

## Title

Achieving excellence and equity through enhancing teacher knowledge in arithmetical development, numeracy pedagogy and quality interactions: A coaching and mentoring approach.

## What did we ask?

### Research Questions:

1. What are the current attainment levels in numeracy in North Lanarkshire?
2. Is there a poverty related attainment gap in numeracy in North Lanarkshire?
3. Does training of teachers on effective pedagogy, numeracy progression and arithmetical development integrated within a coaching and mentoring professional learning model (i.e. Video Enhanced Reflective Practice) help to:
  - a) Improve staff confidence in teaching numeracy?
  - b) Enhance the quality of pupil-teacher interactions?
  - c) Improve perceived pupil confidence in numeracy?

Does this in turn lead to:

- d) Improved attainment in numeracy?
- e) A narrowed poverty-related attainment gap?

## What is the evidence base?

### *Numerical Development*

A child's development in numeracy is a complex process. Development takes place following significant **cognitive restructuring**<sup>1</sup> and develops step by step as described below:

- Emergent number stage: children develop one-to-one correspondence in counting
- Perceptual number stage: children can add together visible quantities
- Figurative number stage: children can manage screened addition<sup>2</sup>
- Initial number stage: children can understand number symbols and operations.
- Facile number stage: children acquire higher order number concepts and can understand the relationships between numbers and operations.

(Steffe et al, 1983, as cited in Munn & Reason, 2007).

### ***Effective Numeracy Pedagogy***

Drawing further on ecological models and social learning theory, Anthony & Walshaw (2009) identified characteristics of effective numeracy pedagogy. These are:

1. Establishing **an ethic of care** through high expectations, a 'togetherness' environment and a risk-taking attitude.
2. **Arrangements for learning** that balance individual, group/ paired work as well as whole class discussion, building on student's thinking.
3. **Mathematical communication** that focuses on pupil 'thinking' that leads to a solution.
4. **Mathematical language:** assessment for learning to gain insight into the pupil's mathematical thinking and providing feedback.
5. Provision of worthwhile challenging tasks, **Making connections** across mathematical topics to develop conceptual understanding.
6. **Use of tools and representations** such as the number system, graphs, diagrams, images, etc.
7. **Sound teacher knowledge** including mathematical content to make key decisions.

### ***Effective Professional Learning Approaches***

Research evidence suggests that effective professional learning opportunities for teachers meet the following criteria:

- Are longer than 14 hours
- Promote teacher ownership and flexibility
- Have a focus on outcomes for learners
- Have support from school leaders
- Include external input on theory and practice

The Video Enhanced Reflective Practice training format employs many of the elements identified above.

For numeracy specific improvements, research suggests a focus on exploring mathematical problems, by employing high levels of effective questioning and student collaboration; challenging pupils to construct their own understanding of mathematical content. Teaching methods are recommended to concentrate on conceptual understanding and problem solving techniques alongside fostering teachers' ability to evaluate learners' mathematical thinking.

Moreover, It is argued that an advance in teacher communication amplifies the effectiveness of numeracy pedagogy, building pupil enthusiasm, which bolsters pupil attainment.

(Church & Allan, 2013)

## What did we do?

### Initial Procedure

1. Devised a 'midpoint' training workshop on effective numeracy pedagogy, numerical development and progression with specific integration into wider strategic work on Mental Agility ('Number Talks').
2. Incorporated this into a VERP model consisting of one day training on Attunement and Micro-analysis with a further four sessions.
3. Developed a coding schedule to measure changes in teacher – pupil interactions and numeracy specific behaviours. Developed questionnaires to be completed by teachers as a means of measuring perceived teacher and pupil confidence at pre-training and post-training.

### Participants

4. Targeted 16 pupils *in SIMD 1-3* and four teachers from schools within North Lanarkshire.

### Method

5. Filmed each teacher performing a mental agility lesson with four selected pupils before training and on the completion of VERP and numeracy input.
6. Teachers completed pre-questionnaires and completed again following the training.

### Analysis

7. Using the developed coding schedule, eight minutes of pre- and post-training footage was analysed.

## What have we found so far?

### Research Question 1:

Across North Lanarkshire, pupils' numerical ability is monitored and tracked using 'Centre of Evaluation and Monitoring' (CEM) standardised assessments in P1, P3, P5, P7 and S2. Results from June 2016 show a dip in children's general mathematical ability across their primary school years. This reflects the national picture in Scotland.

