" ADULTS RE - LEARNING MATHEMATICS: MATHEMATICAL INVESTIGATIONS."

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Abstract:

Mathematical Investigation is a source designed to provide effective practice in some basic concepts in mathematical education and the development of adults' learning skills in a form that generates interest and enthusiasm. This, hopefully. will lead the way to the AH!, HA! experience -

> I thought I had forgotton forever, but it has encouraged a new found interest in mathematics and finally dispelled the mist of difficulty surrounding this subject.

'Adults relearning Mathematics' is some preliminary study of students' attitudes to the learning of Mathematics and teachers who taught them and it is an essential study to activate this awareness.

Introduction:

Mathematics learning in adults Continuing and Community Education has, by implication, three areas of concern: An overview

(1) **Community Education** Certainly, over the last decades, a revolution has occured in adults learning Mathematics and in particular, the concept of "Adults in Community Education", as a process whereby human populations adjust their environment. For a start (Saunders. P. 1981), theoretical orthodoxies have been challenged and the application of such a theory to the analysis of cities have given rise to new questions about the role of the urban system in a capitalist economy in which competition have le d naturally to one form of human organisation by forcing increased functional and spatial differentiation thereby creating utilitarian ties of natural interdependence. The development of "Adult Learning Mathematics- a research forum" is such a revolution.

Analysis of this way of thinking leads me on to Mathematics curriculum principles and practice - educational objectives (see below). My view is that it requires a critical evaluation of the term "Community Education" as well as the re-examination of the more radical traditional approaches to Mathematics in Adult Continuing and Community Education. This requires too raising issues and questions such as "Who are the community?" "How does the concept 'community' come to be used so widely in social theory by sociologists, psychologists and philosophers of Community Education?" (See McKenzie. R. (1967), Jones D. et al (1974), Plant R. (1974), Harvey D. (1973) and Rissman L. (1964))

I shall try to shake the dust off some of these ideas:-

CURRICULUM PRINCIPLES AND PRACTICE.

(ii)

Closely associated with the concept of Community Education concerns the development of curriculum principles and practice as well as the concept of educational objectives. Here the educational implications are fundamental. The increased incidence of planning ,preparation in development and the evaluation in mathematics in adult continuing and community education, means that one needs to include and assume and consider in the discussion curriculum theory, the most essential item in the armoury of modern innovators of continuing education.

What is meant by an educational objective? The need to clarify what is meant by an educational objective empirically has led to a considerable amount of research work, in particular in the USA. One of the most useful and plausible classifications of objectives is that proposed by Bloom's Taxonomy of Educational Objectives et al [1956].The generic term Taxonomy was carefully chosen by Bloom and his co-workers to indicate to us that their classification possessed certain characteristics. These are the cognitive defined as comprising objectives which emphasise reproducing something which has been learnt, the affective comprises objective which emphasise a degree of acceptance or rejection and the psychomotor-which consists of objectives which emphasise some act which requires a neuromuscular co-ordinations. Behaviour of the student is broken into roughly corresponding to thinking, feeling and acting.

What then is the significance of such classifications for Mathematics in Adult Continuing and Community Education teaching and learning? Bloom and his co-workers concerned themselves to compile a taxonomy of educational objectives regards knowledge as the "recall specific and universals, the recall of methods and processes or the recall of patterns, structures or setting" (Bloom el al 1956 pp 62-78 for classification, (Skemp. R. 1971) which according to Stenhouse (1975 p.17) is primarily a psychologist's classification, the logic of being related to the measurements of learning. As such, the significance of such classifications for Mathematics teaching is clear,

For example, if a student learns Pythagoras' theorem, he has achieved an objective in the cognitive domain, if eventually he comes to enjoy logical proofs and to appreciate what constitutes a "beautiful proof" then s/he has achieved objectives in the affective domain. Similarly, geometric drawing and say, the use of slide rule or the computer terminal, do provide us with some objectives in the psychomotor domain.

Fig ROA/1

TOPICS		BEHAVIOURS A	B	C
	1	*	*	*
	2	*	*	
	3	*		
	4	*	*	

Certainly, with Mathematical operations, where most behaviours as in fig ROA./1 appear to have cognitive origins, and Bloom's taxonomy is particularly relevant. For example, if behaviour A forms a basis for evaluation of one class, the behaviours of type AB will form another, while another type of ABC will form yet another class. All of these reveal some pattern that would be of some value in the development of theory and theory of learning Mathematics and clarify the language of Educational Objectives which might help to remove one source of confusion amongst educators.

