**Universidade do Minho**
Escola de Psicologia

Sara Pontes Miranda

# The Influence of Self-regulation on 4th Grade Students' Selective Attenttion

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# The Influence of Self-regulation on 4th Grade Students' Selective Attention

Dissertação de Mestrado
Mestrado Integrado em Psicologia

Trabalho efetuado sob a orientação do
**Professor Doutor Pedro Rosário**
e da
**Doutora Armanda Pereira**

outubro de 2020

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## STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

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Universidade do Minho, 19/10/2020

Assinatura: 

A influência da auto-regulação na atenção selectiva dos alunos do 4º ano.


## Resumo

O sucesso académico é um conceito complexo que compreende não só o bom desempenho académico mas também o desenvolvimento de competências e a concretização dos objetivos de aprendizagem. Muitas variáveis influenciam o sucesso académico, entre as quais estão a auto-regulação e as competências de controlo atencional. Ainda assim, pouco se sabe sobre estratégias que desenvolvam eficazmente as competências de controlo atencional. Posto isto, o presente estudo visa compreender como o treino de estratégias de auto-regulação pode ter um impacto nas competências de controlo atencional, especificamente na atenção seletiva. Além disso, o impacto da atenção selectiva no desempenho na aritmética também foi explorado. Os participantes eram 136 estudantes da quarta classe, com idades compreendidas entre os 8 e os 11 anos de idade. Destes, 68 participaram num programa de intervenção que tinha como objectivo promover a auto-regulação. Todos os participantes preencheram um questionário sociodemográfico, a adaptação do Inventário de Processos de Auto-regulação de Aprendizagem (IPAA) e um sub-teste da Bateria de Avaliação Neuropsicológica de Coimbra (BANC), em três momentos (isto é, antes, durante e após a intervenção). O desempenho na aritmética foi avaliado recorrendo à pontuação dos testes de matemática, que se centraram nas competências aritméticas. No final da intervenção, o grupo experimental mostrou níveis mais elevados de auto-regulação, atenção seletiva e competências aritméticas que eram significativamente diferentes quando comparados com o grupo de controlo. Os resultados deste estudo podem ser importantes para compreender melhor estas variáveis e para conceber melhores práticas académicas.



*Palavras-chave:* estratégias de auto-regulação, atenção seletiva, sucesso académico, desempenho na aritmética

The influence of self-regulation on 4th-grade students' selective attention.


## Abstract

Academic success is a complex concept that comprises not only the good academic performance but also the development of competencies and the accomplish of the ends of learning. Many variables influence academic success among which are self-regulation and attentional control competencies. Still, little is known about strategies that effectively develop attentional control competencies. All considered, the present study aims to understand how the training on self-regulation strategies can have an impact on attentional control competencies, specifically in selective attention. Additionally, the impact of selective attention on arithmetic performance was also explored. Participants were 136 fourth grade students, aged from 8 to 11 years old. From those, 68 participated in an intervention program which purpose was to promote self-regulation. All participants completed a sociodemographic questionnaire, the Inventory of Learning Self-regulated Processes (IPAA) adaptation and a subtest of the Coimbra Neuropsychological Assessment Battery (BANC), in three moments (i.e., before, during and after the intervention). The arithmetic performance was evaluated by resorting the score of the math tests, which focus was on arithmetic skills. At the end of intervention, the experimental group showed higher levels of self-regulation, selective attention and arithmetic competencies that were significantly different when compared to the control group. The findings of this study can be important to better understand these variables and to design better scholar practices.



*Keywords*: self-regulation strategies, selective attention, academic success, arithmetic performance

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## Introduction

Academic success is a complex and broad concept. For the purposes of the current investigation, we understand academic success as a complex net of relationships between academic performance, the achievement of learning objectives, and the acquisition of skills (York et al., 2015). Literature has been highlighting the role played by self-regulation competencies (Blair & Diamond, 2008) and attention control in building a successful academic path (Best et al., 2011; Jacob & Parkinson, 2015; Paananen et al., 2018). For example, extant research has found that attention control, self-regulation (SR), and socio-emotional processing are closely related to children's socioeconomic status and explain about 20% of children academic achievement (Hair et al., 2015; Noble et al., 2015; Paananen et al., 2018). Consistent with these findings, the study by Blair & Dimond (2008) reports that children displaying poor self-regulatory competencies are likely to experience difficulties to build and maintain relationships, pay attention and follow instructions (Montroy et al., 2016). Still, and despite the relevance of these variables, the development of effective strategies to promote attention control has not been receiving researchers attention (Posner, 2003; Rabiner et al., 2016; Razza et al., 2012), and literature analyzing the relationships between self-regulation competencies, attentional control, and academic success is limited. The present study aims to examine the impact of a training on self-regulation competencies on the attention function. Two bodies of literature informed the present study: the cyclical self-regulation model by Zimmerman (2000, 2008) and the attention neuropsychological model (Cooley & Morris, 1990). Findings of the current study are expected to further deepen our understanding of the relationships between self-regulation and attention function and: i) support researchers and educators efforts to design school settings likely to promote learning and academic successful experiences (Rabiner et al., 2016) and ii) help school administrators better identify students at risk and make informed decisions (Abu-Hamour, 2018) and develop educational programs tailored to students needs (Duncan et al., 2007).

