Effect of an intervention in self-regulation strategies on academic achievement in elementary school: A study of the mediating effect of self-regulatory activity[☆]

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ABSTRACT

The aim of this study was twofold: (1) to analyse the extent to which a training program in Self-Regulated Learning (SRL) and Reading Comprehension (RC) strategies would lead to improvements in these competencies in elementary school students, and (2) the extent to which the improvements in these competencies would be associated with improvements in academic achievement. An experimental study with an experimental group and a control group was conducted in an authentic environment with pre, post, and follow-up measures. A total of 758 elementary school students participated in the study, (403 in the experimental group and 355 in the control group). The results revealed that (1) the strategic activity mediated the effect of the intervention on academic achievement. In fact, (a) the intervention produced significant improvements in the reported use of SRL and on RC strategies and (b) the increase in such strategies was associated with higher academic achievement. In addition, (2) we found that, together with this indirect effect, the intervention influenced academic achievement through variables or conditions other than the strategic activity displayed. Likewise, (3) we were able to verify that the indirect effects through RC strategies were greater than those of SRL strategies. Finally, the analysis results showed that the total effect of the intervention explained 30% of the academic achievement variance. These results are discussed in relation to those reported by previous similar studies.

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Efecto de una intervención en estrategias de autorregulación en el rendimiento académico en Primaria: Estudio del efecto mediador de la actividad autorregulatoria

RESUMEN

El objetivo de este estudio ha sido doble: (1) se ha analizado en qué medida un programa de capacitación en estrategias de aprendizaje autorregulado y comprensión lectora ha generado mejoras en estas competencias en estudiantes de primaria, y (2) en qué medida estas mejoras se han asociado con mejoras en el rendimiento académico. Se ha realizado un estudio experimental con un grupo experimental y un grupo de control en un entorno auténtico, con medidas pretest, postest y de seguimiento. En el estudio han participado un total de 758 estudiantes de primaria, (403 en el grupo experimental y 355 en

el grupo control). Los resultados han mostrado que (1) la actividad estratégica ha mediado el efecto de la intervención sobre el rendimiento académico, ya que (a) la intervención ha producido mejoras significativas en el uso de las estrategias entrenadas (autorregulación del aprendizaje y comprensión lectora) y (b) el incremento en tales estrategias se ha asociado con un mayor rendimiento académico. Además, (2) se ha obtenido que, junto con este efecto indirecto, la intervención ha condicionado el rendimiento a través de otras variables o condiciones (distintas a la actividad estratégica entrenada). Asimismo, (3) se ha comprobado que los efectos indirectos a través de las estrategias de comprensión lectora han sido mayores que los de las estrategias de autorregulación. Finalmente, se ha observado que el efecto total de la intervención sobre el rendimiento académico no supera el 30% de la variabilidad del mismo. Estos resultados han sido discutidos en relación con los aportados por estudios previos semejantes.

Introduction

Strategy-based interventions (e.g., interventions on self-regulated learning [SRL] strategies) are focused on improving participants' knowledge on strategic skills (Cerezo et al., 2019), improving metacognition (Dignath & Büttner, 2008), increasing the use of SRL strategies (Manalo et al., 2017), and consequently improving achievement in various academic areas. However, surprisingly, recent studies developed with college students as participants have shown that variability in achievement is not always associated with increases in the reported use of the strategies trained (Jansen et al., 2019). Due to the important implication of these findings to educational intervention, the current study addressed this issue in elementary school. Therefore, a school-based intervention aimed at improving learning strategies and consequently elementary school students' academic achievement was set. Our goal was to find out whether the effect of the intervention on school achievement was mediated by the reported use of macro-strategies (i.e., SRL strategies) and micro-strategies (i.e., Reading Comprehension – RC strategies) trained throughout the intervention. Data may help to further understand the differences found in the literature regarding the effectiveness of the interventions' on learning strategies to improve students' academic achievement.

SRL strategies and academic achievement

Positive relationships have been reported between the use of SRL strategies, task motivation and students' engagement in school tasks (Theobald, 2021). Extant research reports that the use of SRL strategies is likely to translate to positive results in academic self-efficacy, consistency and persistence in tasks, reflexive learning, study habits, well-being and school success (Chu et al., 2020; Kistner et al., 2010). Moreover, these positive effects were found in distinct school grades (i.e., elementary, secondary, and high school) (e.g., Dignath & Büttner, 2008; Donker et al., 2014; Theobald, 2021) and different academic domains (e.g., math, reading, writing, science) (de Boer et al., 2018). For example, prior research investigating elementary school students has reported positive impacts of SRL strategies towards academic achievement in different domains (e.g., de Boer et al., 2018; Dignath & Büttner, 2008). However, in consideration of the fact that not all students develop the skills needed for high-quality learning, or use learning strategies fit for this purpose, previous research has also emphasized the need to train learning strategies in class (e.g., Rosário et al., 2020).

Interventions in strategies, strategic activity, and academic achievement in elementary school students

As Frazier et al. (2021) noted, self-regulation is a social-cognitive process at the intersection of metacognition, motivation, and behavior. We understand self-regulation as a complex process requiring an articulation of one's possible selves, metacognitive

knowledge and effective strategies, and a sense of one's own agency. Prior and recent research studies have reported that children who efficiently regulate their learning behaviors adapt better to their learning environments and control the thoughts associated with learning. In fact, children are better able to manage their learning strategies and find learning activities interesting and fun when they are able to control their learning processes (Chu et al., 2020; Núñez et al., 2013).

