Hewitt, D. (2006) Proceedings of the British Society for Research into Learning Mathematics 26(1) February 2006

DOING MATHS OR PRACTISING THE FINISHED PRODUCT

Stephanie Prestage & Pat Perks

University of Birmingham

This paper considers the teaching and learning of mathematics using the ideas of 'Adapting and Extending' (Prestage & Perks, 2001) in comparison with our observations of the use of exemplar materials such as those in the Secondary Strategy, to allow a discussion of the tensions for our ITE students' planning for teaching. In our test-based culture and the prevalence of national materials do our students have time to do mathematics or is their only strategy to 'practise the finished product'.

INTRODUCTION

The context for this paper is well known and observed. Watson et al (2003, p.1) summarise what we already know about teaching and learning - that it is not a linear process (Denvir and Brown, 1986), that connectionist teachers are more successful (Askew et al 1997), that learners who see intelligence as incremental are better placed to learn than those who believe it is fixed (Dweck, 1999), that countries at the top of the mathematical league tables focus on teaching the complexities of mathematics, not by reducing everything to a technical performance (Hiebert et al 2003). Similar ideas are to be found in this publication (Pendlington, p. 59-64).

In almost direct contradiction to what we know from research the current environment in many schools upholds lots of testing and adherence to the equity curriculum of the National Strategy. Teaching to the test does not always support learning as a recent longitudinal study researching the level of pupils' cognitive and conceptual development found. Y7 pupils are now on average between two and three years behind were they were 15 years ago. Michael Shayer (King's College, the project leader) in an interview about his research says:

> There is some evidence that the extra hour allocated to maths in primary schools under the numeracy initiative has had some impact on Sats scores, but there is evidence of teachers teaching to the tests. This means students can perform well in tests without necessarily understanding the underlying concepts (Education Guardian January 4th 2006)

In the same interview, Paul Black joins in the discussion

> Research from around the world shows that, when the stakes are high, teachers teach to tests. This produces a short-term, three-year uplift in results before they plateau. (ibid.)

The NNS also has an emphasis on teaching over learning with equity high on the agenda (Askew et al 2001), a Y7 package to be delivered (*sic*) equally to all Y7s though some might also need to catch-up as well. The exemplar material in the NNS is connected to outcomes "*As outcomes, Year 7 pupils should for example: …"* And whilst these are declared as outcomes, as potential eventualities, the fact that the strategy offers so many discrete outcomes for each of Y7, Y8 and Y9 gives some credence to the myth that there is so much to get through. In addition, new obstacles

to learning are emerging. In our visits to schools this academic year we found senior management preparing staff for the new short inspection. The ideal of a good lesson is tested against interpretations of the advice from OfSTED, made real in written guidance by senior managers in preparation for these short inspections. The guidance outlines aspects that must be **seen** in **each** lesson. Thus the pedagogical aspects of teaching for each lesson are explicitly set out - starters, plenaries, ICT, a range of teaching styles, a declaration of the lesson objectives and the learning outcomes, high quality marking, active learning, whole class teaching and effective homework setting to name but few! Good ideas become ends in themselves. Class teachers are then sharing this advice with student teachers who are hearing the advice as pedagogic events that must be seen in each lesson[1]. The lessons we have observed are so full of 'stuff' that there seems little time to get on with teaching and learning, to stand back and observe learners.

How do our students learn to teach in this environment given that they participate in the practices of the school and the department and the particular classrooms? How do they make sense, accommodate and assimilate the advice?

A ROUTINISED, ALGORITHMIC APPROACH TO PLANNING[2]

To set the scene, imagine I am a beginning teacher. This is my seventh week of teaching and only my third week teaching in this school. OfSTED have been in (or are due soon) and the senior management in schools are handing out advice for lesson planning ready for observation by OfSTED. I have not received much praise only lots of advice on the elements missing from the lessons observed.

