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ABSTRACT

This paper is based on research work carried out in the Foundation Course in Mathematics at Goldsmiths College, University of London. The theme of the investigation was to investigate the hidden faces of cubes placed on a table. In order to do this, the following investigational teaching styles and learning strategies were adopted: investigate different ways of placing cubes together in certain patterns; draw diagrams of different numbers of cubes in each pattern; find out the number of cubes and the number of hidden faces, then try to find a mathematical rule or an expression which gets from one to the other without having to draw the diagrams; check each mathematical rule to see if it is right; and extend the investigation by changing the formation of the cubes when trying to find any other rules about the investigation such as the maximum or minimum number of hidden faces with eight cubes. Teaching adult students mathematical investigation gives an insight into the way they learn mathematics better and removes the barriers of mathematics phobia. It provides a basis for improving the quality of teaching and learning mathematics which leads to an achievement in mathematics education. It has been concluded that when these teaching investigational strategies are implemented in the education system, teachers of mathematics will justifiably be able to say that adult students are achieving in standards in mathematics education. This has wider educational implications for improving professional teaching standards and skills, and learning strategies, objectives, activities, resources, and outcomes. It is argued that while past teaching techniques in mathematics education have shown that adult students can be trained to use their minds and yet not to think, teaching techniques in mathematics education today should require adult students, as well as young people, to think. Equally important is the development of the necessary skills, knowledge, and understanding required for effective teaching and successful career choices by teachers of mathematics. (ASK)

TEACHING ADULT STUDENTS MATHEMATICAL INVESTIGATION

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TEACHING ADULT STUDENTS MATHEMATICAL INVESTIGATION

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Abstract: Teaching Adult Students Mathematical Investigation (TASMI), is based on the research work carried out for the last 5 years of the Foundation Course in Mathematics at Goldsmiths University of London.
(Angiama, R.O. 1992, 1995).

The theme of the investigation is to investigate the hidden faces of cubes which are placed on a table. In order to do this, I have adopted the following investigational teaching style and learning strategies:

- *Investigating different ways of placing cubes together in certain patterns.*
- *Drawing diagrams of different number of cubes in each pattern.*
- *Find out the number of cubes and the number of hidden faces, then try to find a mathematical rule or an expression which gets from one to the other without having to draw the diagrams.*
- *To check each mathematical rule to see if it is right.*
- *The investigation was extended by changing the formation of the cubes when I try to find any other rules about the investigation such as what is maximum or minimum number of hidden faces with 8 cubes.*

Teaching adult students Mathematical Investigation, is given an insight into the way they learnt mathematics better and removes the barriers of mathematics phobia. It provides a basis for improving the quality of teaching and learning mathematics which leads to an achievement in mathematics education.

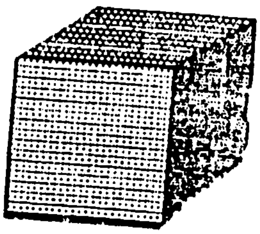
I have concluded that when these teaching investigational strategies are implemented in the education system, then teachers of mathematics will justifiably be able to say, that adult students are attaining standards in mathematics education. This has wider educational implications for improving professional teaching standards and skills, improving learning strategies, improving learning objectives, learning activities, resources and outcomes. I would also argue that whilst teaching techniques (Angiama, RO) 1995), in mathematics education of the past have shown that Adult Students can be trained to use their minds and yet not to think, teaching techniques in mathematics education today, should require Adult Students to think as well as young people in the education system. Equally important is the development of the necessary skills, knowledge and understanding required for effective teaching and successful career choices by teachers of mathematics.

INVESTIGATION 1
(Hidden Faces)

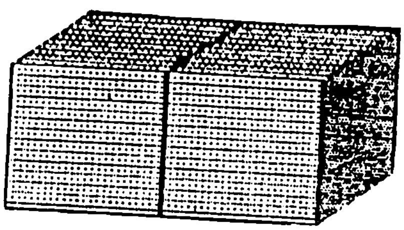
Investigation

When some cubes are placed together on a surface it is impossible to see all the faces of the cubes, because the face/s that lie on the table cannot be seen, nor can those that are connecting with others.

eg with one cube it is only possible to see five of the six faces.



and with two cubes two of the faces are on the floor, and two are connected to each other.



leaving only eight faces that can be seen.

