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Intelligence and Scientific-Creative thinking: their convergence in the explanation of students' academic performance

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Abstract

Introduction. Academic performance is usually generatly explained by students' intelligence, although other factors such as personality and motivation also account for it. Factors associated with a more complex thought process in adolescence are also beginning to gain importance in the prediction of academic performance. Among these forms of thought are scientific, critical, and creative thinking. This paper analyses the convergence of cognitive psychological variables when accounting for academic achievement in Compulsory Secondary Education.

Method. A sample of students (n=98) attending 2nd and 4th year of secondary education in the Region of Murcia participated in this study. Participants took an intelligence test (IGF/5r) and a test of Scientific-Creative thinking (TPCC). In addition, students' achievement in all curricular domains was collected from teachers. In order to analyse the data, curricular disciplines were grouped into three main domains: scientific-mathematical, social-linguistic and artistic domains.

Results. The regression analyses showed a significant complementary contribution of Scientific-creative abilities in the prediction of academic achievement in the three curricular domains, being a better predictor for the artistic domain. In scientific-mathematical and linguistic-social domains, the predictive value of IQ –especially numerical reasoning– is more decisive than scientific-creative abilities. This analysis was conducted by dividing the sample according to students' academic year.

Discussion and Conclusions. When comparing results from the two groups of students, we found that as students advance in their school years, other cognitive variables besides psychometric intelligence start to become more relevant in students' academic achievement. Some important socio-educational implications are drawn from these results.

Keywords: Intelligence, Creativity, Scientific-creativity thinking, performance, adolescence

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Inteligencia y pensamiento científico-creativo: su convergencia en la explicación del rendimiento académico de los alumnos

Resumen

Introducción. El rendimiento académico suele ser explicado en gran parte por la inteligencia de los alumnos, aunque otros factores, como la personalidad y la motivación, también contribuyen a su explicación. En la adolescencia otros factores asociados a un pensamiento más complejo comienzan a tomar importancia. Estas formas de pensamiento se corresponden con el pensamiento científico, el crítico, el creativo. Este artículo analiza la convergencia de variables psicológicas de índole cognitiva en la explicación del rendimiento académico de los alumnos de Educación Secundaria Obligatoria.

Método. Se han tomado alumnos de 2º y 4º curso de un centro educativo de la Región de Murcia, España (n=98) y se ha aplicado un test de inteligencia (IGF/5r) y un test de pensamiento científico-creativo (TPCC), también se recogieron las calificaciones facilitadas por los profesores para todas las áreas académicas. Se agruparon las disciplinas y el rendimiento en tres áreas: Científico-Matemática, Lingüístico-Social y Artística.

Resultados. Los resultados del análisis de regresión muestran una contribución complementaria del TPCC en la predicción del rendimiento académico de los alumnos en las tres áreas curriculares, siendo la predicción más importante en el área Artística. En las áreas Científico-Matemática y Lingüística-Social, es más decisivo el test de inteligencia, en particular el razonamiento numérico. Estos análisis se repitieron dividiendo a la muestra según el curso académico.

Discusión y Conclusiones. Los resultados encontrados en dichos análisis sugieren que avanzando en la escolaridad otras variables cognitivas, pero diferentes de la inteligencia psicométrica más clásica, acaban siendo importantes en la explicación del rendimiento académico de los alumnos, destacándose finalmente algunas implicaciones psico-educativas importantes.

Palabras Clave: Inteligencia, Creatividad, Pensamiento científico-creativo, Rendimiento académico, Adolescencia.

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Introduction

During childhood, intelligence seems to adequately explain school performance in students, but as the transition into adolescence begins, other non-cognitive variables are assumed to be equally relevant in explaining student performance (Bratko, Chamorro-Premuzic, & Saks, 2006; Conard, 2006; Farsides & Woodfield, 2003; Furnham & Chamorro-Premuzic, 2004; Gilles & Bailleux, 2001; Kappe & van der Flier, 2012; Noftle & Robins, 2007; O'Conner & Paunonen, 2007; Poropat, 2009). According to these authors, motivation and personality dimensions acquire relevance in explaining school performance as the individual ages and advances to higher levels of schooling, hence the interest in not confining cognitive skills to just logical or convergent thinking. At the end of adolescence, more complex types of thought, such as scientific, creative and critical thinking are just as valuable as analytic intelligence. These have an abstract nature and a greater association with classic intelligence tests (Ackerman, 1996; Beauducel, Brocke & Liepmann, 2001; Bermejo, Ferrándiz, García-Esteban, & Sáinz, 2013 in press; Ruiz, 2013; Sternberg, 1997). Given that this article focuses on both scientific-creative thinking and the impact of intelligence on school performance, it is important to describe the concepts of intelligence and scientific-creative thinking, particularly the latter, since it has come under examination only more recently.