The advice

Imagine further a 60-minute lesson. Subtract about 10 minutes to get the pupils in and seated, they are arriving from all over the school. I have to deal with pens and pencils and books and coats and ties and then deal with late arrivals. I also collect in homework and take a register. The rest of the lesson must have certain events, so:

- Subtract 10 minutes for a starter which, as this is a maths lesson, has nothing to do with the lesson (called a warm-up). (*Advice: from the NNS an oral and mental starter which the class teacher(CT) and senior management(SM) reiterate as being expected to be seen by OfSTED.*)
- Subtract 5 minutes for going-though-the-answers for this starter (*Advice: CT it is important to have marks in their books; SM interactive marking is a sign of excellent teaching.*)
- Subtract 3 minutes for copying down the lesson objective and some sharing of the lesson outcomes (*Advice: SM take time to explain the objectives and the success criteria with the pupils*). In fact I do not know the difference between lesson objectives and learning outcomes.

Hewitt, D. (Ed.) Proceedings of the British Society for Research into Learning Mathematics 26(1) February 2006 • Available at bsrlm.org.uk © the author

- Subtract 10 minutes for a plenary (*Advice: NNS, a plenary, 5 to 10 minutes; SM take the opportunity to recap the learning, test understanding and link this lesson to the next, perhaps play a game.*)

This leaves just over 20 minutes for the main part of my lesson. So 10 minutes to explain what to do and to copy the examples into the book (*Advice: make sure they have sufficient in their books to revise for the test*) and hand out a work sheet. In my ten minutes of exposition I have to keep a focus on the learning objective which indicates whether this lesson will be successful. Also I know that the pupils will be tested on this mathematics so it is important that they can answer the questions on the test. So I choose to keep the mathematics and the examples both closed and concise. There is to be no struggle. The pupils will practise the 'finished product', questions which look like those they will have to answer on the test. This leaves 10 minutes for practice. However, I stop the class after 5 minutes to go-through-the answers, (*Advice: don't leave them working too long they get bored; SM engage them in the marking*). I repeat this, giving answers at the end of next 5 minutes of working. In fact out of the 20 minutes I probably spend 5 minutes going-through-the answers. Every time I stop them I have to manage the resulting problem behaviour

Imagine the content of the lesson is based on using the angle in a semi-circle to find angles in triangles.

The lesson: The angle in the semi-circle

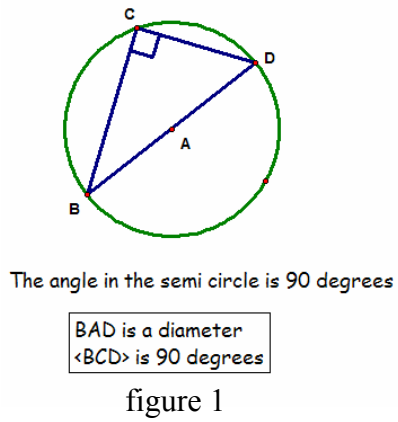

figure 1

I might have figure 1 prepared on Power Point® or the flip chart of an interactive white board (IWB)(*Advice: using ICT shows good organisation*). I do a show and tell and ask them to copy down the theorem. I do not ask them to draw but to stick a circle in their books (*Advice: avoid the use of compasses by handing out small circles for them to stick in their books, ask them to do the gluing for homework*). I rarely have much time for the main part of the lesson so I keep the exposition neat and tidy and so that is requires as little input from the pupils as possible.

I work through a couple of examples like the one in figure 2 that require the pupil to calculate angles using this theorem and I ask them to copy these down. I then handout a worksheet with 20 questions for the pupils to work through containing questions which are similar to those that they will see on the test and offer answers at various times in the lesson.