In this investigation, the number of hidden faces will be looked into...

Method

This investigation will try to follow the following steps.

1. Find a way of putting the cubes together in a certain pattern and then draw a few diagrams of different number of cubes in that certain pattern.
2. Manually count the number of hidden faces and shown faces of the cubes.
3. Draw tables for the numbers that have been collected.
4. Try to find out rules from looking at the way the cubes connect and the numbers in the table for certain patterns.
5. Try a different pattern and follow the above steps again.

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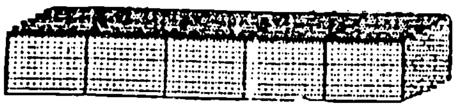
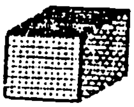
Pattern 1

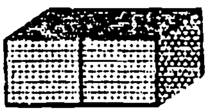
The first pattern tried was straight forward. It consisted of cubes being placed next to one another in a row.



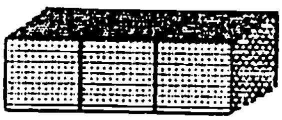
I did a few drawings of different numbers of cubes in this patter, and counted the number of shown and hidden faces in each one.



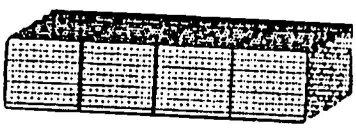
1 hidden, 5 shown



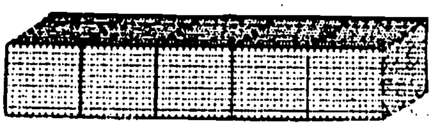
4 hidden, 8 shown



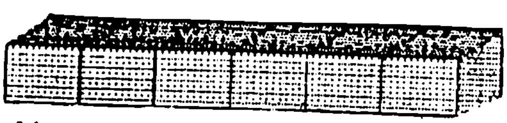
7 hidden, 11 shown



10 hidden, 14 shown



13 hidden, 17 shown



16 hidden, 20 shown

Working Out:
The table for this is:

TABLE ROA/1		
NO cubes (C)	**NO hidden faces (H)**	**NO shown faces (S)**
1	1	5
2	4	8
3	7	11
4	10	14
5	13	17
6	16	20

From the working out diagrams a few things can be seen, for example an average cube has three faces that can be seen and three faces that are hidden, except the two at the end, which have four sides that can be seen. In other words to get the number of hidden faces or shown faces you do this.

$3C + 2 = S$ C being number of cubes and S being number of shown faces.
$3C - 2 = H$ H being the number of hidden faces.

Check

To check the rule $3C + 2 = S$

and $3C - 2 = H$ We will use them to predict the next two patterns.

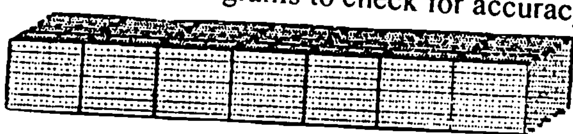
If our rules are correct then for seven cubes places in this pattern the number of shown faces and hidden faces would be.

$3 \times 7 + 2 = 23$ shown faces
$3 \times 7 - 2 = 19$ hidden faces

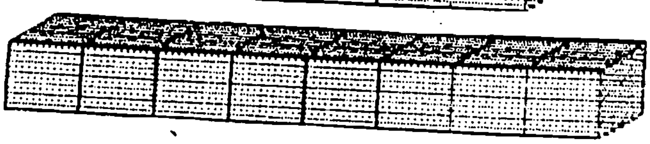
and for eight cubes

$3 \times 8 + 2 = 26$ shown faces
$3 \times 8 - 2 = 22$ hidden faces

and now the diagrams to check for accuracy.



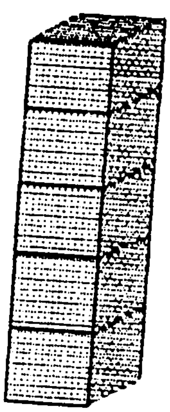
19 hidden, 23 shown



22 hidden, 26 shown

So the rule for the pattern number 1 is, or should be correct!!

