Chapter 4

From Practice to Theory:
The National Foundation for Educational Research and the University of London

Soon after settling in at Challney, I started making enquiries about doing a PhD. I wrote to Sir Frederick Bartlett at Cambridge University under whom Jim Cardno had studied. I enclosed a letter of introduction Cardno had written and asked if I could have an interview with Bartlett about possible study at Cambridge. We arranged a time, but when I arrived Bartlett's secretary told me he had suddenly taken ill and couldn't see me. He would write to me later and arrange another time.

I never did meet him, but he did write back telling me that he'd heard that the new Director of the National Foundation for Educational Research, a young man called Dr. W. D. Wall, was looking for research staff. If I were appointed to a post there, perhaps I could enrol in the doctoral programme at Birkbeck College, a college of the University of London that specialised in part-time study. 'I shall write to young Wall, indeed I shall. I suggest you do the same.'

So I wrote to young Wall. Yes, he replied, he was advertising for three Assistant Research Officers. Perhaps I could come to London for an interview?

The National Foundation for Educational Research (NFER) occupied a lovely old Regency house at 79 Wimpole Street, right in the heart of London's West End. NFER conducted research into educational issues as required by a governing board, disseminated the results of research, developed tests including those for the life-changing Eleven Plus Exam, and sold educational materials and tests.

In December 1957, I found myself walking down Oxford Street and thence into Wimpole Street, parallel to Harley Street. What a place to work, I thought, if I could be so lucky.

Dr Wall was short, nuggetty and genial. He had a large face and high forehead crowned with black hair. He sucked an elaborate meerschaum pipe. He might have been young to Bartlett, but he certainly appeared old to me, well into his forties.

Wall explained that the appointees were to initiate projects in one of three areas: the teaching of arithmetic, the teaching of reading, and technical education. What post would I be interested in? Did I have any ideas about research in any of these areas?

It had to be arithmetic: I knew less than nothing about the other areas. Then the questions: Did I have any ideas about how the teaching of arithmetic might be improved? How would I go about constructing an arithmetic test for junior secondary school? Would I mind travelling to different parts of England and Wales if required?

Only the last I could answer with confidence. ‘No, I wouldn’t mind. As I’m here as a part-time tourist, I’d love to travel.’

‘Come to beautiful Bolton,’ a po-faced man sucking a pipe murmured. I learned later this was Freddie Yates, a man of dry wit, and much respected on the educational scene.

I must have said something right, or maybe there were only three applicants for the three posts. Anyway, I was offered a job at £100 a year more than I was getting as a teacher.

Wall also mentioned enrolling at Birkbeck College; I could work out a thesis topic from the research I would be doing at NFER. Out came another letter of introduction with which Cardno had supplied me: this one to C.A. Mace, Professor of Psychology at Birkbeck. Everything fell into place. That’s how careers were established in those days.

My heart goes out to those who have to do it tough in these neoliberal times.

….The brightest and nicest guy at NFER was the fearless, straight-talking Douglas Pidgeon. He and Yates were a well-known team working from left corner to counter the ideas on intelligence testing from the right corner. Sir Cyril Burt, who had a tremendous influence on British psychology in the pre- and immediate post-war period, claimed, quoting data on identical twins that we now know he fudged, that intelligence tests mostly measured a child’s innate ability. Therefore, he argued, children should be allocated to different types of school – grammar, technical or secondary modern – according to their ability, based on their test performance on the Eleven Plus exam, a procedure that was duly enacted in the 1944 Butler Act. All school children sat for the Eleven Plus Exam at the end of primary school. Roughly 70 per cent of the cohort leaving primary school were deemed ‘failures’ and sent to a secondary modern school, like Challney where I had taught, to complete only four years of secondary education. Grammar and some technical children could go on to A Levels, and thence to university. The argument was that the Eleven Plus gave access to grammar school and university to bright working class children who wouldn’t have had a hope of such an education otherwise. While this was partly true, it also prevented a large majority of children from ever experiencing further education, which greatly exacerbated class divisions in the United Kingdom.

