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THE END OF SPOON FED MATHEMATICS? A REPORT OF A YEAR'S BPRS RESEARCH

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An outline of a development project initiated to prevent the continuation of spoon feeding teaching at a grammar school. The report is covers the background information, research process, some examples of student work, and finally gives some tentative conclusions.

BACKGROUND

"I like school, you don't have to think, they tell you what to do." Anonymous

This quotation concluded my findings at the end of 2001 and summarised very succinctly the challenge presenting my development work. In April 2000 I joined the staff of Tonbridge Grammar School for Girls as the second in the mathematics department. Tonbridge Grammar School for Girls is often perceived as a very successful school, it has a selective intake and achieves outstanding performances from its students in many different areas.

However, as I looked around the mathematics department at the staff and students, I found that the apparent success of the school was founded on a very traditional style of mathematics teaching and the girls that we taught were often unsure of themselves and found it hard to make decisions. The girls appeared to work best when given explicit instructions and some would often prefer to do nothing, rather than make the wrong choice. Many of the girls seemed very unhappy at presenting any piece of work to be marked if that work was not 100% correct. Some of the braver students seemed to have adopted a "working in pencil" strategy for when they were unsure. This demonstrated that they did not really trust their answers, but had at least made the attempt demanded of them.

It was also clear that these habits were more obvious with the sixth form students than with the younger years. It has been suggested that students working at such high levels do not tend to find GCSE all that difficult and are, perhaps, only meeting a real challenge when they start their A-level studies.

In recent years this approach has often been called "spoon-feeding". In a teaching situation it is easy to see how such an approach has been developed. In explaining a difficult concept to a group of students the students query each individual step and need each part of the concept explained in great detail. When they are trying to solve a similar problem on their own they seem more successful if the teacher has broken the initial problem down into a number of smaller problems. Without necessarily having had this strategy in their head, the teacher has, deliberately or otherwise, taken the initial problem and split it into smaller pieces. Each piece is far more readily solved by the students, thus they can solve the whole problem, and therefore feel more successful. Initially all seems well but it becomes clear that this approach leaves the students clutching at a long list of rules to apply in every possible situation. Attempts have been made to teach the students how to break the initial problem down into manageable pieces but students vigorously resist such processes in favour of seemingly easier strategies. This problem was raised by many researchers in the early 1980s, with one pair reporting

> Mathematics is the study of relationships, and not the memorisation of predetermined processes and answers.(Dawson & Trivett, 1981, p36)

Although this was written some twenty-two years ago it is clear to me that many of my students think exactly the opposite, that it is possible to be very successful at mathematics by entirely memorising everything they come across.

A VISION OF THE FUTURE

As I considered the nature of the mathematical experience our girls were undergoing I was forced to question whether this was the best experience we could offer. At the beginning of this academic year I asked my sixth form students what they thought mathematics was all about. These are a typical cross-section of their responses.

> Maths is about solving seemingly impossible problems, and for use in everyday life.

> Maths is all about messy books with loads of wrong answers so I get v frustrated and do it all again! I know there is a point to it, but sometimes it’s very difficult to see what use its ever going to be.

> Maths is about achieving an A-level in a subject that is respected because everybody sees it as difficult, thereby proving yourself to be a competent, intelligent human being, even if you don’t feel like one when in the process of doing this A-level.

These students seem to have their understanding of mathematics largely based on some understanding that mathematics is about solving problems, using the skills that they have learnt. These problems have been based in real-life, though with some fear that these problems are not really of any genuine use. There is some sense also of looking for patterns and trends in numbers. This is coupled with a little of cynicism based on having been forced to learn things that can easily be accompanied by other means, for example learning how to multiply numbers when their calculator can carry out such calculations very easily.

The Technology College Trust produced a report in 1999 entitled “Engaging Mathematics”. This report was written to try to find solutions to the problem of declining numbers of students studying mathematics. In its suggestions for teachers to make mathematics more engaging and enjoyable for students the authors write

> Involve pupils in simple starting-points, then ask how they might vary these, or what questions they could think up to answer next.

> Think of ways in which pupils can be involved in processes such as searching for patterns, making and testing conjectures. (Oldknow & Taylor, 1999, p20.)