Due to the notable importance of effective self-regulation to students' learning quality and achievement, numerous studies have been carried out to investigate how academic achievement is positively affected by interventions aimed at increasing students' SRL activity. Prior meta-analytic research has shown positive effects of these interventions on the academic achievement of elementary school students (Dignath & Büttner, 2008). Moreover, these positive results were found in different content domains (Donker et al., 2014), and both in the short and long term (de Boer et al., 2018). Effective SRL interventions are diverse depending on the theoretical model supporting them, the strategies trained (in addition to SRL), or the objective of the intervention (Panadero, 2017). For example, Donker et al.'s (2014) meta-analysis found three types of learning strategies that were usually included in the intervention programs (cognitive, metacognitive, and management). Furthermore, of the interventions evaluated in this meta-analysis, the metacognitive strategies (i.e., planning, monitoring, evaluation) were the most used, with special emphasis on planning and monitoring metacognitive strategies. With regard to the cognitive strategies (i.e., rehearsal, organization, elaboration), elaboration was the strategy most frequently trained.

Recent research has also investigated whether SRL interventions could produce effects on other factors likely to favor improvements in achievement. For example, Chu et al. (2020) reported the longitudinal effect of children's SRL on reading habits. More specifically, the findings indicated that children's development of SRL can be effective in helping them set regular reading habits. However, children need training for developing good reading skills and reading habits. In fact, there is important evidence showing positive relationships between mastering reading strategies and quality of reading comprehension (Föster et al., 2018). Not surprisingly, developing good reading comprehension skills is one of the main objectives of elementary school (Jian, 2021; Sánchez et al., 1992). Thus, training the development of metacognitive strategies for improving SRL and reading comprehension strategies could strengthen children's reading behavior and improve their academic achievement.

Objective of the current study

A recent meta-analysis by Jansen et al. (2019) examined (a) whether strategic activity mediated the effect of interventions on academic achievement, and (b) the role played by potential moderators (e.g., student characteristics, the characteristics of the measuring instruments and of the strategy interventions) on both
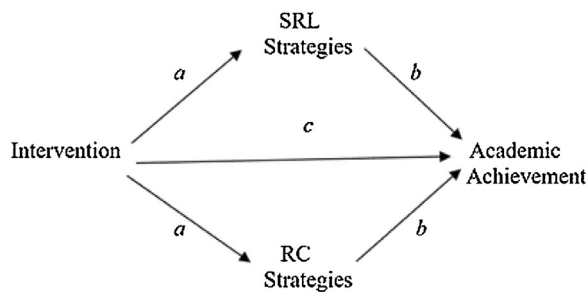
Figure 1. Structure of the direct and indirect effects that were examined [the intervention on strategic activity (*a*), the intervention on academic achievement (*c*), and the strategic activity on academic achievement (*b*)].

the effect of the interventions on participants' strategic activity and the effect of this cognitive and metacognitive activity on achievement. Findings showed that the strategic activity (enhanced by the interventions) mediated the effects of the interventions on achievement, but also that this indirect effect was generally very small. Jansen et al. (2019) concluded that the strategic activity enhanced by the interventions partially mediated the effect of interventions on academic achievement.

Aiming to find out whether Jansen et al.'s (2019) reported findings in higher education may apply also to elementary school students, the current study examined the mediating effect of macro-strategies (i.e., SRL strategies) and micro-strategies (i.e., RC strategies) on the relationship between an intervention on learning strategies and school achievement in elementary school students. To achieve this aim, we developed an intervention study with a three-month follow up in the third and fourth years of elementary school. A structural equation model (SEM) was used to analyze data. In this SEM, the condition (control, experimental), the level of strategies (SRL and RC), and academic achievement were included as central variables of the structural model. In addition, because students were not randomly assigned to conditions, the autoregressive effects of the SRL and RC variables (levels prior to the intervention) were estimated to statistically control for their effects on the post-intervention levels. Finally, academic achievement was included as a latent variable (estimated from achievement in four subject domains: mathematics, science, Spanish language, English language) in order to take into account the potential effect of the content domain on the relationship between the use of strategies (SRL and RC) and students' achievement.

The fit of the current SEM was expected to provide information on: (1) the effect of the intervention on the reported use of SRL strategies and RC strategies (effect "*a*" in Figure 1); (2) the effect of the reported use of SRL and RC strategies on academic achievement (effect "*b*" in Figure 1); and (3) the effect of the intervention on academic achievement through other variables not included in the study (effect "*c*" in Figure 1). In the current SEM, the "*c*" effect represents the *direct effect* of the intervention on academic achievement, and the "*a* x *b*" effect the indirect effect of the intervention on academic achievement, through the reported use of SRL and RC strategies (strategic activity).

In the present study two hypotheses were tested: (1) Based on the results of the meta-analysis by Jansen et al. (2019) with college students, and on data from meta-analyzes with elementary and high school students (e.g., de Boer et al., 2018; Dignath & Büttner, 2008), we hypothesized that the strategic activity (SRL + RC strategies) resulting from the intervention will only partially mediate the effect of the intervention on academic achievement; (2) Previously reported research findings (e.g., de Boer et al., 2018; Donker et al., 2014) indicate that the effects of interventions addressing macro-strategies are smaller than those found for interventions addressing micro-strategies that are content-domain focused. Therefore, in the

present study, we hypothesized that the size of the indirect effect of the intervention on achievement through RC will be greater than that occurring through SRL.

Method

Design

An experimental study (with classes randomly assigned to the experimental group—EG—or the control group—CG) was conducted in an authentic learning context (Spanish language classes). Data were collected at two measurement timepoints (pre-test and post-test) for the two intermediate dependent variables, SRL strategies (macro-strategy) and RC strategies (micro-strategy), and at three measurement timepoints (pre-test, post-test, and follow-up three months after the intervention) for the final dependent variable (academic achievement) in the four subject areas (science, mathematics, Spanish, and English).

Control condition. The teachers of the students in this condition declared that the students had never had any training on self-regulation processes or strategies. The topics of the national curriculum were followed as usual.

Experimental condition. In addition to the national curriculum contents (similar to the control group), the students in the experimental group were provided the intervention program. Every week for one hour, these students received training on the use of SRL macro-strategies and RC micro-strategies in class. The teachers of these students were delivered training in SRL and RC strategies (see the Teacher Training and Fidelity section).

