Studies in Educational Evaluation 70 (2021) 101020

Contents lists available at ScienceDirect

Studies in Educational Evaluation

journal homepage: www.elsevier.com/locate/stueduc

Intelligence quotient, short-term memory and study habits as academic achievement predictors of elementary school: A follow-up study

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ARTICLE INFO

Keywords:
Intelligence quotient
Short-term memory
Study habits
Academic achievement
Elementary school

ABSTRACT

Few studies have explored the differential contribution of general intelligence, short-term memory and study habits has on academic achievement during elementary school, especially during a two-year follow-up. The aim of this study is to determine whether there is a relationship between intelligence quotient (IQ), short-term memory and study habits and their ability to predict the academic achievement of children in elementary school (74 pupils aged 8–9 years old). The instruments used are the General and Factorial Intelligence Test (GFI-3 revised), the Yuste Memory Test (MY), the Study Habits and Techniques Questionnaire (SHTQ) and the average score obtained in the final exams in both 3rd and 4th grade. IQ, short-term memory and study habits are significantly related to academic achievement. These variables can predict 56–59 % ($p < .001$) of the variability of academic achievement. The study concludes that IQ and study habits are two significant predictor variables of academic achievement.

1. Introduction

Poor academic achievement is a frequent problem as can be observed in the latest Programme for International Student Assessment (PISA) (2015). This poor academic achievement is related to greater difficulties in finding employment, taking unstable jobs and receiving lower salaries in adulthood (Eckert, 2006). In addition, poor academic achievement is the main reason students leave school early (European Commission, 2018). Therefore, uncovering the factors related to academic achievement during elementary school could enable us to create early intervention programs that prevent poor academic achievement (from 6 to 12 years old).

Numerous studies have been carried out in recent decades to determine which factors are the most important in academic achievement (Spinath, 2012). Among the most researched cognitive factors, intellectual capacity stands out (Navas, Maicas, & Germán, 2003; Roth et al., 2015). Thus, numerous investigations have shown that general intelligence, understood as Spearman's factor g (1904), is the most powerful predictor for academic achievement (Deary, Strand, Smith, & Fernandes, 2007; Kaufman, Reynolds, Liu, Kaufman, & McGrew, 2012; Rohde & Thompson, 2007). In this vein, other studies have used large samples and have found a relationship between the execution of intelligence tests and academic achievement with the predictive power of .54 (Roth et al., 2015). However, general intelligence is a relatively stable factor (Gottfredson, 2002).

With respect to other cognitive variables, another factor traditionally related to academic achievement is memory (Bayliss, Jarrold, Gunn, & Baddeley, 2003; Bull, Espy, & Wiebe, 2008). Short-term memory allows information to be passively retained for a short period of time; it is a different construct from working memory, since it does not require attentional/executive control (Swanson & Kim, 2007). In addition, working memory is strongly related to IQ, while short-term memory is not (Conway, Cowan, Bunting, Therriault, & Minkoff, 2002; Engle, Tuholski, Laughlin, & Conway, 1999). Short-term memory is associated with performance in both reading and mathematics (Bayliss, Jarrold, Baddeley, & Gunn, 2005; Bull et al., 2008; Hulme, Goetz, Gooch, Adams, & Snowling, 2007; del Valle & Urquijo, 2015; Swanson & Kim, 2007). This relationship between memory and academic performance has been found in children, adolescents, and adults (Bull et al., 2008; Engle et al., 1999; Swanson & Kim, 2007).

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https://doi.org/10.1016/j.stueduc.2021.101020
Received 28 June 2020; Received in revised form 10 March 2021; Accepted 13 April 2021
Available online 21 April 2021

Finally, among the so-called noncognitive variables, study habits are among the most relevant (Bickerdike, O'Deasmhunaigh, O'Flynn, & O'Tuathaigh, 2016; Credé & Kuncel, 2008). Study habits are understood as the learning trends that pupils set in motion privately, that is, each person's systematic or disordered, efficient or nonproductive way of studying (Ayodele & Adebiyi, 2013) or "behavioral dispositions, tendencies, and habits that are not measured by typical cognitive tests, such as tests of school performance, ability, and aptitudes" (Lee & Stankov, 2013, p. 119–120).