Pattern 2

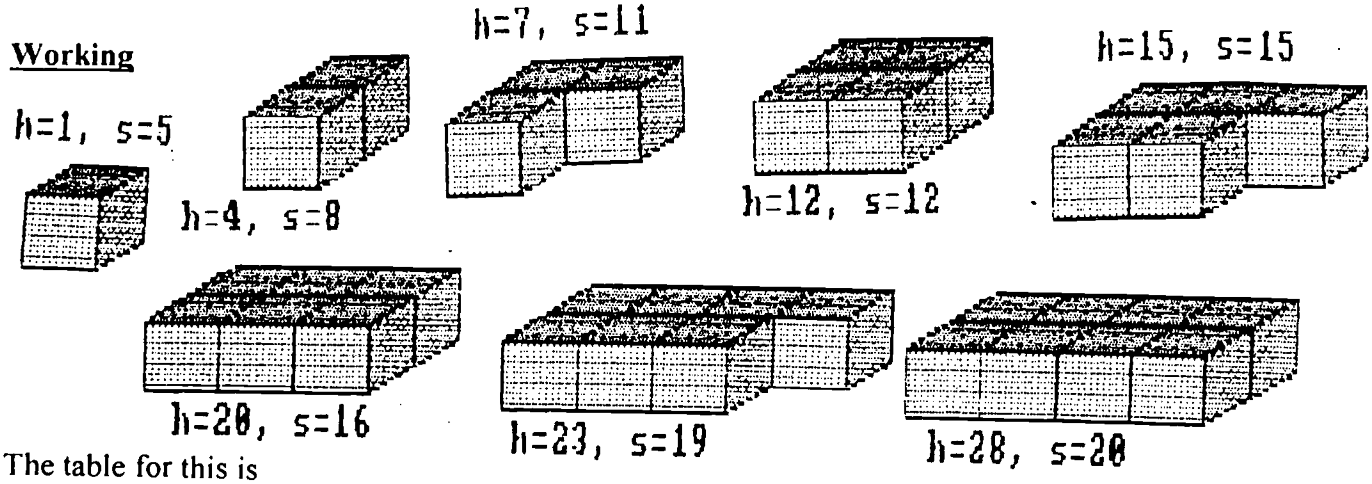


Pattern 2 is similar to pattern 1, just that is stacked on top of another.

The way the cubes connect is very simple and without drawing the table I can have a good guess at what the rule for this pattern is, because all the cubes have four exposed faces, except the top one which has five, so the rules are:

$4C + 1 =$ Shown faces and $2C - 1 =$ Hidden faces

Working



The table for this is

TABLE ROA/2		
No Cubes (C)	No hidden faces (H)	No shown faces (S)
1	1	5
2	4	8
3	7	11
4	12	12
5	15	15
6	20	16
8	23	19
9	28	20

The gaps between the numbers of cubes were irregular, so at first it seemed there wasn't a rule for this one, but on looking closer I found that there were rules, one for the odd number of cubes and one for the even number of cubes. I saw that every cube had two exposed face except the four at the ends whilst each had three exposed faces, so the rule for them would be:

2C + 4 = S
4C - 4 = H

I also noticed that for odd number of cubes each cube had two exposed faces, except for the four at the end, three of which have three faces exposed and one has four. So the rule for them would be:

2C + 5 = S
4C - 5 = H

Check

To check these formulas I will try to predict the result for nine and ten cubes.

Nine is an odd number so
2 x 9 + 5 = 23 shown faces
4 x 9 - 5 = 31 hidden faces

and ten is an even number so

2 x 10 + 4 = 24 shown faces
4 x 10 - 4 = 36 hidden faces

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Check

To test the rule we will first predict the results for seven and eight cubes.

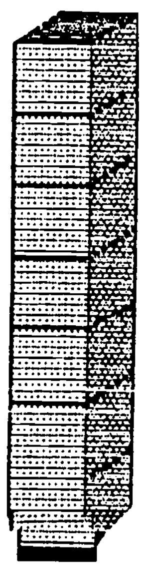
4 x 7 + 1 = 29 shown faces
2 x 7 - 1 = 13 hidden faces