One conceptual framework that bears direct relevance to the present study is the cyclical self-regulation model by Zimmerman (2000, 2008). Self-regulation may be understood as the set of thoughts, feelings, and actions displayed by individuals to attain self-set goals (Tortella et al., 2018). Zimmerman's model (2000) comprises three phases that explain the self-regulated learning process: forethought, performance or volitional control, and self-reflection phase. The forethought phase anticipates the efforts to realize a task and is characterized both by the analysis of the task itself as the self-motivating beliefs (e.g. self-efficacy). The analysis of the task refers to goal setting and strategic planning and is influenced by the self-motivating beliefs. For example, individuals with high self-efficacy doing challenging tasks are more likely to engage with the task because they believe that their intentional behaviors will help them

achieve goals (Cleary & Platten, 2013). In the performance phase, individuals are expected to carry out an analysis of the processes that could affect attention control and action during task execution (Zimmerman, 2000, 2002). To accomplish the former, there two major competencies are required: self-control and self-observation. Regarding self-control, the use of imagery, self-instructions, and attention focusing are examples of important strategies to sustain the attention on the task (Zimmerman, 2013). The self-observation competency comprises processes likely to help individuals maintain focus on their performance, such as metacognitive monitoring (i.e., think about their thoughts) and self-recording (i.e., take notes of details of their performance) (Cleary & Platten, 2013). Therefore, during this phase individuals are expected to do what was planned and, if not, evaluate what should be changed to achieve the pre-established goal (Zimmerman, 2002). This can lead to sequences of self-experimentation in which individuals may change their behaviors according to the feedback received (Zimmerman, 2000). Lastly, the self-reflection phase as suggested by Bandura (1986) influences individuals' response to that experience through self-judgment (i.e., performance assessment and goal comparison) and self-reactions (i.e., self-satisfaction and adaptive inferences; Zimmerman, 2000). This final balance between the performance and the level of satisfaction with the process and outcome enables individuals to reflect on the efficacy of the strategies and methods used. Consequently, it influences their conclusions about the best strategies for future performance attempts (Cleary & Zimmerman, 2004). The feedback received during the three phases, with special emphasis on the last one, reflects the cyclical feature of the self-regulation process (Cleary et al., 2012). For example, in the performance phase individuals lacking self-control competencies are likely to show difficulties to focus attention on the task which could translate to low performance and to fail to achieve the goal set.

The second conceptual framework grounding the current study is the attentional neuropsychological model by Cooley and Morris (1990). Despite the diversity of available definitions for the attentional function (e.g., Colley & Morris, 1990; Lachter et al., 2004; Levitt & Johnstone, 2001) the model by Cooley and Morris (1990) describes this concept as comprising three dimensions: selective, sustained, and divided attention. Selective attention (SA) enables individuals confronted with two or more concurrent stimuli or dimensions of stimuli to attend one and ignore other(s) (Cooley & Morris, 1990; Mahone & Schneider, 2012). Thus, it needs two components (a) one that allows the identification of relevant information and (b) one that grants the inhibition of irrelevant information (Cooley & Morris, 1990). With this in mind, this model views the other two dimensions as special cases of selective attention. Sustained attention is characterized by requiring both processes over a period of time, in other words, as the maintenance of selective attention over a certain period of time (Cooley & Morris, 1990).

On the other hand, divided attention also requires the same processes but to perform two or more tasks simultaneously (Mahone & Schneider, 2012). So, it can be outlined as the performance of two or more selective attention efforts at concurrently. In conclusion, to the selective attention paradigm is added the variable time to characterize sustained attention and the variable number for divided attention.

## Study Purpose

Students in early school years enrolled in classes where attention control is poorly promoted are likely to face difficulties through schooling. For example, these students are likely to struggle to meet the curricular demands as schooling advances and show poor academic performance (Breslau et al., 2009). Extant literature indicates that attention control skills predict later academic achievement at the end of elementary school (Duncan et al., 2007), as well as academic outcomes during young adulthood (e.g., high rates school graduation; Rabiner et al., 2016). Still, little is known about how to develop effective strategies to promote this skill (Posner, 2003; Rabiner, Godwin & Dodge, 2016; Razza et al., 2012). Following Cooley and Morris (1990) model, selective attention is considered a prerequisite for academic achievement and has a close link with mathematic performance (Campos et al., 2013; Keilow et al., 2019; Stevens & Bavelier, 2012). Specifically, with arithmetic word problems. In fact, from the different strands of math competency (e.g., algorithmic computation; Fuchs et al., 2005) arithmetic word problems seem to an optimal domain to better analyze selective attention function. Arithmetic word problems are linguistically presented and require arithmetic solutions (Fuchs et al., 2006), for example, "*With 2 kg of chocolate, how many candies of 30 grams each can you make*?". However, prior to the use of arithmetic skills, to solve these problems successfully students should understand the instructions focusing attention on relevant information, while avoiding irrelevant one (Stevens & Bavelier, 2012). In sum, to solve these problems individuals are expected to use selective attention abilities to extract relevant data from the problem statement and use them to make the correct computations. Additionally, there is strong evidence supporting positive relationships between self-regulation and attention control (e.g., Kaplan & Berman, 2010). According to Zimmerman (2000), individuals self-regulating their behaviors proficiently are likely to focus attention on their task performance and achieve success, but data supporting this proposition is limited. Grounded on these reasons, to further our understanding of the role of self-regulatory strategies on selective attention, we analyzed students' arithmetic word problems performance. For this purpose, we set a school-based intervention aiming to promote self-regulation skills among fourth-grade students following a quasi-experimental design with an experimental group (EG) or a control group (CG), with children randomly allocated to each condition. We hypothesized that by the end of the program, when

compared with CG, the training on self-regulatory skills in EG would be positively associated with higher levels of self-regulation, selective attention, and arithmetic competencies.

## Method

### Participants

The current investigation runs alongside the project Learn-to-Learn, developed in public schools in a region of the north of Portugal. This project was developed with the collaboration of the local municipality and all the fourth grade students enrolled in public schools of this city were invited to participate (the response rate was 99%). The aims of the intervention were to promote a repertoire of self-regulatory learning strategies involved in learning, teamwork, and problem-solving and likely to help improve children's academic sucess. Finally, 931 children participated in the intervention program and their classes were randomly distributed between the EG and the CG. To avoid interaction between participants allocated in each condition, it was ensured that participants from the EG attended different schools from CG. For the purposes of the current study 136 out of the pool of 931 students (15% of the total sample) were randomly selected. More specifically, 68 from the group of children who had benefited from the intervention and 68 from the CG. The participants were aged between 8 to 11 years old ($M$ = 9.04; $SD$ = .558) and 68 were male.