In their meta-analysis, Richardson, Abraham, and Bond (2012), named self-regulatory learning strategies to metacognition, effort regulation, help seeking, peer learning, time/study management, etc. On the other hand, Geller et al. (2017) referred to them as "study strategies". In this line, Credé and Kuncel (2008, p 426), states "that the empirical and theoretical literature relating to these constructs is very large and very fragmented, described by a wide variety of proposed constructs, and operationalized by an array of inventories" like study habits, study skills, study attitudes, study motivation or meta-cognitive skills and Bickerdike et al. (2016, p. 230) states that "the nomenclature and terminology in the literature to describe the mode of learning that students adopt in higher education is diverse…".

This series of concepts is encompassed in the self-regulated learning approach, originally called the information processing approach (Pintrich, 2004) and includes cognitive, motivational, affective and social contextual factors (Pintrich, 2000). This model of self-regulated learning, presented by Pintrich (2004), contains four general assumptions that give us a vision of how learners are conceived: students are viewed as active participants in the learning; learners can potentially control and regulate certain aspects of their own cognition, motivation and behavior; there is some type of criterion or standard against; self-regulatory activities are mediators between personal and contextual characteristics. Encompassed in the description of the self-regulated learning approach developed by Pintrich (2004), habits and study techniques shall be understood as the general attitude towards study, the place of study, the physical condition, the work plan, the procedures and steps for study, performance of exams and class work (Álvarez & Fernández, 2015).

In this regard, some research has found that study skills and attitudes, study habits, and the motivation to study are robustly related to academic achievement at the university stage (Credé & Kuncel, 2008). Similarly, strategies such as effort, attention to work and study environment have been positively related to academic achievement, reporting a variance of up to 10 % in academic achievement in undergraduates (Ruffing, Wach, Spinath, Brunken, & Karbach, 2015).

Furthermore, these types of variables are not related to cognitive skills, which makes them abilities that are independent of the pupil's own intellectual capacity although directly related to the acquisition of new knowledge and learning (Credé & Kuncel, 2008). In addition, these variables are considered less stable than cognitive ability (Richardson et al., 2012).

Despite these interesting findings, the contribution that each of the aforementioned variables has on academic achievement still remains unclear, and which of them has greater predictive power in elementary students. Few studies have explored the differential contribution of each during elementary school (from 6 to 12 years old) in the same prediction model. There are some studies that have researched these contributions separately or with other variables, but we have not found any studies that have investigated study habits and intelligence together in students of 10 years old or younger (Bull et al., 2008; Geary, 2011; Lu, Weber, Spinath, & Shi, 2011). For example, Veas, Castejon, Gilar, and Minano (2015) conducted a study with pupils aged 11–15 years old in which they combined intellectual capacity assessment, self-concept, goal orientation, learning strategies, popularity and parental involvement. All of these factors showed a significant relationship with academic achievement, reporting a variance of 56 % in academic achievement, highlighting the multifactorial nature of this measure. Another study combined general intelligence, learning strategies and goal orientation in the prediction of academic achievement in students between 13 and 15 years of age (Minano, Castejon, & Gilar, 2012). The authors found that the set of study variables explained 66 % of the variability of academic achievement, where 48 % was composed of the intelligence factor and 18 % was represented by the rest of the noncognitive variables. Ruffing et al. (2015) evaluated the general cognitive capacity and learning strategies of students from 17 to 44 years old and found significant relationships between academic achievement and general cognitive ability, with effort being the strategy that presented the greatest relationship.

These results point to the importance of mixing different types of variables in predicting academic performance, and as proposed by Veas et al. (2015), extend the findings in adolescent and college students to elementary school children. Replicating these findings with younger children would aim to detect the strongest predictor of academic performance to promote early assessments in children with poor achievement.

Therefore, the general objective of this study is to evaluate the IQ, short-term memory and study habits of a group of 74 pupils during elementary school, along with the predictive capacity of these variables, with respect to academic achievement over two consecutive years. This general objective is specified in the following specific objectives. The first objective of the study is focused on analyzing the predictive capacity of the study variables (IQ, short-term memory, and study habits) on the academic achievement of both school years and analyze the differences between both years. It is expected that these three variables will significantly contribute to the prediction of academic achievement in both school years and that there are no differences between them. The second objective aims to assess the predictive capacity of the variables (IQ, short-term memory and study habits) in the change in academic achievement from 3rd to 4th grade. It is expected that these three variables will significantly contribute to the prediction in the change in achievement.

