The rise and fall of an investigative approach to mathematics in primary education

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This paper is based on a discussion session held at the March day conference of BSRLM. The session was an opportunity to share points of view about the role of investigative mathematics in primary mathematics teaching. From 1982 when the Cockcroft report promoted this aspect of mathematics, through the introduction of the National Curriculum and the National Numeracy Strategy, to the latest Ofsted research (2011) on 'good practice in primary mathematics', what can we say about the current state and place of investigation in primary schools? In the light of national and international league tables, assessment and the value teachers place on investigations, what is the status of investigations in primary schools?

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A brief introduction was given, tracking the rise and fall of mathematical investigations in primary schools. Investigations appear to have had a brief ‘heyday’ in primary mathematics and now barely exist. The origins of investigations could be tracked back to the twin initiatives of the Nuffield Project, started in 1967, and the Plowden Report, also published in 1967. Both reports promoted the idea that children should have the opportunity to enquire and discover when learning. The idea of mathematical investigations was given a boost in the Cockcroft Report in 1982 and by the subsequent government-funded advisory teams who boosted practice in many schools.

The 1980s was the peak of investigation activity in primary mathematics with several books being written (Burton 1984; Garrard 1986, Mason, Burton and Stacey 1986, PrIME 1985-9). The National Numeracy Strategy (1998) had good suggestions for investigations in its 'Examples' section but this appears to be the tail end of the promotion of this style of mathematics. Currently primary schools are being urged to emphasise calculation and the application of calculation in word problem contexts (Ofsted November 2011). Rarely are open-ended explorations of mathematics mentioned, even in number contexts.

The discussion group consisted of primary teachers and primary and secondary teacher educators, all members of the BSRLM and therefore interested in research. To prompt the discussion, four questions were offered alongside an invitation to raise any points related to school or primary teacher training:

- If teachers do not see the purpose of an investigative approach, will they use it? What is the purpose?
- Is it difficult to teach children how to investigate? What does it involve?
- Are there resources available for an investigative approach which at the same time allow for learning of key mathematics?
- Would teaching children to investigate mathematics improve their test results?

Needless to say, the discussion did not engage with all these questions and raised others which I have attempted to encapsulate below. Investigations were generally seen as being useful to children doing mathematics and contributing many valuable skills to children's learning such as decision making, ownership and motivation. However, some members raised the point that in many places mathematical investigation was never established as a way of working. The uptake was probably variable from county to county depending on the local authority and inspector's interpretation of good mathematics. This was compared to the more compulsory nature of investigations being part of GCSE mathematics testing which occurred as a parallel development. The more formal approach and the need to assess open-ended creative mathematics is a long-standing debate. The point was made that you could now get model answers off the internet which sadly heralds the possible death knell of this style of formal assessment.

Why is it so difficult to establish investigation in mathematics when it offers the opportunity for children to use the mathematics they have learned? There could be various factors causing investigations to be a non-starter in primary schools, some of which are considered here. Interestingly, the practice of reaching solutions with algebraic formulae was seen by some as invalidating investigations in the primary sector as pupils never reached this stage. This view was opposed by others who felt that it was not necessary to extend an investigation to this point.

This led to a discussion on teacher and student knowledge. It was generally felt that a significant number of primary teachers and students did not have a good grasp of the processes involved in investigating. A question was raised as to whether this is (or was ever) a priority in teacher training or in schools as the official documentation gives only a nodding reference to this way of working. It was also recognised that it is not easy to empower children to successfully investigate, it takes a long time for that independent enquiry mode to be established and there appears to be a preference to promote word-based problem solving which has definitive answers. This would be easier to mark, probably take less time and is reassuring in providing a recognized solution and end point; all things which a good investigation is not! In a time of considerable pressure on teachers, these aspects of mathematics can understandably be opted for. They meet, to a degree, the requirement to 'use and apply' mathematics and therefore are a safe option.

One would also have to question whether teachers see any value in getting children to investigate in mathematics. Mathematics is seen by many as a practical subject, providing a tool to be used in everyday life for most children and not the creative tool that makes a few successful scientists. Daily, the political media propounds messages about 'basic numeracy' through teaching calculations and the motivating power of creative application is understandably lost. Lost also are the links of this way of working to children's ability to retain mathematics and the use of mathematics across subjects.

The order of teaching new mathematics can exacerbate this situation. Both through published texts and official curricula there is a strong message of explain the topic, practice the calculation and finally apply the knowledge acquired. One published scheme even labelled this sections A, B and C. Section A explained the mathematics, section B was a practice of the calculation and Section C had many interesting investigations, allowing children to explore their newly acquired knowledge, but, alas, many children did not make it to section C and some were not expected to ever go there. Some enterprising teachers raised the curiosity of their children by starting with Section C although they were few and far between.