Participants

Participants who agreed to participate in the study were 915 elementary school students from the third ($n = 486$, 53.1%) and fourth ($n = 429$, 46.8%) grades. These students were attending 14 state-funded ($n = 607$, 66.3%) and *charter* ($n = 308$, 33.6%) schools in the Principality of Asturias (Spain). This sampling was non-probabilistic and incidental. Nevertheless, the classes enrolled were randomly assigned to either the experimental group (EG) condition or the control group (CG) condition. The EG condition consisted of 405 students (44.3%) of whom 213 were in the 3rd year (52.6%) and 192 in the 4th year (47.4%). The CG condition consisted of 510 students (55.7%), of whom 273 were in the 3rd year (53.5%) and 237 in the 4th year (46.5%). Participants were gender-balanced (total sample: 49.6% girls; GE: 49.9% girls; CG: 49.4% girls). For various reasons (e.g., absence from class on the day of the assessment), of the 915 students, 157 did not participate sufficiently in the study. Finally, 758 students (in 34 classes) were included in the SEM analyses (355 in the control condition – from 16 classes, and 403 in the experimental condition – from 18 classes). The students were aged between 8 and 11 years ($M = 8.81$, $SD = 0.73$). The mean number of students per class was 22.30 ($SD = 4.24$). The majority of the families of these children were from medium-to-high socioeconomic backgrounds living in urban areas. Most of the teachers were female (75.2%), and with extensive teaching experience (number of years of teaching experience: $M = 22.30$, $SD = 12.22$).

Measures

Strategies for self-regulated learning—SRL—(macro-strategy). The SRL strategies were assessed with the Inventory of Self-Regulated Learning Processes (*Inventario de Procesos de Autorregulación del Aprendizaje*, IPAA). Although the IPAA was initially developed for high school students (e.g., Rosário et al., 2012), it was successfully adapted for college (e.g., Cerezo et al., 2019) and elementary

(e.g., Núñez et al., 2013) students. The version for elementary students is provided in Appendix I. This questionnaire is grounded on Zimmerman's (2000) social-cognitive model and comprises 9 items measuring the three phases of the SLR process: *planning* (i.e., Ï make a plan before I begin a written work. I think about what I am going to do and what I need to achieve iẗ), *execution* (i.e., ẅhile I am in class or studying, if I become distracted or lose the thread, I usually do something to go back to the task and achieve my goals"), and *evaluation* (i.e., Ï compare the grades I get with the goals I had set for that subject"). Students responded in a Likert-type format (never [1] to always [5]). Unlike the versions for high school and college, in the version for elementary school the single factor model (general SRL) fits the data better than the three-dimensional model (planning, execution, and evaluation). In the current study the IPAA evidenced good reliability in the pretest ($\alpha = .75$, $\omega = .76$, CR = .78) and in the posttest ($\alpha = .82$, $\omega = .82$, CR = .83), and construct validity, pretest: $\chi^2(27) = 79.11$, $p < .001$, CFI = .96, SRMR = .031; posttest: $\chi^2(27) = 140.97$, $p < .001$, CFI = .95, SRMR = .040.

Reading Comprehension–RC–(microstrategy). RC was assessed with the revised *Battery for the Evaluation of Reading Processes* (PROLEC-R; Cuetos et al., 2007). This widely used test exhibits good levels of reliability and validity. The portion of the scale used in the current study (text comprehension subtest) is made up of four text passages of increasing difficulty along with related questions, both direct and inferential. The students' responses were graded according to the criteria in the test manual, and a single text comprehension score was derived from the answers to the questions based on each of the four text passages.

Academic achievement. Non-standardized tests were used for assessing the students' school domain knowledge. These school tests were similar for all students (all the public schools follow the curriculum designed provided by the Ministry of Education). The tests were created and calibrated by a group of elementary school teachers other than the group of in-classroom teachers who participated in this investigation. The tests included various types of questions of a distinct nature and complexity to assess the students' acquisition of domain-knowledge (i.e., problem-solving, investigation, or practical tasks). The test items were previously selected from the ëxercises sectionöf the textbooks for the four subjects evaluated. Thus, the participating students were familiar with the contents and types of tasks examined. Finally, the students' in-classroom teachers were asked to provide the students' scores in the four subjects at the three evaluation timepoints (terms). The measurement scale had five points (minimum = 1 to maximum = 5). An example of each of the three types of tasks (problem-solving, investigation, or practical tasks) for every subject is provided in Appendix II.

Procedure

Intervention program (the Rainbow Program). The Rainbow Program uses the narrative of "Yellow's Trials and Tribulations," designed for elementary school children. This narrative recounts the adventures of the colors of the rainbow while searching for Yellow, who has suddenly disappeared from the rainbow. "No one should be left behind" is the motto used by the colors of the rainbow to search for their friend. During this adventure, the colors learn useful SRL strategies to help them overcome obstacles and attain their goals. Throughout the 12 weekly 50-minute sessions delivered in the Spanish language classes, with the help of the narrative "Yellow's Trials and Tribulations", students trained in the use of SRL macro-strategies (e.g., time management, goal setting) (Rosário et al., 2017) and micro-strategy RC activities (e.g., self-questioning, summarizing main ideas in one's own words) (Cuetos

et al., 2007; Stoeger et al., 2014) (see Appendix III). The sequence for each session was as follows: (a) summary; (b) chapter reading from the book "Yellow's Trials and Tribulations"; (c) training on SRL strategies applied to school and daily life tasks; (d) training on RC strategies through the reading, with open, closed, direct, and inferential questions; and (e) take-home message (goal-setting activity). The sessions were designed to encourage meta-cognitive reflection about the macro and micro in-session strategies used (e.g., homework, text comprehension tasks, and writing compositions). The aim of this reflection was to promote transfer and generalization of any gains to other contexts and to maintain these learning gains over time.

