The impact of linguistic immersion and economic, social and cultural status on academic performance

Impacto en el rendimiento académico de la inmersión lingüística y del índice socioeconómico y cultural

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Abstract:

The question of language in school has an educational dimension of considerable social interest in Spain since a strong process of immersion in regional languages might be affecting students' performance depending on their linguistic and socio-cultural background. In this context, the paper's aim is to analyse the relations between economic, social, and cultural status (ESCS); the percentage of students who speak a different language at school than at home (language) and school performance in PISA (performance); and in particular to measure the predictive power of the second variable with respect to the third, from a territorial perspective. A methodology was developed based on bivariate linear regression analysis and structural equation modelling, and was applied to data regarding these three variables from the PISA 2015 and PISA 2022 databases. These secondary analyses have confirmed: (a) the importance of the predictive power of ESCS on performance consistently in both 2015 and 2022; (b) the intensification of the association between the two variables in that period; and (c) the emergence of a moderate but significant association of the language variable as a predictor of Performance at the territorial level. The impact of regional ESCS differences on performance increased significantly between 2015 and 2022, which is compatible with an increase in other territorial divides described in the literature. Moreover, the strong linguistic immersion models display

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significant differences between territories in terms of performance. For example, for this reason alone, Catalonia's delay compared to Madrid is approximately one school year.

Keywords: immersion programmes, academic achievement, educational equity, educational policy, educational assessment, structural equation modelling.

Resumen:

La cuestión lingüística en el ámbito escolar presenta en España una dimensión educativa de notable interés social, toda vez que un proceso inmersivo franco en las lenguas regionales podría estar afectando al rendimiento de los alumnos en función de su extracción lingüística y sociocultural. En este contexto, el presente trabajo tiene como objetivo principal analizar las relaciones entre nivel socioeconómico y cultural (ISEC), porcentaje de alumnos que hablan en la escuela un idioma diferente al de su hogar (idioma) y rendimiento escolar en PISA (rendimiento). En particular, se pretende medir el poder predictivo de la segunda variable con respecto a la tercera desde una perspectiva territorial. Se ha desarrollado una metodología basada en análisis de regresión lineal bivariada y en modelos de ecuaciones estructurales aplicadas sobre datos de esas tres variables, disponibles en las bases de PISA 2015 y PISA 2022. La realización de estos análisis secundarios ha confirmado: a) la importancia del poder predictivo del ISEC sobre el rendimiento de forma consistente, tanto en 2015 como en 2022; b) la intensificación del vínculo entre ambas variables en dicho período de tiempo; y c) la aparición de una asociación moderada, pero significativa, de la variable idioma como predictor del rendimiento en el ámbito territorial. Se aprecia que el impacto de las diferencias territoriales en materia de ISEC sobre el rendimiento ha aumentado de forma notable entre 2015 y 2022, lo que resulta compatible con el incremento de otras brechas territoriales descritas en la literatura. Por otra parte, los modelos de una inmersión lingüística severa marcan diferencias significativas entre territorios en materia de rendimiento que se sustancian, a modo de ejemplo, en un retraso, solo por este motivo, de Cataluña respecto de Madrid de un año escolar aproximadamente.

Palabras clave: programas de inmersión, rendimiento académico, equidad educativa, política educativa, evaluación educativa, modelos de ecuaciones estructurales.

1. Introduction

The question of language in the school setting (understood principally in the case of Spain as the problem associated with the coexistence in schools of the official state language and, where applicable, of the co-official language of the particular autonomous community) has become more relevant as models based on families' freedom of choice (or, failing that, an accommodating coexistence between the two languages) have gradually been replaced by models of strong immersion in the co-official language. This process of immersion might be affecting students' performance depending on their linguistic or sociocultural background.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) some time ago established a doctrine (UNESCO, 1953) of favouring use of the mother tongue (the first language that the child learns) in early childhood and primary education. Later on, in its Global Education Monitoring Report (UNESCO, 2016), it warned that "international and regional learning assessments confirm that when home and school languages differ there is an adverse impact on test scores" (p. 24). A more recent document (UNESCO-IIEP, 2021), which provides a significant review of what is known in this regard (Benson, 2004; Bühmann & Trudell, 2007; Pinnock, 2009a, 2009b), states that

> most research now concludes that learning achievement is enhanced when children are taught in their mother tongue for at least the first six years of primary school before the second language, the main language of instruction, is introduced. (p. 1)

Moreover, international research has argued that education based on the mother tongue is of particular benefit to disadvantaged sectors, including in this group those from rural settings (Ball, 2011; Hovens, 2002).

