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Fostering Meta-Cognitive Skills in Young Children

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Abstract

This research report is on fostering young children's metacognitive skills. The study was conducted at a private early childhood education center in a Midwestern city in 2020. The design of the study was a mixed approach including Time Series experimentation naturalistic observation and interviews. Children aged 3-4 years were exposed in alternate weeks to pre-read-aloud prompts which engaged them in their own thinking about the story that was about to be read to them. The children tried to make predictions about the story before the story was read. After the story was read, the children were assessed on their abilities to think about what their thoughts and predictions were before the story was read aloud to them. Data were collected for a total of 11 weeks from two large groups of 20 children each, and one small group of 6 children. Comparison of the data revealed systematic differences between the treatment and non treatment weeks. The results are discussed and implications for further research are drawn.

Keywords: Metacognition in Early Childhood, Young Children's Thinking Skills, Teaching Metacognitive Skills, Young Children Thinking About Thinking

Introduction

Young children learn from their immediate environments. As they learn, they form perceptions about what they see, taste, feel, smell, and hear. These perceptions become the basis for their thinking, and as children grow older, they develop a sense of self and begin to relate more meaningfully to their surroundings. Learning from older children and adults, young children emulate what they see, even before they develop a sense of self as individuals. By the age of preschool (3-4 years) children have a good sense of themselves, their families immediate friends and routines in their lives. However, independent thinking and the reasoning underlying their actions and preferences, are just emerging, and need fostering. Teaching children to better understand themselves and think about how they think is not easy because of their "just emerging" cognitive skills. Young children need to be guided to gain insight into their behaviors, accomplishments, needs and feelings, in order to learn how to monitor their learning and develop resilience to factors that may negatively affect their learning and development. This ability to reflect on one's own thinking is called "meta-cognition", which is a powerful skill for building resilience and nurturing self-awareness (Fleur, 2021; Sudhakar, 2018).

Meta-cognition is defined as the ability to think about one's own thinking (Flavell, 1979), a crucial skill in humans which helps us be self-aware, understand how we do what we do, and why. Piaget's Constructivist theory and Vygotsky's Socio-cultural theory relate children's

conscious awareness of surroundings and opinions of others to meta-cognition (Papaleontiou-Louca, 2008). Piaget highlights children's engagement with the environment as a driver for conscious learning. When children begin schooling, the spontaneity in their learning is reduced due to structured school curriculum. Vygotsky's Socio-Cultural Theory addresses learning as both an interpersonal activity - emphasizing the role of language in the learning process (e.g. child and adult in mediating and scaffolding processes) - and an intrapersonal activity (e.g. children's use of private speech to work through difficult tasks). Together Piaget and Vygostly provide a basis for adult intervention to support and enrich children's learning by guiding them to better engage their own minds.

Taking this understanding in consideration with the myriad of factors facing young children in the 21st century - floods of information bombarding their senses day in-day out, possibly constrained parenting due to long work hours, inadequate adult attention in understaffed classrooms, classism, racism and other social ills - the need to be self aware at a young age is even higher, in order to begin to counter the passive sense of self that can lead to feelings of helplessness and despair. It is important for young children to be guided to become independent learners, to practice self-regulation, and even begin to develop self-advocacy skills. Being able to self-regulate helps children manage experiences that can otherwise overwhelm them (Jacobson 2016).

Conceptual Framework

Four key factors were considered in conceptualizing teaching metacognitive skills to young children. First, young children are naturally curious beings who are interested in learning about their surroundings. They naturally have the urge to learn about the world in order to find out how things work. Children's readiness to learn is a good opportunity for teachers and other adults to step in and structure children's environments in ways that facilitate learning as the children's curiosity demands. Secondly, young children's brains are wired to learn about anything that they encounter (Eliot & Syc, 2008). In infancy for example, children are able to learn, identify and distinguish speech sounds from any language, an ability that is lost with age (Kuhl, 2010). Thirdly, when adults guide children's earning, they increase the children's ability to reach their learning capacity. Lev Vygotsy called this optimum learning capacity Zone of Proximal Development (Berk, 2020, Otto, 2018; McAfee & Leong, 2011). The fourth factor that guided the study is the concept of systematic learning. Having young children tackle the complexity of thinking about thinking necessitates a step-b-step approach in order to have children do one thing at a time. As demonstrated by Information Systems Theory, entities have multiple components (Lerner, 2004; Gregor, 2002); breaking complex tasks into smaller portions makes it manageable for children to learn. Figure 1 shows the relationships between these four factors.