Teacher training and intervention fidelity. Prior to the classroom intervention, the participating teachers in the experimental condition attended a 4×3-h training course in the use of SRL and RC strategies in class. The course consisted of two modules: (a) SRL and RC strategies, and (b) organization and implementation of the intervention. The first module (first session) delivered training on the theoretical model guiding the intervention, as well as on the targeted SRL and CR strategies. In the session covering the second module, the teachers were provided with a manual with the instructions to carry out the intervention, as well as with the worksheets of all the sessions (e.g., structure, tasks, work sequence, and strategies to apply). The third and fourth sessions were hands-on sessions. Teachers studied and practiced on their colleagues the training involved in two sessions of the program (e.g., reading a chapter of story book to be used with their students, performing the SRL and RC tasks, encouraging transfer of learning to other areas of the child's life). Finally, the actions to ensure the fidelity of the intervention were twofold: (1) the teachers received a rubric with the elements and activities for each session. At the end of every session, teachers were expected to complete this rubric and deliver it to the researchers. Teachers reported high adherence to the protocol (95%; $SD = 2.03$). Moreover, (2) two research assistants observed 30% of randomly selected sessions, using the same rubric as the teachers. The treatment fidelity was high: analysis results of data from the observations of sessions indicated high adherence to the protocol (87%, $SD = 2.81$).

Ethical statement. The present study is part of a research project that has been approved by the University of Oviedo Ethics Committee for Research in Social and Human Sciences. Additionally, consent to conduct the study was obtained from the schools and parents of the participating children.

Data analysis

To examine our hypotheses, a structural equation model (SEM) was run (see Figure 2). The model hypothesized that the intervention had a statistically significant effect on academic achievement directly and via the students increased strategic activity (both macro [SRL] and micro [RC] strategies). The model included the pre-test measures as covariates to statistically control for their self-regressive effect. Reasons were twofold: participants were not randomly assigned to the control or experimental groups, and no statistically significant differences were found between GE and CG in the pretest levels for the two intermediate dependent variables SRL: $F(756) = 0.240$, $p > .05$; RC: $F(756) = 0.106$, $p > .05$. The models were fitted using Mplus 8.3 (Muthén & Muthén, 2017) with ML estimator. The fit of the model was evaluated using criteria as follows: χ^2, TLI, CFI, RMSEA, SRMR. There is evidence of a good fit when χ^2 has $p > .05$, TLI $\geq .90$, CFI $\geq .95$, RMSEA $\leq .06$, and SRMR $\leq .05$. The statistics AIC and SSABIC were used to select the best model (the best model is that with lower AIC and SSA-BIC). The effect sizes of the regression coefficients were assessed with the criteria pro-
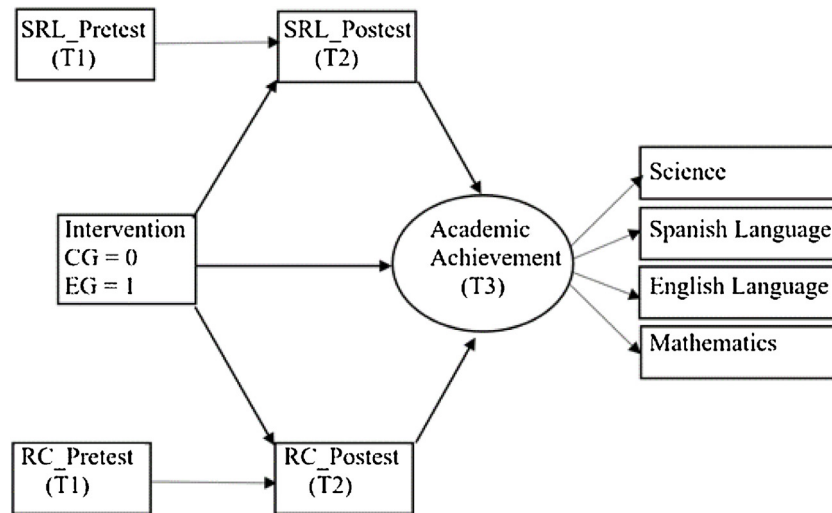
Figure 2. Initial Structural Equation Model hypothesized for the representation of the mediation of strategic activity (SRL and RC). SRL Pre-test (Pre-test Self-Regulation Learning); SRL Postest (Post-test Self-Regulation Learning); RC Pre-test (Pre-test Reading Comprehension); RC Postest (Post-test Reading Comprehension); AA (Academic Achievement); T1 (pre-test), T2 (post-test), T3 (follow-up). The initial SEM model also includes the covariation of the estimation error of the intermediate dependent variables (SRL with CR).

Table 1
Pearson correlation matrix and descriptive statistics of control and experimental groups

	RC_T1	SRL_T1	RC_T2	SRL_T2	SCI_T3	SLA_T3	ELA_T3	MAT_T3
Control group								
RC_T1: Reading Comprehension (pretest)	—							
SRL_T1: Self-Regulated Learning (pretest)	.128*	—						
RC_T2: Reading Comprehension (postest)	.628**	.150**	—					
SRL_T2: Self-Regulated Learning (postest)	.200**	.492**	.309**	—				
SCI_T3: Science (follow-up)	.542**	.155**	.520**	.278**	—			
SLA_T3: Spanish Language (follow-up)	.539**	.143*	.550**	.288**	.805**	—		
ELA_T3: English Language (follow-up)	.482**	.188**	.480**	.240**	.741**	.772**	—	
MAT_T3: Mathematics (follow-up)	.518**	.148**	.483**	.170**	.806**	.760**	.742**	—
M	11.26	4.21	11.62	4.02	3.75	3.84	3.66	3.81
SD	2.66	0.66	2.91	0.80	1.17	1.05	1.24	1.12
Asymmetry	-0.84	-1.15	-0.94	-1.14	-0.75	-0.87	-0.78	-0.88
Kurtosis	0.88	1.73	0.72	1.49	-0.31	0.27	-0.37	0.01
Experimental group								
RC_T1: Reading Comprehension (pretest)	—							
SRL_T1: Self-Regulated Learning (pretest)	-.005	—						
RC_T2: Reading Comprehension (postest)	.392**	.137**	—					
SRL_T2: Self-Regulated Learning (postest)	-.009	.442**	.225**	—				
SCI_T3: Science (follow-up)	.366**	-.111*	.378**	.127*	—			
SLA_T3: Spanish Language (follow-up)	.412**	.037	.370**	.130**	.757**	—		
ELA_T3: English Language (follow-up)	.345**	.124*	.397**	.145**	.733**	.688**	—	
MAT_T3: Mathematics (follow-up)	.412**	.063	.345**	.085	.675**	.780**	.680**	—
M	11.35	4.19	13.80	4.44	3.84	3.80	3.76	3.79
SD	2.41	0.70	2.17	0.55	1.07	1.02	1.15	1.15
Asymmetry	-0.48	-0.94	-1.33	-0.99	-0.91	-0.72	-0.72	-0.82
Kurtosis	0.10	0.64	2.13	0.27	0.30	0.07	-0.29	-0.08