Regarding developing countries, Reily (2019) mentions a long list of experimental studies with control groups based on standardised tests, which show the benefits of using the mother tongue in school in a notable range of countries. The institutional documents cited above adopt a position that summarises the contributions of previous studies and reviews aligned with similar results. These results are consistently repeated in the setting of the developed countries.

For example, in the United States, Thomas and Collier (1997, 2002) carried out a large-scale longitudinal study on educational provision for minority-language students in public schools in the USA and their effect on academic performance, based on the records of around 200 000 students. They found that the strongest predictor of performance in the second language is the amount of formal education in the mother tongue.

In the European context, the most notable position is that of the Council of Europe, which, despite its clear support for multilingualism, accepts and develops the position established by UNESCO with regards to the use of the mother tongue in school. This is set out in Document 10837, of 7 February 2006, of the Parliamentary Assembly, which includes the report of the Culture, Science and Education Commission (Parliamentary Assembly, 2006) and which in point B.12 of its explanatory memorandum takes the following position:

> Obviously, in European societies, everyday use of the official language is the main precondition for the integration of children whose main language is different from the official one of the country or region. However, a great deal of research is agreed on one point: immediate schooling of such children in a language they do not know well or at all (here, the term is teaching "through submersion") seriously jeopardises their chances of academic success. Conversely, bilingual education based

> on the mother tongue is the basis for long-term success. (p. 2)

It is important to emphasise that the results described above do not in any way invalidate the desirable objective (Bialystok *et al.*, 2012) of multilingualism in school, but that they simply question the use of some procedures or strategies for achieving it. In this sense, Cummins (2001), on the basis of the research, underlines the following:

> Bilingualism has positive effects on children's linguistic and educational development. When children continue to develop their abilities in two or more languages throughout their primary school years, they gain a deeper understanding of language and how to use it effectively. … The research suggests that bilingual children may also develop more flexibility in their thinking as a result of processing information through two different languages. (p. 17)

Nonetheless, Cummins (2001) aligns himself with the positions mentioned above relating to the use of the mother tongue in school when he says that "mother tongue promotion in the school helps develop not only the mother tongue but also children's abilities in the majority school language" (p. 18). This is what he calls "interdependence theory".

In the specific case of Spain, studies on linguistic teaching models' effects on students are scarce (Clots-Figueras & Masella, 2013; Calero & Choi, 2019; Carabaña & Fernández-Enguita, 2019), particularly relating to their impact on school performance. The work by Calero and Choi (2019) mentioned above which centres on academic performance and is solely limited to the case of Catalonia is notable in this regard. The authors perform secondary analyses based on the PISA 2015 database using multilevel linear models, and they conclude that the immersion policy has a negative effect on academic performance which they summarise as follows: "The results we have set out clearly point to the existence of a problem of equity, that generates 'losers' from the policy of linguistic immersion in Catalonia" (p. 16, own translation).

Moreover, the work of Carabaña and Fernández-Enguita (2019) centres on the relationship between regional languages in Spain and students' sense of belonging in the educational centre. To do this they use secondary analyses of the PISA 2015 database and conclude that this feeling (which is relevant both for students' well-being and for their performance) is notably lower in the bilingual autonomous communities, as "all of the students who study in regional languages depress the level of identification with the centre, regardless of the language of their homes" (p. 1, own translation). The authors propose as an explanatory hypothesis a "school-society diglossia": the sense of belonging to the school suffers when the language of instruction is the one that is less preferred or of less social use.

Although not directly related to academic results, the work of Clots-Figueras and Masella (2013) on language, education, and identity, based on data from surveys

carried out in Catalonia, shows that respondents who have been exposed for longer to teaching in Catalan have stronger Catalan feelings. The effect also seems to be present among individuals whose parents are not of Catalan origin; furthermore, according to the authors, the reform also affects political preferences and attitudes towards the organisation of the state.