### Research Question 2:

The gap in standardised scores between pupils living in the most deprived areas (SIMD 1-3) and the least deprived areas (SIMD 8-10) is 9.14%. Results for mental arithmetic showed the gap in standardised scores between pupils living in the most and least deprived areas increased as children moved through their primary schooling (e.g. P3 is 6.90%, P5 is 6.53% and in P7 is 10.14%). This pattern is replicated in teacher judgement submissions. These results show that children who are living in areas with high levels of deprivation, on average, are performing below children of a similar age group from low areas of deprivation.

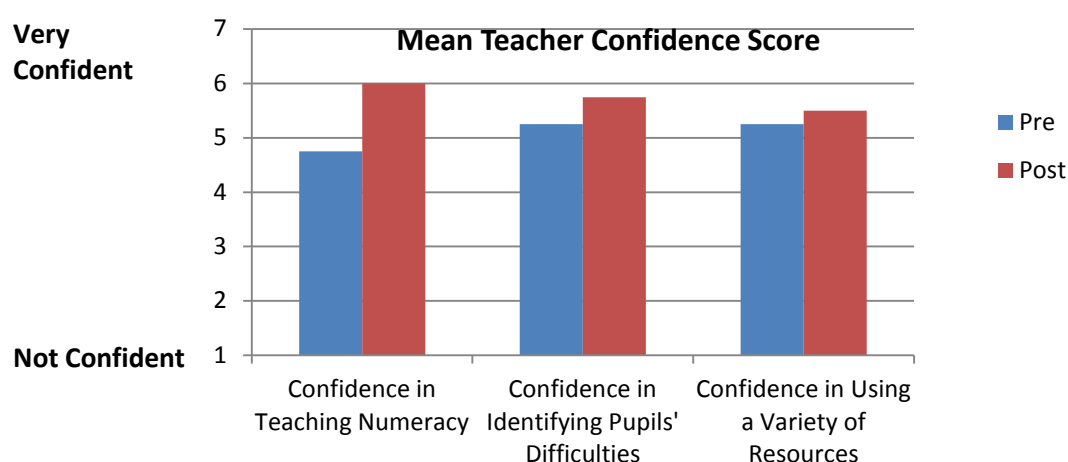
Furthermore, as the gap in attainment is wider at the later primary school years this indicates that deprivation level has the highest impact on children's learning at this stage.

### Research Question 3a:

Following the training, teachers rated themselves significantly more confident in teaching numeracy than they did prior to the training pre-training (Mean = 4.75, Standard Deviation = 0.5) and post-training (Mean = 6.0, Standard Deviation = .00) conditions; paired  $t(3) = -5.0$ ,  $p = 0.02$ ). All teachers rated themselves at post-training as '6' out of '7' suggesting teachers are now confident in this area. One teacher in particular increased their rating of confidence of '4' at pre-training to '6' at post-training, highlighting the benefit of the training for staff confidence levels.

In addition, following the training there was also a slight increase in teacher confidence in identifying pupils' difficulties and using a variety of resources to deliver numeracy lessons although these were found to be statistically non-significant, as shown in figure 1.

**Figure1** Figure 1 shows an increase in confidence for all three areas following the training. The greatest increase was seen in 'Confidence in Teaching Numeracy' with the average score increasing by '1.25', a statistically significant result.



### Research Question 3b:

Following training, on average teachers demonstrated more '*encouraging initiatives*' (waiting and listening), '*receiving initiatives*' (praise to encourage learning) and '*developing attuned interactions*' (receiving and responding verbally). This suggests that following the training, teachers allowed pupils more time to answer questions and praised children more for the contributions which they gave within the class.

Teachers also increased the number of times they interacted with pupils through verbal response.

Furthermore, there was an increase in the number of times teachers reiterated (written or verbally) a numeracy strategy shared by the pupils to the rest of the group (pre training  $n = 4$ ; post training  $n = 25$ ). Encouraging pupil participation through these behaviours allows lessons to be less teacher-led and encourages children to be more independent learners.

These results however were found to be non-significant using statistical analysis, despite the overall increase.