2. Method

2.1. Participants

The sample is composed of elementary school pupils from the autonomous community of Aragon (Spain). The sample of convenience is made up of 74 pupils (39 male/35 female) aged 8–9 years old (mean = 8.35; SD = .48) who are enrolled in the 3rd grade of elementary school in a state-subsidized school in the province of Zaragoza. The inclusion criteria were as follows: 1) to be in the 3rd grade of the designated elementary school, 2) to have no diagnosis of mental disorder according to the DSM-5, 3) to have no physical disability that could prevent the evaluation from being carried out, and 4) to have parental/legal guardian signed informed consent to participate in the research. All participants had a medium-high socioeconomic level.

School grades were recorded longitudinally for the same pupils for two consecutive years, i.e., during 3rd grade in 2016−17 and during 4th grade in 2017−18. In the second year, the study lost two participants as they left the school (N = 72 pupils).

2.2. Instruments

The instruments used to measure the different variables are explained below. *The General and Factorial Intelligence Test* (*GFI-3 revised*) (Yuste, 2009) was used to measure the intelligence variable, the *Yuste Memory Test (MY)* (Yuste, 2010) was used to measure short-term memory and the *Study Habits and Techniques Questionnaire* (SHTQ) (Álvarez & Fernández, 2015) was used to measure study habits in 3rd grade. In addition, the academic achievement variable was measured by the pupil's grades for the two consecutive school years.

2.2.1. The general and factorial intelligence test (GFI-3 revised)

The GFI/3 revised version has been previously used (Yuste, 2009). It is composed of six subtests, namely, analogical relations, verbal comprehension, numerical/verbal problems, basic numerical concepts, completing scenes and completing figures. These subtests are presented in two parts, in this case A and B, which are composed of 144 items, with multiple choice questions for 5 alternatives. The online correction score of the test was used, which provides a standard score (IQ). The administration time is 40 min for part A and 36 min for part B. According to its authors reliability analyses indicate values between .70 and .92 using the Kuder-Richardson coefficient. Construct validity was performed using factorial techniques. There are correlations (concurrent validity) between the GFI and the Raven test (.31–.62) and the domino test (.38–.72).

2.2.2. Yuste memory test (MY) (Yuste, 2010)

This test is composed of a group of tests with the objective of evaluating short-term memory by auditory-verbal stimuli. The application can be either individual or collective (in this case, it was decided to apply it collectively) and has a duration of 25 min. The test is designed for four different levels depending on age. Therefore, we applied Level I, which corresponds to pupils aged 8−10. It consists of the oral presentation of words that the pupil must remember and the memorization of narrations to answer a series of questions later. A correct answer is scored as one point, and an incorrect answer is scored as zero. A maximum of 57 can be obtained (raw scores are used). This test is valid for assessing a child's memory. The reliability of the test is .80 according to the authors of the test (information included in the test manual).

2.2.3. Study habits and techniques questionnaire (SHTQ) (Álvarez & Fernández, 2015)

This test assesses how the student studies. The questionnaire is broken down into seven levels: (a) the general attitude towards study, understood as the predisposition, interest and motivation towards study; (b) the place of study, explained as the physical location occupied for study and which benefits concentration and performance; (c) the student's physical condition, related to the personal physical conditions that allow good performance for study; d) the work plan, which includes everything related to good planning and structuring of time and material; e) study techniques, understood as guidelines for studying, i.e. knowing "how to study"; f) exams, exercises and homework, in relation to the guidelines to be followed when carrying out this type of action. Finally, g) assignments, which includes the aspects to be taken into account when carrying out an assignment, e.g. initial outline, sources of information, etc. This questionnaire consists of a total of 56 items to be answered with a "yes" or "no". Raw scoring was used for the analyses. The test lasts 30 min and was administered collectively.