The recent publication of the PISA 2022 data, with a notable fall in scores for Catalonia in the three main areas of the assessment (OECD, 2023), has again put the strictly educational dimension of the linguistic question on the agenda in the social and political spheres (López-Rupérez & García-García, 2023; Rodríguez, 2023; Rodríguez-Sanmartín, 2023).

However, this is a question that concerns Spain as a whole, as well as Catalonia, for different reasons. Firstly, because we are facing situations that affect fundamental rights that the state is responsible for guaranteeing. And also, because seven autonomous communities (at present, the Balearic Islands, Catalonia, the Valencian Community, Galicia, Navarre, and the Basque Country) have models where co-official languages coexist with Spanish, which is the official language of the whole of Spain. In some cases, these linguistic models have approached broad immersion. It is, therefore, advisable to find evidence relating to the case of Spain that makes it possible to reflect on the magnitude of the effects and their consequences on an empirical basis.

For these reasons, in the present work, this question is approached from a territorial perspective, adopting a focus that combines the socio-economic and academic performance aspects with the linguistic ones, using the PISA data to do so. The main objectives of this research are:

1. To provide a comparative overview, by means of a descriptive analysis, of the 2015 and 2022 PISA results, with a detailed presentation of the scores for: performance; Economic, Social, and Cultural Status (ESCS); and language in different autonomous regions and cities of Spain.

2. To construct and evaluate a structural equation model (SEM) of the influence of the ESCS index on academic performance in science, mathematics, and reading on the sample of data from PISA 2015.

3. To analyse the impact of the language spoken at home on academic performance in PISA 2022 by means of a bivariate linear regression analysis.

4. To build and evaluate an SEM (structural equation model) of the relationship between ESCS and the percentage of students who speak a different language to the one that is dominant in schools (language) and its influence on academic performance in science, mathematics, and reading in the sample of data from PISA 2022.

2. Method

2.1. Samples

The present study uses two data sets. On the one hand, it uses the national PISA sample (OECD, 2016) corresponding to the 2015 edition. This sample comprises 6736 students (39 066 when including the expanded samples from the autonomous communities) and is representative of the Spanish population of 15-year-old students, mainly enrolled in the fourth year of obligatory secondary education. It also uses the sample from the 2022 edition of PISA (OECD 2023) in a similar way. This comprises 30800 students as it considers all of the available samples from the autonomous communities and cities.

Table 1 presents detailed information about the sizes of the samples used according to the different regions.

TABLE 1. Size and representativeness of the sub-national samples in the 2015 and 2022 Editions of PISA.

	2015		2022	
	n	**%**	***n***	**%**
Spain	6736	17.2	-	-
Andalusia	1813	4.6	1707	5.5
Aragon	1798	4.6	1420	4.6
Asturias	1790	4.6	1724	5.6
Balearic Islands	1797	4.6	1576	5.1
Canary Islands	1842	4.7	1686	5.5
Cantabria	1924	4.9	1677	5.4
Castile and Leon	1858	4.8	1733	5.6
Castile-La Mancha	1889	4.8	1671	5.4
Catalonia	1769	4.5	1597	5.2
Valencian Community	1625	4.2	1625	5.5
Extremadura	1809	4.6	1685	5.9
Galicia	1865	4.8	1824	4.5
Madrid	1808	4.6	2138	6.9
Murcia	1796	4.6	1669	5.4
Navarre	1874	4.8	1826	5.9
Basque Country	3612	9.2	3244	10.5
La Rioja	1461	3.7	1394	5.3
Ceuta	-	-	345	1.1
Melilla	-	-	259	0.8
Total	39066	100	30800	100.0

Source: prepared by the authors based on the PISA 2015 and PISA 2022 databases.

2.2. Variables

The variables of interest have been organised into three basic categories, treating them as latent variables. In a context like the present one where SEM is used, it is important to note that latent variables are underlying constructs that are not directly observable but instead are inferred through observed variables. The three categories of latent variables used in the study are:

Performance latent variable (performance), disaggregated by areas:

- Mean performance in mathematics: this includes the gross values for the mathematics subject evaluated in 2015 (Per_Mat_15) and in 2022 (Per_Mat_22).

