PRACTICAL ACTIVITIES FOR POST-16 MATHEMATICS.

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The value of practical work has long been recognised at the primary level. Many teachers acknowledge the value of learning by 'doing' rather than just being shown or told. There is also evidence to suggest that studying mathematics in context helps to increase motivation and develops modelling and problem solving skills. Despite these benefits, practical activities are rarely used in secondary mathematics classrooms. Most teachers attribute this to time constraints. An investigation into the role and implementation of practical work for older pupils has been initiated in co-operation with the Centre for Mathematics Teaching at Plymouth University. We have gathered a number of practical activities on a theme of parabolas for use with secondary school pupils. We are studying pupil and teacher attitudes and comparing male / female, urban / rural and Scottish / English responses. The ethnographic / illuminative evaluation methodology will be used.

The value of practical work in learning mathematics has long been recognised. The Haddow Committee (1926) recommended giving greater emphasis to practical work for "not only does it supply a concrete and experimental basis from which the pupil may proceed to abstract reasoning, but it vitalises the work for the pupil and stimulates his (sic) interest in it".

Practical activity is a key element in the development of understanding.

"For most children, practical work is the most effective means by which understanding of mathematics can develop. It enables them to think out the mathematical ideas which are contained and so to progress from the handling of actual objects to a stage in which pictures or diagrams can be used to represent these objects and then to a final stage in which symbols are used which can be manipulated in abstract ways."

(Mathematics Counts, Cockcroft Report, 1982)

A lack of sufficient practical experience can often cause problems for pupils.

"Mathematics is an abstract subject and becomes almost exclusively so too quickly for many pupils. Without sufficient practical experience the pupils are unable to refer abstract mathematical concepts to any form of reality."

"Failure in high-order skills (conceptual structures and general strategies) is often due to insufficient variety in the experience provided."

(Curriculum Matters 3: Mathematics 5-16 HMSO 1985)

As well as helping student to assimilate new concepts and discover important ideas for themselves it can act as a diagnoser of misconcepts and incomplete knowledge.

"When working in a class of ten year-olds recently I observed two girls who had worked out the number of pages of a local paper devoted to news, advertisements, sport and so on. I asked them what fraction of the paper was devoted to each category. They had "done" fractions, but had almost certainly never used them. Their first reaction was to turn "19 pages" into 1/19, 2 pages into 1/2, and so on. They then noticed that this had led them to say that half the paper was devoted to births, marriages and deaths and half to cinema advertisements. The ludicrous nature of this interpretation of results produced by themselves led them to rethink the whole meaning of fractions and they produced a revised and correct list of fractions. One hour of practical activity taught them more about fractions than hours of computational drill."

(Alistair McIntosh, Mathematics Teaching 100, Sept. 1982)

There is also some evidence to suggest that practical work can develop affective factors.

"Even in schools in which the general atmosphere was lively and supportive, the need of children to work at mathematics in practical ways had not always been recognised, so that attitudes to mathematics in some classrooms contrasted strongly with attitudes towards other work."

(Mathematics Counts,Cockcroft Report, 1982)

Practical activity may provide opportunities for working cooperatively and for talking about mathematics:

"Practical activities in the classroom can create an informal environment where the students can discuss and communicate mathematical ideas between themselves and with the teacher."

(Potari, D. & J.W. Searl, Teach. Math. Appl.8 , 2,56-68, 1989)

and it seems likely that showing applications to real life will provide motivation.

Despite these benefits, practical activities are rarely used in secondary mathematics classes.

Most teachers blame lack of time. It does seem that some investigation of the possibilities/difficulties of practical work for upper secondary pupils may be worthwhile.

At the Edinburgh Centre for Mathematical Education we have developed a number of practical activities on the theme of parabolas. These are practical in two different ways:

- They involve the pupils in "doing", e.g. lego parabola activity.

and/or

- They relate the school mathematics to real life, e.g. building a suspension bridge.

Activities which can be adapted for use with pupils across the full range of abilities have been developed.

One activity, for example, involves pupils in curve stitching to envelope a parabola and then using their own cardboard parabola to make a parabolic mirror which will focus light to a single line. This activity can involve working on equation of a straight line, negative numbers, decimals, coordinates in 4 quadrants, algebraic work at different levels (use of variables, substitution, the discriminant...), spreadsheets and so on, as appropriate to the student. It also makes a connection with real life (discussion of radar etc.) demonstrating clearly a useful application of this mathematics.

We have carried out some pilot studies, trying out ideas with pupils in secondary school (S2 (age 13/14) a range of different abilities), in primary school, special school, at a workshop for very able pupils and a workshop for all ages at Edinburgh International Science Festival. We have also tried out our ideas with undergraduate mathematicians and surveyed their responses to the material.

We have now made arrangements to work with the Centre for Mathematics Teaching at Plymouth University and have recruited a number of schools to take part in the project. We plan to concentrate on S5 pupils (age 16/17) across the full range of abilities.

The ethnographic / illuminative evaluation methodology will be used. We hope to look closely at teacher as well as pupil responses to the use of practical activities and to make comparisons between male and female responses and city and rural as well as Scottish and English schools.