Note. Control group (n = 355), Experimental group (n = 403); RC_T1 and RC_T2 (minimum 1, maximum 16); SRL_T1, SRL_T2, SCI_T3, SLA_T3, ELA_T3 and MAT_T3 (minimum 1, maximum 5).
*p < .05. **p < .01.

posed by Cohen (1988): d = 0.20 small; d = 0.50 medium; d = 0.80 large.

Results

Preliminary analysis

Table 1 presents the means, standard deviations, asymmetry, kurtosis, and Pearson correlation matrix for the control and experimental groups. The skewness and kurtosis data suggest that the variables are normally distributed. Likewise, the variables are sufficiently correlated to carry out a SEM analysis.

Analysis of the mediation of strategic activity

Fit of the initial path model (and subsequent re-specification)

Table 2 presents the data for the fit of the models (initial and final). Initial data suggested that this model did not show a satisfactory fit. The modification indices and the residuals from the initial model were examined, and a re-specification was conducted (i.e., a direct effect of the RC pre-test on academic achievement was estimated). With the inclusion of the aforementioned effect, the fit of the model improved significantly ($\Delta\chi^2_{(1)}$ = 92.02, p < .001), and the final model indicates an excellent fit.

Table 2
Indices of fit for the initial model and the re-specified model of mediation of strategic activity

	Initial SEM Model	Final SEM Model	Good fit Criteria
χ^2	160.410	68.389	–
df	21	20	–
p	<.001	<.001	> .05
TLI	.932	.975	≥ .90
CFI	.957	.985	≥ .95
RMSEA	.094 [.08 - .107]	.056 [.042 - .071]	≤ .06
SRMR	.074	.036	≤ .05
AIC	11581.595	11491.574	the smallest
SSA-BIC	11616.521	11527.955	the smallest

Note. TLI (Tucker-Lewis Index), CFI (Comparative Fit Index), RMSEA (Root Mean Square Error of Approximation), SRMR (Standardized Root Mean Square Residual), AIC (Akaike), SSA-BIC (Sample-Size Adjusted BIC).

Table 3
Results of the mediation model of SRL activity for the four subjects

	RW	SRW	SE	T	p <.	Cohen's d
Structural model						
INT → SRL_T2	0.422	.299	.030	9.914	<.001	0.772
INT → RC_T2	2.135	.388	.027	14.268	<.001	1.212
INT→ AA_T3	-0.302	-.155	.035	-4.419	<.001	0.325
SRL_T2 → AA_T3	0.142	.103	.034	3.056	.002	0.223
RC_T2 → AA_T3	0.116	.327	.040	8.236	<.001	0.627
RC_T1 → AA_T3	0.139	.361	.035	10.319	<.001	0.809
RC_T1 → RC_T2	0.507	.468	.026	17.977	<.001	1.724
SRL_T1 → SRL_T2	0.433	.418	.029	14.595	<.001	1.250
SRL_T2 ↔ RC_T2	0.300	.228	.035	6.536	<.001	0.489
Measurement model						
AA→ SCI	1.000	.873	.011	80.603	<.001	–
AA→ SLA	0.940	.891	.010	90.268	<.001	–
AA→ ELA	1.005	.826	.013	61.714	<.001	–
AA→ MATH	0.984	.850	.012	70.629	<.001	–

Note: RW (Regression Weights); SRW (Standardized Regression Weights); SE (Standard Error); SRL (Self-Regulated Learning); RC (Reading Comprehension); INT (Intervention: 0 = Control, 1 = Experimental); AA (Academic Achievement); SCI (Science); SLA (Spanish Language); ELA (English Language); MATH (Mathematics).
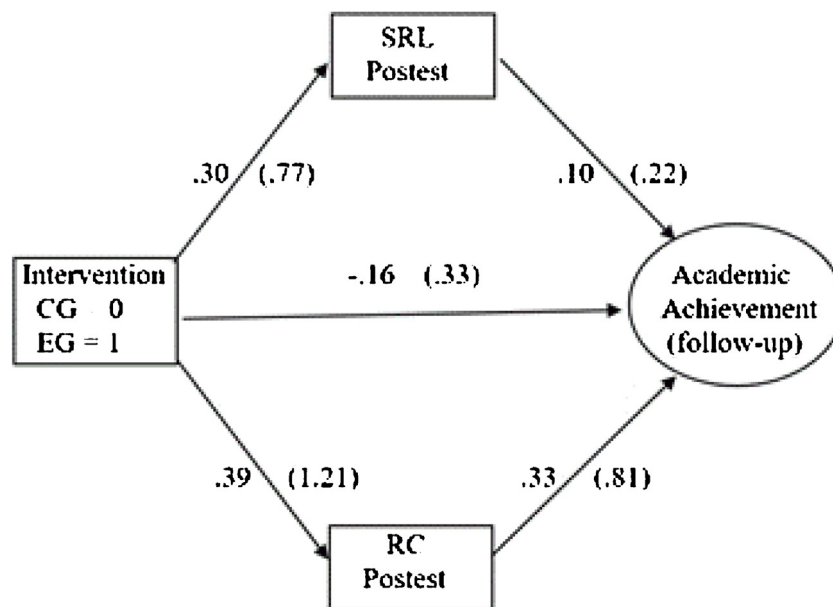

Figure 3. Parameters of interest in the Final Structural Equation Model hypothesized for the representation of the mediation of strategic activity (SRL and RC). CG (Control Group); EG (Experimental Group); SRL Postest (Post-test Self-Regulation Learning); RC Postest (Post-test Reading Comprehension). The effect sizes are in parentheses.