- Mean performance in language: this includes the gross values for the language subject evaluated in 2015 (Per_Rea_15) and in 2022 (Per_Rea_22).

- Mean performance in science: this includes the gross values for the science subjects evaluated in 2015 (Per_Sci_15) and in 2022 (Per_Sci_22).

Economic, cultural, and social status (ESCS) index latent variable:

- ESCS of the values reported in PISA 2015 (ESCS_15).

- ESCS of the values reported in PISA 2022 (ESCS_22).

Percentage of students who speak a different language than that of the school at home (language) latent variable:

- Percentage of students who speak a different language at home and at school, according to the figures from the 2022 PISA report (Language_22).

2.3. Analytical procedures

In line with the objectives of the research, we have performed an analysis with three basic focusses. As a first approach, a comparative analysis of relevant data with an essentially descriptive orientation was performed. For this comparison, the mean values of the variables described above corresponding to the years 2015 and 2022 were compiled. To complement the above, a bivariate linear regression analysis was performed to assess the predictive value of the language variable with regards to the performance variable for 2022. Finally, various SEM structural methods were used (Bryman & Cramer, 1994; Pérez *et al.;* 2013) to validate a causal model that jointly encompasses the performance and ESCS variables in 2015, and another identical model for 2022, in this case adding the language latent variable to the analyses.

The structural equations model used derives from a technique that combines factor analysis with linear regression, going beyond simple measurement of the direct impact of the independent variables on the dependent one by considering the interaction and possible indirect influence between them. Although it does not demonstrate strict causality, it facilitates reasoning about causal hypotheses that are supported by empirical evidence (Batista et al., 2000). The assumptions in

this research of the existence of at least one weak causal order and of the causal closure are accepted (Kim & Kohout, 1988). This type of approach is a common practice in studies of a similar nature (Bulut *et al.*; 2012; Calero & Choi, 2019; López-Rupérez *et al.*; 2021; Salas *et al.*; 2017; Swe *et al.*; 2020).

Version 2.3 of the *Jamovi* statistical analysis software was used (The jamovi project, 2022) to perform these analyses. This is based on the R lavaan software package (Rosseel, 2012) for structural equation modelling (Gallucci & Jentschke, 2021) and for graphic representation of path diagrams (Epskamp *et al.;* 2019).

3. Results

3.1. A comparative overview of the PISA 2015 and 2022 results

Table 2 shows the performance results from the 2015 and 2022 editions of PISA for by areas and mean, ESCS, and language. These data provide a comparative overview of academic performance and associated factors in different regions, making it possible to approach a comprehension of the educational and social dynamics over a sufficiently long time period. Furthermore, this period deliberately disregards the anomaly for Spain of the 2018 edition in the implementation of the tests (and consequently in their results), as PISA has done in the country reports (OECD, 2023).

TABLE 2. Performance, ESCS, and language scores of the samples in the national and sub-national OECD levels corresponding to the 2015 and 2022 PISA editions.

Zone	Per_Mat		Per_Rea		Per_Sci		Per_Mean		ESCS		Language
	2015	2022	2015	2022	2015	2022	2015	2022	2015	2022	2022
OECD	490	472	493	476	493	485	493	478	0	0	11.18
Spain	486	473	496	474	493	485	491	477	-.51	-.03	19.40
Andalusia	466	457	479	461	473	473	473	464	-.87	-.18	6.31
Aragon	500	487	506	488	508	499	505	491	-.39	.00	10.66
Asturias	492	495	498	497	501	503	497	498	-.42	.09	4.48
Balearic Islands	476	471	485	472	485	480	482	474	-.65	-.05	51.80
Basque Country	492	482	491	466	483	480	489	476	-.25	.18	15.30
Canary Islands	452	447	483	463	475	473	470	461	-.80	-.21	5.41
Cantabria	495	495	501	494	496	504	497	498	-.43	.03	3.82