Burt's views on intelligence testing led to his 'pint-pot' theory of over- and under-achievement. You give an intelligence test to find out children's 'capacity'. You then give an attainment test, arithmetic say, and find those whose arithmetic performance doesn't match up to what their intelligence would suggest. These children are 'under-achievers'; they need coaching to bring them up to speed. 'Over-achievers' are those who perform higher than their level of intelligence theoretically should allow; these children are rare, Burt said, and need to be treated carefully. As they are already working to their maximum, coaching could even be damaging.

Sound reasonable? Pidgeon and Yates said it was a load of old cobblers'. Forget the tests' names, intelligence and arithmetic, call them Test A and Test B that correlate at a reasonable level. You will find, as someone as statistically sophisticated as Sir Cyril Burt should well know, that as many kids will perform better than expected on Test B on the basis of its correlation with Test A, as will perform worse on Test B. And in that case, you give remediation to all kids not doing well in arithmetic, not just to some who happen to do well on another test.[1]

Burt was furious when Pidgeon and Yates published their paper. He rang up the NFER and asked to speak to Mr. Pidgeon.

Julie, the girl who manned the switchboard, and a low scorer on Test A, asked: 'And 'oo might I say is speakin'?'

'Tell him it's Burt, here.'

'Bert 'oo?'

'Just *Burt*,' the great man said testily.

She rang through to Pidgeon, leaving the line open: 'Mr. Pidgeon, a funny old codger called Bert wants to speak to you. Wouldn't give 'is uvver name. Shall I put 'im froo?''

Zed Dienes was a Hungarian-born mathematician at the University of Leicester who had invented a way of teaching mathematics by using blocks and other concrete representations of quantity, on the basis of a variability principle. He argued that if children were fully to understand our decimal number system they also needed to learn other number systems, according to his variability principle. He had algebra materials based on the same principle.

[1] I'm unable to find Pidgeon and Yates' original article but the issue is discussed by P.E. Vernon in 'A new look at intelligence testing', *Educational Research, 1,* 3-12,1958.

NFER was interested in marketing his materials and part of my job was to research their effectiveness.

I went to Leicester to investigate. My first visit was to a secondary modern school, for students who had been rejected from an academic grammar school education. The teacher of a Form 1 (Year 7) class announced the period: ‘Algebra’. At which, to my astonishment, a loud cheer went up. The kids excitedly grouped themselves around tables in fours and pulled out Dienes’s Algebraic Experience Materials (AEM). I went to a table.

An eleven-year-old girl explained how they were going to factorise a quadratic expression. She wrote down $2x^2 + 3x + 1$. She explained: ‘*x* can mean any number. Like this strip is *x* inches long, I don’t know how many that is.’ She picked up a strip of plastic from the box of AEM materials.

‘Doesn’t matter, see,’ someone else said.

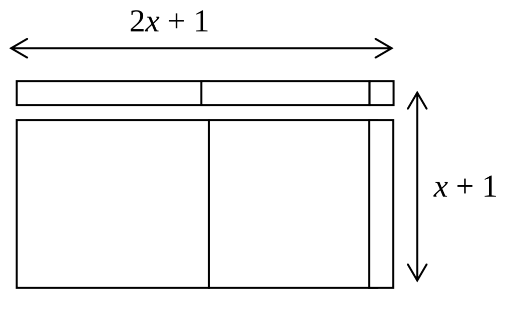
‘So x^2 is like a square with sides *x* inches long, now, innit? Like this ’ere, see?’ She picked up a plastic square and put the strip alongside it to show it was indeed a square of side *x*.

A ginger haired boy butted in. ‘Yus, so $2x^2$ is two of these things.’ He laid out two squares on the table, butted against each other.

The girl regained her territory. ‘And 3*x* is three strips,’ she took two more out of the box, ‘and 1 is one little square the width of the strip. Now we’ve got all the bits. You gotta make a rectangle out uv this lot, like it’s factors.’

‘That’s a multiply,’ the ginger boy explained to half-witted me.

They formed a rectangle with the pieces:



‘So there you are. The factors of $2x^2 + 3x + 1$ are $(2x + 1)$ multiplied by $(x + 1)$.’

‘Obvious, innit?’

I played nasty. ‘What about the factors of $2x^2 + 4x + 1$?’

They pulled an extra strip from the box. They couldn’t make a rectangle using that with all the rest.

‘Can’t do them.’

‘We haven’t done them yet.’

I asked Dienes about that. He shouted with laughter, as was his wont. ‘Oh, that’s simple. You complete the square.’

