Article

Evaluation of the Computerized Strategic Reading Program applied to Elementary School Students[1]

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Abstract: Nationwide studies and evaluations performed in Brazil have shown that most elementary education students have difficulties in reading comprehension, despite the fact it is a skill that is essential for academic success. This study evaluates a Computerized Strategic Reading Program (*Programa Informatizado de Leitura Estratégica* - PILE) intended to improve reading comprehension of elementary school students. A total of 58 students attending from the 5th to 8th grades, with a mean age of 12.52 years, participated: 29 comprised the control group (CG) and 29 comprised the intervention group (IG). A Cloze test was used pre- and post-measurement. The PILE was administered for six weeks, totaling 19 meetings. There was significant improvement from the pre- to the post-measurements for levels of reading comprehension in both the IG and the CG. The IG experienced a greater impact from the intervention, suggesting that PILE was effective in improving reading comprehension among these students.

Keywords: Elementary Education, Psychological Assessment, Reading Comprehension.

Avaliação do Programa Informatizado de Leitura Estratégica para Estudantes do Ensino Fundamental

Resumo: Estudos e avaliações nacionais realizadas no Brasil têm revelado que alunos do ensino fundamental apresentam, em sua maioria, dificuldades para compreender textos, apesar de esta competência ser imprescindível para o sucesso escolar. O presente estudo objetivou avaliar o Programa Informatizado de Leitura Estratégica (PILE) destinado a promover a compreensão em leitura de alunos do ensino fundamental. Participaram 58 alunos de 5ª a 8ª séries, com idade de 12,52 anos, em média, 29 estudantes compuseram o grupo controle (GC) e 29 o de intervenção (GI). O Teste Cloze Básico-MAR foi utilizado como pré e pós-medida. O PILE foi administrado durante seis semanas, totalizando 19 encontros. Verificaram-se melhoras significativas, da pré para a pós-medida, para os níveis de compreensão em leitura de GI e GC. Constatou-se que GI sofreu grande efeito da intervenção, o que sugere que o PILE foi efetivo na implementação da compreensão em leitura desses estudantes.

Palavras-chave: Ensino Fundamental, Avaliação Psicológica, Compreensão da Leitura.

Evaluación del Programa Informatizado de Lectura Estratégica para Estudiantes de Escuela Primaria

Resumen: Estudios y evaluaciones realizadas en Brasil revelaron que alumnos de enseñanza primaria presentaron, en su mayoría, dificultades para comprender textos, aunque esta competencia sea imprescindible para el éxito escolar. Así, el objetivo de este estudio es evaluar el Programa Informatizado de Lectura Estratégica (Programa Informatizado de Leitura Estratégica-PILE) que tiene el propósito de promover la comprensión en lectura de alumnos de enseñanza primaria. Participaron 58 alumnos de 5º a 8º años, con promedio de 12,52 de edad. De ellos, 29 compusieron el grupo control (GC) y 29 el de intervención (GI). El Teste Cloze Básico-MAR fue utilizado como pre y post-medida. El PILE fue administrado durante seis semanas, totalizando 19 encuentros. Fueron verificadas mejoras significativas para los niveles de comprensión en lectura del GI y GC. El GI tubo gran efecto de la intervención, lo que sugiere que el PILE fue efectivo en la implementación de la comprensión en lectura de esos estudiantes.

Palabras clave: Enseñanza de Primer Grado, Evaluación Psicológica, Comprensión de Lectura.

The National Curriculum Parameters (NCP) for the Portuguese language (Ministry of Education [MEC], 1998) propose that students of the 5th to 8th grade are able to use various technological resources and information sources to acquire and construct knowledge, from their skill in reading. It is expected that the students, in order to finalize this first stage of formal schooling, are skilled readers and that they use different forms of language to communicate.

Despite these goals, in Brazil 11.8% of the population aged over 15 years show little proficiency in reading and writing and this rate increases to 26% if those who have not completed the initial four years of primary school are considered (Instituto Brasileiro de Geografia e Estatística

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[IBGE], 2006). Besides, the evaluations on the performance in reading carried out by the National Evaluation System of Elementary Education (SAEB) in 2003 revealed that 59% of the elementary education 4th grade Brazilian students had not mastered the written language, and thus make up the profile of individuals that are in the phase of decoding words (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira [INEP], 2003).