On one hand, *Intelligence* is defined as the cognitive skill that allows each individual to think, learn and solve the problems of everyday life with different degrees of agility (Jensen, 1998; Primi, Ferrão, & Almeida, 2010; Sternberg, 1997). In academic terms, this ability is reflected in the quantity and quality of acquired learning; its relationship to academic achievement has been a traditional topic of study in psychology. With investigations reaching back over a century, intelligence has been purported to be a strong and universal predictor of academic performance (Chamorro-Premuzic & Furnham, 2005; Colom & Flores-Mendoza, 2007; Deary, Strand, Smith, & Fernandes, 2007; Laidra, Pillmann, & Allik, 2007; Primi et al., 2010; Rosander, Bäckström, & Stenberg, 2011; Taub, Keith, Floyd, & Mcgrew, 2008).

On the other hand, *scientific thinking* can be generically defined as a set of cognitive processes and skills used to solve problems of a scientific nature, it can also be considered as the cognitive process that a researcher uses when performing studies or other typical scientific activities (Dunbar & Fugelsang, 2005; Paul & Elder, 2003). Among these cognitive functions we can mention induction and deduction, analysis and synthesis, problem solving, causal reasoning or syllogistic reasoning, confrontation and implications, as well as fluency and flexibility of ideas or novelty and originality, which are more directly associated with creativity. Two specific moments tend to be valued in scientific thinking: the proposal of a hypothesis and the experimentation or testing phase, the latter being performed in order to confirm or reject the stated hypothesis (Klahr & Dunbar, 1988), taking into consideration that at these two moments both creativity and intelligence become relevant (Ferrando, Prieto, Ferrándiz & Sánchez, 2005; Ferrando, Bermejo, Sainz, Ferrándiz, Prieto, & Soto, 2012; Prieto, Ferrando, Hernández, & Sainz, 2011a; 2011b).

To the best of our knowledge, there is little research that links scientific-creative thinking to academic performance. But such a relationship seems obvious if we accept the classical claims that training in scientific thinking favours both cognitive development and students' performance in science and mathematics (Bredderman, 1983; Harlen, 1999; Ostlund, 1998; Tipps, 1982). These positive effects have led researchers to design assessment tools of scientific-creative thinking, assuming creativity is one of the main components of scientific thinking, or at least an important one in the phase of posing a hypothesis to explain phenomena.

Regarding the design of instruments that assess scientific-creative thinking, it is important to consider the weight or relevance attributed to processes of creativity (fluency, flexibility and originality) and scientific content. In some tests the content can be viewed as a deciding component of performance, in which case, the students' score would be determined by their academic background in the scientific area or based on the scientific content of each task in the test. In other tests, the student's scientific knowledge is not as essential to completion of the test and, thus, creative skills may be more decisive in the outcome. For example, the Test of Integrated Science Processes (TISP, Tobin & Capie, 1982), which evaluates student's performance in planning and conducting research in a scientific area, requires a good level of pertinent knowledge. By contrast, performance on the Scientific Creativity Test (Hu & Adey, 2002) does not depend as much on scientific knowledge as it does on the creative process. This test has been validated for a Turkish sample, and has achieved a good reliability index (Pekmez, Aktamis, & Taskin, 2009). Another test designed to evaluate scientific and creative thinking is the Creative Scientific Ability Test (C-SAT, Sak & Ayas, 2011). This test aims to assess scientific skills such as formulating and testing hypotheses and assessing evidence; relevant in this production are the classical cognitive processes associated with creativity (fluency, flexibility and originality).

Aims

This exploratory article aims to assess the contribution of intellectual abilities and creative-scientific thinking to explaining academic performance in a group of students enrolled in Secondary Education. Since studies on the relationship between intelligence and academic performance are much more common, this study attempts to verify whether scientific-creative thinking accounts for the variance in academic performance.