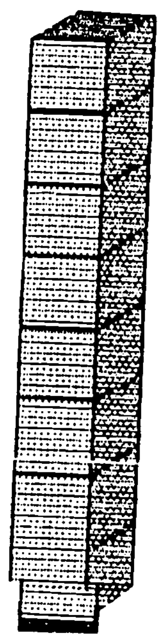
and for eight cubes

4 x 8 + 1 = 33 shown faces
2 x 8 - 1 = 15 hidden faces

and here are the diagrams

h=13, s=29 h = 15, s=33

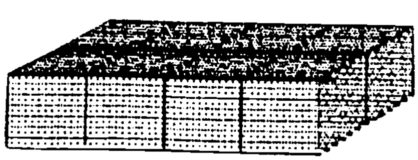




so my second rule is correct

PATTERN 3

This pattern is more complex than the last



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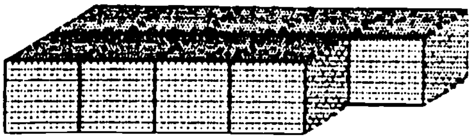
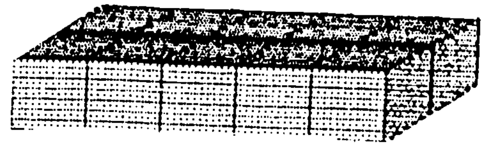
and the diagrams



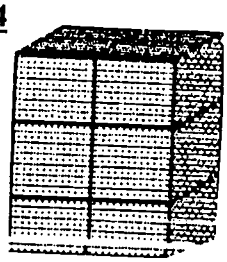
hidden=31 shown=23



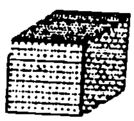
hidden=36 shown =24

and so my third pattern rule works.

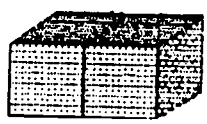
PATTERN 4



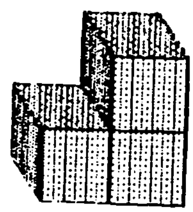
This pattern is similar to the previous pattern



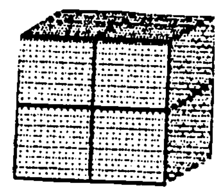
h=1, s=5



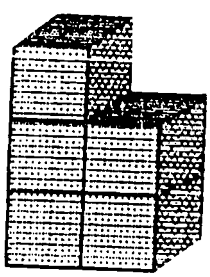
h=4, s=8



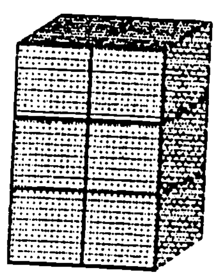
h=6, s=12



h=10, s=14



h=12, s=18



h=16, s=20

And the workings for this pattern

The table showing the results.

TABLE ROA/3		
No Cubes (C)	No hidden faces (H)	No shown faces (S)
1	1	5
2	4	8
3	6	12
4	10	14
5	12	18
6	16	20

because of having the experience of solving pattern 3, pattern four is quite easy, if the number of cubes is even then each cube has three exposed sides except the top two which have four exposed faces. So the rule for that would be

3C + 2 = S and 3C - 2 = H

and for odd each cube has three exposed faces except the top two, where one has four faces and the other has five faces showing so the rule for that would be

3~C + 3 = S and 3C - 3 = H

CHECK

To check this rule I will predict the results for seven and eight cubes.
Seen is an odd number so:

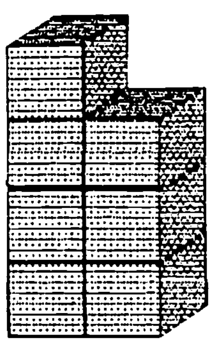
3 x 7 + 3 = 24 shown faces
3 x 7 - 3 = 18 hidden faces

and eight is an even number

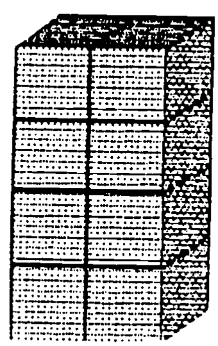
3 x 8 + 2 = 26 shown faces
3 x 8 - 3 = 22 hidden faces

and the diagrams to check the rules

h=18, 2 =24



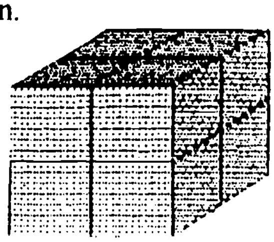
h=22, s=26



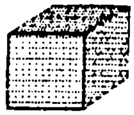
So the rules for Pattern 4 are correct !!!

PATTERN 5

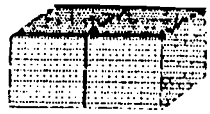
This pattern is the most complicated one so far because there are a lot more hidden faces inside the pattern.



