

## Title

Developing numeracy pedagogy to improve numeracy attainment and motivation for all (3 Challenge primary schools & mixed SIMD primary schools across South Ayrshire Council)

## What did we ask? (Research Questions)

1. Does implementation & evaluation of a Concrete-Pictorial-Abstract (CPA) pedagogical approach in 3 Challenge schools improve numeracy attainment within SIMD 1&2?
2. Does a CPA pedagogical approach improve pupil's motivation for numeracy in 3 Challenge schools?
3. Does a CPA pedagogical approach improve staff perceptions of numeracy in 3 Challenge schools?
4. Does implementation of a CPA pedagogical approach across 6 other primary schools of mixed SIMD, improve pupil and staff motivation for numeracy?
5. Does implementation of a CPA pedagogical approach have a differential impact on pupils' motivation for numeracy in Challenge schools relative to mixed SIMD schools?

## What is the evidence base? (link to your definition of the poverty gap)

In Scotland, the attainment gap refers to 'the gap in attainment between the most and least advantaged children' (Scottish Government, 2014). There is evidence a considerable poverty-related attainment gap in numeracy exists that is evident prior to school entry and persists and widens throughout education (Scottish Government, 2013). In 2017 pupils across P3-7 attending Attainment Challenge Schools in South Ayrshire typically performed less well in standardised numeracy GL and Centre for Evaluation and Monitoring (CEM) assessments compared to authority and national averages, with between 22.56%-27.50% of pupils in Challenge schools performing "very low" or "below average" in numeracy attainment. Therefore, numeracy pedagogy across these stages is indicated for continuous development in this pilot study.

The Concrete-Pictorial-Abstract (CPA) pedagogical model has been found to be effective when applied to numeracy (Hoong, Kin & Pien, 2015; Safro et al. 2014; Watt, 2013; Witzel, 2005). This strategy, based on Bruner's learning theory, consists of three stages; (1) concrete (learning through real objects); (2) pictorial/representational (learning through image representation); and (3) abstract (learning through abstract writing) (Bruner, 1966). Bruner stressed that for full conceptual understanding, it was necessary to teach material through this cycle.

One approach was selected to support the implementation of the CPA model as it was underpinned by the CPA model. It identifies multi-sensory approaches and concrete manipulatives as hallmarks of effective numeracy pedagogy (Askew et al. 1997; Fuson, 1992; Williams Review, 2008) and has been found to promote attainment in numeracy (Oxford University Press, 2011). Furthermore, in published case studies, teachers report improvements in children's attitudes towards numeracy using the approach (Oxford Press, 2013).

## What did we do?

This project ran from September 2018-May 2019 with two strands using a simple pre- post design with interim evaluations from teaching staff.

### Project Strands

#### 1. Implementation & evaluation of the CPA approach to meet needs of 3 Challenge schools

All staff completed training in the CPA approach and agreed to implement. Two schools implemented the approach in P2 class, while one implemented in P5-P7 classes in line with attainment data. Control data was also collected from the corresponding P5-P7 classes not receiving the intervention.

#### Evaluation

- GL Numeracy Assessments
- *Pupils' Motivation for Numeracy Questionnaire*
- Staff Impact Questionnaire – targeting implementation and impact. Completed by class teachers in January 2019 and March 2019.

#### 2. Implementation of the CPA approach across 6 other primary schools of mixed SIMD to improve pupil and staff perceptions of numeracy

All staff completed training in the CPA approach and agreed to implement with a P2 class in line with attainment data.

#### Evaluation

- *Pupils' Motivation for Numeracy Questionnaire*
- Staff Impact Questionnaire – as above

## What have we found?

1. Does implementation & evaluation of the CPA approach in 3 Challenge School improve numeracy attainment within SIMD 1&2?

### P2

Although two Challenge schools piloted the approach, GL Assessment data was returned by one school. Findings are below.

P2 GL Maths Assessment Measures	Pre	Post	p-value
Standard Age Score	88.27	106.73	$p < 0.05$
Overall Stanine	3.36	5.82	$p < 0.05$
National Percentile Rank	24.77	65.05	$p < 0.05$

Statistical analysis indicates that the CPA approach significantly improves numeracy attainment in P2 pupils attending the Challenge school.

### P5, P6 & P7

The CPA approach was piloted with P5, P6 and P7 classes in one school and GL Assessment data was returned for P5 and P6. Statistical findings suggest the CPA approach significantly improves numeracy attainment in P5 pupils in a Challenge school.

Findings suggest the CPA approach significantly improves P6 pupils' numeracy attainment attending a Challenge school, relative to Control.