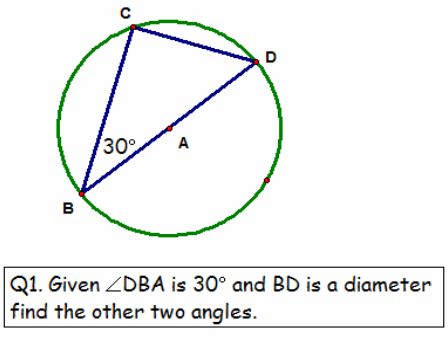

figure 2

I cannot pay attention to the actual learning because having stated my learning objective I have to make

Hewitt, D. (Ed.) Proceedings of the British Society for Research into Learning Mathematics 26(1) February 2006 • Available at bsrlm.org.uk © the author

sure that this can be rehearsed in the plenary. I never offer a distraction (for example a question with a triangle not on the diameter); there is no time to extend the pupils beyond their comfort zone as this may play havoc with my intended plenary. I have an extension question but no-one will get to it due to time constraints (*Advice: SM make sure you explicitly plan for G&T and SEN pupils in your class*.)

Mathematically all of this is a dead end. There is nowhere to move on mathematically. But it is tidy. The pupils have to rely on memory to 'know' this theorem. In the next two lessons I will offer similar introductions to other circle theorems. I am not enjoying myself, there seems to be no time to do anything. I have to constantly make pedagogic shifts in my lesson so that all aspects may be seen.

ALTERNATIVE VIEW

An alternative approach to this lesson takes thoughts about mathematics and the learners as a starting point. The isosceles triangle is the key concept I will use (knowing crucial key concepts for teaching is something we would like to discuss). A cuing in activity might be related to measuring and calculating angles in isosceles triangles in circles. If the pupils cannot do this activity I will stay with this in the lesson.

The main activity takes the starting point from above, removes a given (the theorem) and adds a given (a radius) (see Prestage and Perks (2001) for the ideas of removing and adding givens). The pupils are asked to draw diagrams like figure 3, to measure only one angle and then to calculate the rest. (I choose to deal with the issues of compasses and making choices.) When there is sufficient data in the room we will have a discussion about the angle in the semi-circle. I cannot go through answers as everyone is working on different data. We are generating specific cases that will let us move to a generality. Discussion will reveal what is happening in the room. I also watch and observe as the pupils are working. Depending on the group we might use algebra to prove the generality. I might demonstrate the generality using dynamic geometry software. I cannot tell what you will learn today but over several lessons I am highly focussed in my ambitions for this topic overall. My main plenary might be at the beginning of the next lesson.

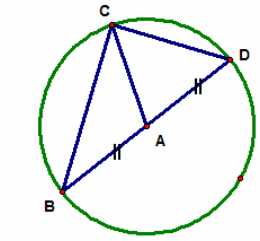

figure 3

I read the pace of the lesson and have an extension ready if needed – add in some givens, extend CA to E and join EB and ED and calculate the newly constructed angles, figure 4. This might lead to work on angles subtending the same segment; angles at the centre being double that at the circumference and/or specific cases of the cyclic quadrilateral. I will listen to the pupils to decide the direction of this lesson but I have organised the extensions so

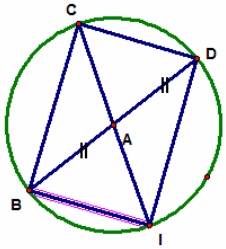

figure 4

Hewitt, D. (Ed.) Proceedings of the British Society for Research into Learning Mathematics 26(1) February 2006 • Available at bsrlm.org.uk © the author

that there is some progression through the mathematics; theorems emerge. I gain another shift in the mathematics by removing a given, the diameter, and yet another by removing the radii. But I have five years to progress through this mathematics. I am in no hurry. OfSTED would need to see the series of lessons to 'see' all the elements they perceive as satisfactory let alone good or outstanding.

DISCUSSION

The two approaches are markedly different. The tasks in the second version have a 'work towards' approach to begin to set the theorem in the context of already known geometry, whilst allowing practice of that which is said to be known. In the more traditional first task, the rule is given and then practised as is expected in the test.