(111) **Adults Learning Mathematics.** The third area of concern in this presentation is Adults Re-learning Mathematics through Mathematical Investigations. This has profound effects on the teaching of Mathematics since it gives students the power to perform numerical calculations with ease, (as can be seen in the work of the case study), which, for some, would be almost impossibly difficult.

Most adult students, defined as people over 18 years of age, share a fairly uniform experience of Mathematical education in the education system. Through their primary and secondary education, they learned how to add, subtract, divide and multiply. Perhaps many did not like it that much, but most seemed convinced that it was both useful and somehow good for them. Yet many adult students went through this experience of being enumerate will tend to shudder at the word "Mathematics". This no doubt provides us with a clue to the first prong of the attack that lead to revolutionary changes required in what was previously one of the most static of school subjects. With the new trends in education like the development of the National Curriculum as a whole which derived from the belief

that learning could actually be enjoyed, change had to be considered along these lines, particularly in Mathematics' education.

Why do so many people have problems with Mathematics? (see Frankenstein et al 1989). How can teachers of Mathematics, (my emphasis), help students deal with Mathematics' anxiety? What is Mathematics? Mathematics studies the relationships and calculations from quantity, shape, statistical information and time. None the less it is a practical activity with inference logic, and not merely a theoretical study. Although Mathematics has enormous power to solve practical problems, it is still regarded, justifiable, as an abstract subject. Yet Mathematics is a culminative subject and the analogy of constructing a house is appropriate here. My research into Adults Re-learning Mathematics shows that if the foundation of the house is weak, the resulting structure is bound to be shaky. A good foundation coupled with a good method of teaching Mathematics will surely produce good results.

It is therefore, appropriate to mention the Foundation Course in Mathematics that I teach at Goldsmiths' College, University of London which started in 1990. In addition to the questions posed above, I ask myself the following set of questions: (Angiama R. O. 1992).

1.1	What am I trying to do?
1.2	Why am I trying to do it?
1,3	How am I doing it?
1,4	Why am I doing it that way?
1.5	Why do I think this is the best way?
1.6	How do I know that it works?

and show how they can be brought to bear on Mathematics in Adult Continuing and Community Education. I shall also want to address each of these questions very briefly and in particular to relate them to the experiences of Adults Re-Learning Mathematics through Mathematical Investigations.

1.1 What am I trying to do?

The foundation course in Mathematics is designed to give those without the conventional qualifications the opportunity to study Mathematics to a standard which will allow entry to the Intermediate Certificate in Mathematics' course offered by the Department of Mathematical Sciences. The Intermediate Certificate in Mathematics is a one year course requiring attendance on one full day and two half days a week whilst the Foundation Course in Mathematics is a Saturday per week one year course to study Mathematics to A level standard. Completion of the Certificate Course leads to a place on one of the Mathematics' Honours Degree courses here at Goldsmiths' College.

1.2 Why am I trying to do it?

The reason why I am trying to do it is because it will help fill the gap in the shortage subject areas like Mathematics, within the education system. My goal then in developing the Maths' Foundation Course is that we should engage many people in the discipline in order to keep abreast with changes in society brought about by increased industrial and commercial activity which involved people in more complex Mathematical calculations. Both in the twentieth and twenty first centuries, many industrialists began to express concern about the mathematical inabilities of young people who came to them from schools and colleges of higher education for employment. As Elaine Williams notes in the Independent in July 23rd 1992:,

> Behind the bright demeanour of our graduates and under graduate students lie some fearfully innumerate individuals.

1.3 How am I doing it?

The focus is the development of modules of unit booklets and the value for students is greatly enhanced which included an element of student self-assessment including a self-diagnosis of strengths and weaknesses. Such self-assessment by students of their own learning has been very effective and each unit has its explicit aims and objectives, outlining the knowledge, skills and processes inherent in the unit booklet and these are shared with the students who have been asked to complete an exercise at the end of most pages. The unit scheme also offers the possibility of negotiation between the Course Co-ordinator and students on certain key issues, such as the method of teaching and learning Mathematics. I argue that Mathematics is a cumulative subject and it is like when building a house, if the foundation is very weak then it follows that the structure is bound to collapse. I also argue that a good foundation coupled with a good method of teaching is sure to produce good results, and we can be sure to turn out many good Mathematicians to meet the needs of our challenging and ever increasing demands of the schooling system and the demands of the technological world. The great acceleration of technological development here and around the world since the second world war has shown no sign of abating, rather increasing and the demands of the future are tremendous. Yet the teaching methods of teaching Mathematics remain very much one of teaching particular techniques formally in Mathematical Investigations, Mathematical Videos, Visiting Lecturers, Audio-Visual Demonstrations and Practice on the computers.