2.2.4. Academic achievement

The pupils' grades were obtained during two consecutive school years (the 3rd grade of elementary school in 2016−17 and the 4th grade of elementary school in 2017−2018). The average grade for the following 10 subjects was calculated at the end of the year (one final grade for 3rd grade and another for 4th grade): natural sciences, social sciences, language, English, physical education, artistic education, music, art, religion and mathematics. The grades are awarded by the children's teacher as a result of the assessments carried out throughout the year in the different subjects to assess the level of acquisition of the curricular content. Score for each student was obtained from the average of the three assessments carried out during the academic year (December, March and June). A quantitative score was obtained (from 1 to 10): fail (F) (from zero to 4.9: considerable further work is required); sufficient (E) (5 to 5.9: performance meets the minimum criteria); satisfactory (D) (6 to 6.9: fair but significant shortcomings); good (C) (7 to 7.9: generally sound work with a number of notable errors); very good (B) (8 to 8.9: above the average but with some errors) and excellent (A) (9 to 10: outstanding performance with only minor error).

The summary of the tests and instruments used in the present work are described below in Table 1.

2.3. Procedure

All the participants obtained signed informed consent to participate in the study. The tests were administered by a person trained in educational neuropsychology. The tests were administered in the mornings and in a quiet room inside the school. First, the IQ test (GFI-3 revised) was carried out over three sessions in 3rd grade, then the memory test (MY) was carried out during one session, and finally, the study habits questionnaire (SHTQ) was conducted in other session. All of the sessions lasted 45 min each approximately. Academic achievement data were recorded over two consecutive years (3rd grade in 2016−2017 and 4th grade in 2017−2018) for the same pupils.

2.4. Data analysis

Once the data had been collected, the corresponding analysis was carried out using the SPSS program, version 25 (IBM Corp, 2017), including the calculation of descriptive statistics (mean, standard deviation, minimum and maximum) and the Pearson's linear correlation coefficient, including age as a control variable.

To perform the analysis of the first objective, multiple linear regressions were applied using the Enter method (forced entry) (criteria: probability of F to enter < 05). All variables were included in a block in the following order: age (control variable), sex male (control variable), IQ, memory and study habits. The sex variable was changed to a dummy variable to incorporate it into the regression (sex male). As dependent variables, 3rd and 4th grade academic achievement were introduced in different regressions. To compare the two regression models, Amos Graphics v.23 program was used to running a path model that involves the two regressions model (3rd grade academic achievement and 4th grade academic achievement). Model comparison assuming unconstrained model to be correct (assuming that the regression coefficients may be different between the grades) compared to a fixed model (the regression coefficients are the same between two grades). Structural weights have been taken into account to interpret the model.

To calculate the change (objective 2), a *t*-test of related samples was first performed to determine whether the change was significant. Then, a subtraction was made (4th grade academic achievement - 3rd grade academic achievement). Finally, a linear regression was performed with this score using the same procedure as explained in objective 1. The level of significance used was .05.

Table 1
Descriptions of the Variables.

Variable	Type	Instrument	Scores
IQ	Quantitative	*GFI*-3 revised questionnaire (Yuste, 2009)	1−144 in general intelligence. Subsequent IQ data entry.
Short-term memory	Quantitative	Memory test (MY) (Yuste, 2010)	1−57, 1 being the least and 57 being the highest. Raw score
Study habits	Quantitative	SHTQ questionnaire (Álvarez & Fernández, 2015)	1−56, 1 being the least and 56 being the highest. Raw score
Academic achievement	Quantitative	Academic history 2016−2017 course 2017−2018 course	Average final score of the two grade levels (3rd and 4th grade of elementary school). 1−10, 1 being the lowest and 10 being the highest

3. Results

Table 2 provides descriptive data on the study variables. In the case of IQ, the results are between a score of 85 and 115 (mean = 107.62). In terms of memory, the average raw score is 28.31, which is close to the 40th percentile. For the study habits scores, the average score is 37.55, which is in the 48th percentile. Finally, with regard to the mean academic achievement, the subjects studied present values of over 7 (in the range of 0–10), reaching level C (good: generally sound work with a number of notable errors). A statistically significant and positive correlation was observed between the three variables (IQ, short-term memory and study habits) and academic achievement over the two years ($p < .01$) (Table 3). The age variable was included in the correlation as a control variable. No significant correlation was found for $p < .01$ (Table 3). The results show statistically significant differences in the IQ variable ($p = .001$) (boys= 112.74 and girls=101.94).