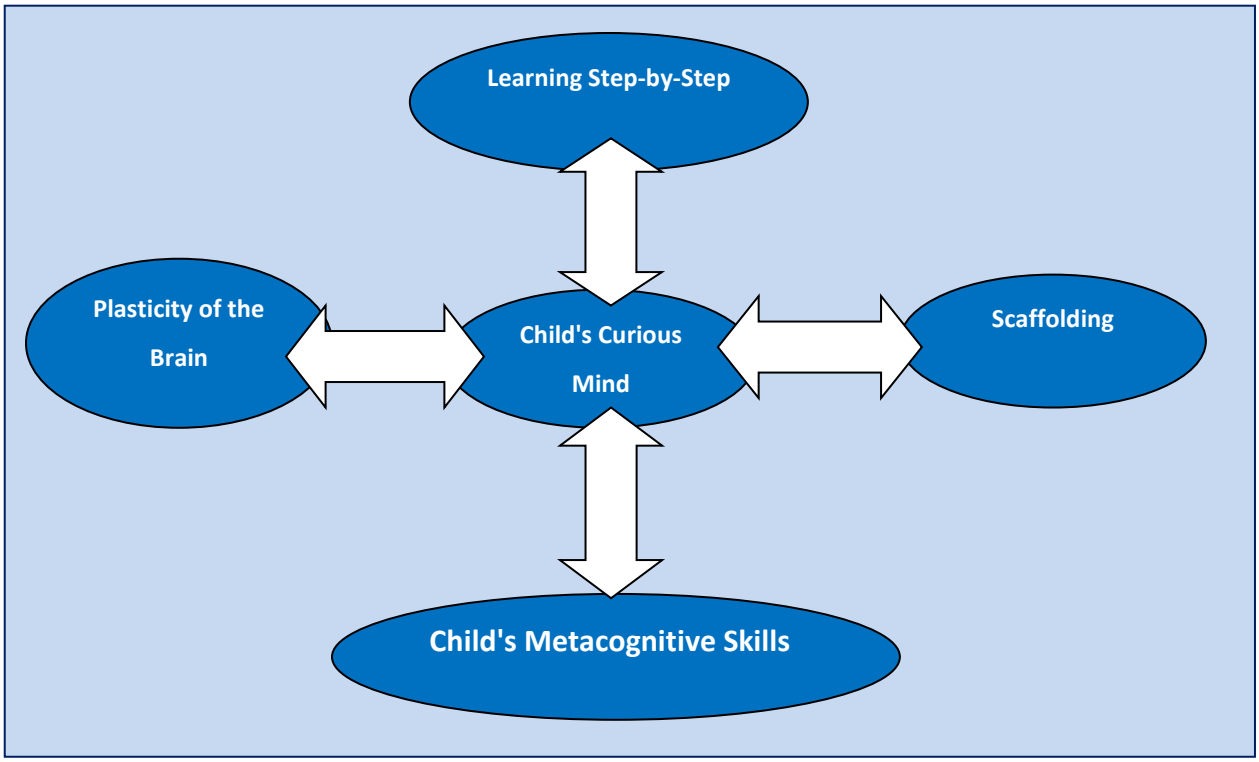

Figure 1: Key Elements in Building Children's Metacognitive Skills

Literature Review

Meta-cognition is a multidimensional construct with two major levels - knowledge about cognition and control and regulation of cognition (Panaoura & Philippou, 2007). Flavell (1979) describes meta-cognitive knowledge as knowledge about persons, tasks and strategies; thus it includes knowledge about strengths and weaknesses of own memory and learning about cognitive requirements of tasks, as well as knowledge of ways to attain cognitive learning and achieving goals. Knowing how we think and why, helps us to self-regulate in our learning. A person's ability to regulate his/her own learning is central to successful learning and working (Handel, Artelt & Weinert, 2013). It is documented that children who are taught to use meta-cognitive strategies early on are more resilient and more successful both in and out of school (Jacobson, 2016). In Jacobson's words:

> "When kids hit difficult problems - the seemingly insurmountable English essay, a math test that takes on epic proportions, social struggles that leave them feeling frustrated, - it can be tempting to give up and resort to four words no parent ever wants to hear 'I can't do it'. Kids need to be able to make the transition from 'I can't'' to the proactive 'How can I?' (unpaged).