### Procedure

This research followed a quasi-experimental design to assess the efficacy of a program to promote self-regulation, attention, and mathematic competencies. The intervention program was conducted during the first term of the academic school year (September through December). The one-hour weekly sessions took place in classrooms and were developed by a trained psychologist with the presence of the teacher. At the end of the intervention, teachers from the control group were delivered a course on self-regulation. The purpose of this course was to enable them to introduce self-regulatory skills during their classes and help their children improve self-regulation strategies on their school work. Protocol for data collection was the same for all participants, irrespective of the condition. First, parents/guardians and teachers were delivered Information on the study and asked to sign an informed consent allowing their children or their agreement to participate in the research. Data from self-regulation and selective attention measures were collected prior to the beginning of the program, during the program, and at the end of the program. Students completed these measures in the classroom with an assistant researcher supervision, i.e., each

item was read aloud by the researcher to ensure that all students understood what was asked. Regarding the arithmetic competency measure, data were collected at the beginning and at the end of the program.

### *General description of the program*

This school-based intervention was designed to promote a repertoire of self-regulatory strategies (e.g., setting-goals; time management; making decisions; monitoring tasks; self-evaluation) among fourth graders. The Intervention aimed to develop children's control and autonomy of their learning while enabling their abilities to learn-to-learn and consequently foster their school success. This intervention is grounded in the social cognitive theory (Bandura, 1996) according to which students' motivation and self-regulation are influenced by the learning setting and contextual variables.

### *The story-tool Yellow's trails and tribulations.*

The program relied on a story-tool, *Yellow trials and tribulations* (Rosário et al., 2007) intentionally developed to convey learning strategies and promote self-regulatory processes among elementary school children. This story narrates the adventures and the challenges of rainbow colors while searching for his lost *Yellow* friend in the woods, because we are all important and no one should be left behind. Children while reading the adventures of the rainbow colors in search for *Yellow* learn useful self-regulatory strategies likely to help them overcome the difficulties and persist in their efforts to achieve their goals. For the purpose of the current research, in each session one chapter of the book was read outloud in class followed by a discussion of the experiences of the rainbow colors against the self-regulation processes. These discussions stressed the closeness of the experiences lived by the rainbow colors to those of the children to facilitate the tranfer of these learnings to their own school life. What is more, these in class discussions were intentionally guided to provide an opportunity for students to acquire, practice, and reflect on the self-regulatory strategies used by characters to overcome challenges and attain their purpose (i.e., find Yellow). Besides, during the discussion, students were encouraged to assign meaning to and discover the usefulness of the strategic content presented to their progress.

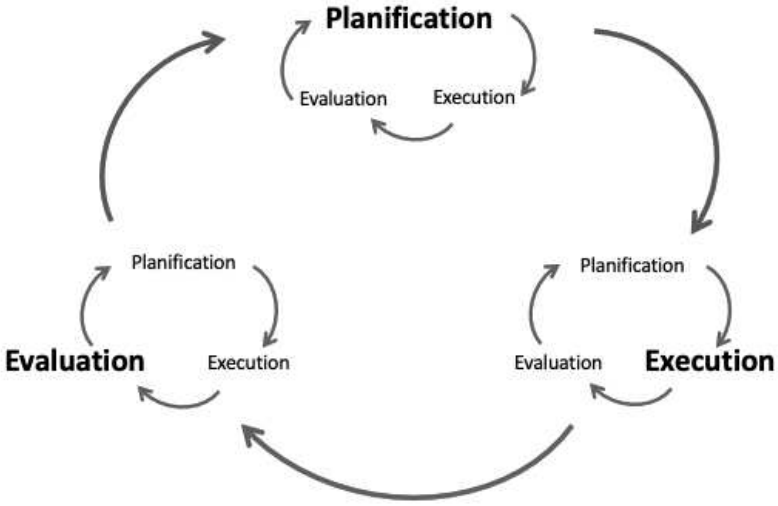
### *The Self-Regulated Learning (SRL) Model*

Chlidren who self-regulate proficiently their behavior, actively assume control and responsibility over their thoughts, emotions, and behaviors in order to achieve a goal (Zimmerman, 2002). The narrative used in this intervention is grounded on the PLEE model – Planning, Execution, and Evaluation – (Rosário et al., 2007; Rosário & Polydoro, 2012). This model is based on Zimmerman's model, which comprises

three interdependent yet interrelated phases – forethought, performance or volitional control, and self-reflection. This model has a cyclical nature, each of these phases are informed by the previous phase and informs the following phase. For example, forethought processes are informed by the self-reflection processes and inform the performance or volitional control processes. The PLEE model adds a recursive element to the previous model. For example, to complete the first phase of the SR cycle – Planning – individuals are expected to plan, execute, and evaluate their plan. All cycle takes place within each phase. So, according to Rosário (2007), the PLEE model explaining self-regulation learning has a cyclic and a recursive nature.

**Figure 1**

*Illustration of PLEE Model*




*Session structure*

The program was comprised of 12 sessions, 60 minutes each. In total, children read and discuss the content of the 17 chapters of the story-tool. Each session began with a review of the contents worked in the previous session, followed by the reading of a new chapter. With the help of a research assistant with training in delivering SR interventions, children discussed the self-regulation processes presented in the chapter using the following aspects of knowledge: declarative (i.e., *What is?* the definition of a concept), procedural (i.e., *How?* the operationalization of the knowledge), and conditional (*When? Where? Why?* in which circumstances could the knowledge be used) knowledge (e.g., Ryle, 1949). These

guidelines allowed students to assign meaning and structure to learnings and fostered possible ways to apply these strategies to their daily lives. For example, one of the chapters reported the old children story of the three little pigs. Discussion on this content provided an opportunity for students to reflect on the importance of using attention control strategies while working. For example, students were encouraged to examine the distractors that can interfere in their school work and analyze strategies that may help avoid them. Afterwards, students were presented a consolidation task to do in group (e.g., make a plan to have a picnic in the park with the rainbow colors). Finally, at the end of the session, children were invited to reflect on new learnings and asked to write a take-home message likely to emphasize the content discussed.

