Doing what comes naturally

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My plan for this session was to try to bring together, in an exploratory way, a number of ideas which have come to me over the years from my experiences as a teacher and teacher trainer, as the evaluator of a national project which introduced a calculator to six- year-olds to examine its effects on the traditional primary number curriculum and, more recently, as a researcher developing a theory of learning with a colleague.

I wanted to use the session as a forum for discussion with participants about their own learning and that of the students they work with. My hope was that all of us would gain from the experience and further our understanding of the learning process and the learners we encounter. In consequence, the session was part workshop, part discussion and part research report and I see all participants as vital contributors to all those processes.

The first thing I attempted was an exploration of a small piece of mathematics learned by all of us at school: subtraction. When I undertake this kind of exploration with students, as yet usually unaware of the insights the teacher has to have into the elementary processes of arithmetic, I usually start by identifying through them the subtraction method they learned at school. I follow this up by asking them to do a subtraction mentally.

In the case of experienced teachers, as were the participants at this conference, we miss out the preliminary exercise and concentrate on their own inner methods, which I tend to assume come naturally to them rather than having come from a teacher.

As always happens in such an exercise, I found a variety of methods emerging, many of them similar to those I have met elsewhere, one or two quite different. The methods which come out most frequently are either some kind of counting on or counting back method or an idiosyncratic combination of the two. A method using negatives is particularly interesting. 532 - 286: 200 from 500 is 300, 80 from 30 is -50, 6 from 2 is -4 giving 246.

In this workshop two new methods emerged, one immediately translating the numbers into money, £5.32 - £2.86, indicating a recognition of the power of money and the fact that many less able learners can often handle money yet be unable to work with numbers out of context. The other method the user found quite difficult to articulate while being very confident in its execution.

This reinforces earlier conclusions that we all have personal methods for calculating which seem natural to us and sometimes the methods of others can seem alien and cause conflict for us. I use these words deliberately because they relate to research into the learning process I have been doing with a colleague, developing a theory of learning which we call Natural, Conflicting and Alien.

In this theory we postulate that we all have learning experiences to

which we respond according to how we interpret those experiences. A natural experience is one which feels right and fits with the way we already think; a conflicting experience is one which jars, feels wrong, causes us to feel a sense of confusion; an alien experience is one which seems to have no connection with any part of our current way of thinking.

Our response to a natural experience is to add to earlier experiences and reinforce our current way of thinking; a conflicting experience makes us feel the need for some kind of resolution to get rid of the jarring, the confusion. In this case we may find we have to modify our previous way of thinking to take the new experience into account but sometimes this can be difficult to do so conflict can cause a problem in the progress of our learning. The response to an alien experience can be to avoid or ignore it, to evade it by recourse to something familiar, or to take it on board as a completely new but disconnected way of thinking.

Initially, we only identified natural and conflicting but later found that some of the incidents we encountered, in developing and testing our theory, were not explained by the concept of conflicting. Sometimes what seemed like an obvious contradiction to us as observers did not appear to be noticed by the learner. This led us to introduce the third concept and, in doing so, we realised that a strong element in our theory is the need to try to see the experiences we are concerned with from the point of view of the learner involved rather than merely seeing it from our position as observer. It also helped to draw our attention to the value of being aware of the ways in which we ourselves learn and the fact that in any teaching incident the teacher too is a learner.

Having outlined the theory, the session moved to a consideration of the two other aspects of my current work: trying to help undergraduates overcome personal inadequacies in elementary number work and observing children in the CAN (Calculator Aware Number) project who, as well as having free access to a calculator at all times, were not taught the standard algorithms we all learned at school but were, instead, encouraged to develop their own personal methods of calculating for addition, subtraction, multiplication and division.

These two experiences occurring side by side over a period of years enabled me to gain insights from both groups which I might otherwise not have had. I observed striking similarities between the two groups and one significant difference. Both groups showed that they were equally able to devise their own calculating methods but one group, the children, were supremely confident in what they did, the other, the students, were identifiable by their lack of confidence and a strong sense of inadequacy about their competence with number.