Most meta-cognition research has been conducted with students in upper grade levels, with minimal but increasing attention to the younger age groups. Young children are capable of thinking about what they know; but they need help thinking about how they know it and how to regulate their thinking about what and how they know. Through guided reflective discussion and writing, older children are able to evaluate what they know, how they come to know it as well as the underlying reasons; and are also able to regulate their ways of understanding what they already know. Younger children are more hands-on in their approach to new concepts; they require concrete objects and adults to aide their thinking about what they are experiencing, an important step towards learning how to control and regulate their individual processes of learning. When young children learn to think about their own thinking, they begin to become aware of their strategies of learning, the thinking underlying the decisions they make and the resulting actions taken in solitary situations, in classrooms and in social situations. While children may not know that they are engaging in meta-cognition, they nevertheless develop an understanding of their own strategies for learning and achieving goals.

There is a difference between knowing how one learns and makes decisions, and controlling and regulating the learning and decision making processes. Research has shown that meta-cognitive knowledge can develop from domain-specific and situation-specific learning, that is, specific content learned within a specific domain; and also from generalized knowledge that transcends several domains (Borkowiski, Chan & Muthukrishna, 2000). Destan and Roebers (2015) found that performance estimation accuracy is related to global and item-level meta-cognitive monitoring. A significant body of the research on meta-cognition has shown that the development of meta-cognitive knowledge starts in kindergarten and continues to grow into adolescence and adulthood (Alexander & Schwanenflugel, 1996; Artelt, Neuenhaus, Lingel & Schneider, 2012; Baker 1989; Hasselhorn, 2006, Schneider & Lockl, 2006) if educational processes continue to be challenging to the learner (Veenman et al, 2006). Research with fifth graders showed that meta-cognitive knowledge was better represented with a multidimensional model than a uni-dimensional model (Neuenhaus, Artelt, Lingel & Schnider, 2011).

Not much research has focused attention on young children, however, evidence that young children possess meta-cognitive and self-regulating abilities is accumulating (Fleur, 2021; Mari & Saka, 2018; Roberts, 2017; Robson 2016; Bernard et al, 2015). Children have been found to be more likely to display self-regulation and meta-cognition in post hoc interviews about an activity rather than during the activity. It is suggested that observation and interviews be combined with other tools to make children's learning more visible to themselves and to adults (Robson, 2016). Children's own interests are another important factor. Neitzel et al (2016) found that children's interest-based activities provided understanding of their meta-cognitive talk and strategies for progress monitoring. Robson (2016) also found that children were significantly more likely to demonstrate self-regulation and meta-cognition in child-initiated activities. The challenge is for teachers to develop and prepare learning contexts that include varieties of high-quality learning activities to capture and sustain children's interests. While most preschool classrooms operate with learning centers, balancing challenge and interest will be important to trigger meta-cognitive processes in children, rather than merely engaging in routine activities regardless of children's interests and/or lack of response to motivation by the teacher.

Indicators of meta-cognitive abilities will depend on content being learned and importance of resolving a problematic situation in a specific domain or across domains. For example, if a

preschooler is building a tower with blocks and decides to use a block with a different color as she/he puts one on top of the other, but suddenly abandons the idea and decides to use just one color, the preschooler will certainly have reasons for: 1. deciding to build with different colors, and 2. deciding to use only one color. First the preschooler must have preferred to build with different colors. The idea of colors is abandoned when another thought comes in to further inform the cognitive and motor processes of building the tower. To help the preschooler think about the second thought in relation to the initial thought, the teacher's help is necessary. The preschooler was just thinking and doing, and did not necessarily think about the initial thought. The teacher helps the preschooler gain more control over the thought processes. Brown (1987) showed that spontaneous control over one's own learning process may occur without the affected person being aware of it. It is also shown that related perceptions and appraisals (Nelson and Narens, 1990) that may occur before, during and/or after the problem solving activity (Flavell 1979, 1971) underlie use of self regulation strategies, and are necessary in acquiring meta-cognitive knowledge and skills. The actual and conscious regulation of the learning process however, takes place through planning, monitoring and meta-strategic activities, which is, the implementation of meta-cognitive knowledge in the process of self-regulated learning (Schneider & Artlet, 2010; Flavell, 1979).