1.4 Why am I doing it that way?

The reason why I am doing it that way is because I believe that most adult students share a fairly uniform experience of Mathematics' education as well as young people in the education system. I have argued that teaching methods of teaching Mathematics remain very much one of teaching particular techniques formally and practice on the computers. Why computers? It is because the use of computers has helped adult students Re-Learning Mathematics better and gain more confidence in the subject. Throughout the long history of mathematical education, men and women have always wished they could calculate more quickly. Through the centuries, as each mathematical discovery was made and knowledge advanced, the calculations facing mathematicians became more and more complicated and demanded an ever greater amount of time. The use of the computer in the course has helped many adult students Re-Learning Mathematics and needs further investigation especially for very weak students but also to add variety for all students. At the same time many adult students who went through this experience of Re-Learning Mathematics confess in their innumeracy and lack of proper guidance.

A student of mine on the Foundation course in Mathematics (in 1991/2) said this,

> Leaving school over thirteen years ago with no guidance to prepare myself with the outside world has had an effect upon me even up to now. Gaining 4 CSE's I was unlucky not to find employment straight away from school. It took me two years to land my first job. My first encounter with work was a challenging one. But after settling down as a booking clerk, it wasn't enough. I wanted to do more but was unsure what it was I wanted to do. (MW1992)

1.5
WHY DO I THINK THIS IS THE BEST WAY OF DOING IT

The mathematics Foundation Course is now gaining momentum among the students of Electronics from the University of Greenwich, English and Psycology graduates and particularly among primary school teachers who have the responsibility to identify childrens mathem atical achievements not only in relation to the National Curriculum, but also in relation to their social, emotional and personal development.

The children in our schools today are growing up in an age rapidly been altered by science and technology. Keeping pace with accelerated advances and being unaware of what the future will expect of these children makes the task of the primary school teacher and those who produce the theories to guide these children more exciting and challenging than ever before.

It is essential that these children should have some understanding of mathematics and it's allied subjects in order to cope with modern living and realise that most of the scientific advances are based on simple concepts of mathematics that they can comprehend. I would argue also that much of A- level mathematics is concerned with mastering techniques.

1.6
HOW DO I KNOW IT WORKS

Mathematics Education is our saving 'Grace' to our living on this earth. A former student who is now reading a four year BSc mathematics degree here at Goldsmith's College said:

> The Foundation Course in Mathematics is the ideal course for recent school leavers and adults who are interested in updating their skills in the field of mathematics. By devotion, time and interest for just one year, you can achieve a level of mathematics to GCSE and A-level standard. After completing this course with no doubt you will be so motivated that one will more than anxious to continue to a higher level mathematics. I have done this course during 1990-1991 and at present I am doing a four year extension degree in mathematics. Thanks to the Mathematics Foundation Course (Ronald Josiah 1993).

Case Study 1
Investigation (M. Soudans.)

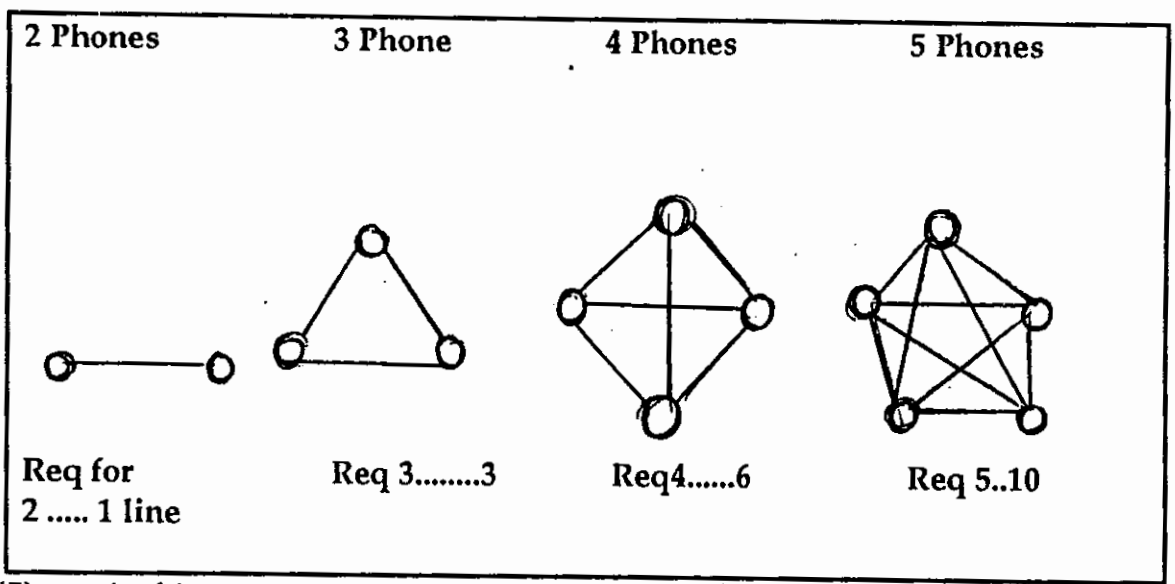
(1) Introduce the problem:

We have a set of telephones and we can't find out how many lines do we need to connect them because every telephone has to be connected to every other telephone.

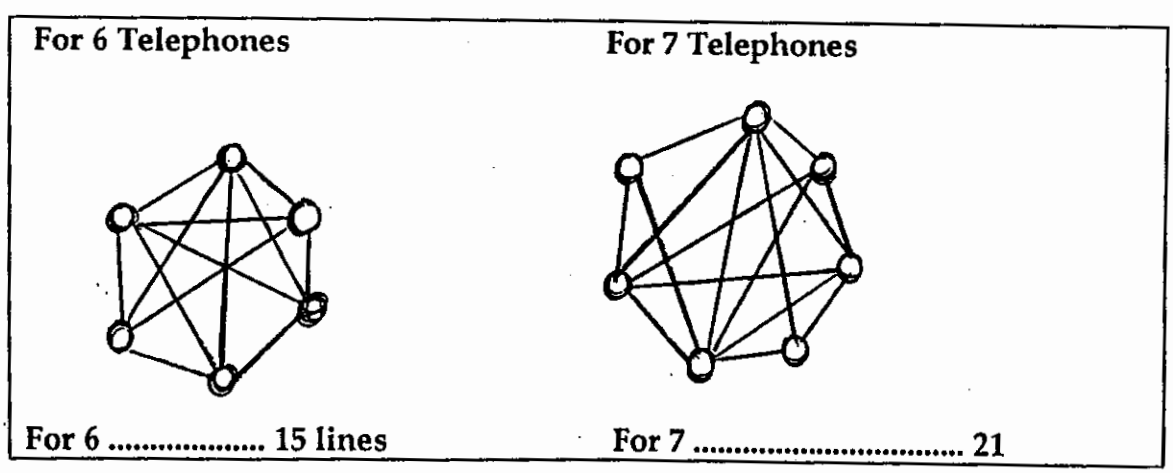
(2) To solve our problem we need very simple examples.

(3) Let's try 2/5 telephones by drawing lines between them.

(4)



(5) At this stage we can't say anything. We need to continue with more examples to see if any clear rule comes up.



Now let's collect all our results, from above, and show them in a table:

Number of Telephones	2	3	4	5	6	7
Number of Lines	1	3	6	10	15	21

Having done this table it seems to me that the number of lines of any number is the sum of the last number of telephones and of lines.

THE RULE FOR THIS INVESTIGATION.

Let us have n number of telephones and n' number of lines and P number of lines for (n - 1) telephones.

So $n' = (n - 1) + p$

Let us try to work out for 8, 9, 10 and 11 telephones.

For 8, n = 8 and p = 21
so n' = (8 - 1) + 21
= 28
So for 8 telephones we need 28 lines.

For 9, n = 9 and p = 28
n' = (9 - 1) + 28
= 36
So for 9 telephones we need 36 lines.

For 10, n = 10 and p = 36
n' = (10 - 1) + 36
= 45
So for 10 telephones we need 45 lines.

For 11, n = 11 and p = 45
n' = (11 -1) + 45
= 55
So for 11 telephones we need 55 lines.