As alluded to previously, the best investigations are open-ended and provide a variety of solutions. It is difficult to assess them. Secondary schools have had to meet this challenge for a number of years. Primary schools moved through practical assessment activities very rapidly between the publishing of the TEGAT Report (1987) and the third year of assessing Standard Assessment Tasks (SAT) for seven year olds. The national tests soon took on a much narrower paper-based form despite continued efforts to provide some more open-ended questions. It is a well-known fact that teachers will teach to the test, particularly when so much is dependent on outcome. Therefore, the likely test content becomes the curriculum.

A final point to raise on the negative side (but not discussed) is the current high-profile expectation to raise standards through improvement of primary school children's ability to calculate. Who can argue with a wish to improve this? However one can argue with the best way to do this. Children are more likely to remember the meaningful. Learning one type of calculation after another is rather like learning a list of spellings. They can be remembered but meaningfulness will create more neural connections and use will strengthen the neural pathways (Greenfield, 2000). In English meaningfulness is established by definition and context whilst in mathematics by everyday application of number in shopping, puzzles, other subjects, problem solving and investigating mathematical situations. Is mathematics application being actively promoted in all these contexts?

Reference was made to other subjects. It was generally felt that enquiry skills and enquiry opportunities were offered in several other subjects but not often in mathematics. It appears that mathematics can be 'used' in other subjects but little is transferred in return. Learning mathematics seems to be seen as an isolated activity. Learning a type of calculation is a unique, isolated skill not done in connection to the real world. Often contexts for use are seen as a practice of the algorithm and contexts for application offered as limited sequels. Few enquiry tasks are set in mathematics lessons as there is little time to consolidate knowledge. However, in other subjects mathematics is utilised, and strategies for enquiry frequently used. For example, recording and interpreting data from science experiments, pattern making in art and design, dates and time spans in history, researching skills when seeking information, use of direction and location in geography. Mathematical investigations require additional skills of enquiry such as assembling information, drawing upon previous knowledge, coming up with a strategy and employing it, interpreting and recording findings, seeking patterns and relationships, extracting general points, considering whether they can be transferred to new situations (Garrard, 1986). Some of the skills which stand out and belong to other disciplines are the ability to ask oneself questions, observe closely and transfer knowledge. Many teachers have adopted strategies that enable these to develop such as talk partners, pupil questioning, systematic observation and justification. It would be great if they could be transferred back into mathematics in the context of investigations with the teacher overtly promoting the processes involved.

A final thought shared in the group was the fact that really young children are inquisitive, really do explore their environment, do experiment and ask themselves questions. This was nicely illustrated by the example of a son who took one bite out of every biscuit in the packet just to see if they all tasted the same. Why do children stop posing questions, take time to explore what they want to know, not develop their enquiry skills as they enter and progress through the primary school? How can we as teachers of students and children strengthen this process in mathematics before it is completely lost?

Investigations may not be seen as a key element of the current primary mathematics curriculum but as the numeracy strategy is archived it is a good time to reflect on approaches to the curriculum which enable children to, engage with, learn and remember their mathematics. Investigations and an enquiry or investigative approach have much to offer in meeting these three aims. As other subjects utilise a full range of technologies, resources and teaching styles, it is important that primary mathematics does not revert to an endless diet of algorithmic knowledge.

References

Burton, L. 1984. Thinking Things Through. Oxford: Blackwell
Cockcroft, W. 1982. Mathematics Counts. London: HMSO
Department for Education and Science 1988. The TEGAT Report. London: DES
Department for Education and Employment (DfEE) 1999. The National Numeracy Strategy: Framework for Teaching Mathematics from Reception to Year 6. London: DfEE
Garrard, W. 1986. I don't know, let's find out. Leicester: Mathematical Association
Greenfield, S. 2000. The Private Life of the Brain London, Allen Lane/The Penguin Press
Mason, J., Burton, L. and Stacey, K. 1986. Thinking Mathematically. London: Addison-Wesley
Nuffield Project 1967. I do and I Understand. London: Chambers/Murray
Ofsted 2011. Good Practice in Primary Mathematics. London: HMSO
Plowden, B. 1967. Children and their Primary Schools. London: HMSO
Schools Curriculum Development Committee (SCDC) 1984. Exploratory Study (PrIME project led by Hilary Shuard (1985-9)