Evaluation of the final model

Table 3 presents the statistics related to the fit of the final SEM, and Figure 3 portrays the findings of most interest. The findings were as follows: first, the effect of the intervention on strategic activity (SRL and RC) was confirmed, so that the students of the experimental group significantly increased, to a greater extent than those of the control group, in their reported use of SRL and RC strategies.

More specifically, we found that the intervention had a positive and significant impact on the reported use of SRL strategies (b = .30, d = 0.77), with an effect size close to large, and of RC strategies (b = .39, d = 1.21), with a very large effect size. Second, strategic activity (reported use of SRL and RC strategies) was found to be posi-

tively and significantly related to academic achievement. However, the association between the reported use of SRL strategies and academic achievement was much smaller than that of the RC strategies ($b = .10$ and $b = .33$, respectively). Consequently, while the effect size of the reported use of SRL strategies on academic achievement was small ($d = 0.22$), that of the RC strategies was medium ($d = 0.63$). Third, the intervention was also significantly associated with academic achievement in a direct way, although negatively ($b = -.16$), and with a small effect size ($d = 0.33$).

Mediation analysis: Indirect effects

Table 4 shows the indirect effects (specific and total) of the intervention on academic achievement. Analysis results for the total indirect effects indicate that the intervention had a significant and positive impact on academic achievement through the increase of strategic activity (SRL + RC) ($b = .32$), with a medium effect size ($d = 0.63$).

Therefore, our findings indicate that strategic activity mediates the effect of the intervention on academic achievement. However, when analyzing the specific indirect effects, we found that the mediation effect was mainly through RC ($b = .25$, $d = 0.53$). In fact, the size of the effect of the intervention through SRL was statistically significant, but small ($b = .06$, $d = 0.21$). Finally, the results of the present study show that 31.4% of the variability in academic achievement was associated with the intervention.

Discussion

Extant literature reports evidence supporting the efficacy of interventions on SRL strategies to improve learning and achievement (Jansen et al., 2019; Theobald, 2021). Regardless of the educational stage, interventions on SRL strategies draw on the idea that increasing students' strategic resources will improve the quality of their learning and is expected to translate to better academic achievement (e.g., de Boer et al., 2018; Donker et al., 2014). However, findings from recent meta-analyses of studies with college students as participants indicate that the strategic activity resulting from training on learning strategies only partially mediates the effect of the interventions on achievement (e.g., Jansen et al., 2019). However, to the best of our knowledge, no studies provide information on this mediation effect in elementary school students. Therefore, the aim of the current study was to analyze the mediating effect of macro (i.e., SRL) and micro-strategies (i.e., RC) on the relationship between learning strategy intervention and school achievement in elementary school students.

About the mediational role of strategic activity

Focusing on the total indirect effects, the analysis results indicated that SRL + RC strategic activity only partially mediated the effect of the intervention on academic achievement. In fact, the current results show that academic achievement improved indirectly through the SRL and RC activity, and directly through other variables not included in this study (e.g., task motivation and time on task, or even to the match between the students' approaches to learning and the teachers' approaches to teaching). In general terms, however, these results confirm our first hypothesis and are consistent with Jansen et al.'s (2019) findings. The effect of the intervention on academic achievement, through the strategic activity promoted by the intervention (i.e., $b = .32$), was greater than that reported in previous studies. This finding may be due to the fact that the current intervention included training on RC strategies in addition to that on SRL strategies. In fact, the size of the effect of the intervention on academic achievement, through the

SRL activity (i.e., $b = .06$), was similar to that reported in the meta-analysis by Jansen et al. (2019) with college students ($b = .05$). Thus, the hypothesis of partial mediation was confirmed for elementary school students, but the effect size found was not greater than that of college students (Jansen et al., 2019: $b = .18$; present study: $b = .16$). However, the fact that at these early ages the increase in SRL macro-strategies, as a consequence of interventions such as ours, does not lead to great improvements in general academic achievement does not mean that these interventions should not be included in the instructional process. On the contrary, it is possible that the consolidation of SRL strategies, the perception of usefulness, and the development of perceived competence for their effective use, need time and diverse opportunities to translate to better learning processes.

The mediational process through SRL and RC strategies: Lessons learned

Our second hypothesis was also confirmed. The mediation of RC strategies was greater than that of SRL strategies. This is consistent with results from other studies conducted with elementary school students (Donker et al., 2014). Our findings suggest that young students may find training on domain-focused strategies (e.g., RC) easier to apply to school activities than training in general learning strategies (e.g., SRL). Similar results were obtained in a recent intervention study in the area of writing with elementary school students (Rosário et al., 2019). These authors found that (1) training in writing strategies notably improved the quality of written compositions, compared to those of control students, and (2) the quality of the compositions was not significantly higher in students with training in a program including, in addition to specific writing strategies, general self-regulation strategies (similar to the SRL strategies training in the current study). A possible explanation for these results may lie in the lack of maturation of young children to use SRL macro strategies (i.e., although they may learn them in the training phase, they may not be fully capable of using them autonomously in their daily learning activities). Moreover, teaching in early elementary school years is likely to encourage external regulation rather than self-regulation. This approach to teaching might help to explain the current findings of (a) greater increases in RC strategies than in SRL strategies, and (b) greater effect sizes for the use of RC strategies on achievement than those found for SRL strategies.

