Abstract

Having the ability to solve problems contributes to an optimal quality of life, as every individual solves problems daily. Mathematical problem-solving stimulates different cognitive functions and leads to skills development and understanding. Solving problems in a group contributes to the students' success more than solving them individually. However, working in a group presents many challenges, including cognitive, metacognitive, motivational, and behavioral ones, which require appropriate and effective support. Effective work in a group depends on the group's ability to activate group cooperative orientation processes (SSRL - Socially Shared Regulation of Learning). The group members share and discuss their perception of the task and its goals. They reflect on and manage the learning process correctly and jointly to achieve the learning objectives. Cognitive load when solving mathematical problems individually and in a group in general can cause difficulties.

The current study examined how Self-Group Video Reflection training on shared learning in solving math problems affects reflection processes, SSRL processes, and achievement in mathematical problem-solving among middle school students in Israel. Its purpose was to develop, implement, and evaluate a tool to promote SSRL, judgment reflection, and modification reflection, and to improve student's achievements in mathematical problem-solving, through documentation and analysis of group learning processes.

The study used reflective abilities in two different aspects: 1. Reflective support through watching a video or from memory. 2. Assessment of reflection processes – using a questionnaire to assess reflection processes. For this purpose, three learning groups were built: (1) SGV-Ref (Self-Group Video Reflection): a group that received reflection training based on the analysis of recorded shared learning processes; (2) Rec-Ref (Reconstruction Reflection): a group that

received reflection training based on memory reconstruction; and (3) No-Ref: a control group without reflection training.

The study was conducted using mixed methods – namely, it comprised a quantitative part and a qualitative part. In the quantitative part, 90 ninth-grade students participated, 48 boys (53.3%) and 42 girls (46.7%). The students were sampled from four different schools, including state and state-religious schools. All students were at level A in mathematics and were randomly assigned to the research groups equally, with 30 students in each group.

In the qualitative part, three students from the SGV-Ref group and three students from the Rec-Ref group were sampled: two students with high mathematical achievements, two students with medium achievements, and two students with low achievements. The purpose was to examine additional aspects related to the processes of self-regulation learning: a qualitative-verbal expression of mathematical knowledge at the cognitive level, as well as group guidance for learning at the meta-cognitive level.

The research utilized the following tools: Self-report questionnaires to assess offline self-regulation processes (Motivational and self-regulated learning components questionnaire - MSLQ, Adaptive instrument for the regulation of emotions questionnaire - AIRE), self-group videos to assess online self-regulation processes, level of achievement in mathematical problem-solving, and a reflection questionnaire.

The data collection consisted of five main stages: For Stage 1, the students filled out pre-test (MSLQ, AIRE) (offline questionnaires) to evaluate the regulation processes. For Stages 2,3,4, the students were divided into groups of three students and were taught new material that included mathematical problem-solving. They recorded their learning process and reflected on it (except for the No-Ref group). Accordingly, the SGV-Ref group reviewed their videos and

performed a judgment and modification reflection. The REC-Ref group performed a judgment and modification reflection, without reviewing their videos (i.e., Reconstruction Reflection). Stages 2 and 3 were repeated three times and consisted of three different mathematical tasks. Each task was scored separately (a total of three scores per student). For Stage 5, the students were required to complete post-tests (MSLQ, AIRE) (offline questionnaires).

The coding of the answers related to the students' reflection level was conducted according to their responses to the questionnaire and by using the reflective level coding tool. The measurement of online self-regulation processes was performed through group discourse analysis. The videos were coded using Observer XT14 version 15. The research hypotheses were tested using a two-way mixed design ANOVA, with time as an independent within-subjects variable and study groups as an independent between-subjects variable. The analyses were conducted using SPSS software. The thematic analysis method was used to analyze the content of the open questions in the reflection questionnaire.

The first research hypothesis was that the reflective ability in the SGV-Ref group would be higher compared to the Rec-Ref group, in both types of reflection (judgment reflection and modification reflection). In addition, the judgment reflection ability will be higher than the modification reflection ability. The second hypothesis was that the level of SSRL, Self-Regulation Learning (SRL), and Co-Regulation Learning (Co-SRL) components would be higher among the SGV-Ref group, compared to the Rec-Ref group or the No-Ref group. The third hypothesis was that the achievements of the SGV-Ref group in mathematical problem-solving would be higher compared to the Rec-Ref group or the No-Ref group.

As hypothesized, the SGV-Ref group's reflective ability was higher than the Rec-Ref group in both types of reflection (judgment reflection and modification reflection). Further, the judgment reflection ability was higher than the modification reflection ability. With regards to

SSRL, SRL, and Co-SRL, the SGV-Ref group demonstrated a higher increase in planning and evaluation when compared to the Rec-Ref group. Also, the SGV-Ref group demonstrated consistent improvement in all forms of self-regulation. No significant improvement was found in the No-Ref group. As for achievements in mathematical problem-solving, the findings showed a significant increase of approximately 17 points in the SGV-Ref group's score, at both the second and third time points, compared to the first time point. An increase of approximately 10 points was observed in the REC-Ref group's score at the second time point but not at the third time point, whereas no significant improvement was observed in the No-Ref group.

Similar to the quantitative findings, a positive and contributing effect of reflection training in a digital environment emerged from the qualitative findings. The qualitative findings revealed that the SGV-Ref group demonstrated a significantly higher level of discourse expressing task-appropriate mathematical knowledge, along with its chronological development; SSRLs, SRLs, and Co-SRLs have been improved; work has been controlled and planned throughout the task stages, performance has been consistently assessed and evaluated, and reflection abilities have been improved.

This study contributes both theoretically and methodologically. On the theoretical aspect, a comprehensive analysis of SSRL theories, cognitive load theory, and reflective abilities was carried out. This included quantitative and qualitative methods and by using the latest methodologies for online problem-solving measurement. Furthermore, this study proposed the division of Co-SRL into two measures: SRL-Co-Ask and SRL-Co-Response; an innovative division that has not yet been identified in the literature. Therefore, this study contributes to the research literature and sheds light on the study of self-group video reflection in mathematics. Through examining the three different variables - reflective abilities, SSRL and performance - alongside combining the results between them, enabled to obtain a complete

picture of the importance of reflection in group cooperative orientation and improving student achievements.

On the practical aspect, the findings allow educators and policymakers to examine additional methods for cultivating SRL within the existing math curriculum. This study provides a tool for teachers to use in the classroom, during group learning. By providing this tool, we can support and promote the development of mathematical knowledge, reflective abilities, and shared group learning processes. In order to leverage high-quality SSRL, teachers can utilize it to promote different goals in the teaching process.