### *Treatment integrity*

Treatment fidelity procedures regarding the implementation of the protocol were used as follows (Capin et al., 2018).The three research assistants that implemented the program, had experience in delivering interventions focused on SRL; moreover, prior to the start of the intervention they received a dossier with session sheets. This dossier helped monitor the protocol for each session (e.g., activities set, take home message). What is more, during the implementation of the intervention, assistant researchers met with the senior researcher on a weekly basis to discuss incidents regarding the implementation and adherence to the protocol (e.g., goals for each session).

Finally, an expert on SRL with no participation on the implementation of the sessions watched 30% of the sessions using a protocol record sheet. Data from the video observations showed that the researcher completed a mean of 91% of the activities (range 83-95). This indicates a high treatment integrity for the program.

## Instruments and Measures

Participants were presented a questionnaire divided in two parts: i) sociodemographic information (e.g., gender, age, number of brothers, parent's ages and academic abilities), ii) this part comprises an instrument to assess SR, *Inventory of Learning Self-Regulation Processes* (IPAA) adaptation (Rosário et al., 2010), and a subtest of the *Coimbra Neuropsychological Assessment Battery* (BANC) (Simões et al., 2016) to acess the selective attention (SA).

The IPAA assesses nine SRL strategies concerning the three phases of the SRL process: *Planning* phase (e.g., "I make a plan before I begin working. I think about what I want to do and how I need to complete it."), *Execution* phase (e.g., "If I become distracted or lose concentration while I am in

class or studying then I usually try to regain to achieve my goals."), and *Evaluation* phase (e.g., "I compare the grades I received with the goals I set."). The 9-item scale was rated on a five Likert scale (1, *never* and 5, *always*). The confirmatory factorial analysis supports the construct validity of this measure ($\chi^2(27, 4288)= 350.73$; $p < .001$; GFI = .982; AGFI = .970; TLI = .957; CFI = .968; RMSEA = .053, 90% CI (.048, .058)).

The BANC is designed to children and adolescents from 5 to 15 years old and includes a range of subtests to evaluated different domains of neuropsychological functioning such as memory, language, attention, executive functions, laterality, orientation, and motor function (Simões et al., 2016). We used a performance measure to assess selective attention to overcome a possible limitation of teacher's reports on their students' attention in class. Literature has been alerting that these are subjective measures that can be biased; for example by teacher's expectations about students performance (Fuchs et al., 2005). For the purposes of this study, to assess selective attention, we used the Two Signal Cancellation test (Simões et al., 2016). The task has a duration of ten minutes, and participants are expected to perform the test individually. Each child is presented with a paper with twenty-five lines of square stimulus and is asked to identify and tick the target square present at the top of the paper. This subtest allows measure selective attention because requires the ability to point out two target stimuli among eight different stimuli, and the sustained attention because participants are expected to maintain attention for a short period of time.

Finally, to analyze the arithmetic competency it was accessed the score of the math test, which focuses on this skill. The test scores ranged from 1 - *Insufficient* to 4 - *Excellent*.

### Data analysis

The statistic analysis was realized by the quantitative data processing program IBM SPSS (*Statistical Package for the Social Sciences*), version 27.0. The analysis included (a) a descriptive analysis of all results; (b) a mixed design analysis of variance (ANOVA) to analyze the effect of intervention over the time in SR and SA; (c) pairwise comparisons corrected using Bonferroni adjustments to learn about the differences between EG and CG and within subjects; (d) an ANOVA unifactorial to explore the impact of selective attention on arithmetic competencies; and (e) a t-test for paired samples to analyze the arithmetic differences within subjects.

## Results

Table 1 summarizes the descriptive statistic data of the three dependent variables (i.e., SRL, attention and mathematic) for the EG and CG in the three moments. The descriptive analysis, as hypothesized, suggest that students from EG incremented the levels of all competencies after the first moment. However, over time, the CG presented a lower SR mean in the M2 when compared with M1 and M3. Concerning the SA mean values, the results suggest an increment over time. The same pattern seems to be present in the mean values for the arithmetic competency.

**Table 1**

*Means and standard deviations for the two treatment groups.*

| | Control Group | | Experimental Group | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| Self-regulation | | | | |
| M1 | 3.59 | 0.76 | 3.65 | 0.63 |
| M2 | 3.39 | 1.03 | 3.95 | 0.63 |
| M3 | 3.57 | 1.05 | 4.19 | 0.55 |
| Selective Attention | | | | |
| M1 | 6.75 | 10.09 | 6.67 | 6.66 |
| M2 | 11.58 | 7.43 | 14.68 | 5.06 |
| M3 | 14.48 | 8.29 | 19.27 | 5.61 |
| Arithmetic | | | | |
| M1 | 2.57 | 1.10 | 2.74 | 0.70 |
| M3 | 2.57 | 0.87 | 3.01 | 0.74 |

### Mixed design ANOVA

To analyze the effect of the intervention on SR and SA competencies over the time was run a mixed ANOVA. There was a significant main effect of time and group in SR ($F$(2,258) = 9.548, $p$<.001) and SA ($F$(2,258) = 8.766, $p$<.001) competencies. In this line, taking together the multivariate contrast test indicates that was a change through the three moments (Lambda Wilks = .381; $F$(4,514) = 79.634, $p$< .001, $\eta^2$ = .383). Moreover, this analysis reveal an interaction between moments and group condition, which means that there are differences between EG and CG (Lambda Wilks = .873; $F$(4,514) = 9.035, $p$< .001, $\eta^2$ = .066). This information is relevant because clarifies the role of the intervention in explaining the differences between moments. These analysis also informed that the tendency of scores is linear for both groups in SR ($F$(1, 129) = 39.951, $p$< .001, $\eta^2$ = .236) and in SA ($F$(1, 129) = 271.043, $p$< .001, $\eta^2$ = .678). Also, there are a linear tendency regarding the interaction between the two groups, either in SR ($F$(1, 129) = 14.490, $p$< .001, $\eta^2$ = .101) as in SA ($F$(1, 129) = 12.048, $p$< .001, $\eta^2$ = .085).