Limitations and future lines of research

The results of this study, despite being promising, should be viewed with some caution, mainly due to several limitations related to the design of the research, the data collection strategy, and the nature of the measures taken and the instruments used. First, the design followed in the present investigation is robust. However, the current conclusions could have been, to some extent, different if there two experimental groups were used instead: one with training in SRL strategies, and the other with SRL + CR (as in Rosário et al., 2019). Estimating the specific effects (and mediation effects) of each of the two types of strategies might have been able to shed light on the importance of each of the components of the intervention. Second, the instruments for evaluating the SRL and CR strategies provided information on the level of SRL or CR, but on the specific strategies trained in the intervention program. Therefore, we must interpret the results cautiously because we have gathered indirect indicators of the use of SRL and CR strategies. Future research could consider including specific and general measures of strategies. Third, SRL was assessed with self-reports which have limitations to capture complex constructs. While Jansen et al. (2019) found no notable effects of the type of evaluation instrument

Table 4
Specific and total indirect effects

	Estimate	SE	T	p <.	Cohen's d
Specific indirect effects					
Intervention → SRL → AA	.061	.021	2.918	.004	0.213
Intervention → RC → AA	.254	.036	7.094	<.001	0.533
Total indirect effects					
Intervention → SRL+RC → AA	.316	.038	8.325	<.001	0.634

Note. SRL (Self-Regulated Learning); RC (Reading Comprehension); AA (Academic Achievement).

on the magnitude of the mediation of SRL activity, future studies should consider using more than one measurement mode (e.g., log-file data, eye-movement data, physiological measures, video data) (Järvela et al., 2021; Panadero, 2017; Rovers et al., 2019). Finally, important variables of the students (e.g., task motivation, strategy motivation, possible selves, agency, students' perceptions of teacher support), of the teachers (e.g., teacher self-efficacy to implement self-regulated learning), of the instructional context (e.g., match between study approaches to learning and teaching approaches to teaching, group size) and of the family context (e.g., parental support) were not considered in the present study and, potentially, could have affected the results. For this reason, and as Jansen et al. (2019) noted, future studies should consider including many of those variables that may help to further understand this phenomenon.

Conclusions

The findings of the present study are consistent with previous findings on college students (Theobald, 2021). Our intervention with elementary school students was efficacious in improving the use of SRL strategies, but this improvement had limited impact on academic achievement. Despite being effective at increasing students' strategic activity (with a large effect size for SRL and very large for RC), this improvement did not, at least to the expected extent, lead to a notable improvement in academic achievement (a small effect size for SRL and a medium for RC). The explanation for the current findings may be more related to the teaching process or to teacher and/or student roles (e.g, de Smul et al., 2018; Frazier et al., 2021; Högemann et al., 2021; Karabenick et al., 2021; Kitsantas et al., 2021), rather than the students' lack of macro (SRL) or micro (RC) strategies despite the intervention program they received. For example, despite the consensus among educators about the need to develop students' self-regulation competences, the teaching approaches used may not provide adequate opportunities for using SRL strategies in daily class learning activities. Therefore, students with limited opportunities to use strategies in class may feel that these interventions are of little use in facilitating their school progress (Cerezo et al., 2019). Importantly, improvements in school achievement may be closely related to opportunities to use SRL strategies in class and progress in their classroom work. What seems clear is that improving the stock of students' self-regulation resources is not a sufficient condition for increasing their academic achievement proportionally.

Appendix I. *Inventario de Procesos de Autorregulación del Aprendizaje* (IPAA)

1. Hago un plan antes de comenzar a hacer un trabajo. Pienso en qué voy a hacer y qué necesito para realizarlo.
   Ejemplo: Si tengo que hacer un trabajo sobre dinosaurios. . . pienso en el texto, en las fotografías que quiero poner, de dónde puedo sacar la información, a quién puedo pedir ayuda, etc.
2. Durante las clases y en mi estudio en casa, pienso en cosas concretas de mi comportamiento para cambiarlo y lograr mis objetivos.
   Ejemplo: Si tengo apuntes de clase que no están muy bien tomados, si los profesores me llamaron la atención en clase por no atender, si mis notas están bajando,. . ., pienso en todo lo que tengo que hacer para mejorarlo.
3. Me gusta comprender el significado de las asignaturas que estoy aprendiendo.
   Ejemplo: Cuando estudio, lo primero que hago es intentar comprender los temas y después intento explicarlos con mis palabras.
4. Cuando me dan una nota, pienso en cosas concretas que tengo que hacer para mejorar.
   Ejemplo: Si saqué una nota baja porque no hice los ejercicios que me había mandado el profesor, pienso en ello e intento cambiar.
5. Guardo y analizo las correcciones de los trabajos para ver dónde me equivoqué y saber qué tengo que hacer para mejorar.
   Ejemplo: Busqué en mi carpeta el trabajo de conocimiento del medio del trimestre pasado para ver los fallos y mejorar en este trimestre.
6. Tengo un horario de estudio y lo cumplo. Si no lo cumplo, pienso el por qué no lo cumplí y saco conclusiones para después evaluar mi estudio.
   Ejemplo: Ayer no trabajé casi durante la tarde porque vinieron mis primos a verme. . . después revisé mi horario y me di cuenta de que hoy debo recuperar mis horas perdidas.
7. Estoy seguro de que soy capaz de comprender lo que me van a enseñar y por eso creo que voy a tener buenas notas.
   Ejemplo: Siempre estoy con mi lápiz en la mano, pendiente de las ideas del profesor para no perderme lo importante, así aprobaré sin problema la asignatura.
8. Comparo las notas que saco en una materia con mis objetivos propuestos para aquella materia.
   Ejemplo: He sacado un 5 en lengua y me había propuesto sacar un notable. . .me he dado cuenta de que necesito trabajar más.
9. Busco un lugar donde esté concentrado para estudiar.
   Ejemplo: Cuando tengo que estudiar necesito estar lejos de las distracciones, por eso lo hago siempre en mi habitación en mi mesa de estudio. Otras veces voy también a la biblioteca, donde todo está en silencio.