Assessing meta-cognitive abilities is complex. Recent rsearch has shown that assessment methods used to measure metacognition in young children tend to underestimate children's abilities (Mari & Saka, 2018; Whitebread et al 2010). Studies have utilized meta-cognitive awareness inventories, meta-cognitive knowledge tests (Handel, Artelt & Weinert, 2013), cognitive judgments (Efklides, 2011), structured, unstructured and directed tasks (Marulis, 2015); eye-tracking in controlled laboratory experiments (Markus, Proust & Sodian (2013); through physical activities and games (Chatzipanteli, Vasilis, & Athanasios, 2013) or self-reported or actual strategy use (Veenmann & Elshout 1999). Use of assessment approaches based purely in neuroscience do not necessarily translate to classroom practice.

Classroom teachers use interaction and questioning approaches to assess young children's metacognitive skills (Gourlay, 2019) as drawn from the children's responses; thus detecting the skills practically and within context. While efforts to connect neuroscience approaches and classroom approaches (Fleur, 2021; Larkin 2009) will emerge from cumulative research, the research has to be conducted in practical ways that make sense to teachers and to the children. In this study, classroom-based motivational and observational techniques carried out by teachers were used to assess children's meta-cognitive abilities and how the children begin to monitor, understand and control their own learning.

Methods

Classroom activities for this research were carried out by teachers in their own classrooms, during regular teaching. Two preschool teachers were identified and trained on how to carry out the prompting of children by motivating them and inviting them to make predictions and then later loop back into their thinking after the story was read to them. The teachers then assessed children to determine if each child could loop back and connect to their earlier thoughts and predictions.

Study Design

The study was designed as a mixed method approach combining Time Series experimentation, naturalistic observation and interviews. Time Series design involves administration of treatment in alternate time periods. The dependent variable is measured before the first administration of the treatment and the measurements are used as base data. The dependent variable, i.e., the variable of interest is measured during the time the treatment is administered, and also during the time the treatment is not administered. Treatment and non-treatment times periods have to be of equal intervals. Teacher observations and conversation-like questions asked in non-testing ways are effective ways of obtaining data from young children. Teacher interviews provide rich descriptions of children's behavior.

Study Sample

Forty children in two groups of 20 each participated in the study for three weeks. Each group was an intact class. Another small group of 6 children participated in the study for 8 weeks. This small group was part of one of the large groups. The large groups, which had started the research in March had to stop because of the COVID-19 situation. In September, the research resumed with a small group of only 6 children.

Data Collection and Instrumentation

A framework was developed for teachers to use with preschoolers, in which the teachers would draw children's attention to their own thinking and predictions about a story before the story was read aloud to them. After the story was read-aloud, the teacher would have one-on-one assessment interaction with each child to determine if the child was able to "loop-back" to her/his own thoughts and predictions made at the beginning, before the story was read. The teacher engaged each child using four questions: (i) what the child's thoughts about the story were before the story was read aloud, (ii) what the child's thoughts were after the story was read aloud, (iii) if the thoughts were the same or different before and after the story was read, and (iv) why.

The teacher's assessment would indicate if the child was successful at looping back to her/his previous thoughts and predictions about the story before read-aloud began. While the prompting was done in alternate weeks, the assessment to identify if children were able to loop-back was done each week, three weeks with the large groups of 20 children each (40 total), and 8 weeks for the small group of 6 children. Teachers wrote responses on each child's data sheet each time, on which the child was identified only by a number throughout the data collection process. Teachers also wrote notes on each child's responses. Teacher interviews sought information on verbal excerpts from children that stood out in any way, relating to articulation or verbalization processes. It is documented in research that one problem that inhibits accuracy of assessment of young children's metacognitive skills is their ability to articulate their thoughts (Mari and Saka, 2018; Whitebread et al, 2010).