In this overview of the initial years of schooling, these national evaluations (INEP) found that students in higher grades still present poor performance with regard to language. The reports of SAEB revealed that only 10% of the 8th grade graduates (INEP) and 5% of those who completed the elementary education in the 3rd year of high school were considered competent readers (INEP, 2004). Further to this, Brazilian studies on the theme (Carvalho, 2006; Joly & Nicolau, 2005-2006) show results which corroborate those of the INEP, revealing that elementary education students have, in the majority of cases, difficulty comprehending texts.

Reading comprehension corresponds to extracting the main message of a text and is considered a complex procedure of decoding graphic symbols. This requires the interaction of the reader with the text in order to understand it and is revealed as the fundamental cognitive ability for the acquisition of knowledge. It covers some aspects of intelligence, such as analytical skills (analysis, evaluation or comparison), practical skills (application of knowledge in specific situations or tasks) and creative skills (original thought, invention, or imagination) that are directly or indirectly involved in the procedures used for effective comprehension. Given this information, it can be observed that reading comprehension is a result of a cognitive effort directed toward the way the task is accomplished, both from the view of the reader and the task itself (Brown & Smiley, 1978; Calderón, 2003; Joly & Lomônaco, 2003; Marchant, Lucchini, & Cuadrado, 2007; Randi, Grigorenko, & Sternberg, 2009; Salvia & Ysseldyke, 1991; Sánchez, 1995; Schreiber, 2009).

The strategic reader processes the information read in light of the macro and micro textual levels, with the micro exemplified by the search for the idea or meaning of a specific phrase and the macro by the summary of the main ideas of the text. Apart from the use of specific procedures for each level, the strategic reader promotes the interaction of these procedures with their prior knowledge on the theme, then constructs a mental image of the text and an adequate comprehension (Griffith & Ruan, 2009). Skills are involved in information processing and the implementation of reading strategies that require the interaction and coordination of many components, thus, the evaluation of reading comprehension requires instruments focused on the proposed objective.

Capovilla, Joly and Tonelotto (2006) indicate some instruments available for evaluating reading comprehension in Brazil, which include the verification of word decoding, competence in silent reading and comprehension. Specifically for the purpose of this study, the Cloze technique is highlighted among the comprehension measurement methods. It consists of a text with some words omitted with the respondent filling the gaps so that the phrases make sense. This technique, according to a review undertaken by Joly (1999, 2006, 2009) on the studies carried out in Brazil since 1970, is effective not only as a diagnostic measure, but also as an intervention strategy to improve reading comprehension.

In order to use the Cloze as a reading comprehension evaluation instrument, Joly (2004) constructed the Basic Cloze Test-MAR for students of the 2nd stage of elementary education (4th and 5th year). In order to verify the psychometric properties of the test, two studies were performed. The first was performed by Joly and Nicholas (2005-2006) with 511 students aged 9-14 years ($M = 9$, $SD = 8.4$), with 53.4% of the children male, in the 4th grade of elementary education, of both public and private schools of the state of São Paulo. The accuracy of the evidence was obtained by means of *Cronbach's alpha* coefficient, which revealed a good index ($\alpha = 0.95$). Guttman's Method of Halves, applied to obtain the reliability coefficient of the test through the internal consistency of the items, revealed an accuracy of 0.90 ($\alpha = 0.90$ for part 1 with 30 items and $\alpha = 0.92$ for part 2 with 29 items) and a correlation of 0.83 between the two forms. The test presented evidence of validity regarding the criterion age and also when comparing the extreme groups, allowing the discrimination in the study sample of the skilled readers in relation to those who presented difficulties in reading (Joly & Nicolau, 2005-2006).

The second study conducted for the Basic Cloze Test-MAR (Joly, 2004), with the same sample, was performed by Joly, Nicolau, Piovezan, Dias and Istome (2007) in which the Item Response Theory was applied. For this study, the test again revealed a good level of reliability ($\alpha = 0.95$). An estimation of the parameters of the items was performed through the two-parameter logistic model, which indicated a good fit for this model, due to 98.4% of the items being adjusted, and the fact that these do not present residues greater than 1.46. The test revealed a mean difficulty index of 0.81 (SD=1.16). Of the total items, it was noted that 25 could be considered difficult, because they had difficulty values (b) above 1.50. However, only one item of the test proved to be very difficult ($b= 3.00$) for the sample studied, due to it presenting a difficulty index above the critical value of 2.95. The discrimination (a) of the items of this test showed an average index equal to 1.04 (*SD*=0.25), but with a variation from 0.61 to 1.75, above the critical value of 0.30.

