Finding Common Threads: Researching the Mathematics in Traditionally Female Work.

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Throughout the world, the largest single group of people who attain lowly in institutional mathematics is women. Throughout the world, the traditional work of women involves a very large amount of unacknowledged mathematical thinking and skill. How can we give recognition to the mathematics women actually do?

Gender and Low Attainment

The past thirty years has seen a large amount of research into differences in performance in school mathematics between boys and girls. Though many may claim (and though many would still dispute) that, so far as the school population is concerned, there is no longer a problem, the same cannot possibly be said for the adult population. The fact is that throughout the world, the general public reaction to women doing mathematics is surprise, scorn or disbelief.

Research into the mathematical performance of females is admirably reviewed by Willis (1989). A hundred years ago it was accepted, even amongst educated women that girls were physically, emotionally and intellectually ill-equipped for the serious study of mathematics. Until about thirty years ago it was widely and complacently believed that girls were less *able* than boys. The question was seen in genetic terms as some sort of female disability and there was much research on visual and numeric differences in performance. Competing psychological theories and the various political movements of the 1960s however finally exposed the flaws in the biological arguments that justified class and race as well as gender differences. By the 1970s the question had changed from 'Why *can't* girls do maths?' to 'Why *don't* girls do maths as well as boys?', in other words there was a shift in emphasis from ability to achievement. The lower achievement of girls was seen as a problem, for them, and research centred on affective issues, achievement motivation, success avoidance and so on. In fact, there was no real evidence that girls did achieve less. The evidence is that they achieve as well but that they participate less and the research question of the 1980s was 'Why *won't* girls do as well as boys in mathematics?' or in other words 'Why do girls drop out?' The answer is not genetic, it is social.

Mathematics in Work: Women at Work.

During the 1980s I ran a project called Maths in Work which looked at the mathematics used by young, unskilled workers in the first job in the Inner

London area. This work has been reported elsewhere (for example Harris, 1991a and 1991b) so only the briefest of reviews will be made here. The Project started with research questionnaires listing a set of mathematical and other skills which had been administered to young people at work.

There are many kinds of problems with this type of research not the least of which is the widespread public and professional perception of workplace mathematics as just arithmetic of a certain level. Throughout its chapter on mathematics in the workplace, even the prestigious Cockcroft Report (1982) uses the word 'mathematics' while referring mainly to calculations. Following back the lists of 'basic skills' that now form part of National Vocational Qualifications, through the demands of industry that prompted the Cockcroft enquiry in the first place, and comparing them with those of the seventeenth century in Howson (1982) for example, one can see that the perception of workplace mathematics as sums has hardly changed. Inventions such as logarithms or the pocket calculator seem to make little difference to the public view of working mathematics as the four rules, ratio and percentages.

If the questionnaires (or interviews) of workplace research confine themselves to this limited perception, then they will limit the answers they provoke. The research merely becomes part of the self-fulfilling prophecy that maintains the status quo. Responses to questions <u>not</u> about mathematics however can be very revealing. A finding of the Maths in Work Project was that when the young workers were asked for example about the communications or practical skills they used at work, they often revealed a use of mathematics they had previously denied when asked about it specifically from a mathematics questionnaire. Hairdressers, for example, denied that they used ratio and proportion when asked about them as mathematical skills, yet used the word 'proportion' when they explained the necessity for mixing hair tints accurately, in responses to questions about their practical skills.

Such responses make the scores of responses to mathematics questionnaires meaningless. They also reveal some of the subtleties of workplace research which are not usually analysed. The widespread negativity towards mathematics supported by the public acceptance that people cannot do it allows it to be normal to answer questions about mathematics negatively. The research responses also seemed to suggest that when mathematical skills caused the workers no problem, then they were regarded as common sense. They only became 'mathematics' when the worker could not do them. This widespread response was just one measure of the separation of mathematics skills from the context in which they are used by both workplace research questions and by educational institutions where mathematics is taught. By keeping the mathematics skills as recognisably the mathematics of schools and exams, learned, practiced and assessed out of contexts that give them any meaning, the research ensured that the workers, no longer in a school situation, did not recognise them once they were embedded in the chores of daily life.

The Work of Women

The mathematics of educational institutions does enormous damage by this separation. The approach of first teaching the isolated skills and then their applications, as if mathematics was some sort of ointment to be rubbed onto various sore places, is ineffective. The alternative, what might be called the vitamin view of mathematics is to learn to recognise and develop mathematical thinking in its natural habitat, embedded organically in the systematic solution of daily problems. The following is an example of some domestic work I did recently. The reader is invited to analyse the mathematics in it.

> I have just moved house and one of the many jobs I have been doing is making curtains. The house has rather large windows and the whole business of making curtains is therefore expensive. For my bathroom window I found an economic solution in the material made for making duvets which is about seven feet wide. In deciding how much of it I had to buy, I measured the window across and down, allowing a few centimetres at the top and bottom for hems and headings. A properly made curtain has to be at lease double the width of the window if it is to hang and cover well, and because the duvet cloth was so wide I would only need two 'drops' of it, one for each side of the window. The cloth I chose from the range had a small repeat design on it and I bore it home in triumph as a bargain. In the evening I spread it out on floor ready to cut it in half, only to find to my dismay that the all-over pattern had a repeat of about twenty centimetres that I had not noticed in the shop. I had not bought enough to match the design across both curtains. For some time I worked at various solutions: cutting both pieces in half vertically to break up the pattern for example. In the end, I found that by splitting the pattern in half, that is pretending it had a ten centimetre repeat when it hadn't, being mean with the hem and deciding that I was not going to lie in bath and worry about my curtains anyway so long as the room was cosy, I went ahead and made them. I had to line them of course and lining material does not come seven feet wide, but that is another story.