The first objective was to explore the analysis of the predictive capacity of the variables (IQ, short-term memory and study habits) on academic achievement (Table 4).

Multiple linear regression shows that the included variables have a predictive capacity of 59 % ($p < .001$) on 3rd grade academic performance. Analyzing the coefficients, we can observe that sex, age and memory are not significant predictors. On the other hand, we can observe that IQ and study habits are the significant predictors ($\beta = .406$; $p < .001$ and $\beta = .546$; $p < .001$ respectively).

In the linear regression with 4th grade academic performance, we observed a predictive capacity of the variables of 56 % ($p < .001$). Again, sex, age, and memory were not found to be significant. IQ and study habits are again the significant predictors ($\beta = .570$; $p < .001$ and $\beta = .333$; $p < .001$ respectively).

The results of the model comparison indicate that there are no statistically significant differences between the regression coefficients presented in the both grades (3rd vs 4th grade) (DF = 5; CMIN = 5.189; $p = .393$), therefore, the weights of the predictor variables are the same in the two consecutive years.

The second objective of the study was to explore the predictive capacity of the variables (IQ, short-term memory and study habits) on the change of academic achievement from 3rd to 4th grade. Firstly, a comparison of the means of repeated measures (*t*-test) was carried out to determine if there was a significant difference between the mean of the 3rd grade (mean = 7.80, SD = .91) and that of the 4th grade (mean = 7.57; SD = 1.03). The results showed a significant difference, displaying a lower mean in the 4th grade (t = 3.759, $p < .001$). The Cohen's *d* was .236, which indicates a small effect size.

Next, the average scores of the two years were subtracted to calculate the change. The results show a mean difference of −.236 with a SD of .532. Finally, a linear regression was performed with the change scores (Table 4).

The results indicate that the variables are able to predict 12 % of the change between 3rd and 4th grade ($p = .014$). Again, the significant variables are IQ and study habits ($\beta = .415$; $p = .002$ and $\beta = -.300$; $p = .017$, respectively). The results show that one SD increase in IQ is associated with a 0.41 (SD) increase in change in academic achievement and that one SD increase in study habits is associated with a 0.30 (SD) decrease in change in academic achievement. Therefore, IQ and study habits are associated with opposite effects on change over the grade of an academic year.

Table 2
Descriptive Data of the Variables.

Variable	M	SD	Min.	Max.
IQ	107.64	14.13	74	139
Memory (RS)	28.31	6.62	8	43
Study habits (total) (RS)	37.55	6.66	21	48
3rd grade academic achievement (mean total)	7.78	.92	5.4	9.4
4th grade academic achievement (mean total)	7.57	1.03	5.2	9.6
Change in academic achievement	−.236	.532	−1.60	1.10

Note. SD = standard deviation; Min. = minimum; Max. = maximum; RS = raw score.

Table 3
Correlations of IQ, Memory, Study Habits and Academic Achievement.

Variable	Age	IQ	Memory	Study Habits	3rd Grade AA
IQ	.281*	–			
Memory	.066	.120	–		
Study habits	−.066	.195	.217	–	
3rd grade AA	.064	.543*	.282*	.658*	–
4th grade AA	.064	.656*	.293*	.491*	.857*

Note. IQ = intelligence quotient; AA = academic achievement.
* $p<.01$.

Table 4
Results of the Multiple Linear Regression Analyses for Academic Achievement and Change in Academic Achievement.

Variable	B	SE	β	R^2 adjusted	*p*
3rd grade AA (mean average)					
Sex male	.097	.168	.053		
Age	−.073	.158	−.038		
IQ	.026	.006	.406**	.599	<.001
Memory	.018	.011	.127		
Study habits	.075	.011	.546**		
4th grade AA (mean average)					
Sex male	.127	.198	.062		
Age	−.222	.188	−.103		
IQ	.041	.007	.570**	.565	<.001
Memory	.025	.013	.160		
Study habits	.051	.013	.333**		
Change in AA					
Sex male	−.022	.145	−.020		
Age	−.159	.137	−.143		
IQ	.015	.005	.415*	.129	.014
Memory	.005	.010	.069		
Study habits	−.024	.010	−.300*		

Note: IQ = intelligence quotient; AA = academic achievement.
* $p < 0.05$.
** $p < .001$.