To evaluate the efficacy of the Cloze technique as a development of reading comprehension and diagnostic instrument, Santos (2004) conducted a study with 24 students from the 5th grade of elementary education. Structured texts were used in different forms of the Cloze technique, taken from Portuguese Language books, and the gaps obeyed the rational, independent of the category of words omitted. The evaluation was performed in the pre- and post-test moments

and through an intervention program using several texts in which the technique was applied. The students made the corrections immediately after completing the text, through the reading of the full text by the test supervisor. In the pre- and post-test, the texts were organized by omitting the 5th term; in the other stages of the intervention program, every 10th term was omitted, with the ratio of omissions gradually decreasing in order to increase the level of difficulty.

The study lasted two months and the sessions were held weekly, with eight sessions in total. In the pre-test all the students were at the level of frustration, i.e. none of them achieved more than 40% of correct answers in the applied Cloze test. In the post-test 11 students remained at the level of frustration, while four moved to the instructional level and 10 to the independent level. The results showed that this technique applied to a text appropriate for the age group of the respondents, seems appropriate to evaluate and develop reading comprehension.

Joly (2006, 2009) proposed the organization of the text from the specific criteria relative to the number of words, omissions of terms, size of gaps and answer choices, aiming to determine different levels of difficulty using the Cloze technique. This variation was called the Cloze Oriented System (COS) and can be strategically used to broaden the skills required in the comprehension of a text and, therefore, to prevent later problems. The COS is organized from a particular criterion, which in turn determines the difficulty of the text.

The analysis of the efficiency of the COS concerning its relationship with reading attitude and its validity was the aim of a study by Joly (2007). The Computerized Comprehension Program (*Programa Informatizado de Compreensão* - PIC) was applied with 40 students of the 1st to 4th grades of elementary education and based on the COS of excerpts from stories of Brazilian children's literature. It was administered twice a week, with a total of 18 sessions. Before and after the PIC, the participants responded to a traditional Cloze test and also to the Reading Attitude Inventory, a printed protocol adapted to Portuguese, aiming to evaluate the reading attitude of the students and the influence of the PIC on academic and recreational reading. The results showed that the performance of all the participants in reading comprehension was higher after participating in the PIC and significant differences were found regarding the reading attitude. Significant differences were verified in the attitude toward academic reading in the post-test between the proficient readers and those who had little skill.

Brazilian studies using the Cloze technique to measure the reading comprehension of students verified levels below expectations for the level of schooling investigated (Joly & Nicolau, 2005-2006; Oliveira, Boruchovitch, & Santos, 2007, 2008) and also confirmed the efficacy of the technique in the diagnosis of reading comprehension. Intervention studies

with the Cloze technique corroborate the lower than expected performance in reading tasks related to comprehension and fluency and indicate the scope for higher levels after the interventional procedure in this area (Englert, Zhao, Collings, & Romig, 2005; Gabl, Kaiser, Long, & Roemer, 2007; Joly, 2007; Joly & Lomônaco, 2003).The Cloze technique, therefore, is configured as effective both in the diagnosis and the remediation of reading comprehension.

Considering the relevance of reading for learning, as noted earlier, and the need for educational programs valid for this purpose, this study aimed to evaluate the Computerized Strategic Reading Program (*Programa Informatizado de Leitura Estratégica* - PILE) for the development of reading comprehension of elementary education students.

Method

Participants

A total of 58 students who had the permission of their parents or guardians, and regularly attended the 5th (51.7%), 6th (24.1%), 7th (15.5%) and 8th (8.6%) grades of elementary education in a public school in Brazil, participated in this study. It was therefore a convenience sample taken from the entire population of students of the 5th to 8th grades of the educational institution where this study took place (Maroco, 2007). A total of 58.6% of the participants were female and 41.4% male. The mean age of the participants was 12.52 years (SD = 1.417). The students were divided into two groups, using simple random selection, composing the control group (CG) (n = 29) and the intervention group (IG) (n = 29). The specific characteristics of each group are presented in Table 1.

Table 1
Characterization of the Groups of Participants Regarding Gender, Grade and Age

Variable	Control Group	Intervention Group
Gender (%)		
Female	58.6	58.6
Male	41.4	41.4
Grade (%)		
5th	51.7	51.7
6th	27.6	20.7
7th	10.3	20.7
8th	10.3	6.9
Age (years)		
Minimum	11	11
Maximum	16	16
Mean	12.31	12.72
SD	1.168	1.623

Instruments

The following describes the instruments used in the study.