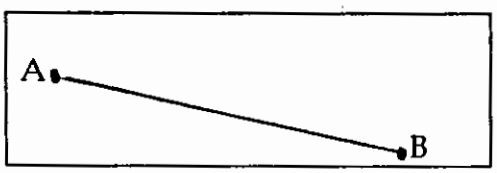
Case Study 2
Investigation 11 (m. Soudans)

Introduce the problem:-

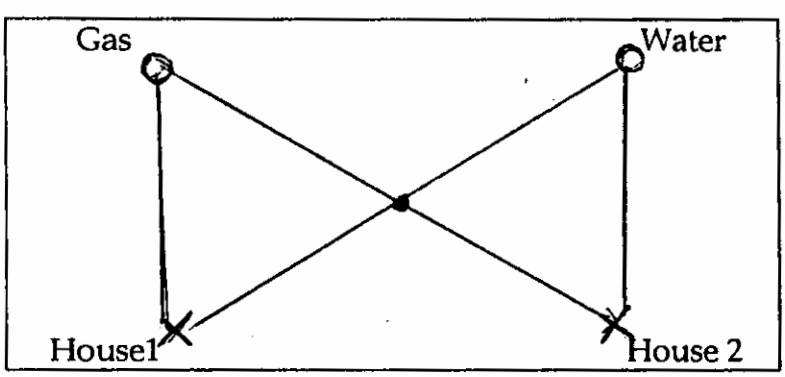
Each house gets water and gas from different stations i.e water station and gas station.

Say the water station is point A and the house is point B.

As we know, from the first investigation, we two points we have one straight line.



Now we test this with **two houses and the two services:**

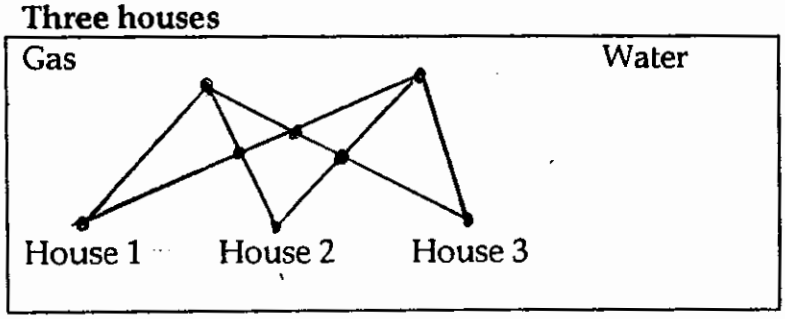


Here's a diagram of the pipes when there are two houses and there's **one** place where the gas and water pipes cross over each other.

Reminder:- Our problem is to find a general rule for n number of houses and the amount of times that the pipes cross over each other.

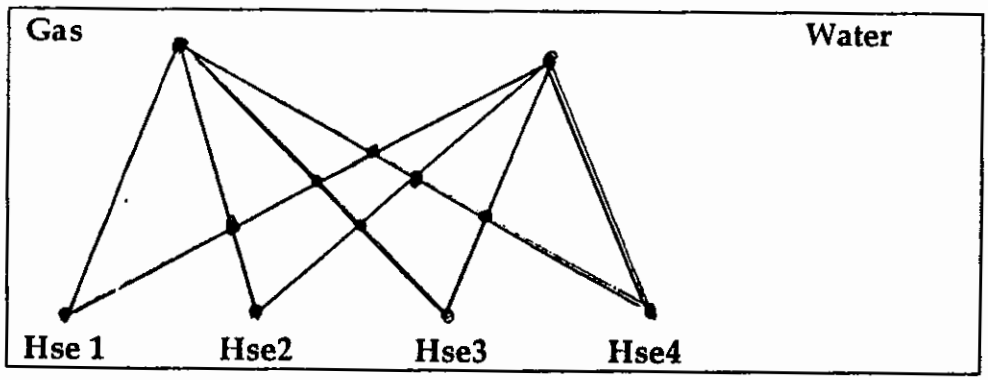
So let's go with more examples:-

Three houses



For 3 houses 3 pipes cross over.

4 Houses



For 4 houses 6 pipes cross over.

In order to save space here I will recount what happened when 5, 6 and 7 houses were investigated in the same way. The results were as follows:

For 5 houses 10 pipes cross over.

For 6 houses 15 pipes cross over.

For 7 houses 21 pipes cross over.

Lets copy all these results on a table so as to see if there is a rule for n houses.

Number of Houses	Number of cross-overs.
2	1
3	3
4	6
5	10
6	15
7	21

If we examine the results very well we will find that each line has a relation to the previous one.

Let us say that n = the number of houses and p = the number of cross overs.

So p = (n - 1) + k (where k is the number of cross overs for (n- 1) houses.

Having reach this conclusion let's try the rule out for 8 and 9 houses.

For 8 houses, **p = (8- 1) + 21**

= 28

For 9 houses, **p = (9 - 1) + 28**
= 36

In the same way, using this formula, you can work out the number of pipe cross overs for any given number of houses.

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