My point is that I had not consciously <u>applied</u> mathematics to the problems of my curtains, windows and budget. I had never thought "What mathematics do I need to solve this?" What I had done was to find myself measuring and calculating in both imperial and metric units at once, depending on what I was measuring and in analysing and manipulating symmetries - an aspect of mathematics that rarely gets a mention in workplace research.

My experience of the research I had been working on, backed up my own experience as a practical householder caused me to reject the skills-and-applications approach in both my research and publications. Instead I did my research in the workplace, working alongside workers and learning their thinking instead of interviewing them and using my own perceptions of their work to analyse what they were doing. For the learning materials I was contracted to produce, I tried to bring mathematically rich, practical problems from the various places where I had worked into formal classroom situations through learning materials which were honest and realistic and did not prescribe a particular answer.

The first pack of learning materials to emerge from the Project was concerned with the design and making of cardboard boxes. Both learners and teachers enjoyed them and found them effective, so the Project went on to look for more everyday activity with materials as ordinary as cardboard. As an experienced home dressmaker and knitter, cloth was an obvious choice.

Research for a pack of learning materials using cloth as the main resource continued in both the industrial and domestic spheres, (Harris in press). Domestic research included analysing the way a cross-stitch embroiderer in former Yugoslavia and a weaver from Bangladesh worked up the symmetries of their designs, and the handling of different symmetries in a Scottish Tam O'Shanter. Industrial research included a study of how socks, umbrellas and ties are designed and manufactured in bulk. As the Maths in Work office began to fill with samples of cloth the suggestion arose of making them into an exhibition. This was the origin of the exhibition Common Threads set up originally at the University of London Institute of Education for about ten days, but which went on to tour England for two years and the world for the following four. Its exhibits were entirely cloth and its captions entirely mathematics and it demonstrated incontrovertibly the enormous wealth of mathematical skill deployed when women from all over the world get on with their traditional domestic work of knitting, sewing, embroidery, weaving and basket making.

Crediting the Mathematics in Traditional Women's Work

The effects of the exhibition were immediate, indeed they were responsible for its long life and tours that had never been part of the plan. Common Threads stimulated a different perception of working mathematics from the traditional model of the applications of school-based arithmetic. It stimulated cross-curricular work in schools and colleges: it gave confidence to both women learners and teachers who saw their own work credited for its intellectual as well as practical or aesthetic content: it asked pertinent questions about why such work is not traditionally regarded as mathematical and it demonstrated, once again, the gross bias in mathematics education towards male interests, male methods and male achievement.

The international response was also remarkable. Gender bias in mathematics education is a world wide problem and many countries felt that they could use Common Threads as a resource in their own work. It was this expressed need that caused the British Council to take over Common Threads and re-design it for overseas travel. The saga of how the re-design process drew the exhibition back into the rejected public perception of mathematics as a set of low level skills is discussed elsewhere (see Harris in press). The version that toured overseas in two copies was radically different from the original in philosophy and content but it did speak to mathematics educators in a number of countries when I could be there to demonstrate the now invisible research behind it.

In some developing countries the potential was particularly inspiring. There are many development projects for women which teach textile skills for commercial independence. For such, Common Threads raised the possibility of learning mathematics while learning textiles crafts and obtaining both a commercial skill and an educational qualification at the same time. Such a project demands commitment, which was never a problem but it demands funds and funds demand access to formal funding bodies. By the very nature of things such bodies are not controlled by radicals ready to abandon the accepted view of workplace mathematics particularly for a bunch of village women weavers.

Another extension of the Maths in Work Project's work with textiles has been more imaginatively supported. For the year 1993-4 I worked as Scientist in Residence at the Women's Institute College, under the COPUS Project. The Committee on the Public Understanding of Science is a project of The Royal Society, The Royal Institution of Great Britain and The British Association for the Advancement of Science. My work at Denman College was to identify and reveal the mathematics in some textiles courses and help plan future projects to developing mathematics. The three courses I worked through and analysed were in knitting, the making of curtains, cushions and blinds, and strip patchwork. The common feature of my participant observations on all three courses was that all on-task talk was all mathematical. The moment the work 'mathematics' was mentioned however, there was an immediate display of attitude problems. The problem for the future is how to handle the attitude: there is no problem with the mathematics potential.

Once again it is revealed that there is nothing wrong with the women's mathematical skills and competence. They do rather more mathematics in their daily work than a lot of people. Yet research into gender and mathematics still pathologises women. Women have been accused of being genetically incapable of doing mathematics, of being unwilling to compete, of not knowing what they are doing even when they do it. It would be possible to go on doing the sort of research that reveals what mathematics women do, that explores way of crediting it, that builds confidence that helps them compete, but the problem is not theirs. The problem lies in a society that sees workplace mathematics as a limited and impoverished version of the real thing and women as incapable of even that. The research perhaps should become more political. Maybe I should address myself in future to exploring and publishing the ways in which public ignorance and male prejudice maintain a pernicious dual handicap on half the world's population.

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