Basic Cloze Test-MAR (computerized) developed for the Brazilian socio-cultural context by Joly (2004). It consists of an extract from the story of the children's book *The Brown Boy* (Pinto, 1986), indicated to evaluate reading comprehension for students of the 4th to 8th grades of elementary education. The text has about 300 words, contains 59 omissions replaced by lines, all of which are the same size. The completion of the gaps is literal, and for every correct answer one point is awarded, giving the maximum possible score of 59 points. Studies on the psychometric quality of the instrument were perfromed by Joly and Nicolau (2005-2006) and Joly et al. (2007).

The Computerized Strategic Reading Program (*Programa Informatizado de Leitura Estratégica-PILE*) was developed by Joly (2008) with the aim of promoting reading comprehension, and is intended for students of the 5th to 9th years of elementary education. The PILE originated and was adapted from the program created by Joly (1999) in terms of computer language, quantity of text and level of difficulty. It consists of a series of excerpts from stories to which the Cloze Oriented System (Joly, 2006, 2009) is applied, in a sequence of gradually increasing difficulty regarding the number of words between omissions and additional clues (choice options, size of the space, word database), considering the Cloze Oriented System as the criteria for the organization of the texts. The texts were selected considering their appropriateness for the age of the participants, regarding the topic, text structure and vocabulary.

The sessions of the program are divided into three stages:

Stage 1 - The Cloze technique is applied to three extracts of 150 words each from different stories of literature (Bandeira, s.d.), appropriate for the education level, with the omission of the 10th term and with two options for filling the gaps

Stage 2 - The Cloze technique is applied to three extracts of 200 words each from different informative science texts (taken from texts related to environmental conservation projects for example), appropriate for the level of education, with the omission of the 8th term with three options for filling the gaps.

Stage 3 - The Cloze technique is applied to three extracts of 250 words each from different informative texts related to modern themes (internet, selective garbage collection and transgenic foods), appropriate for the level of education, with the omission of the 6th term, with a single list of words for filling all of the gaps.

The program records the responses of the student who, when finished, has the opportunity to correct the gaps filled incorrectly. At the moment when the system records the performance of at least 75% correct answers the program passes to the next text, with the rate of filling the gaps of each text defined by the participant. The texts of the first stage are literary, while the second and third are informative.

With each new stage, the respondent rehearses an example to ensure that they know the type of response required for the texts of the next stage. Additionally, an image-summary of each text can be accessed to assist in the comprehension and filling the gaps. The option to access the image is also available in the examples of the three stages.

After filling in the gaps of each text and achieving the necessary level of correct answers, the respondent informs the program of any words in the text that were unknown. Next some comprehension questions concerning the text are answered. For the texts of the first stage, two literal comprehension questions are presented, while in the second stage there are three comprehension questions, two literal and one inferential. For the third step, five comprehension questions are presented, two literal, one inferential, one critical and one creative. The instructions for the completion of the PILE are described in the initial screens of the software. In all the intervention sessions, a monitor was present to guide the students, answer questions and solve technical problems.

Procedure

Data collection

The Basic Test Cloze-MAR was applied as the pre-measurement, in the computer lab of the school. This was carried out collectively before the groups were divided and the intervention started, and was computerized. After this, the students who would compose the intervention and control groups were randomly selected.

The students who composed the IG participated in the PILE. The program was administered over six weeks, three times a week, with an approximate duration of 1 hour per meeting, totaling 19 meetings. Once the IG concluded the PILE, the computerized Basic Cloze Test-MAR was reapplied as the post-measurement, both with the IG and the CG, at the same time, to verify possible changes in comprehension of texts and the use of metacognitive reading strategies. It is important to highlight that the IG participants completed the PILE from the 5th session of intervention.

Data Analysis

The data analysis was performed using parametric statistical tests since this model meets the criteria of normal distribution for the sample ($n = 58$), as measured by the Kolmogorov-Smirnov normality test (Maroco, 2007), as well as the measurement conditions in the interval scale of the performance in reading comprehension, according

to the criteria of Siegel (1975). It should be noted that the IG and CG were organized by simple random selection of the participants, a method that increases the strength of the inferences from the results of the analyzes performed with the margin of error of 5% (Bunchaft & Kellner, 1998; Maroco, 2007). The tests used were the Student's *t* test for independent samples when comparing the IG to the CG and for the paired samples when verifying the performance in reading comprehension of the IG before and after the PILE. The calculation of the effect (*d*) was used according to the procedure presented by Cohen (1988) aiming to analyze the differences in the scores of the IG and the CG in comprehension based on the other measurement parameter and on the practical significance of the result. It should be noted that, according Maroco, analysis of the power of the statistical test, of the confidence interval, of the sample size, of the observed variance and/or of the size of the effect can help to diagnose the presence or absence of statistical significance. Together with these analyzes, multiple linear regression was carried out with *enter* and then *stepwise* selection of the variables*,* to obtain a parsimonious model that allows predicting the comprehension performance as a function of the independent variables (scores of the steps and total of the PILE).

