Bar-Ilan University

The value of combined metacognitive-emotional support during mathematics "Interactive Storytelling" in kindergarten on SRL and problem solving

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Submitted in partial fulfillment of the requirements for the Master's Degree in the School of Education, Bar-Ilan University

Ramat Gan, Israel 2019

Abstract

Verbal mathematical problems are an important issue in preschools. The verbal problems develop mathematical thinking, deepen the meaning of adding and subtracting and lead to the application of mathematics in daily life. Dealing with verbal questions as early as in preschool develops the required skills to cope with verbal problems throughout the years of education. This process is crucially important, as studies indicate that solving verbal problems is the most difficult topic for elementary school students (OECD, 2014; Schoenfeld, 1992) and that many students encounter difficulties in acquiring knowledge and skills for successful coping with the topic (OECD, 2014). These difficulties often stem from the fact that students do not know how to activate their knowledge, i.e., they do not use metacognitive processes effectively (NCTM, 2000). Often, these difficulties lead to negative feelings that interfere with the learning process (OECD, 2014). Thus, there is significant importance in cultivating the ability to solve verbal questions at a young age, while taking into consideration the metacognitive and emotional components (Mark-Zagdon, 2006; Ministry of Education, 2010; Huisman, 2013). One of the ways to develop metacognitive skills and reduce negative feelings regarding mathematical verbal problem solving is self-regulated learning.

Self-Regulated Learning (SRL) focuses on the meta-cognitive component in the motivational-emotional aspect and is defined as a process in which the learner is responsible for his/her own self-development while making use of "thoughts, feelings and actions that are derived from the person himself/herself and are designed as a cycle to accomplish the person's goals" (Zimmerman, 2000, p. 14). In Self-regulated learning (SRL), the learner sets goals for himself, plans, monitors and reflects on his work prior to learning, during learning and after learning, while referring to the metacognitive and emotional components (Pintrich, 2000; Schraw, 2006; Zimmerman, 2008a). The metacognitive component refers to planning and assigning learning resources, identifying knowledge and assessing the learning in different time points of the learning process. This process leads to a high motivation and higher achievements (Brown, 1987; Flavell, 1976). Studies indicate that cultivating metacognitive skills plays a

significant role in teaching mathematics **as early as in preschoolers.** The findings of these studies indicate that metacognitive skills affect the development of mathematical thinking (Ginsburg et al., 2008; Greenes et al., 2004; Whitebread & Coltman, 2010). The emotional component in the self-regulation process refers to activities and strategies that students use to identify and regulate their negative and positive feelings throughout the learning process. This is considered an important aspect to the learning process, as studies indicate that negative feelings may reduce motivation (Tzohar-Rozzen, 2012) and lead to low achievements (Sansone & Thoman, 2005). The combination of both metacognitive and meta-emotional components allows for more effective learning processes that lead to high achievements (Zimmerman, 2000, p. 14).

Despite the vast importance of the emotional component in the self-regulation process, majority of the intervention programs in the field focus on the metacognitive aspect only and there are scarce intervention programs that directly deal with the emotional aspect in schools and preschools. According to the relevant professional literature, the few intervention programs that included the metacognitive and emotional aspect in an integrated manner, focused on students in schools and not in preschoolers.

The current study focuses on the question of the contribution of each of the programs for developing metacognitive and meta-emotional self-regulated skills and the achievements in solving verbal problems among preschoolers, compared to subjects that did not participate in programs (control group)?

In order to empirically investigate this question, two intervention programs were developed: **integrated self-regulation**, which includes the meta-cognitive and meta-emotional aspects; **meta-cognitive self-regulation** in the meta-cognitive aspect only. These intervention programs were based on **Pintrich's self-regulation model (Pintrich, 2000)** that includes three phases: planning (prior to executing the task), monitoring and control (during the task) and reflection (after executing the task), in adaptation to preschoolers. The self-regulation was

conducted via **explicit instructions and self-questions**, adapted to preschoolers, during an **active story** (see 'Method' chapter).

The focus varied in each of the intervention programs: in the integrated program, it included meta-cognitive and meta-emotional support, while the meta-cognitive included meta-cognitive support. Both programs were compared to a control group that learned with an active story without meta-cognitive and meta-emotional support.

In light of the above, the goals of the current study are:

1. To examine the effect of each of the intervention programs on the meta-cognitive and meta-emotional guidance processes in solving verbal problems among preschoolers (post intervention);
2. To examine the effect of each of the intervention programs on the achievements in verbal problem solving among preschoolers (post intervention);
3. To examine the effect of each of the intervention programs on meta-cognitive and meta-emotional guidance processes and the achievements in verbal problem solving among preschoolers in transfer over-time (two months).

The sample included 90 subjects from three preschools in the northern district of Israel (30 subjects from each preschool), between the ages 5-6. The subjects were randomly divided into three study groups, in accordance with the intervention programs. The intervention programs lasted approximately two months and were conducted in groups of five subjects, twice a week, and each session lasted about 25 minutes. There were 8 sessions in total. The study tools included tests for examining general mathematics and language knowledge, conducted prior to the intervention. In order to examine the **achievements in verbal problem solving**, a test of four standard questions and one numerical insight question was conducted. In order to examine the meta-cognitive and emotional **guidance**

processes¸ a structured observation was conducted to assess and compare meta-cognitive and emotional self-regulation of the subjects in the various groups, while solving verbal problems. The test and observation were conducted in three time points: prior to the intervention, post intervention and two months post the intervention.

Herein are the main results of the study:

Meta-cognitive and meta-emotional guidance processes – it was found that the integrated group presented the highest change in using meta-cognitive and meta-emotional statements of the planning, monitoring and control and reflection types. As noted above, the subjects were presented with tools for meta-cognitive and meta-emotional guidance during the integrated guidance.

The meta-cognitive and meta-emotional guidance processes in transfer over-time (two months' post intervention) – it was found that the integrated program was most effective and that the subjects integrated the meta-cognitive statements in the three solution phases. Moreover, it was found that the meta-cognitive statements in this study indicate that subjects from the integrated group used meta-emotional statements throughout all of the solution phases. It was further observed that this group presented with the highest frequency of using meta-emotional statements. On the contrary, the subjects in the meta-cognitive and control groups did not use meta-emotional statements at all.

Achievements in solving verbal problems in transfer over-time (two months' post intervention) – it was found that the group that underwent **integrated guidance** presented the greatest improvement over time (two months' post intervention) in the question that requires numerical insights, compared to the other groups.

This study has a theoretical, methodological and practical contribution

In the theoretical aspect, the study **deepens** the understanding as to the importance of integrating the meta-cognitive and meta-emotional components in solving verbal problems and **expands** this knowledge regarding preschoolers.

In the methodological aspect, this study used quantitative and qualitative measurement tools, which were constructed, processed and validated for the purpose of this study, in adaptation to preschoolers.

In the practical aspect, two intervention programs, adapted and effective for self-regulated learning in solving mathematical verbal problems in preschoolers were developed. These programs can be used as a basis for training kindergarten teachers and in continuing education programs for kindergarten teachers in the mathematics and self-regulation aspects as well as in other aspects learned in preschools.