The pairwise comparisons for the main effect of EG and CG over the time in both variables, SR and SA, corrected using Bonferroni adjustments are below (see tables 2 and 3). To aid this analysis, figures 2 and 3 show, respectively, the estimated means for SR and SA for each group.

**Table 2**

*Paiwised comparisions between EG and CG.*

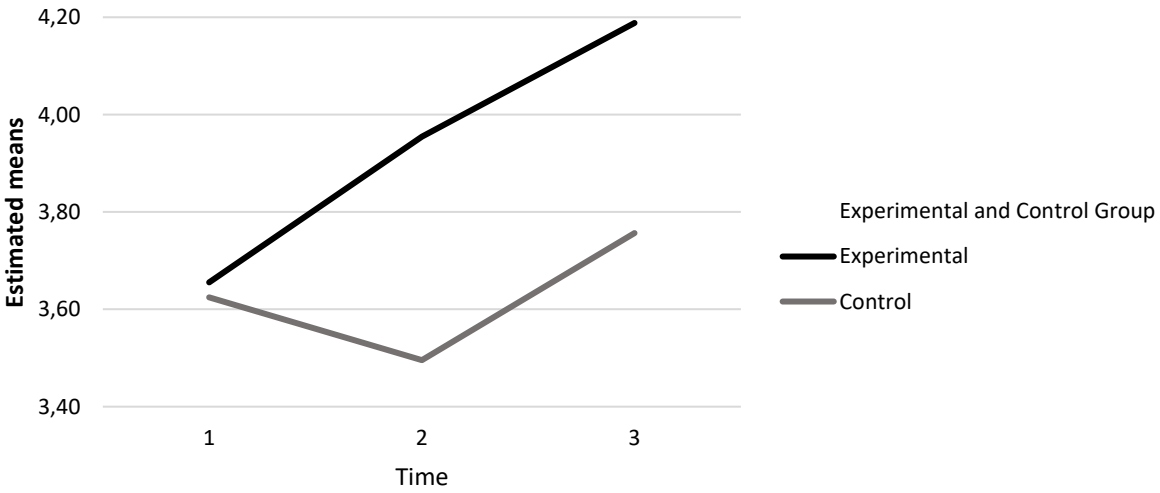
| | Control Group * Experimental Group | | |
|---|---|---|---|
| | Moment 1 | Moment 2 | Moment 3 |
| | *Mean difference* | *Mean difference* | *Mean difference* |
| Self-Regulation | -0.03 | -0.46** | -0.43*** |
| Selective Attention | 0.12 | -3.49** | -4.51*** |

*Note*. ** $p < .01$, *** $p < .001$

Table 2 results show that the significant main effect is statistically significant between EG and CG, in both moment 2 and 3. This result is congruent with the expected since being at the pre-intervention moment, all participants were in the same condition.

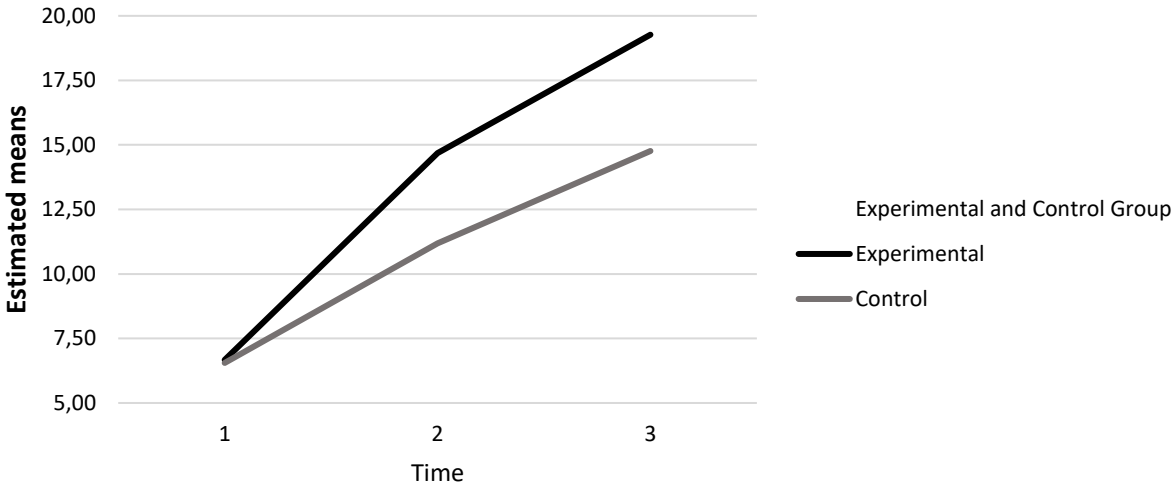
**Figure 2**

*Graphical representation of the levels of SR corresponding to the EG and CG over the three moments.*



## Figure 3

*Graphical representation of the levels of SA corresponding to the EG and CG over the three moments.*




## Table 3

*Pairwise comparisions whitin subjects.*

| | Control Group<br>*Mean difference* | Experimental Group<br>*Mean difference* |
|---|---|---|
| Self-Regulation | | |
| M1 – M2 | 0.13 | -0.30*** |
| M2 – M3 | -0.26** | -0.23* |
| M1 – M3 | -0.13 | -0.53*** |
| Selective Attention | | |
| M1 – M2 | -4.64*** | -8.01*** |
| M2 – M3 | -3.58*** | -4.59*** |
| M1 – M3 | -8.21*** | -12.60*** |

*Note*. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 3 indicates that the main effect is statistically significant to EG in the three moments for both competencies, SR and SA. The CG showed statistically significant differences between all moments for SA but on SR the data only suggest statistically significant differences between M2 - M3.