Method

Participants

This study was performed with an incidental sample of 98 students (55% male) from a Secondary School in the Region of Murcia (Spain). Participants attended 2nd and 4th year of Compulsory Secondary Education (ESO-Educacion Secundaria Obligatoria), ages 12 to 16 (M = 14.6, SD = 1.42). Also noteworthy is that some participants showed cognitive difficulties and belonged to the curricular diversification program, while others were identified as high ability students (i.e. gifted or talented students).

Data Collection Tools

Data was collected through two instruments. The first was the “Scientific Creativity Test” (SCT), developed by Hu and Adey (2002) to determine students’ level of scientific *creativity*. This test consists of 7 tasks: Task 1 (Glass) - Write a list of all the different scientific uses a piece of glass could have; Task 2 (Space) - If you could travel into space in a rocket ship and visit another planet, what scientific questions would you like to research?; Task 3 (Bicycle) - How could we improve an ordinary bike to make it more interesting, useful and appealing?; Task 4 (Gravity) - Describe what would happen in the world if there was no gravity; Task 5 (Squares) - How many different ways could you divide a square into four equal parts ?; Task 6 (Napkins) - Assuming you have two types of napkins, how can you determine, through various experiments, which one is the best?; and Task 7 (Apples) – Now you must design a machine that harvests apples (a. Draw the machine, b. Name the machine, c. Name the different parts of the machine you have designed and write what each piece is for). These seven tasks assess three dimensions of creativity: fluency, flexibility and originality, except for the last task, which only considers fluency (number of machine functions) and originality. Several studies have been done with this test, including a study by the authors themselves, emphasizing that the global test obtains a satisfactory reliability index (α = .89) as well as adequate inter-rater agreement (between .79 and .91). Also noteworthy is the fact that factor analysis identified a single factor that explains 63% of variance. This same data was confirmed in the adaptation and validation study of the SCT for Spain (Ruiz, Bermejo, Prieto, Ferrándiz, & Almeida, 2013), excluding the "Square" task which presented several difficulties in convergence with the other tasks (this task tends to evaluate convergent thinking more than divergent thinking depending on the instructions given to the subject and the type of task to be performed). For the present study, the general factor and creative dimensions scores (i.e. fluency, flexibility and originality) were used. It should be noted that this test is aimed at students aged 12 to 16 years, with an application time of approximately 60 minutes.

The renewed Factorial General Intelligence Test, Level 5 (*Prueba de Inteligencia General y Factorial* nivel 5 renovado, IGF/5r) by Yuste (2002) was used to assess intelligence. Intelligence is assessed as a general factor distributed among six subtests (verbal analogies, number series, logic matries, sentence completion, numerical problems and figure completion). The subtests are grouped according to their verbal content (verbal analogies and sentence completion), numerical content (numerical strings and arithmetic problems) and figurative-spatial content (figure completion and logical matrixes), thus producing three general scores: Verbal reasoning, Numerical Reasoning and Spatial Reasoning. In this paper, the scores of all three reasoning tasks were used, their reliability indexes being: verbal reasoning (α = .879), numerical reasoning (α = .882) and spatial reasoning (α = .875).

Students' Academic performance was also considered in this study. For this purpose, the school's headmaster facilitated the students' final grades on different subjects. Academic performance was grouped into three subject domains, using the mean score of the school subjects: *Science-Mathematics*, including grades obtained in mathematics (2^{nd} and 4^{th} year), sciences (2^{nd} year) and biology (4^{th} year); *Social-Language Arts*, which included grades in Spanish, English and Social Studies (for both years); and *Art*, which included grades for music and physical education (for both years).

Procedure

To carry out the study, the headmaster's and parents' approval was obtained before applying the tests. Students were informed of the purpose of the study and confidentiality of the data collected was assured. First, the "Scientific Creativity Test" (Hu & Adey, 2002) and the revised Factorial General Intelligence test, Level 5 (IGF/5r; Yuste, 2002), were administered by trained personnel following the authors' instructions. Secondly, students' academic performance data was gathered.

Data Analysis

Descriptive methodology and correlational analysis were used to study the association between different variables. In addition, regression analysis was used to estimate the explanatory power of the scientific creativity and intelligence dimensions on academic performance of students. Statistical data analyses were conducted with SPSS v. 20 (IBM, 2011).

