instigation and running.