### ANOVA unifactorial

To analyze the impact of selective attention on arithmetic competencies was conducted an ANOVA unifactorial. The results from this analysis were summarized on table 4.

**Table 4**

*ANOVA unifactorial for arithmetic competency.*

| | Control Group * Experimental Group | | | | | |
|---|---|---|---|---|---|---|
| | *SS* | *df* | *MS* | *F* | *p* | *η2* |
| Mathematic | | | | | | |
| M1 | 0.89 | 1 | 0.82 | 1.05 | .308 | .01 |
| M3 | 6.62 | 1 | 6.62 | 10.12 | .002** | .07 |

*Note.* ** $p < .01$

The results indicate that only in moment 3 were statistically significant differences between EG and CG ($F(1, 134) = 18.299$; $p < .001$, $\eta^2 = .070$). Hence, these results suggest that self-regulatory training seems to have influence on selective attention with impact on arithmetic skills. Building upon these results, it was run a t-test for paired samples in order to analyze the differences within subjects.

**Table 5**

*T-test for paired sample for Arithmetic competency.*

| | Control Group | | | Experimental Group | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *t* (67) | *M* | *SD* | *t* (67) |
| Mathematic | | | | | | |
| M1 * M3 | .00 | .75 | .00 | -2.79 | .64 | 3.58*** |

*Note.* *** $p < .001$

As we can see on table 5, the findings indicate that only in EG were statistically significant differences between M1 and M3 ($t(67) = - 3.584$; $p < .001$).

## Discussion

The promotion of self-regulatory learning strategies educates individuals to become active and responsible agents of their learning process (Rosário et al., 2007). During this process, among other skills, the individual needs to be able to control their attention. For example, during the performance

phase of Zimmerman's model for self-regulation of learning, if a student establishes study for a math test as a goal, need to allocate correctly their attention, focusing on the subject for the test and avoid possible distractors (Baumeister & Vohs, 2004). In other words, they need to employ selective attention competencies to self-regulte their learning (Baumeister & Vohs, 2004). On the other hand, according to the literature selective attention competencies have been associated with performance in arithmetic word problems (Campos et al., 2013; Fuchs et al., 2006; Stevens & Bavelier, 2012). These problems are presented in written format and require to the individual to select the relevant information and ignore the irrelevant information in order to make the computations that will lead them to the correct solution (Stevens & Bavelier, 2012).

This knowledge leads us to our hypothesis that students who benefit from self-regulatory training will reveal higher levels of self-regulatory strategies, selective attention and arithmetic competencies. The results confirmed our hypotheses showing statistically significant differences between EG and CG for all competencies over the time.

Accordingly, despite the results are preliminary, "*Yellow Trial and Tribulation*" intervention program revealed to be effective in promoting self-regulation strategies. These results support the evidence about the use of classroom interventions that rely on the exploration of narratives as an effective methodology for the promotion of these type of skills (Högemann, 2011; Pereira et al., 2019; Rosário et al., 2016).

On the other hand, although the results showed significant differences between the two groups for selective attention competencies, it is important to reflect on the fact that both groups improved these competencies. This information suggests that probably there are other variables, as staying in classroom or academic routines (Simões et al. 2016), that influence the development of this competency. Another argument that could help to explain this improvement in both groups is that selective attention appears to develop in parallel with the maturation of the specific areas in the prefrontal cortex required for its expression (Gogtay et al., 2004; Wassenberg et al., 2008). Although, according to the average results per age for the Two Signal Cancellation subtest of BANC (Simões et al., 2016), the control group remained the expected results for your age group (scores between 8 and 14). On the other hand, the students in experimental group improved their scores for values corresponding to the average of children aged 13/14 years old (scores between 18 and 20). Besides, according to the statistical analysis, these differences between groups are statistically significant, suggesting an effect of self-regulatory training on selective attention skills.

Moreover, the data also revealed that students who benefited from self-regulatory training improved their arithmetic competence when compared to the CG students. These results can be supported by the

relationship between selective attention and arithmetic competencies (Campos et al., 2013; Keilow et al., 2019; Stevens & Bavelier, 2012) and help to confirm the improvement of selective attention competencies in EG.

In sum, the preliminar results of this study are an important contribution to reflect about effective strategies to promote attentional control competencies, helping to address the reported gap in the literature in this area (Posner, 2003; Rabiner et al., 2016; Razza et al., 2012). Moreover, this study results support two possible implications to educative practice. Firstly, inclusion of the narrative-based programs for the promotion of self-regulation learning strategies in elementary school-years as an effective practice. Secondly, warn to the characteristics of the delivery of arithmetic word problems, that are presented in a written format and offer the opportunity of children rehearse the selection of the relevant information, discarding the other. Regarding the former, teachers should consider accompany oral lessons with the written support in a intentional way to increase children's acquisition and comprehension of the scholar subjects. Future research should consider study the impact of former in children's learning outcomes.

### Limitations and future research

Some limitations should be addressed to this study. First limitation is regarding the self-report nature of the instrument used to measure self-regulation competence. Self-report measures may not be sensitive to capture the real effects of intervention. Future studies should consider complement with performance measures (e.g. Hannoi Tower) and other sources of information (e.g., teachers and/or parents/legal guardians perceptions).

In addition, according to Stevens & Bavelier (2012) the effect of selective attention competencies on the performance of mathematic word problems is mediated by working memory. So, another suggestion could be to analyze the effect of self-regulatory training on working memory. Lastly, it might be interesting to include collecting follow-up data in order to understand whether the intervention has maintained the effects found over the time.