4. Discussion

The general objective of this study was to evaluate the intelligence quotient (IQ), short-term memory and study habits of a group of elementary school students, as well as to analyze the predictive capacity of these variables on academic achievement over two consecutive years (3rd and 4th grades). The results indicate that there are positive correlations between academic achievement and the three variables in both 3rd and 4th grade. The results indicate that the variables are capable of predicting 56–59 % of the variability of academic performance. IQ and study habits are the significant predictive variables while memory does not show any prediction. The descriptive data indicate that the sample studied has an IQ between 85 and 115. Scores for memory and study habits are close to average for children who are in elementary school.

The results of the analysis of the relationship between IQ and academic achievement indicated a statistically significant correlation. The relationship between IQ and academic achievement has been supported by numerous studies (González-Pienda, 2003; Lynn & Meisenberg, 2010; O'Connell, 2018; Saß, Kampa, & Köller, 2017), although there is less agreement on the level of that correlation. Thus, while some studies speak of coefficients of .70 (Mackintosh, 1998), other studies present more moderate results where the intellectual factor as measured through standardized tests reports a 41 % variance in academic achievement (Primi, Ferrão, & Almeida, 2010); this variance even goes as low as 22 %

(Richardson et al., 2012). In that sense, Roth et al. (2015) found academic achievement correlation values of .45 in elementary school, .54 in middle school and .58 in high school. The authors interpret these results as an increase in the school level as school content becomes more demanding as students progress through grades. We have not found significant differences, possibly since only one academic year had passed, but there was a trend like that shown for Roth et al. (2015). The increase in school demands, the development of better study habits, or the pass of time, could be different causes of the variability found between studies on the relationship between IQ and academic performance. However, it would be necessary to follow up with students in a longitudinal study to know how the relationship between IQ and academic achievement changes over time (Geary, 2011).

In regard to the relationship between short-term memory and academic achievement, a moderate correlation has been found and they are similar in the two grades. Related studies show similar findings, such as Castillo-Parra, Gómez, and Ostrosky-Solís (2009), who found a statistically significant positive relationship between memory and academic achievement, which indicated that the importance of this factor decreases from the age of 12. Another important issue to highlight is the result of the stability of the relationship between short-term memory and academic achievement in the two consecutive years evaluated. Other studies have found similar correlation coefficients in higher educational levels, such as the study by del Valle and Urquijo (2015), which found that the relationship between short-term memory and academic achievement in university students has a coefficient of .34. On the other hand, Sarver et al. (2012) performed a 4-year follow-up of children up to 16 years of age and found correlations of moderate intensity (.37–.45) among the study variables according to the subject (reading, math or language). These results indicate that having a better short-term memory is related to better academic achievement and remaining stable for the following grade levels even though the level of academic demand is higher.

In terms of the relationship between study habits and academic achievement, significant correlations were found. The results are consistent with those of other studies that conclude that the use of study habits has positive effects on academic achievement (Mendieta, Mendieta, & Chamba, 2015; Toledo, Toledo, & Zambrano, 2016; Valero, 2011), thus, indicating that to learn adequately, one needs to develop a methodology or study habits. For example, Chen et al. (2018) found that a positive attitude towards the study of mathematics predicted academic achievement in children aged 7–10. In addition, they found that this attitude towards mathematics was related to the activation level of the hippocampus even after controlling for IQ, age, working memory, and math anxiety. In this way, the hippocampus might mediate the relationship between some study habits and attitudes and academic achievement. However, similar results have also been found with other educational levels. Credé and Kuncel (2008) carried out a meta-analysis in which they found a strong relationship between study habits and academic achievement in college students, concluding that study habits and study skill measures are the most important predictors of academic achievement when IQ is not evaluated. Similar results have been found in first-year college students (Kleijn, van der Ploeg, & Topman, 1994; West & Sadoski, 2011).