Data Analysis

Three types of data were collected: numerical data, i.e., numbers of children who were able to "loop back" to their previous thoughts and predictions before the story was read, teacher's notes and interview responses. The numerical data were organized in charts. Teachers' notes and interviews were analyzed to add clarity and elaboration on specific excerpts from children's utterances.

Findings

The results of the study are summarized in Table 1, Table 2, Figure 2, Figure 3, Figure 4 and Figure 5.

Table 1 Title 1: Children's Loop Back Results From The Two Large Groups

Variable Prompting	Group	Week 1	Week 2	Week 3
		No PSP	PSP	No PSP
TLB	Large Group 1 (20 children)	No TLB=14 TLB =2	No TLB = 3 TLB = 15	No TLB =12 TLB =6
TLB	Large Group 2 (20 Children)	No TLB=16 TLB =2	No TLB = 6 TLB = 14	No TLB =14 TLB =6

PSP = Pre-Story Prompting TLB =Thought Loop-Backs

Table 2: Children's Loop Back Results From The Small Group

Variable Prompting	Group	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
		No PSP	PSP	No PSP	PSP	No PSP	PSP	No PSP	PSP
TLB	Small Group (6 Children)	No TLB=4 TLB=2	No TLB =2 TLB =4	No TLB =4 TLB =2	No TLB =5 TLB=1	No TLB=3 TLB =2	No TLB=2 TLB =4	No TLB=5 TLB =1	No TLB=1 TLB =5

PSP = Pre-Story Prompting TLB =Thought Loop-Backs

The results in Table 1 show that when children were prompted before the story was read-aloud, more children were able to loop-back to their previous thoughts and predictions about the story.

The results in Table 2 show that when children were prompted before the story was read-aloud, more children were able to loop-back to their previous thoughts and predictions about the story. These results are provided on graphs in Figure 2 - Figure 5