## References

Abu-Hamour, B. (2018). The cognitive profiles of Jordanian students at risk for math disability. *International Journal of Inclusive Education, 22*(10), 1093-1107.

Bandura, A. (1986). Social foundations of thought and action. Englewood Cliffs, NJ, 1986.

Baumeister, R. F., & Vohs, K. D. (Eds.). (2004). *Handbook of self-regulation: Research, theory, and applications.* The Guilford Press.

Best, J. R., Miller, P. H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences*, *21*(4), 327–336.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and psychopathology*, *20*(3), 899-911.

Breslau, J., Miller, E., Breslau, N., Bohnert, K., Lucia, V., & Schweitzer, J. (2009). The impact of early behavior disturbances on academic achievement in high school. *Pediatrics, 123*(6), 1472-1476.

Campos, I. S., Almeida, L. S., Ferreira, A. I., Martinez, L. F., & Ramalho, G. (2013). Cognitive processes and math performance: a study with children at third grade of basic education. *European Journal of Psychology of Education*, *28*(2), 421-436.

Capin, P., Walker, M. A., Vaughn, S., & Wanzek, J. (2018). Examining how treatment fidelity is supported, measured, and reported in K–3 reading intervention research. *Educational Psychology Review*, *30*(3), 885–919. https://doi.org/10.1007/s10648-017-9429-z

Cleary, T. J., Callan, G. L., & Zimmerman, B. J. (2012). Assessing self-regulation as a cyclical, context-specific phenomenon: Overview and analysis of SRL microanalytic protocols. *Education Research International*.

Cleary, T. J., & Platten, P. (2013). Examining the correspondence between self-regulated learning and academic achievement: A case study analysis. Education Research International, 2013, 1– 18. https://doi.org/10.1155/2013/272560

Cleary, T. J., & Zimmerman, B. J. (2004). Self-regulation empowerment program: A school-based program to enhance self-regulated and self-motivated cycles of student learning. *Psychology in the Schools*, *41*(5), 537-550.

Cooley, E. L., & Morris, R. D. (1990). Attention in children: A neuropsychologically based model for assessment. *Developmental Neuropsychology*, 6(3), 239-274. https://doi.org/10.1080/87565649009540465

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental psychology, 43*(6), 1428.

Fuchs, L. S., Compton, D. L., Fuchs, D., Paulsen, K., Bryant, J. D., & Hamlett, C. L. (2005). The prevention, identification, and cognitive determinants of math difficulty. *Journal of educational psychology, 97*(3), 493.

Fuchs, L. S., Fuchs, D., Compton, D. L., Powell, S. R., Seethaler, P. M., Capizzi, A. M., Schatschneider, C., & Fletcher, J. M. (2006). The cognitive correlates of third-grade skill in arithmetic, algorithmic computation, and arithmetic word problems. *Journal of Educational Psychology*, *98*(1), 29.

Gogtay, N., Giedd, J. N., Lusk, L., Hayaski, K. M., Greenstein, D., Vaituzis, A. C., Nugent, T. F. 3rd, Herman, D. H., Clasen, L. S., Toga, A. W., Rapoport, J. L., & Thompson, P. M. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of the Sciences*, *101*, 8174–8179.

Hair, N. L., Hanson, J. L., Wolfe, B. L., & Pollak, S. D. (2015). Association of Child Poverty, Brain Development, and Academic Achievement. *JAMA Pediatrics*, *169*(9), 822.

Högemann, J. (2011). *Promoção de competências de auto-regulação na escrita : um estudo no 1.o ciclo do ensino básico.* (Master dissertation, University of Minho).

Jacob, R., & Parkinson, J. (2015). The potential for school-based interventions that target executive function to improve academic achievement: A review. *Review of Educational Research, 85*(4), 512–552.

Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. *Perspectives on psychological science*, *5*(1), 43-57.

Keilow, M., Holm, A., Friis- Hansen, M., & Kristensen, R. M. (2019). Effects of a classroom management intervention on student selective attention: results from a randomized controlled trial. *School Effectiveness and School Improvement*, *30*(2), 194–211. https://doi.org/10.1080/09243453.2018.1557701

Lachter, J., Forster, K. I., & Ruthruff, E. (2004). Forty-five years after Broadbent (1958): still no identification without attention. *Psychological review, 111*(4), 880.

Levitt, T., & Johnstone, B. R. I. C. K. (2001). Rehabilitation of Neuropsychological disorders: a practical guide for rehabilitation professionals. *The assessment and rehabilitation of attention disorders* (pp. 27-52). Psychology Press.

Mahone, E. M., & Schneider, H. E. (2012). Assessment of attention in preschoolers. *Neuropsychology review, 22*(4), 361-383.

Montroy, J. J., Bowles, R. P., Skibbe, L. E., McClelland, M. M., & Morrison, F. J. (2016). The development of self-regulation across early childhood. *Developmental Psychology, 52*(11), 1744–1762. https://doi.org/10.1037/dev0000159

Noble, K. G., Houston, S. M., Brito, N. H., Bartsch, H., Kan, E., Kuperman, J. M., Akshoomoff, N., Amaral, D. G., Bloss, C. S., Libiger, O., Schork, N. J., Murray, S. S., Casey, B. J., Chang, L., Ernst, T. M., Frazier, J. A., Gruen, J. R., Kennedy, D. N., Zijl, P. V., Mostofsky, S., ... & Sowell, E. R. (2015).

Family income, parental education and brain structure in children and adolescents. *Nature neuroscience*, *18*(5), 773.

Paananen, M., Aro, T., Närhi, V., & Aro, M. (2018). Group-based intervention on attention and executive functions in the school context. *Educational Psychology, 38*(7), 859-876.