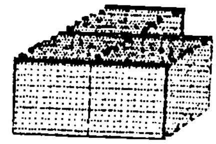
and the workings



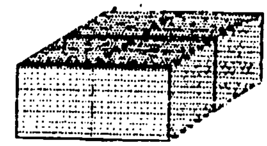
h=1, s=5



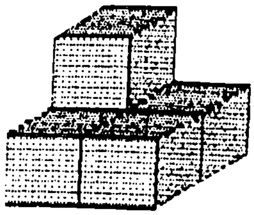
h=4, s=8



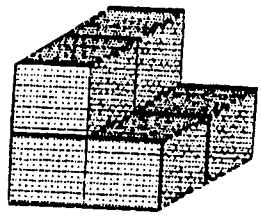
h=7, s=11



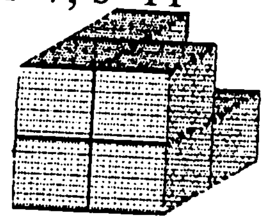
h=12, s=12



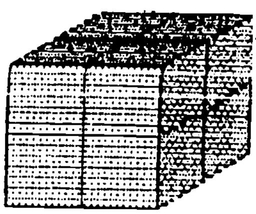
h=14, s=18



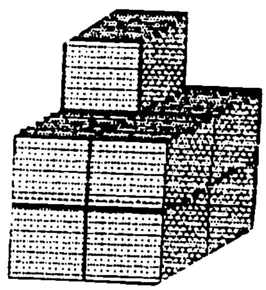
h=18, s=20



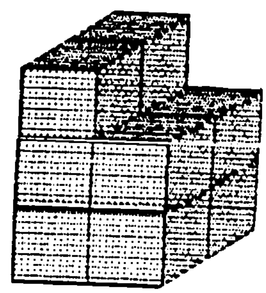
h=22, s=22



h=28, s=22



h=30, s=26



h=34, s=28

here is the table for it.

TABLE ROA/4		
No Cubes (C)	No hidden faces (H)	No shown faces (S)
1	1	5
2	4	8
3	7	11
4	12	12
5	14	18
6	18	20
7	22	22
8	28	22
9	30	26
10	34	28

The rule here after lots of working out on rough paper is, if the number of cubes make a rectangle, in other words is a multiple of 4, then the rule is, because each cube has two exposed faces, except the top four which have three faces exposed:

2 = 4 = S and 4C - 4 = H

and for any other number of cubes it is:

2C + 6 = S and 4C - 6 = H

Check

So if my rules are right then for eleven and twelve cubes the results would be.

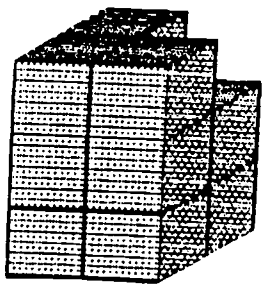
Eleven is not a multiple of 4 so:

2 x 11 + 6 = 28 shown faces
4 x 11 - 6 = 38 hidden faces

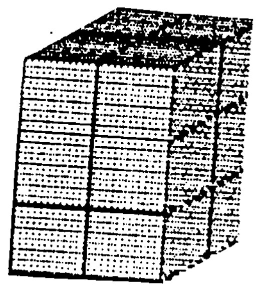
and for twelve which is a multiple of 4 the answer is:

2 x 12 + 4 = 28 shown faces
4 x 12 - 4 = 44 hidden faces

and the diagrams



h=38, s=28

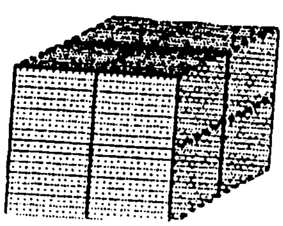


h=44, s=28

my predictions were correct. The rules must be correct as well !!!

PATTERN 6

This pattern is a square clock and the number of cubes don't go up in one's. Here's an example.