These comments guide us to another interesting suggestion – that the students could be more involved with their choice of work. Perhaps we need to move away from the teacher directing all of the students' work, but seek tasks that the students can begin to develop under their own initiative. This has two immediately obvious long-term benefits. Firstly that this skill of individual development of problems is much needed for GCSE coursework in years 10 and 11, and secondly that this is also working towards a more independent approach to the students' learning, which addresses many of the problems that my previous research uncovered. There are many places to turn to uncover the right sort of starting point for such tasks. There may come a time when it is appropriate to give the students a very wide choice of task, perhaps even allowing them to choose their own area to investigate. For our first year we will seek a more modest approach and look for a task that the teacher can introduce, but the student can develop and extend.

RESEARCH PROCESS

As a teacher-researcher I had to grapple with defining the type of research methodology that I would be following. Action research is an inquiry-based process. It allows the researcher to focus their attention on a specific situation. This often results in a highly focused study. This process builds on the professionalism of teachers, encouraging further reflection and study of the specific problem. Hegarty writes

> Teaching is a professional, skilled activity. Expert teachers do not come into the classroom programmed with a set of rules drawn from a manual of good teaching practice…. Excellent teaching is founded on insight, creativity and judgement. (Hegarty, 2003, p30)

Action research builds on the insight of teachers by encouraging them to reflect on their current practice and identify parts of it that could be improved. The improvement process is as free of constraints as possible to allow teachers to use their own creativity as much as they are able to. Action research also allows teachers to begin to judge their own work and to develop their own success criteria. Action research requires a disciplined approach. The action researcher has to rise above the mere tinkering in order to make changes to their practice.

One challenge facing action researchers is that of objectivity. The whole process of action research ties up the researcher with the classroom being observed. The researcher cannot remain aloof and detached from the situation. Traditional scientific research made much of the remote investigator who was able to observe a situation without influencing it. In this sense the action researcher fails. The task of the researcher is not to remain detached, but rather to take account of the connections between the observer and the observed. In the educational field progress is being made far more slowly. Stenhouse (1975) argued for direct teacher involvement in the educational research process;

> All well-founded curriculum research and development, whether the work on an individual teacher, of a school, of a group working in a teacher's centre or of a group working with the co-ordinating framework of a national project, is based on the study of classrooms. It thus rests on the work of teachers. (Stenhouse, 1975, p143)

In his view all educational research has its foundations in the work of teachers. Educational theories should have their basis in the classroom. He believed that teachers were professionals who generated theory based on their classroom practice. Almost thirty years later it is encouraging to see more and more research being carried out in this way.

TWO EXAMPLES OF THE WORK

And so in September 2002 we began the new lessons with year seven. To begin with I had planned a series of lessons looking at the way in which we communicate the mathematics that we know.

The initial statement "two odd numbers always add up to make an even number" provoked a good discussion with the first class that I met. The following dialogue was very interesting.

Student: We know that it is true because 1 + 3 = 4.

Teacher: Are you convinced from one example?

Student: What about 3 + 5 = 8, 1 + 1 = 2?
(many more were suggested)

Teacher: How many examples do you want to give?

Student: All of them.

Now at one level this final answer is a very good one. In order to be convinced about the truth of a statement specifying every possible answer is a perfectly sensible strategy. Perhaps this would best be described as a scientific proof? In the same way that a scientific theory is often tested under all possible conditions, perhaps the validity of the mathematical statement should be tested using all possible numbers. The student quickly realised a small flaw in their argument.

Teacher: How many are there?

Student: (looking quite embarrassed) lots!

So the student quickly realises that there are an infinity of possibilities for each number, the number of possible pairs seems more than infinite, if that were possible. With this group nothing further arose from the discussion. Perhaps sensing a dead end in this line of thinking, no one else managed to create a more satisfactory solution. With another class a different approach was taken quite quickly. One student started the following line of attack.

Student: You could think of odd numbers as being some pairs of numbers and an extra one, and so if you put two odd numbers together you'll have a pair of the extra ones, and this would make another pair.