The league tables and National Tests have created a focus on testing, resulting on teaching that is focused on testing, hence a curriculum that is focused on testing leading to a pedagogic style of 'give the rule, practise the rule' which focuses on practising the finished product for the test. Perhaps such styles allow for easy accounting for the teaching and hence permit an account for delivering the requirements of the outside measures. We have schools where the Spring Term of Y9 is deemed to be revision for the Key Stage 3 test. We suspect that the demand to have mathematics in the league tables for GCSE grades A to C will add to this. The pressures of OfSTED with their proforma observation sheets for what must be seen in satisfactory and good lessons add further to the routines of the 'stuff' of lesson.

There are many consequences and tensions in giving student teachers expected routines and events that must be seen in the lesson. We offer a few of them here.

- The first is the use of the lesson objective, in being required to tell the pupils what they will learn and in the plenary that is demanded during which time the pupils will repeat what they have learned. The student teacher is required to hear a re-statement of the lesson objective in order that this lesson is deemed successful. Denvir and Brown (1986) showed that learning maths is not a linear process and that being immersed in one aspect can frequently lead to unexpected learning. The student teacher is not allowed to learn to listen for unexpected learning, to work on the complexities of the relation between teaching and learning. The result is that it is easier to offer a lesson where you can account for "Today you will learn how to …"
- Time is an issue since so little of the lesson is given to learning. The routines of orthodox structures, the variety of resources, the going through the answers and the change of activity which disturb behaviour all eat into the time for learning mathematics.
- The expectation that the same curriculum for pupils of the same age is necessary has to be balanced by being seen to differentiate.
- The overload of advice relating to structures and routines rather than learning and mathematics leads to paralysis for the learner teacher.

Hewitt, D. (Ed.) Proceedings of the British Society for Research into Learning Mathematics 26(1) February 2006 • Available at bsrlm.org.uk © the author

Many of our learner teachers would not challenge the algorithmic style of teaching; this is what they remember of mathematics. The process is how they have passed their tests. So a distinction between learning for the test and learning mathematics is hard for them to appreciate. The structures can make you feel that you are achieving. The alternative is messy, it is not in the textbooks, the questions do not appear in that form in the test.

How do we help our learners manage the tensions seen in schools? How do we help them change from deliverers of test fodder to become teachers of mathematics? Does advising them to teach differently help them and the learning of their future pupils or does it simply bring the tensions to breaking strain?

NOTES

1. We stress the fact that this is what the students hear and not always what is said.

2. The lesson outlined here is constructed from observations, discussions and written observations from others in schools mentoring the student-teachers we tutor.

REFERENCES

Askew M, Millett A, Brown M, Rhodes V, Bibby T (2001) Entitlement to attainment: tensions in the National Numeracy Strategy, *The Curriculum Journal,* 12[1], 5-28.

Askew M , Brown M, Rhodes V, Johnson D, Wiliam D (1997) *Effective teacher of Numeracy*, London: King's College.

Denvir, B and Brown M (1986) Understanding of Number concepts in low attaining 7-9 year olds: Part i and Part ii, *Educational Studies in Mathematics,* 17, 15-36 and 143-164.

Dweck C (1999) *Self-theories: Their role in motivations, personality and development*, Psychology Press: Philadelphia,

Education Guardian (2006) *Children are less able than they used to be* The Guardian Tuesday January 24th 2006 p.3.

Prestage S & Perks P (2001) *Adapting and extending tasks for the secondary classroom: new tasks for old,* London: David Fulton.

Tanner, H., Jones, S., Kennewell, S. and Beauchamp, G. (2006) Interactive whole class teaching and interactive white boards, *Paper presented at the BSRLM day conference March 2005*, University of Warwick,

Watson A, De Geest E, Prestage S (2003) *Deep Progress in Mathematics: The improving attainment in mathematics project*, University of Oxford.

Hewitt, D. (Ed.) Proceedings of the British Society for Research into Learning Mathematics 26(1) February 2006 • Available at bsrlm.org.uk © the author