Ethical considerations

The Research Ethics Committee of the São Francisco University reviewed and approved the execution of this study under CAAE protocol number 0260.0.142.000-08. It should be noted that, before the start of data collection the Terms of Free Prior Informed Consent (TFPIC) were sent to the parents of the students to obtain permission for the participation of their children. Furthermore, the consent of the director of the institution to conduct the entire study procedure was also obtained.

Results and Discussion

In view of the objective of this study, the Student's *t* test for independent samples was performed to verify whether the control and intervention groups were different regarding the level of reading comprehension in the pre-measurement, so that the inferences to be made could prove the hypothesis of the validity of the PILE to develop reading comprehension. There were no significant differences observed between the groups in relation to comprehension performance ($t[56] = 1.467$; $p = 0.148$). Therefore, the equivalence of the IG and CG at the initiation of the study was determined.

Table 2 presents the descriptive statistics regarding the performance of the participants in reading comprehension in the two evaluations performed. The maximum possible score of the Basic Cloze Test-MAR used to assess the level of reading comprehension before and after the intervention

is 59 points. The midpoint of this test is, therefore, between 29 and 30 points. It can be noted that the two groups did not reach a score greater than the midpoint. Considering that the test was constructed for students of the educational level attended by the participants, this finding corroborates the national studies carried out by INEP (2003, 2004), as well as investigations by Joly and Nicolas (2005-2006) and Oliveira et al. (2007, 2008, 2009), that indicate difficulty in reading and text comprehension.

Table 2

Descriptive Statistics of the Reading Comprehension score regarding the pre- and post-measurements by Group based on the Basic Cloze Test-MAR

| Statistics | Basic Cloze Test-MAR | | | |
| | Pre-measurement | | Post-measurement | |
	CG	IG	CG	IG
Minimum	5	0	6	4
Maximum	29	28	30	29
Mean	17.14	14.48	19.48	19.90
SD	5.992	7.689	6.104	5.888
Lower CI*	14.86	11.56	17.16	17.66
Upper CI*	19.42	17.41	21.80	22.14

Note. CG - Control group. IG - Intervention group.
*CI - confidence interval of 95%.

The performance in the PILE was verified through the means of the scores in each text. The scores were also compared to the standard scale for the purposes of comparison of the performance of each text and stage. It was observed that the performance of students in the third and final stage was the highest among the stages (Table 3).

Table 3

Descriptive Statistics of the Scores in the Programa Informatizado de Leitura Estratégica-PILE in the Standardized Scale

PILE		Minimum	Maximum	Mean	*SD*
Stage 1	Text 1	-2.44	0.65	-0.0012	0.9999
	Text 2	-3.15	0.75	-0.0027	1.0001
	Text 3	-2.76	0.70	-0.0019	0.9999
Stage 2	Text 1	-2.31	1.37	-0.0015	1.0000
	Text 2	-1.76	1.11	-0.0006	0.9999
	Text 3	-2.02	1.17	-0.0013	0.9999
Stage 3	Text 1	-0.75	2.18	0.0003	1.0000
	Text 2	-0.90	1.89	0.0005	1.0000
	Text 3	-0.80	1.53	0.0003	1.0000

The *t* test for dependent samples was applied to verify possible differences in the performance of the IG and CG in relation to the level of reading comprehension at the pre- and post-measurement, considering that the IG participated in the PILE. There were significant differences for both the IG ($t[28] = -5.122$; $p \leq 0.001$) and for the CG ($t[28] = -5.147$; $p \leq 0.001$), revealing that there were alterations in the pattern of comprehension of both groups.

Due to these results, the calculation of the effect (*d*) of the PILE on the performance of each group was carried out, considering the evaluation performed at both times (pre- and post-measurements). The effect size shows, through the standardized scale "z", how much the two means differ in terms of standard deviations. This analysis aimed to evaluate the effect of the PILE on the reading comprehension through another parameter and was another way to verify differences between the means, having the procedures proposed by Cohen (1988) as the reference.