Results

Table 1 shows the descriptive statistics of students' scores in the creative dimensions and their global score (ScientCreatThink) as measured by the "Scientific Creativity Test" (SCT; Hu & Adey, 2002), as well as their cognitive skills (verbal, numerical and spatial reasoning) as measured through the IGF/5r (Yuste, 2002). In addition to the minimum and maximum scores, the mean and standard deviation are presented, as well as skewness and kurtosis of the distribution.

***Table 1*. Descriptive statistics data from the TPCC and IGF/5r Tests**

Variables	Min	Max	Mean	SD	Skewness	Kurtosis
Fluency	.33	15.8	4.84	2.92	1.43	2.79
Flexibility	.40	11.0	3.70	2.06	1.28	2.15
Originality	.50	31.3	7.95	5.71	1.80	4.00
ScienCreatThink	1.3	56.3	15.88	10.21	1.62	3.37
VerbalReasoning	.00	21.0	8.69	4.70	.520	-.075
NumericalReasoning	.00	23.0	9.93	5.31	.421	-.447
SpatialReasoning	1.0	23.0	10.52	4.96	.353	-.071

Once the results obtained with the SCT were analyzed, the mean was verified to be closer to a low performance level; however, there were students with very high or far above average scores, which explains the high standard deviation values, as well as higher rates of skewness and kurtosis. A more Gaussian distribution of the results was obtained through the IGF/5r Reasoning Test indicators. The IGF/5r test average scores tend to be around an intermediate value in the data distribution, the standard deviation values were not very high and the rates of skewness and kurtosis were suitable.

Descriptive statistics of students' academic achievement according to their year in school are presented in Table 2. It is important to mention that students' scores have been grouped into three different subject domains: *Science-Mathematics*, *Social-Language Arts*, and *Art*.

***Table 2.* Descriptive statistics for students' performance in the three curricular domains, according to year in school**

	2nd year				4th year			
	Min	Max	Mean	SD	Min	Max	Mean	SD
SciencMat	1.0	10.0	5.29	(2.06)	1.0	10.0	5.19	(2.39)
SocLang	1.0	10.0	4.88	(2.00)	1.0	10.0	5.41	(2.52)
Art	1.0	10.0	7.53	(1.30)	1.5	10.0	7.75	(2.10)

The values obtained in academic performance were very similar for students in both 2nd and 4th year of Compulsory Secondary Education (ESO). Thus, the highest mean score was observed in subjects associated with the *Art* domain, followed by the *Scientific-Mathematics* domain. The lowest mean score corresponds to the *Social-Language Arts* domain. In turn, the variance of school grades was lower in the *Art* domain, with greater differences in students' grades in the *Science-Mathematics* and *Social- Language Arts* domains.

Table 3 shows the correlation coefficients between intelligence, scientific creativity, and students' academic performance scores, depending on the students' year in school (2nd and 4th).

***Table 3*. Correlations between the creativity and intelligence dimensions and academic performance by area, according to year in school**

	2nd year (n=51)			4th year (n=47)		
	ScienMat	LangSoc	Art	ScienMat	LangSoc	Art
Fluency	.372**	.397**	.303*	.449**	.387**	.517***
Flexibility	.374**	.416**	.312*	.460**	.390**	.519***
Originality	.381**	.421**	.335*	.434**	.356*	.526***
ScieCreatThink	.387**	.426**	.332*	.522***	.472**	.580***
VerbalReason	.323*	.329*	.144	.623***	.611***	.478**
NumericalReas	.547***	.453**	.283*	.728***	.765***	.586***
SpatialReason	.546***	.442**	.383**	.643***	.580***	.480**

Caption: **p*<.05; ***p*<.01;****p*<.001 (2-tailed test)

It is noticeable that intelligence correlated more strongly with academic performance than did creative scientific thinking. This is more evident for 4th-year students, with some correlation coefficients exceeding .70. Moderate correlation coefficients were obtained between scientific creativity and academic performance, with the strongest relationship seen in the subjects belonging to the *Art* domain in 4th year. For 2nd year students, the highest correlation was found between scientific creativity and spatial reasoning, followed by the correlation between scientific creativity and the Art domain. Furthermore, the correlation coefficient between verbal reasoning and academic performance in the *Art* domain was very low, a mere .14.

Academic performance has a higher correlation with students' overall measure of scientific-creative thinking than it has with the individual dimensions of scientific-creative thinking (Fluency, Flexibility, Originality), approaching a coefficient of .50/.60 in 4th year students.