Finally, the results on the predictive capacity of IQ, short-term memory and study habits on academic achievement revealed that our variables of interest (IQ, memory and study habits) predict 59 % of the academic achievement in the first year of evaluation and 56 % in the second year of evaluation. IQ and study habits are the only significant predictive variables. The present study finds no significant difference in the regression coefficients of the study variables with the academic performance of 3 rd Grade and with the academic performance of 4th Grade. That is, the predictive weight remains the same with respect to the prediction of academic performance in two consecutive years. This percentage is similar to that found by Veas et al. (2015), who assessed cognitive and noncognitive variables in adolescent students (middle school), including IQ and learning strategies, among others, and obtained a predictive model of 61 %. However, they only conducted one assessment to measure the academic achievement; therefore, the coincidence of the current study's findings with these results brings a component of temporal stability to this prediction. In the last objective, the change in academic achievement between 3rd and 4th grade was analyzed. The results indicate that there are lower scores in academic achievement in the second year, which may be because the academic level demand is higher, and therefore, the content of the subjects is more difficult. The predictive model shows that IQ and study habits are the significant predictors. It is necessary to highlight the coefficient of study habits (−.30), since it is negative, instead, the IQ coefficient was positive (.41). While the increase in IQ is associated with greater change in academic performance, the opposite would occur with study habits, i.e., their increase is associated with less change in performance. Thus, there appears to be a trend whereby most students with higher IQ would experience more variation in their academic performance while most students with high levels of study habits would experience less change in their performance. These results indicate the importance of students also having a good acquisition of study habits as a variable associated with the stability of academic performance. These results must be interpreted with caution due to several limitations because the study has a small sample, and the measurement of academic performance is not entirely objective, since it not only depends on the level of acquisition of academic learning, but also on other factors (multifactorial) such as the child's behavior. Despite this, we must bear in mind that the results shown in this paper present a model that can predict almost 60 % of the variability of academic performance with only three variables (IQ, memory and study habits).

Our study included a measure of general intelligence and another measure of short-term memory, but we have not included other cognitive processes such as working memory or processing speed, which are also related to academic achievement (Geary, 2011; Lu et al., 2011). However, working memory and general intelligence are strongly related processes, and including them together could increase the weight of these common factors (Conway et al., 2002; Engle et al., 1999). Other noncognitive variables, such as motivation, parent education, school attitudes, socioeconomic level or classroom-level effects, also have substantial weight (Froiland, 2020; Lu et al., 2011; Minano et al., 2012) since some forms of parent involvement also predict both academic achievement and some aspects of study habits at this age (Froiland, 2020). The non-inclusion of these variables is a limitation and may have led to a possible overestimated effect size which can lead us to interpret the results with some caution. It would be desirable to analyze the specific weight of these components along with others that have also been shown to be relevant, such as personality factors, motivation and parental education, in larger samples of school-age children and to take a longitudinal approach similar to that presented here but of longer duration, where it would be possible to closely follow the evolution of these different variables related to academic achievement in elementary school. Variables such as expectations, autonomy support and the relationship between families and school should be taken into account in future research (Froiland, 2020). Another factor that must be taken into account is the nature of many of the intelligence assessment tests. Some of the components that they contain and that are related to measures of crystallized intelligence are related to learning processes, which could increase the relationships found between IQ and academic performance. A future direction extending the present research should examine the interaction between cognitive and non-cognitive variables and if study habits are more important for those with low IQ.

From these results, it can be concluded that IQ and study habits are the most important factor (predicting almost 60 %), and that while short-term memory is related, it is not a significant factor in predicting academic achievement in elementary school children. These results remained stable for two consecutive years in elementary school students (3rd and 4th grades). When a child has low academic performance, it is

necessary to carry out psychoeducational evaluations. The results of the study show us that IQ and study habits can be predictors of good academic performance, so they should be evaluated preferentially. In contrast, short-term memory is apparently less important, although more research is needed on this point. The evaluation can not only be focused on cognitive variables such as IQ, rather it is essential to measure study habits also. The results show the need for students to acquire study habits since they are easy to learn and adapted to compensate for academic demands throughout the school year. Therefore, it is important to implement programs which would be focused on improving the study habits of children before 8 years. This study provides a more stable view of these needs, since it provides a measurement of two consecutive years.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgements

No funders were involved in study design, analyses, manuscript preparation, or decision to submit for publication.

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