So why are the children confident and the students lacking in it? Backed up by the research I have been doing I am convinced that the confidence comes from 'own methods' being encouraged in the project whereas the students all felt that their own methods had to be done in secret and were 'not the right way to do it'. I have many stories of the undermining of confidence brought about from being forced to a standard way of working which inhibited the internal methods many of them were already developing secretly.

It is my belief that, even for able pupils, the methods taught at school were often alien and, if learned, did not become part of their natural ways of thinking but were learned as something totally disconnected, sometimes with disastrous effects on competence as well as confidence.

In the final part of the session the group looked at and discussed four incidents selected from my own experience which I believe demonstrate the ideas and concepts the session had been designed to bring out. The incidents dealt with concerned a journalist, an undergraduate on a numeracy course, a graduate with a PhD and a less able boy from the CAN project.

The journalist

He was questioning my belief in people's self-devised methods, saying that he himself always used the method he was taught at school. He asked me to give him a specific example of a personal method. When I did so, he said "Oh yes, I often do that myself" thus both refuting what he had earlier told me and demonstrating that, sometimes unconsciously, people do devise their own methods and use them appropriately.

The undergraduate

A group of students were trying to reproduce the method they had been taught at school. I overheard a conversation between two students which eventually I felt compelled to investigate. The conversation was as follows:

A. Why are you doing that?

B Well, I have to put 2 there because 1 won't be enough ..... oh dear, I wish she would let us do it in our heads.

When I investigated this very curious snippet of conversation I discovered that the student was trying to recreate the equal additions method for subtraction. She remembered that she had to add a one to the unit column at the top and the tens column at the bottom but she neglected to remember that, whereas the 1 added in the units column represents a ten, in the tens column it is only one. This meant that she made the 8, say, in the tens column into 18 instead of 9.

Then when she wanted to add her 1 to the top of the tens column and the bottom of the hundreds column she needed a 2 to make the 3, say, into 23 because 18 cannot be taken from 13. Doing this she not only modified the method but it brought her to an impasse when she came to the hundreds column where she found she had to take 22 from 6.

(The question was 632 - 286. I suggest you try it for yourself to see the predicament she got into.)

The student's attempt on the face of it suggests complete confusion but, on reflection, it is possible to see that she had some understanding about place value but failed to use it successfully in trying to recreate a method which probably seemed alien to her at school. That she wanted the chance to do the subtraction in her head shows that she did have an effective personal method.

The PhD seeking numeracy help

She told me that she was hopeless with numbers and always got her family to do any calculations she needed to do but she wanted to try teaching and felt she must do something about her inadequacy.

She did simple additions by counting on her fingers and, after seeking an explanation of a million, she asked if £1000 added to another £1000 would make her a millionaire.

I probed further and discovered that she added two consecutive numbers without using her fingers. For 6 + 7 she told me the answer immediately and explained that two sixes were twelve so the answer was thirteen. Later I discovered her using this idea in her attempts at subtraction by, for example if the top number was 2 and the bottom one 7, saying that if the bottom number had been 6 that would have given 6 but with 7 it gave 5.

It seemed to me that, having had her own method commended, she was able to build on it in new circumstances.

The less able boy in the CAN project

I have followed this boy through school from the age of six to his present position in his third year in secondary school. At his primary school the teachers managed to keep him out of the then 'remedial classes'; in his secondary school he has been relegated to the bottom group, seen as one of 'special needs'.

At six he showed that he could add up a column of figures by finding tens, using, for 6 add 8, the expedient of 'taking 2 from the six and putting it with the 8 so the answer is 14". At 11 he was able to pick out odd numbers from a set of answers and explain why they could not be even, something I have not always found average twelve or thirteen year olds able to do. At 13 I looked with him at a task he was doing about a boy saving up from his paper round to buy a bike, compared and discussed with him our two ways of doing the calculation. There were ways in which his approach bettered mine but each reflected our individual ways of working.

In discussing these incidents and the ideas contained within the session, a number of pertinent questions were raised, I hope to the advantage of all of us. For you the reader, I hope that the ideas I was trying to bring together in the session itself will be discernible from what I have written and, in particular, I hope that the ideas behind my title of Doing what comes naturally will come through in this report.

Further details about the CAN project, the numeracy courses and the research described can be obtained from the author, School of Mathematics, University of Hull, Hull HU6 7RX.