In addition, on average teachers used more open-questioning to encourage pupil contribution, resulting in more pupil-led interactions being observed. Given that reducing teacher-led interactions is a central aim of VERP, the difference seen between pre and post-training suggests that teachers achieved this change in behaviour as a result of the training. Results however were found to be statistically non-significant, although the average increase was a promising result.

### Research Question 3c:

Following the training, on average teachers perceived pupils as contributing more to maths discussions significantly more at post-training (Mean = 2.5, Standard Deviation = 0.63) than at pre-training (Mean = 1.88, Standard Deviation = 0.34) conditions; paired  $t(15) = -0.50$ ,  $P < 0.01$ . This shows that teachers noted pupils discussing and contributing more in numeracy which suggests an increase in pupil confidence.

In addition, teachers were asked to rate how confident each selected pupil was in their own numeracy abilities. Results showed that prior to training only five pupils were rated as '6' or above (31%) for their confidence in own abilities, following the training this has risen to eight pupils (50%), as shown in Figure 2.

**Figure 2**

**Q. How confident/ secure would you perceive the child to be in their numeracy abilities?**

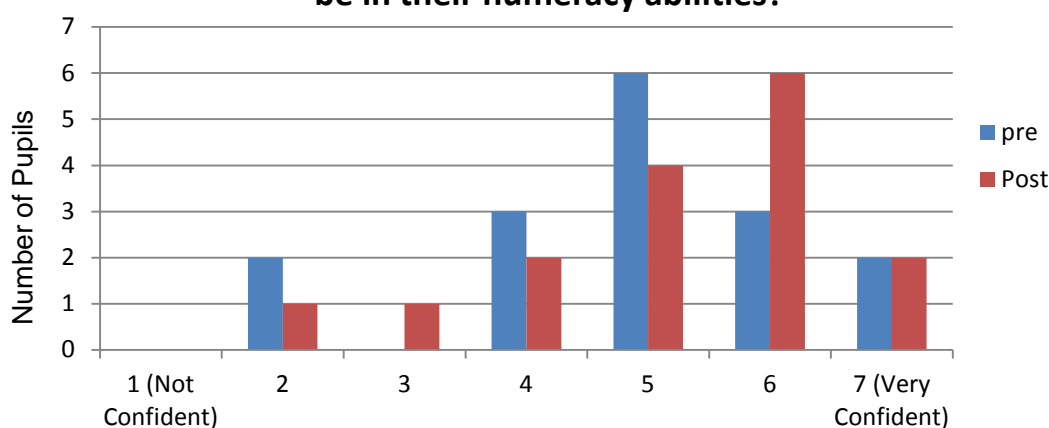


Figure 2 shows that prior to training only five pupils were rated as '6' or above for their confidence in own abilities, following the training this has raised to eight pupils.

## What do we plan to do next?

The findings from the research show that VERP plus numeracy training impacts positively on teachers knowledge and skills.

On completion of the training, improvements were observed in the frequency of open questioning by teachers and also in many of the attunement behaviours. This study shows that the combination of numeracy sessions, focusing on conceptual mathematical knowledge and VERP training, has contributed to the significant increase in the confidence of teachers in teaching numeracy. It is anticipated that this change in teacher behaviour could lead to increased positive numeracy-based outcomes for children in their class which can be further explored in future evaluations.

Positive trends were observed in the areas of

- 'teacher confidence in identifying pupils' difficulties' and 'using a variety of resources to deliver numeracy lessons,'
- 'encouraging initiatives' (waiting and listening),
- 'receiving initiatives'(praise to encourage learning) and 'developing attuned interactions'(receiving and responding verbally),
- interacting with pupils through verbal response
- in the use and frequency of open-questioning to encourage pupil contribution.

While not statistically significant the results of this small scale research are promising. Building on these findings, further consideration will be given to how this staff development model i.e. developing teacher skills in interactions and reflection along with input on numerical development can be strengthened and expanded. This will be considered for universal, targeted and specialist numerical approaches within North Lanarkshire Council.

### Footnote:

<sup>1</sup>children link together their own understanding of quantities for verbal numbers e.g. 1, 2, 3 with numerical concepts e.g. addition, subtraction

<sup>2</sup> totals of two numbers that are added together are hidden and re-shown to check child's answer

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### For further information and access to materials

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