Pereira, A., Rosário, P., Lopes, S., Moreira, T., Magalhães, P., Núñez, J. C., Vallejo, G., & Sampaio, A. (2019). Promoting School Engagement in Children with Cerebral Palsy: A Narrative Based Program. *International Journal of Environmental Research and Public Health*, *16*(19), 3634.

Posner, M. I. (2003, March). *Educating the developing brain* (Conference presentation). APA, Toronto, Canada.

Rabiner, D. L., Godwin, J., & Dodge, K. A. (2016). Predicting academic achievement and attainment: The contribution of early academic skills, attention difficulties, and social competence. *School Psychology Review, 45*(2), 250-267.

Razza, R. A., Martin, A., & Brooks-Gunn, J. (2012). The implications of early attentional regulation for school success among low-income children. *Journal of applied developmental psychology, 33*(6), 311-319.

Rosário, P., Lourenço, A. A., Paiva, M. O., Núñez, J. C., González-Pienda, J., & Valle, A. (2010). Inventário de processos de auto-regulação da aprendizagem (IPAA). In C. Machado, MM Gonçalves, LS Almeida & MR Simões (Coords.). *Instrumentos e Contextos da Avaliação Psicológica* (pp. 159-174). Quarteto.

Rosário, P. S. L., Núñez, J. C., & Gonzalez-Pienda, J. (2007). *Auto-regulação em crianças sub-10. Projecto Sarilhos do Amarelo.* Porto Editora.

Rosário, P., Núñez, J. C., Vallejo, G., Cunha, J., Azevedo, R., Pereira, R., Nunes, A. R., Fuentes, S., & Moreira, T. (2016). Promoting Gypsy children school engagement: A story-tool project to enhance self-regulated learning. *Contemporary Educational Psychology*, *47*, 84-94.

Rosário, P., Polydoro, S. A. J. (2012). *Capitanear o aprender: Promoção da autorregulação da aprendizagem no contexto escolar.* São Paulo: Casa do Psicólogo.

Ryle, G. (1949). *The concept of mind*. Londres: Hutchinson.

Simões, M. R., Albuquerque, C. P., Pinho, M. S., Vilar, M., Pereira, M., Lopes, A. F., Santos, M. J. S., Alberto, I., Lopes, C., Martins, C., & Moura, O. (2016). *Bateria de Avaliação Neuropsicológica de Coimbra (BANC): Manual Técnico [Coimbra Neuropsychological Assessment Battery: Technical Manual]*. Cegoc.

Stevens, C., & Bavelier, D. (2012). The role of selective attention on academic foundations: A cognitive neuroscience perspective. *Developmental cognitive neuroscience*, *2*, S30-S48.

Tortella, J. C. B., Rosario, P., & Polydoro, S. A. J. (2018). Self-regulated learning: Teacher training and student's education in the school context. *Revista de Educação PUC-Campina*, *23*(3), 333-337.

Wassenberg, R., Hendriksen, J. G., Hurks, P. P., Feron, F. J., Keulers, E. H., Vles, J. S., & Jolles, J. (2008). Development of inattention, impulsivity, and processing speed as measured by the d2

Test: results of a large cross-sectional study in children aged 7–13. *Child Neuropsychology*, *14*(3), 195-210.

York, T. T., Gibson, C., & Rankin, S. (2015). Defining and measuring academic success. *Practical Assessment, Research, and Evaluation*, *20*(1), 5.

Zimmerman, B. J. (2000). Handbook of Self-Regulation. *Attaining self-regulation: A social cognitive perspective. In Handbook of self-regulation (pp. 13-39).* Academic Press.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview*. Theory into practice, 41*(2), 64-70.

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American educational research journal*, *45*(1), 166-183.

Zimmerman, B. J. (2013). From cognitive modeling to self-regulation: A social cognitive career path*. Educational psychologist, 48*(3), 135-147.

# Appendix

Universidade do Minho

Conselho de Ética

**Comissão de Ética para a Investigação em Ciências Sociais e Humanas**

Identificação do documento: CEICSH 066/2019

Relatores: Emanuel Pedro Viana Barbas de Albuquerque e Marlene Alexandra Veloso Matos

Título do projeto: *Aprender a Aprender*

Equipa de Investigação: Pedro José Sales Luís da Fonseca Rosário, Centro de Investigação em Psicologia, Escola de Psicologia, Universidade do Minho; Adriana Sampaio (PhD), Departamento de Psicologia Básica da Escola de Psicologia da Universidade do Minho; Armanda Pereira (PhD), investigadora Pós-doc no Centro de Investigação em Psicologia (CIPsi), da Escola de Psicologia, da Universidade do Minho; Daniela Rosendo (MSc), bolseira de investigação no Centro de Investigação em Psicologia (CIPsi) da Universidade do Minho; Sandra Mesquita (MSc), bolseira de investigação em Psicologia da Educação; Sara Teixeira (MSc), bolseira de investigação no Centro de Investigação em Psicologia (CIPsi), da Universidade do Minho

**PARECER**

A Comissão de Ética para a Investigação em Ciências Sociais e Humanas (CEICSH) analisou o processo relativo ao projeto de investigação acima identificado, intitulado *Aprender a Aprender*.

Os documentos apresentados revelam que o projeto obedece aos requisitos exigidos para as boas práticas na investigação com humanos, em conformidade com as normas nacionais e internacionais que regulam a investigação em Ciências Sociais e Humanas.

Face ao exposto, a Comissão de Ética para a Investigação em Ciências Sociais e Humanas (CEICSH) nada tem a opor à realização do projeto, emitindo o seu parecer favorável, que foi aprovado por unanimidade pelos seus membros.

Braga, 14 de outubro de 2019.

O Presidente da CEICSH

Assinado por : **ACÍLIO DA SILVA ESTANQUEIRO ROCHA**
Num. de Identificação: BI042754054
Data: 2019.10.18 17:46:26 Hora de Verão de GMT

CARTÃO DE CIDADÃO

**Anexo**: Formulário de identificação e caracterização do projeto