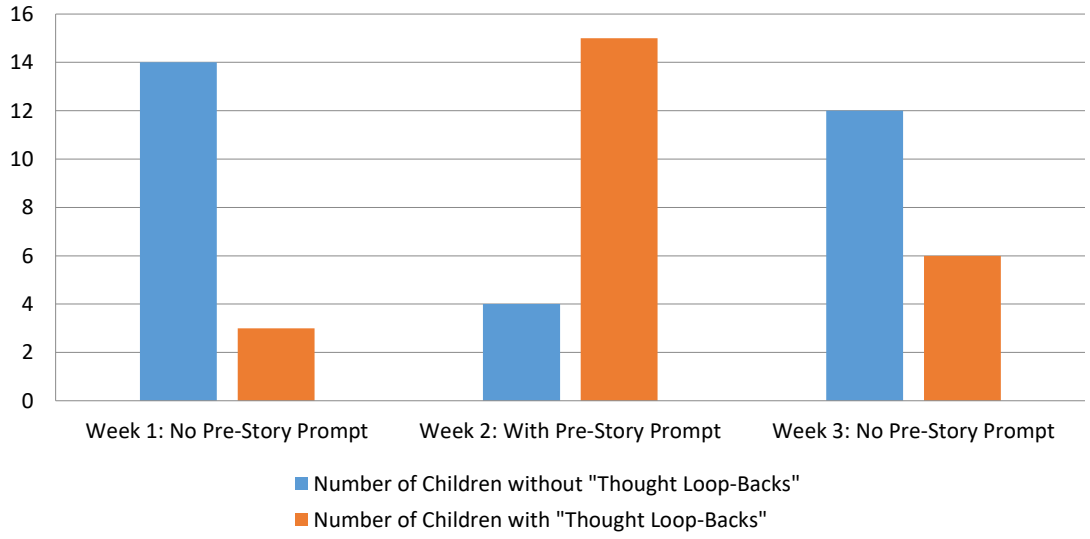

Figure 2: (Child 1-20): Number of Children With and Without Thought Loop-backs

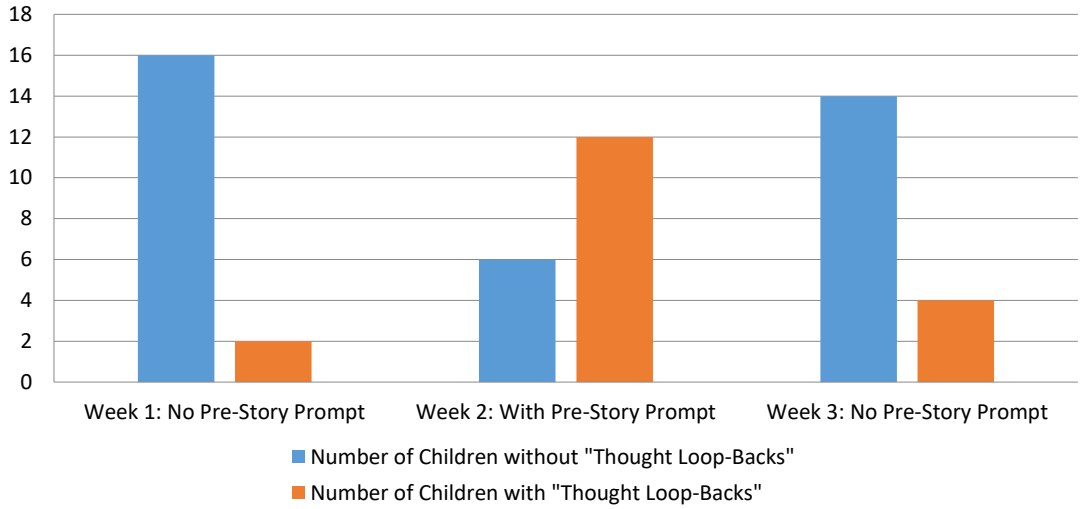

Figure 3: (Child 21-40): Number of Children With and Without Thought Loopbacks

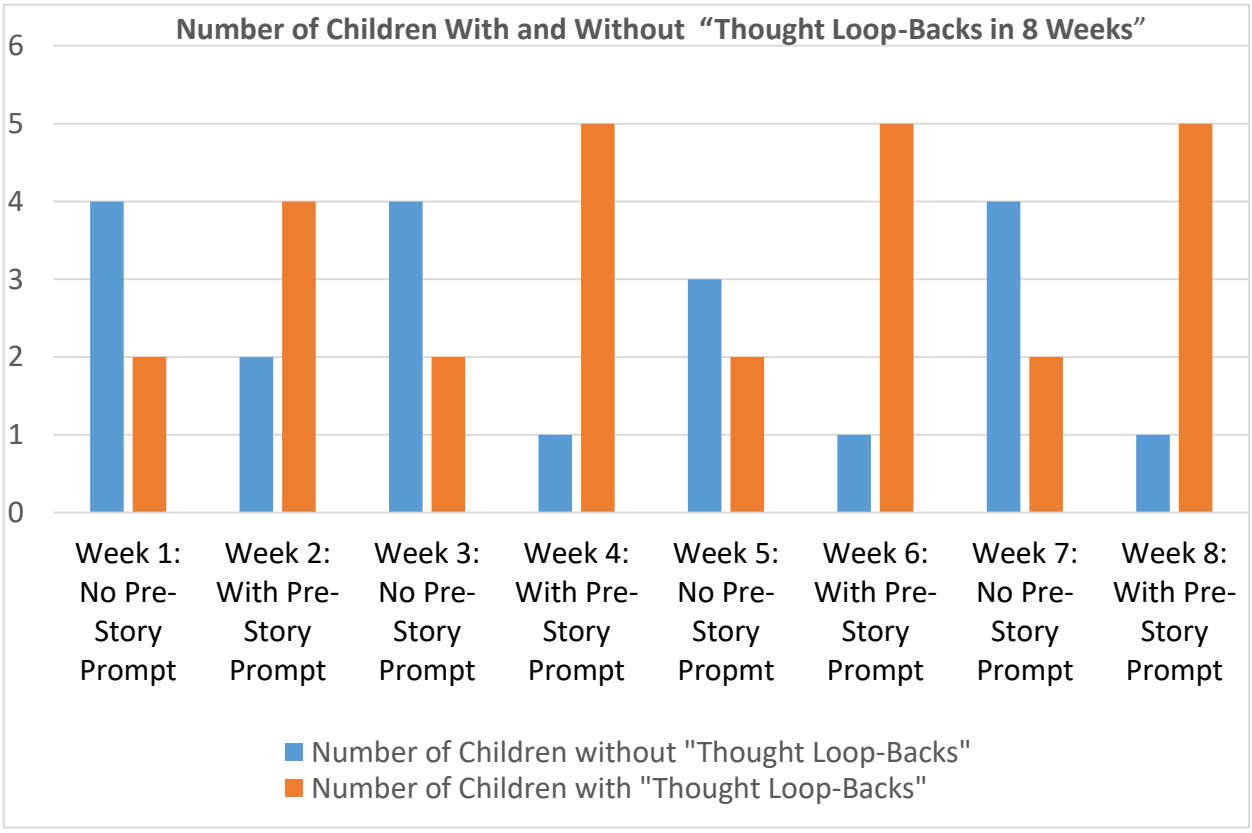

Figure 4: (Child 1-6) Number of Children with and without Thought Loopbacks in 8 Weeks

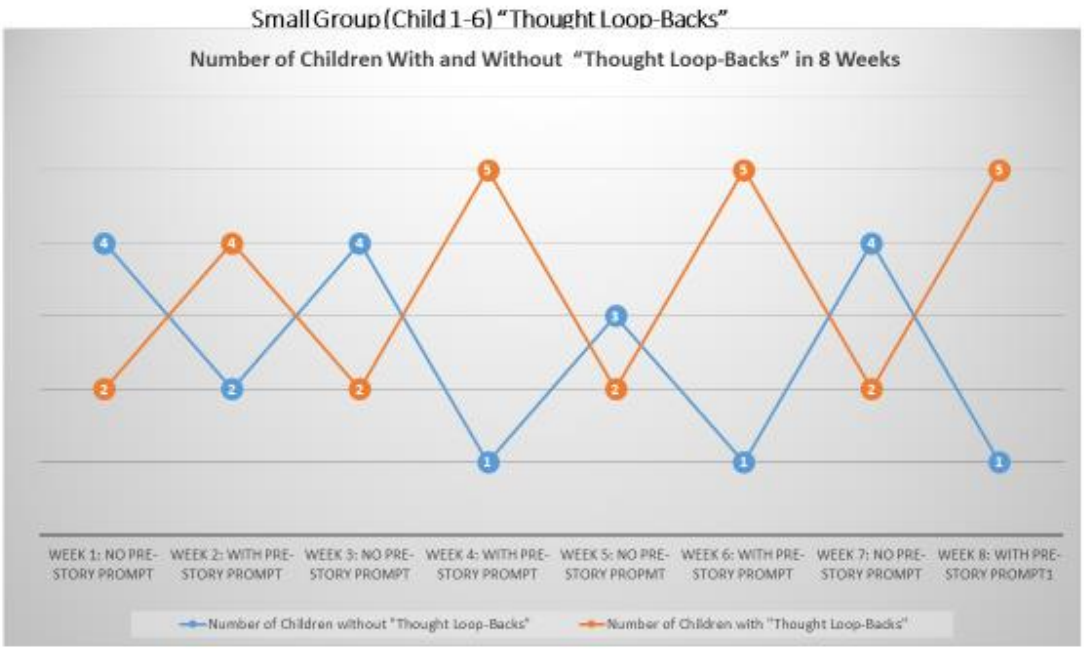

Figure 5: (Child 1-6): Number of Children with and without Thought Loopbacks in 8 Weeks

Discussion

The results show that more children were successful during the intervention weeks in trying to connect to their own thinking prior to the story read-alouds. As summarized in Table 1, the first large group, i.e. Child 1-20, had 14 children in Week 1 who did not experience loop-backs to their prior thinking, and only 3 who were able to do so. There was no pre-reading prompt in Week 1. In Week 2, 4 children did not experience loop-backs, while 14 were able to experience loop-backs. Week 2 was the first week of intervention. In Week 3, there was no pre-reading intervention; and, as shown in Table 1 and in Figure2; during this week 12 children did not experience though loopbacks, while 6 children did.

In Group 2 (Child 21-40) there were similar results. In Week 1, where there was no pre-reading prompt, the number of children who did not experience loopbacks was 15, while only 2 experienced thought loopbacks. In Week 2, there was pre-reading prompting; and 12 children demonstrated thought loopbacks while 6 did not. Similar results are observed in Week 3, which had no pre-reading prompt; and 14 children did not experience thought loopbacks, while only 4 did.