Some of the rest of the class took a little more convincing of this strategy. It seemed too early to try to write something algebraic, but some students were able to produce a diagrammatic representation of an odd number as being a number of pairs and one “odd one”. When each odd number is represented in this way the sum can be seen as a number of pairs plus two “odd ones”. These two “odd ones” thus make another pair, and so the sum can be said to be an even number.

This sort of thinking was exciting to witness. This was thinking beyond the use of numerical examples, the diagrammatic approach made sense to the student and she was able to utilise it to give a very good proof of the general statement. She was also able to explain her approach, so that others in the class could also be convinced by it.

From my limited experience of my two classes I was very pleased with the students’ initial approach. They seemed to understand the problem, and were willing to try and talk about their answers. With continuing examples many more seemed to grasp the concepts of mathematical explanations.

Much later in the year we spend several weeks working with Pascal’s triangle. Much varied work was produced, but one student in particular discovered some significant mathematics entirely on her own. She had been working on powers of 11 and had noticed that the first few powers of 11 were clearly just the first few rows of Pascal’s triangle. Then she hit 115 and had to explain how 161051 could be produced,

> “I saw if you get a row from Pascal’s triangle you can make it come to an answer from the powers of 11. You don this by adjusting all the boxes with the 2 digits inside. For example, in the line 1, 5, 10, 10, 5, 1 by treating the 10 as 1 thousand rather than 10 hundreds and continuing this procedure as you work to the left then you can produce 161061. This also works for higher numbers in the triangle.”

SOME DIFFICULTIES

An interesting staff issue arose part way through the autumn term. After the initial set of tasks my approach was to stay two or three weeks ahead of things, to give me some means to react to the way in which the tasks were being received. I hoped that two or three weeks notice would give staff enough time to digest the information – it has seemed over the past few years that the other teachers only really plan their lessons about a week ahead at the very most. During this term though a couple of staff asked for “solutions” to the problems being set. For “normal” mathematics this is a perfectly reasonable request. The text books that we use for years seven to nine have a teacher’s volume with answers in, and so it does not appear unreasonable that the staff are wishing to receive a set of solutions to accompany this new material. However, this request does strike at the heart of the objectives of the new lessons, but at a new level. The aim is to encourage the students to work more independently, to need less spoon-feeding and to be able to think for themselves, to plan new areas of work without being quite so teacher-led. But what does this mean for the teacher? Can the teacher have every possible solution previously mapped out? At that time the request for answers from a teacher sounded very much like the request for answers from a student. I was left to ponder this dichotomy. In order to prevent spoon-feeding the students is it necessary for me to spoon-feed the staff? For many of these tasks it is very hard to predict all possible interesting spin-offs.

So to what solution? Two immediate solutions presented themselves. Firstly, to encourage staff away from the reliance on knowing all the answers in advance, for me to work at a staff level, in the same way that I want my staff to work at a student level. If it is possible for me to model the behaviour and approach that I expect from them then perhaps the staff will understand more fully. On a second level it might be appropriate for me to give some outline solutions to the most obvious route and what I expect to be the most common solution. Maybe not for every task, and maybe not in the greatest of detail, but perhaps this gives some level of support to the staff – again perhaps I am able to model the same level of progression with the staff that I am expecting my staff to model with their students.

CONCLUSION

At the end of the year it was clear that the students and staff had coped well with the changes. The students were working more independently and we will continue to develop this ability over the coming years. It will be interesting to see how they progress, especially when they face GCSE coursework. The staff were discussing mathematical problems amongst themselves, which I hadn't witnessed at the school before.

As a department this has begun a discussion concerning our beliefs about mathematics. What experiences do we wish our students to have, and how can we ensure that they all obtain a fair deal.

As a conclusion I would like to end with the words of one of our year seven students. When asked for her suggestions for future improvements she wrote

> "Well, ice-cream and music with a couple of playstation games and A-list celebrities would be cool, *but as far as Maths lessons go, this is pretty good*."

At the beginning of this report I spoke of our students' reluctance to show enthusiasm towards their mathematics. In a wonderfully British understated way this comment goes some way towards giving a glimpse of enthusiasm and enjoyment. As an endorsement of our work so far this is quite enough.

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