Education Scotland
Foghlam Alba

Title

Metacognition and Numeracy

What did we ask? (Research Questions)

- Does increasing teachers' knowledge of metacognition lead to children using metacognitive strategies in solving problems in numeracy?
- How can teachers use metacognitive knowledge to enhance children's ability to solve problems in numeracy during the First Level of Curriculum for Excellence?
- Can children in the First Level demonstrate use of metacognitive strategies in their solving of problems in numeracy?

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

Metacognition (Flavell, 1979) refers to knowledge about and regulation of one's cognitive abilities during the process of learning. The Education Endowment Foundation (a) (2018) define self-regulated learning as comprising cognition, metacognition and motivation. They describe *metacognition* as the ways in which 'learners monitor and purposefully direct their learning' (p 9) and *metacognitive strategies* as 'the strategies we use to monitor or control our cognition'. All three of the components of self -regulated learning interact in complex ways during the process of learning.

Much research on metacognitive skills in children has focussed on children aged nine years or above. Whitebread et al (2009) explored metacognition in 3-7 year old children, devising observation tools to assess metacognition in younger children. Assessment of children's use of metacognition *during* a task in particular, appears to be more accurate than assessment before or after the task (Veenman et al, 2006).

In addition to thinking about how to assess metacognition in children it may well be important to understand teachers' own metacognitive understanding. Wilson and Bai (2010) suggested that having such knowledge would enable the development of appropriate training programmes for teachers to support their pedagogical understanding of what is required to teach children to use metacognition.

Providing explicit instruction in metacognitive strategies is important, as although children will develop metacognition as they mature, most will not spontaneously develop all the strategies they will need (Schraw et al, 2006, Schraw, 1998). Schraw emphasised that direct training such as this

needs to include teaching around *how* to use strategies as well as *when* to use them, and *why* they are beneficial.

Children's metacognitive skills play an important role in ensuring effective learning, especially in the case of disadvantaged learners. This may be linked to disadvantaged children being less liable to describe their thinking and explaining their ideas than more advantaged learners, which may impact on their ability to learn Mathematics or affect teacher perceptions of their ability (Pappas et al, 2003). The Education Endowment Foundation (b) (2018), rated metacognition and self-regulated learning as 'a high impact, low cost approach to improving the attainment of disadvantaged learners' many of whom might be those affected by poverty.

What did we do?

Eight P2 and 3 classes were recruited, based on an observed dip in numeracy attainment throughout Stirling Local Authority between primaries 3 and 4. Three schools were identified to participate in the project: two were chosen because they were situated in areas of deprivation (schools B and C) and a third (School A) which expressed an interest in participating. In the context of the Pupil Equity Fund, schools B and C received significant funding with 45.5% and 24.5% of their school roll respectively being in receipt of Pupil Equity Funding (PEF). Less than 1% of School A's school role received PEF funding. Training was provided to the class teachers from Stirling EPS service on metacognition and numeracy and the teachers were asked to model 'think aloud' strategies to their class during maths problems for a period of 6 to 8 weeks.

Each teacher selected 5 pupils who worked as a group whose numeracy attainment was below that of their peers. The frequency of planning, monitoring and evaluation behaviours of these pupils were assessed by teachers using a metacognition observation schedule adapted from Bryce & Whitebread (2012) at the beginning and end of the project.

Pupils were provided with a metacognition prompt sheet with questions which supported the planning, monitoring and evaluation process and rating the difficulty of each metacognitive task using a traffic light system. Teachers also provided qualitative feedback on the project.

The Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) was used to assess teachers' knowledge of metacognition as well as their regulation of cognition across eight distinct domains; declarative, procedural and conditional knowledge, planning, information management strategies, comprehension monitoring, debugging strategies and evaluation at the start and end of the project.

What have we found?

Of the eight teachers who were initially recruited in the study, four dropped out (all three teachers from School B and one from School A). Data was gathered from three out of four remaining teachers for 16 pupils. These teachers reported the use of metacognitive strategies as having a positive impact on their teaching practice. They stated that they would pause more

frequently during times when the class were working to revisit the metacognitive prompts with the whole class e.g. 'had they seen a problem like this before?' as they had found these prompts beneficial. One teacher said she would continue in the routine of problem solving weekly as the routine was something her class enjoyed and made good use of. The teachers reported an increase in numbers of children using resources, e.g. number lines, during maths to solve problems. Two of the teachers reported an initial increase in the vocalisation of her groups' problem solving which then became internalised towards the end of the eight weeks. They hypothesized, but could not be sure, that the decrease in vocalisation of their thought processes could be due to an increase in pupils' confidence using metacognitive strategies to solve maths problems. The post teacher observation schedule identified an increase in frequency in planning and monitoring behaviours observed across all groups. Notably, planning, monitoring and evaluating metacognitive behaviours were observed far less frequently in School C compared with School A at the beginning of the project. As such a greater increase in the frequency of these behaviours was observed by the class teacher in School C. This suggested that the metacognitive input had an enhanced benefit on children from the school with high levels of PEF funding. Finally, the process was not observed to have an impact on teacher self-reported MAI scores.

What do we plan to do next?

Data has to be gathered from the remaining teacher and we plan to undertake a focus group of the pupils to gain an understanding of their perspectives on the use of metacognitive strategies and completion of the pupil prompt sheet.

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