Based on the criteria established by Cohen (1988), it was noted that the CG had a small to medium effect size (*d* = 0.386), while the PILE had a large effect on the IG (*d* = 0.798), suggesting that the Program was effective for the implementation of reading comprehension for these students. The effect observed for the CG possibly denotes the teaching and school development relative to the level of education that the student belongs. According to Cohen's criteria, this confirms the results of the analysis of the effect (*d*), and attributes criterion validity to the PILE.

These results corroborate the study of Joly (1999) regarding the effect of the intervention program used to implement comprehension, as well as the studies by Joly (2007) and Joly and Lomônaco (2003). They also indicate the importance of intervention to implement the performance in reading comprehension, confirming studies by Girgin (2007), Joly (2006), Joly and Istome (2008), among others. It should be noted that the efficiency of the COS applied to intervention programs (Joly, 2007, 2009) and of the Cloze as a diagnostic and remedial technique (Englert et al., 2005; Gabl et al., 2007; Santos, 2004) were verified.

In order to identify the stage and texts of the PILE that contributed most to the performance of the IG after the program, the associations were verified between the performance of the IG in the PILE and Basic Cloze Test-MAR. The total score on the Basic Cloze Test-MAR at the post-measurement was associated positively and significantly with the performance in the second and third texts of step 3 ($r_{texto2} = 0.421$, $p < 0.05$; $r_{texto3} = 0.574$, $p < 0.00$), as well as the total score of the third stage ($r_{stage3} = 0.507$, $p < 0.00$) and the total score of the PILE ($r_{stage3} = 0.424$, $p < 0.05$). Due to this, the multiple linear regression with *enter* and then *stepwise* selection of the variables, was used to obtain a parsimonious model that allows the prediction of the comprehension performance at the post-measurement according to the independent variables (scores of the stages and total of the PILE). Multicollinearity was diagnosed between stages 1, 2, 3, and the total score of the PILE. It was found from the simple

linear regression between the Basic Cloze Test-MAR score in the post-test as the dependent variable and the score of the 3rd stage of the PILE that this step, among the independent variables of the PILE, was the most representative to verify the prediction.

The stepwise multiple linear regression, between the scores of the Basic Cloze Test-MAR in the post-test as the dependent variable and the scores of the stages of the PILE as independent variables, allowed the third stage of the PILE to be identified as the only independent variable in the model that best explains the variability of 23% of the performance in reading comprehension at the post-measurement ($F [1.27] = 9.354$; $p = 0.005$; $R^2_a = 0.23$). The model predicts 50.7% of the performance of the post-measurement in comprehension.

By way of summary, it was found that the Computerized Strategic Reading Program (PILE) (Joly, 2008) is appropriate to intervene in the reading comprehension of elementary education level students in a first exploratory study of feasibility and validity. It is important to realize that computerized intervention programs are becoming important means to enable the formation of strategic readers through critical and autonomous reading comprehension, as they promote greater control of the time and answers, as well as minimize costs and stimulate the use of technology by the students.

Conclusions

Considering the results found in this study, evidence of validity for the PILE was verified, although the proof of its efficacy in promoting the level of reading comprehension of the students who participated in the intervention was limited to the results of the analysis of the effect (*d*). Despite the advances provided by the results of this study, the limitations are emphasized regarding the size and homogeneity of the sample with respect to the type of school. It is suggested that studies be undertaken that also consider the answers given to the questions that follow the texts, the response time, the total time consumed in carrying out the program for each student, among other variables, with larger, more representative samples and with students of the private teaching network.

Future studies are also suggested that evaluate the difficulty level of the texts, include a training module on metacomprehension, cover the teaching of basic metacognitive strategies, evaluate the basic reading skills, and compare good and poor readers or that include specific modules with informative texts by area of knowledge (geography, history, science, etc.). It is important to verify that only stage 3 of the PILE is sufficient to implement the reading comprehension of the students, given its predictive capacity for such performance identified in this study. Along with these suggestions, studies that aim to adapt the PILE to other levels of education, for example, the first stage of elementary education, high school education and higher education are also necessary.

In addition, it is also suggested that the performance in the PILE be related to other variables that are associated with school performance, such as motivation for learning, memory, attention, phonological awareness, among others. Thus, considering the technological advances already discussed and the PILE as a computerized tool, teaching methods can be expanded so as to minimize possible learning difficulties resulting from the deficit in reading comprehension.

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