Correlations between cognitive measures (intelligence and scientific-creative thinking) and academic performance were higher in the 4th year than in the 2nd . The only exceptions were correlations between the three dimensions of creativity and academic performance in the *Social-Language Arts* domain. Finally, it is surprising that academic achievement did not correlate with verbal reasoning to the same degree that it did with numerical and spatial reasoning (in this case, only students in the 2nd year of secondary education).

In order to examine whether the psychological measures converge in explaining students' academic performance, linear regression analyses (stepwise method) were conducted. For these analyses, students from 2nd and 4th years were placed together as a single sample, which is numerically more suitable for a regression analysis. For this step, Z scores were calculated for the three curricular domains by taking the mean and standard deviation within each year in school separately, as there are differences in the curriculum depending on the year (2nd or 4th). A similar procedure was followed for psychological measures of intelligence and scientific-creative thinking, since there are verified differences according to age and grade of the students. The most important data from these analyses are presented in Table 4. The model is shown to be statistically significant for all three dependent variables corresponding to the curricular domains considered: *Science-Mathematics* ($F(3,85) = 23.132$; $p < .001$); *Social-Language Arts* ($F(3,85) = 15.489$; $p < .001$); and *Art* ($F(2,86) = 14.433$; $p < .001$).

Table 4. Stepwise Regression Analysis

Variables	R^2	R^2Adj	B	SE B	Beta	T	Prob
Dependent variable: *Science-Mathematics*							
NumericalReas	.364	.357	.331	.100	.358	3.321	.001
SpatialReas	.415	.402	.249	.089	.267	2.510	.014
FlexibilityDim	.449	.430	.184	.080	.200	2.297	.024
Dependent Variable: *Social-Language Arts*							
NumericalReas	.249	.241	.255	.094	.285	2.703	.008
FlexibilityDim	.305	.288	.225	.083	.252	2.696	.008
VerbalReas	.363	.331	.224	.089	.251	2.514	.014
Dependent Variable: *Art*							
ScienCreatThink	.214	.205	.022	.086	.365	3.616	.001
NumericalReas	.264	.247	.149	.062	.244	2.421	.018

Once the data synthesis from the regression analyses had been studied, we verified that the SCT and IGF/5rdimensions could explain, in a statistically significant manner, students' academic performance in the three major domains identified: *Science-Mathematics, Social-Language Arts* and *Art*. A higher percentage of variance is accounted for in the *Science-Mathematics* domain (a total of 43% of explained variance), as compared to 33% in *Social-Language Arts* 33% and 25% in *Art*.

We must highlight the relevance of numerical reasoning in explaining academic performance in the three curriculum domains, as it is the first variable to enter the model, and explains more than half of the variance for the two more academic domains (Science-mathematics, Social-Language Arts). This is not the case for performance in the *Art* domain, where the overall score for scientific-creative thinking first enters the model, followed secondly by numerical reasoning. Also noteworthy is the fact that spatial reasoning played a complementary role in explaining student performance in the domain of *Science-Mathematics*, and is replaced by verbal reasoning when we turn to performance prediction in the *Social-Language Arts* domain. Lastly, a significant contribution of *flexibility* is noted when explaining students' academic performance in *Science-Mathematics* and *Social-Language Arts* domains.

Discussion

First, with regard to distribution of students' scores in the applied tests and their academic performance, a greater dispersion of scores is found on the SCT than on the IGF/5r. This indicates that there are some students with very good scores on the SCT, but the vast majority has a very low level of creative output. This explains the high dispersion, skewness and kurtosis in the three creative dimensions of SCT and its overall score, and suggests great contrasts in performance on the scientific-creative thinking test, with most students presenting great difficulties in production, either because of their difficulties in the creative tasks or their difficulties in science tasks. In turn, when analyzing academic performance, students of 2^{nd} and 4^{th} year of secondary education show their highest scores in subjects from the *Art* domain and their lowest scores in *Social-Language Arts* subjects, with academic performance in the *Science-Mathematics* domain coming in at an intermediate position.