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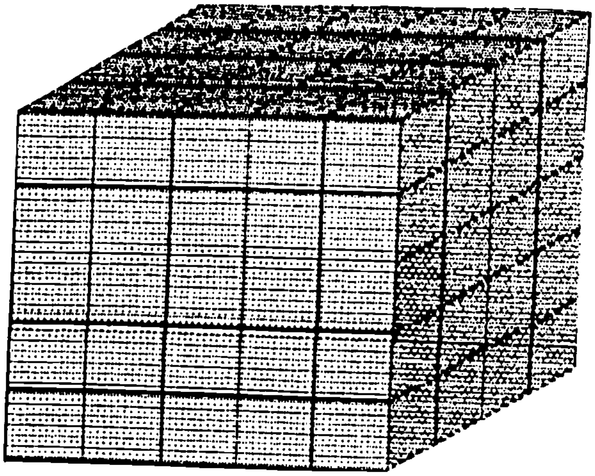
Check

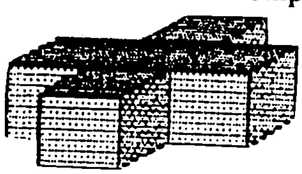


h=625, s=126

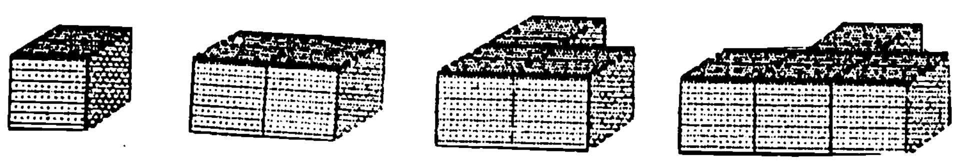
so the rule does work.

PATTERN 7

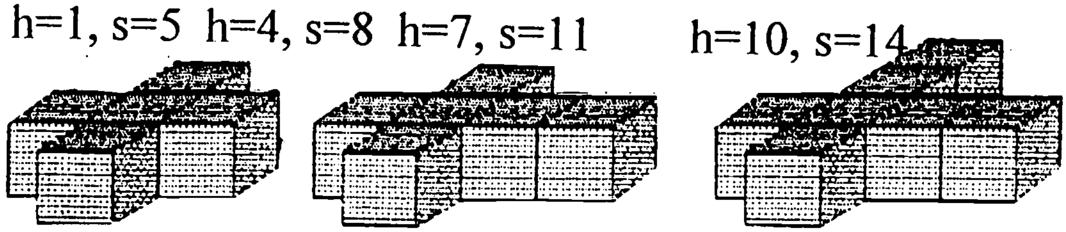
This looked like a complicated pattern



And the workings



h=1, s=5 h=4, s=8 h=7, s=11 h=10, s=14



h=13, s=17 h=16, s=20 h=19, s=23

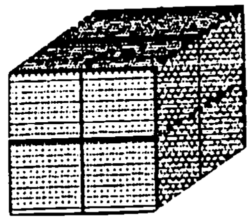
The rule for this one is very easy, every cube has three shown faces except the end four which have four each and the middle one which has only one. So the rule is

3C + 2 = S and 3C - 2 = H

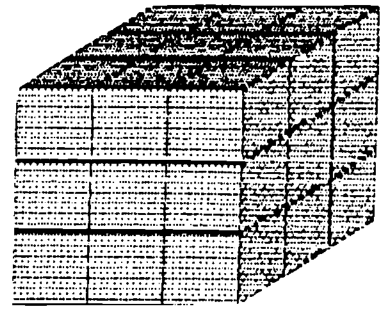
the rule works for all of the above so I won't check it. I hope it is right ????

Here is the workings I did for this pattern:

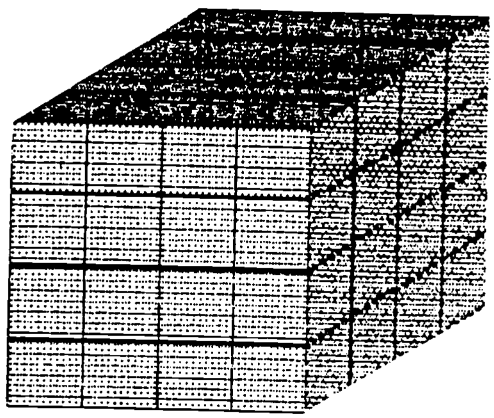
h=1, s=5

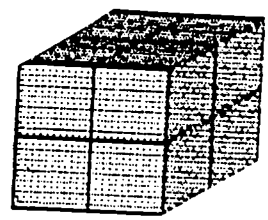


h=28, s=20



h=117, s=45





h=306, s=80

The way to work out the number of shown faces here is to find out the length of one of its sides then to square that to find the area of one face, then multiply by 5 to get the five sides of the cube that you can see.