Appendix II. Examples of tasks corresponding to the academic achievement test

	Problem solving	Investigate	Practical tasks
Mathematics	Build an isosceles triangle with an angle of 40$^\text{o}$ using two sides of 6 cm each.	Maria wants to buy a new pair of spectacles for her daughter. She has three options for the lenses: single vision, progressive and bifocal lenses; and four options for the optical frames: metal, plastic, nude and dual toned frames. Maria wants to draw a schema to learn her options. Can you help Maria?	In a local grocery, D. Antonia makes packs with 12 items each of fruits and vegetables. She is struggling to organize her work. Can you help her by fulfilling this table? Packs: 1, 2, 4, 5, __, __; Fruits and vegetables: 12, __, __, __, 120, 240
Spanish Language	Read the story of the turtle and the rabbit race. Afterwards, impersonate the turtle and write a short compositing to explain why you have accepted the race, and your goals for the race.	Search for short texts on the climate change. Write short messages to encourage the role of students in climate change.	Read the text in the page 45 and identify nouns, adjectives and verbs
Sciences	Read the information on the textbook regarding magnets and magnetism. Write a short text about the "earth as a giant magnet".	Study the images in the book (p. 56) to learn the development of a frog. These data will help understand patterns of change until reach adulthood.	Complete the following texts: a) Some animals, such as the cockroaches, _____ and _____ don't have bones, but they have an outer skeleton. They can move due to their _____. b) Some invertebrates, such as _____, have a soft body and they move due to the liquid in its interior. c) The vertebrates move due to the_____, the articulations and the _____. d) For example, fish have _____ that help them swim.
English Language	Write the following sentences on the board: *She likes ice cream.* *They like ice cream.* Encourage the children to notice and explain the difference between the two sentences. Next to the first sentence, draw a girl with a happy face next to an ice cream cone. Next to the second sentence, draw two girls with a happy face next to an ice cream cone. Underline the verbs in each sentence. Explain that when we are using *he* or *she*, we add an *s* to the verb. Elicit other pairs of similar sentences and write them on the board with simple pictures. Repeat the procedure with *He doesn't like yoghurt /They don't like yoghurt.*	Give each child some old magazines and an envelope. They find a photo of a healthy food item, cut it out and put it in the envelope. Divide the class into pairs to create healthy lunch boxes.	Listen the audio and repeat Owen, do you like hamburgers? No, I don't. Do you like salad? Yes, I do. Do you like chips? Yes, I do. Do you like sweet corn? No, I don't. Do you like eggs? No, I don't. Do you like pineapple? Yes, I do.

Appendix III. Structure and content of the Rainbow Program

Session	Title	Reading	Reading Comprehension	Objectives and Study Skills	Activities	Self-reflection
PRETEST						
1	The beginning...	Chapters 1 and 2	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Promotion of the ability of being respectful with peers.	-Development of a confidentiality agreement.	Why are we here?
				-Development of the accomplishment of class rules.	-Production of a rules list.	
2	Reading makes me feel good!	Chapters 3 and 4	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Understand the importance of reading.	-Completion of the task "how to make a plan considering the environment and time".	Why is it better to plan things?
				-Make a definition of a plan. Knowing how and when to make a plan.		
3	I make a plan, execution and evaluation	Chapters 5 and 6	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Define the 3 phases of the cyclic self-regulated learning model: plan, execute and evaluate.	-Creation of a fish origami, to implement the self-regulated learning model.	Why is it better to divide goals into small steps?
4	I like learning more	Chapters 7 and 8	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Think over the challenge of group working and the inherent personal gains.	-Development of the activity "searching strategies and objectives" to do everyday tasks.	Development of an essay on the model of self-regulated learning.
				-Debate using an organized speech.		Refection on how we did.
5	I'm a detective, I research and I solve my own problems!	Chapters 9 and 10	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Behavior analysis and responsibility assumption.	-Completion of the activity: "what do I do if...". Under certain circumstances, children should propose appropriate behavior.	Why we should not be lazy?
				-Definition of problem. -Identification of the most common problems (laziness, lying, disobedience...)		
6	My motto: "When I'm wrong, I also learn"	Chapters 11 and 12	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Reflect calmly.	-Development of an activity where they have to think about 3 syllable words that start with "TE".	Why it does not matter if we are wrong?
				-Understand that if you do not find the answer on the first try, do not get discouraged. -Promote the ability to learn from failures.		
7	The podium of my trophies...	Chapters 13 and 14	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words). -First: constant organization -Second: never give up -Third: not to waste time	-Assess the organization in our lives. Explain that good organization is a sure path to academic success.	-Making a study schedule for home, where they will establish times for study and leisure.	Why we need to be organized?

8	Strategies with volition sauce	Chapters 15 and 16	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Learning how to give value to the effort, concentration and constant work.	-Completion of an exercise to concentrate and also to have willpower.	Why do we have to pay attention in class?
				-Learning to be aware that "who wants does more than who can"		
9	Foolproof tricks: tidy notebooks, underlining, and many schemes!	Chapter 17	Questions about chapters read and task completion (e.g., self-questioning, summarizing main ideas in one's own words).	-Give importance to learning strategies.	-Completion of the activity "The Solar System" making a scheme from the proposed text.	Why schemes help us to review the topic?
				-Learn how to underline well. -Learn how to make a good scheme.		
10	I'm already a brilliant student!		The whole class makes a book summary	-Promote the ability to argue and debate in an environment with diversity of opinions.	-Completion of the activity: "Now you're a super-student", Students have to give advice to a class-mate to improve their achievement.	Final thought where you will produce a summary of all topics worked together
	POSTEST **FOLLOW-UP**					

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