As for the correlations between psychological test scores and students' academic performance, higher ratios were observed in 4^{th} year than in 2^{nd} year of secondary education, hinting at the fact that cognitive variables become more important as students advance in school and learning becomes more demanding. There were also higher correlations between academic performance and the three reasoning dimensions than between academic performance (measured by the IGF/5r) and the three science-creativity dimensions (measured by the SCT). This is more evident in fourth-year students. For second-year students, correlations between verbal reasoning and scientific-creative dimensions are similar, with a non-significant correlation between verbal reasoning and academic performance in *Arts* . Also worthy of mention are the high levels of correlation on the SCT in 4^{th} year as compared to 2^{nd} year, even if they remain lower than those obtained on reasoning tests. This data may be consistent with the claim that beginning in adolescence, other not strictly intellectual variables begin to have relevance in explaining students' academic performance (Bratko et al, 2006; Furnham & Chamorro-Premuzic , 2004; Kappe & van der Flier, 2012; Noftle & Robins, 2007; Paunonen & O'Conner , 2007; Poropat, 2009). Furthermore, correlations between numerical reasoning and students' academic performance were higher than correlations with verbal reasoning, which may contradict the fairly widespread perception among educators as to the importance of the native tongue in general academic performance.

The regression analysis data confirms that, just like measures of psychometric intelligence, broader cognitive variables such as scientific-creative thinking also make an important contribution (Beauducel et al, 2001; Ruiz, 2013; Ruiz et al., 2013; Sternberg, 1997). Combining students from 2^{nd} and 4^{th} year of secondary education, in order to ensure a sample of around one hundred participants, it was verified that the cognitive variables were more relevant in explaining academic performance in the *Science-Mathematics* subject domain, and less relevant for the *Arts* domain, which is understandable due to the nature of learning in the disciplines involved. In turn, numerical reasoning was found to have greater predictive ability for the three curricular performance domains; spatial reasoning was also important in the prediction of *Science-Mathematics* performance and verbal reasoning in the prediction of *Social-Language Arts* performance. These results can also be found in other studies and can be explained based on the more scientific or linguistic nature of these two curriculum domains (Lemos, Almeida, Guisande, & Primi, 2008).

Finally, the dimensions of scientific-creative thinking make a significant contribution in explaining students' academic performance and they increase the predictive power of classic intelligence tests. In the more academic subjects, the contribution of flexibility stands out, and in subjects of expression and art, scientific-creative thinking surfaces. If flexibility, as compared to the other creative dimensions (fluency and originality), is believed to have a greater effect on the cognitive processes of analysis and information selection when producing responses and solving problems, then the association between these three dimensions of SCT and academic performance can be better understood (Ruiz et al., 2013).

Conclusions

The aim of this research paper was to assess the contribution of intellectual skills and scientific-creative thinking in explaining academic performance in students enrolled in compulsory secondary education (ESO). The results allowed us to conclude that, in line with other research in this domain, intelligence tests are still good predictors of academic achievement. Interestingly, its importance was highest in subjects belonging to the *Science-Mathematics* domain (40% of explained variance) and lowest in the *Arts* domain (5% of explained variance), with *Social-Language Arts* at an intermediate level (28% of explained variance).

At the same time, results of the scientific creative-thinking test provided a small but statistically significant contribution in predicting academic performance, adding 3% of explained variance in the Science-Mathematics domain and 5% in the Social- *Language Arts* domain. Scientific creative thinking was particularly relevant in explaining academic performance in subjects belonging to the Art domain (20% of explained variance). For performance in subjects from the Science-Mathematics and Social- *Language Arts* disciplines, the most important dimension of SCT was flexibility; in the Art domain, the highest contribution in came from the overall measure of scientific creative thinking, and was even greater than the traditional measures of intelligence used in this study.

We also underscore the importance of numerical reasoning in explaining academic performance in the three curricular domains, where it would be assumed that verbal reasoning would be the most important, given that learning and assessment in all disciplines is done through the native language. Spatial reasoning and verbal reasoning also contribute to the explained variance in school performance, but here the data tilts in the direction of previous research: spatial reasoning is most important in the Science-Mathematics domain and verbal reasoning in the Social-Language Arts domain. This is interesting because both spatial and verbal reasoning depend on the nature of integrated disciplines in each of these curricular domains.

Future Directions

In the future it would be interesting to increase the size and heterogeneity of the sample to allow more robust statistical analyses and confirmatory models, even allowing us to analyze how these cognitive variables explain academic performance over the course of Secondary Education. If we look at the correlations obtained for students in 2^{nd} and 4^{th} years of Secondary Education, we observe an increase in the coefficients as they progress through the school system. This is an interesting reaffirmation that the impact of cognitive variables on academic performance declines as the student progresses through school, due to the growing importance of motivational and personality variables.

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