The small group of 6 children was observed for a longer time period, i.e., 8 weeks. The results show a similar trend as in the large groups. In weeks 1, 3, 5, and 7, when there was no intervention, i.e., the pre-reading prompts, the numbers of children who demonstrated thought loopbacks were 2, 2, 2, and 2, compared to the intervention weeks 2, 4, 6, and 8, when the numbers of children who were able to loop back into their previous thinking before the story was read aloud to them were 4, 5, 5, and 5 respectively, as shown in Figure 4 and Figure 5.

The descriptive data from teacher's notes on children's responses showed that the preschoolers had differing degrees of complexity in their verbal responses. Some children would answer the first question (What were your thoughts about the story before we read it?) with a few words while others would use complete sentences. Some examples of verbatim responses were "I thought the story was about spiders"; "I thought the story was about a cat but it was about an unhappy girl", "I thought she was a bad girl, but she was just sad". Some children went straight to contrasting even before they were asked to compare their thoughts before and after the read-aloud.

More interesting were children's verbalizations that provided the reason even before they were asked "why". For example, one child said: "I thought the story was about spiders because the picture looked like a spider". There were also instances of children affirming themselves by saying: "I was right, I thought the story was about lady bug".

Overall, more children experienced thought loopbacks when they were prompted to tap into their thinking and make predictions about the story prior to the story being read to them. These results point to a potential to teach preschoolers how to think back to their own thoughts and perhaps even monitor those thoughts. This is an opportunity for teachers to build on the preschoolers' abilities to think about their own thinking, and probably also regulate learning behavior. It was surprising how positively the children responded to the teacher's prompting in their after read-aloud responses. One might think that the preschoolers were already at a stage where they could think about their own thinking. However, when they responded to the same after- read-aloud questions without the prior prompting, fewer children were able to go back to their own thinking.

The explanation is certainly that without prior prompting, the children did not think about their thinking regarding the story, or, they did not see the need to try to articulate their thoughts, prediction, or even opinion what to expect from the story. When they were asked to think and predict specific things about the story, they were able to do that; and later they could go back to their previous thinking and talk about it.

Conclusion

This study has demonstrated that preschoolers can respond positively to pre-reading prompts that target development of the children's metacognitive skills. The findings add to the metacognitive research with young children, showing that 3-4 year olds are capable of thinking about their own thinking. The following statements can be made based on the results of this study:

- The preschool children (3-4 year olds) had the capability to think about their own thinking when guided step-by-step-step to do so.
- When prompted in (non-testing ways), the preschool children demonstrated their metacognitive skills; i.e., tapping into their own previous thoughts and articulated them. When they were not prompted, the children did not necessarily demonstrate those skills.
- Teachers and parents can engage in the non-threatening procedure used in this study to try to foster children's metacognitive skills, as much as opportunities allow. Such practical activities may help children develop abilities to understand their own thinking, if there are no other underlying constraining factors.

Accessibility of the Research

This research is not just for academic purpose, even though the results certainly open avenues for academic discussion and further research. Teachers can use the same approach as used in this study to estimate and monitor their children's abilities to think about their own thinking; and provide opportunities for children to explore why they think the way they do, and how they can regulate their thinking for better learning and self-monitoring. As children participate in such practice they will grow in their own metacognition, providing even more opportunities for teachers to scaffold and help them build their metacognitive and self-analysis skills. There is also opportunity for parents to use the same or similar procedures with their children at home to support their children in metacognition and self-regulation.

Further Research

Suggestions for further research include a stricter experimental design, larger sample size and several sites, to minimize the influence of specific school contexts. Experimental designs with control groups will clearly *establish causality* and also minimize the role of memory that is possible in Time Series design. Large samples that are organized in small sub-groups will be more manageable than whole large groups which take a long time for teachers to have one-on-

one assessment session with each child. Since school contexts differ socioeconomically, socially, and culturally, it will be beneficial to conduct similar research in different school sites to see if results are similar, which will indicate whether at the preschool age of 3-4 years, children are generally capable of learning metacognitive skills and to what extent.

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