Year Group	Treatment Group	Mean Standard Age Scores		p-value	Mean Change Scores	p-value
		Pre	Post			
P5	Intervention	93.08	105.58	<0.05	12.5	<0.05
	Control	92.92	87.85	<0.05	-5.17	
P6	Intervention	84.14	101.07	<0.05	16.93	<0.05
	Control	85.14	86.21	0.092	1.07	

Year Group	Treatment Group	Mean Overall Stanine		p-value	Mean Change Scores	p-value
		Pre	Post			
P5	Intervention	4.08	5.83	<0.05	1.75	<0.05
	Control	4.08	3.42	<0.05	-0.67	
P6	Intervention	2.93	5.92	<0.05	2.36	<0.05

	Control	2.93	3.14	0.082		0.21	
Year Group	Treatment Group	Mean National Percentile Rank		p-value		Mean Change Scores	p-value
		Pre	Post				
P5	Intervention	36.5	62.92	<0.05		26.42	<0.05
	Control	34	22.92	<0.05		-11.08	
P6	Intervention	17.07	53	<0.05		35.93	<0.05
	Control	18.21	19.79	0.142		1.67	

**2. Does the CPA approach improve pupil motivation for numeracy in 3 Challenge schools?**

**P2**

Mean Motivation for Numeracy Score		p-value
Pre	Post	
25.55	25.86	0.60

Findings suggest the CPA approach does not have a significant impact on P2 pupils' motivation in a Challenge school.

**P5, P6 & P7**

Year Group	Treatment Group	Mean Motivation for Numeracy Scores		p-value		Change Scores	p-value
		Pre	Post				
P5	Intervention	23.53	22.53	0.179		1.10	0.104
	Control	24.90	26.00	0.111		-2.28	
P6	Intervention	23.00	22.44	0.575		-1.00	0.800
	Control	22.67	21.67	0.534		-0.56	
P7	Intervention	23.17	22.83	0.517		-0.33	0.615
	Control	21.71	22.36	0.866		0.64	

To investigate the impact of the CPA approach on pupils' motivation for numeracy in P5, 6 and 7, statistical tests compared change in motivation for numeracy ratings across intervention and control groups. Findings suggest the CPA approach does not have a significant impact on P5, P6 or P7 pupils' motivation in Challenge schools.

### 3. Does the CPA approach improve staff perceptions of numeracy in 3 Challenge schools?

Qualitative data from the staff impact questionnaires were analysed using thematic analysis (Braun & Clark, 2006) and main themes extrapolated are outlined below.

#### Implementation

- Staff reported it was necessary to adapt their numeracy pedagogy depending on the needs and size of the group
- Secondly, staff were supported to understand the CPA approach to numeracy pedagogy through centrally organised Taster sessions delivered by an independent representative. However, staff expressed a desire for more training throughout the year.

#### Impact

Staff highlighted benefits of the CPA pedagogy and included:

- Pupils' enjoyment and confidence accessing the CPA approach was consistently highlighted across all schools
- Staff reported the CPA approach promoted pupils' conceptual and procedural skills:
  - Visual support in building understanding has been most helpful
  - Increased number sense
  - Place value links made easy
  - Improved understanding of basic numeracy vocabulary

### 4. Does implementation of the CPA approach across 6 other primary schools of mixed SIMD improve pupil and staff motivation for numeracy?

Mean Motivation for Numeracy Ratings		<i>p</i> -value
Pre	Post	
25.62	26.40	<0.05

Statistical analysis indicate the CPA approach significantly improved P2 pupil's motivation for numeracy in 6 mixed SIMD schools with significantly higher ratings at post-test.

**5. Does implementation of the CPA approach have a differential impact on P2 pupils' motivations for numeracy in Challenge relative to mixed SIMD schools?**

	Mean Motivation for Numeracy Score		Mean Change Score	p-value
	Pre	Post		
Challenge School	25.90	25.69	-0.20	<0.05
Mixed SIMD School	25.62	26.40	0.79	

To evaluate whether the intervention had a differential impact on P2 children's motivation for numeracy in Challenge relative to mixed SIMD school, statistical analysis compared the change scores of the two groups. The CPA approach had a significantly positive impact on motivation for numeracy in mixed SIMD than Challenge schools.

### What do we plan to do next?

A proposed next step for South Ayrshire Council to continue to support the evidence-informed CPA pedagogy and resources utilised in this study to maintain efforts to close the poverty-related attainment gap. Challenge schools in particular may benefit from a systematic focus to promote pupils' motivation for numeracy through developing positive mindsets (Dweck, 2007) to ensure the positive gains made here are sustained.

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