I remembered that term from Sixth Form – without the plastic – but didn’t he mean ‘complete the rectangle’? Anyway, he solved that by adding strips and units until he could form a rectangle, and then took the same amount of material away.

Some Leicester primary schools also used Dienes’ Multibase Arithmetic Blocks (MAB). These were three-dimensional representations of units, ‘longs’ (strips), ‘flats’ (squares) and ‘blocks’, the longs, flats and blocks being scored with a line that denoted the number of units in each. Three-blocks were scored in threes to represent a three-number system, five-blocks in fives for a five-number system, and so on for seven-blocks and ten-blocks. Ten-blocks represented our decimal number system: a unit was 1, a long was 10, a flat was 10 x 10, that is 100, and a block was 10 x 10 x 10, or 1,000.

Dienes was using his principle of variability: we learn concepts by abstracting from a variety of examples. To really understand something, you need to experience varying examples of it in different applications. The Japanese have a saying ‘The fish is the last to discover water’, which means much the same thing. Dienes argued that children won’t properly understand our decimal system unless they experience non-decimal systems. Hopefully they may then more easily generalise from the idea of a base, to that of the power to which the base is raised, to the ideas underlying calculus.

Another well-established principle is that children learn more effectively from doing than from being told. So you don’t tell them how to shuffle the symbols around to factorise a quadratic (as I had been taught), you make a physical model of it – several models in fact (variability) – which enables children to do the maths by acting directly.

A sample of Leicestershire schools using the Dienes materials was added to the sample of the 82 schools already signed up for the arithmetic project. The schools were categorized as ‘traditional’ methods, which emphasized tables and calculation; ‘structural’ methods, which used blocks and systematic concrete representations of number (of which the Dienes materials were a special case); and ‘motivational’ methods, which were based on activity and interest.

But how to conceptualize these different categories? Mechanical arithmetic was usually seen as a matter of rule-following and memorizing, which behaviourism could handle as repetition and reward. Problem solving, on the other hand, was about insight and understanding, which was much more difficult to handle in terms of existing theory. Max

Wertheimer referred to the latter as quite separate processes; he called repetition and memorization a γ process and understanding and nonroutine problem solving an α process.[2] Using this framework, I used behaviourism to conceptualize γ processes; and Piaget, gestalt psychology and Dienes's variability principle to conceptualize α processes. But it was a dog's breakfast. I wanted to explain all mathematical thought in terms of a single unifying theory, not in terms of these incompatible theories, but such a single theory was nowhere in sight.

The actual results of the NFER research were disappointing, not what I had hoped for and expected. Traditional methods produced the best results overall. However, very bright children did best using sets of blocks like Cuisenaire, not the slow learners as Cuisenaire-users were claiming. Children taught in informal schools not using structured concrete materials did worst, although they liked arithmetic more than most others.

But the most interesting finding was on the Dienes materials. When compared with closely matched traditionally-taught, Dienes-taught children performed exceptionally well in all aspects; the longer they had been working with the Dienes materials, the stronger the effect. To my surprise, Dienes-taught children way outshone traditionally taught in *mechanical* arithmetic, supposedly best taught by traditional drilling and table chanting. The reason was that in adding, subtracting, multiplying and dividing, Dienes-taught kids worked out what they were doing, even the slow learners. They didn't need to remember their tables and number facts. Playing around with the flats and longs and blocks of different bases had 'explained' it all to them. In other words, what I had called a γ process had become for most children taught by the Dienes method an α process.

I wrote a report for NFER on the efficacy of different methods and under what conditions.[3] As I write now, it strikes me how prescient was the title, although I hadn't thought so at the time: *Mathematics and the conditions of learning*. Although a book about teaching methods, the title was about learning.

As Thomas Shuell, later said,'… what the student does is actually more important in determining what is learned than what the teacher does.'[4] Which seems pretty obvious at first glance, but it turns our usual conception of teaching on its head. It took me many years to get my head properly around that challenging notion (see Chapter 13).

[2] Wertheimer, M. (1945) *Productive thinking*, New York: Harper.
[3] *Mathematics and the conditions of learning*, London: National Foundation for Educational Research, 1967.
[4] Shuell, T. (1986). Cognitive conceptions of learning. *Review of Educational Research*, 56, 411- 36.