The way to work out the hidden faces is to multiply the length of one of its sides by the power of three to get how many cubes there are, then multiply that by six to get the number of faces altogether. Then you subtract the number of shown faces from the total number of faces, to see how many of the faces are hidden.

eg To get the hidden and shown number of faces for a cube which is 5 cubes long you first get the number of shown faces:

5 x 5 = 25 square per side of the big cube
25 x 5 = 125 shown faces

then you subtract that from the total number.

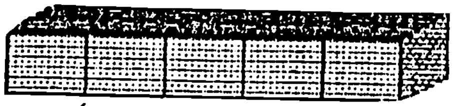
5^3 = 125 cubes in the big cube
125 x 6 = 750 faces altogether
750 - 125 = 625 hidden faces

CONCLUSION

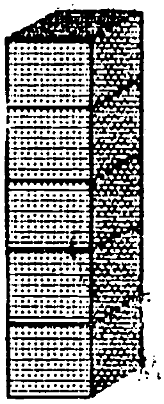
From previous workings of previous work I have found out the following:

C being number of cubes
S being number of shown faces
H being number of hidden faces

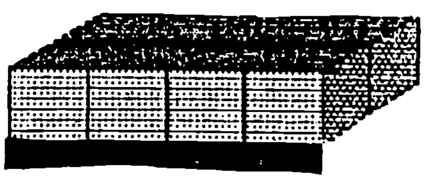
The formulas for:-

1. 

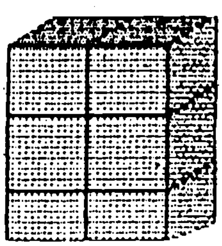
is 3C = 2 = S
3C - 2 = H

2. 

is 4C - 1 = S
2C - 1 = H

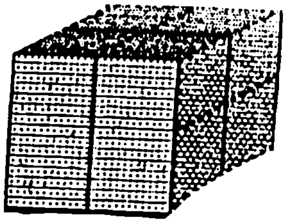
3. 

is if C is an even number. 2C + 4 = S
4C - 4 = H
if C is odd 2C + 5 = S
4C - 5 = H

4. 

is if C is an even number 3C + 2 = S
3C - 2 = H

if C is odd 3C + 3 = S
3C - 3 = H



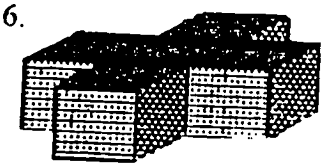
is if C is a multiple of 4, $2C + 4 = S$

$4C - 4 = H$

if C isn't a multiple of 4 $2C + 6 = S$

$4C - 6 = H$

6.



is $3C + 2 = S$

$3C - 2 = H$

7. In both there are always a pair to any formula, and the pair is always "opposite"

eg $3C = 2 = S$

$3C - 2 = H$

/\

this is always inverted so + 2 becomes - 2 and - 5 becomes + 5

8. That the first numbers of all the pairs of formulas always add up to six, because that is how many sides cube has.

I have argued that Teaching Adult Students Mathematical Investigation (TASMI), is given an insight into the way they learn Mathematics better and removes the barriers of Mathematics phobia. It provides a basis for improving the quality of teaching and learning Mathematics which leads to an achievement in Mathematics education and, therefore, lends to an improvement on standards.

Equally important is the view that in a Mathematics department in Adult Continuing and Community Education (ACCE) in the education system is concerned with 'keeping standards', then this is best done directly by a considered and regular review of teaching policy of curriculum content and style of teaching. The concept of teaching style in the teaching of Mathematics is so varied that it is difficult to put forward any clear definition. Perhaps the most useful suggestion that can be made is that style of teaching varies according to the teacher's personality, background and knowledge of subject (Ryans, D.G. 1960, Komisar et al 1965).

In all these dimensions, it is important to remember that our primary concern in teaching Mathematical Investigations should be the improvement and learning of the overall continuing education of the Adult Student. I would also argue that whilst teaching techniques (Angiama, R.O. 1995), in Mathematics education of the past have shown that Adult Students can be trained to use their minds and yet not to think, teaching techniques in Mathematics education today, should require Students to think as well as young people in the education system. Equally significant point is the knowledge and understanding required for effective teaching and successful career choices b... teachers of Mathemati...

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