Castile and Leon	506	499	522	498	519	506	516	501	-.44	.08	3.45
Castile-La Mancha	486	464	499	468	497	475	494	469	-.66	-.16	6.52
Catalonia	500	469	500	462	504	477	501	470	-.35	-.02	55.54
Valencian Community	485	473	499	482	494	483	493	479	-.53	-.10	24.56
Extrema-dura	473	469	475	468	474	479	474	472	-.79	-.14	2.32
Galicia	494	486	509	485	512	506	505	493	-.52	.07	36.19
La Rioja	505	493	491	487	498	500	498	493	-.46	-.06	8.17
Madrid	503	494	520	496	516	502	513	497	-.01	.25	5.82
Murcia	470	463	486	468	484	482	480	471	-.82	-.24	7.40
Navarre	518	492	514	478	512	489	515	486	-.32	.02	27.75
Ceuta	-	395	-	404	-	410	-	403	-	-.47	26.41
Melilla	-	404		405		414	-	408	-	-.79	15.92

Source: prepared by the authors based on OECD 2016 and 2023.

A systematic analysis of the data from Table 2 reveals the following:

- Regarding the performance variables, with the exception of Asturias, Cantabria, and La Rioja, which improve in at least one of the areas, all of the others worsen in all three. Accordingly, when the mean scores are taken into account, all of them apart from the first two worsen. Catalonia with 31 PISA points and Castile-La Mancha with 25 are the ones that display the largest declines.

- In the case of ESCS, all of the autonomous communities improve in relation to the OECD mean in the period between 2015 and 2022, which results in Spain improving by .48 points, positioning itself above the updated mean. The improvements in Andalusia and the Balearic Islands stand out, with increases of .69 and .60 ESCS points respectively. This phenomenon is analysed in the discussion section.

- Regarding the percentage of students who speak a different language at home to that of the school, Catalonia and the Balearic Islands, with values of 55.54% and 51.80% respectively, are the autonomous communities with the highest values for this variable. At the other extreme, Extremadura and Castile and Leon, with 2.32% and 3.45% respectively, have the lowest values.

3.2. Structural equations model corresponding to PISA 2015

In a first approach, a model was defined that centred exclusively on the 2015 data, establishing the relationship between ESCS and performance in science, mathematics, and reading. Application of the SEM using the maximum likelihood method with non-linear optimisation evaluated a model that incorporates latent variables (ESCS and performance) and observed variables. This model reveals significant relations between ESCS_15 and academic performance, supported by statistical tests and with an adequate fit.

Various indices were used to evaluate the quality of the model's fit, the results of which are shown in Table 3; these indices indicate that the proposed model displays a reasonable fit, significantly better than a reference model (χ^2 = 92.48, p <.001). The indices, such as the standardised root mean squared residual (SRMR <0.05), the root mean square error of approximation (RMSEA <0.05), the adjusted goodness of fit index (AGFI >0.95), the comparative fit index (CFI >0.90), or the Tucker–Lewis index (TLI >0.70), support the solidity of the model, following the recommendations of Schermelleh-Engel *et al.* (2003).

TABLE 3. Indices of fit of the SEM PISA 2015 model.

	Values obtained
Value of p in $\chi 2$	.008
$\chi 2/df$	4.87
GFI	1
AGFI	0.999
SRMR	0.047
RMSEA	0.009
CFI	0.91
TLI	0.731
Bentler–Bonett Normed Fit Index (NFI)	0.895
Parsimony Goodness of Fit Index (PGFI)	0.143
Parsimony Normed Fit Index (PNFI)	0.298
Akaike Criterion (AIC)	378.019

Table 4 shows the parameter estimations, along with the measurement model for the relationship between academic performance and ESCS in 2015. The first section shows the path coefficient between academic performance and ESCS, indicating that an increase of 1 ESCS unit is associated with an estimated increase of 48.3 units in academic performance, with a confidence interval of 95% between 28.1 and 68.4. This coefficient is significant ($\beta = 0.748$, $p < .001$), suggesting a positive relationship between ESCS and academic performance.

Similarly, Table 4 shows the estimates for the model for measuring the latent variables. ESCS_15, as the observed variable of the ESCS latent variable, has a standardised coefficient of 1.000, which indicates a perfect relationship. Likewise, with regards to academic performance, it can be seen that the observed variables (Per_Sci_15, Per_Mat_15, Per_Rea_15) have standardised coefficients of 1.00, 0.99, and 0.90 respectively, signalling the relationships existing between these observed variables and the latent variable of performance.

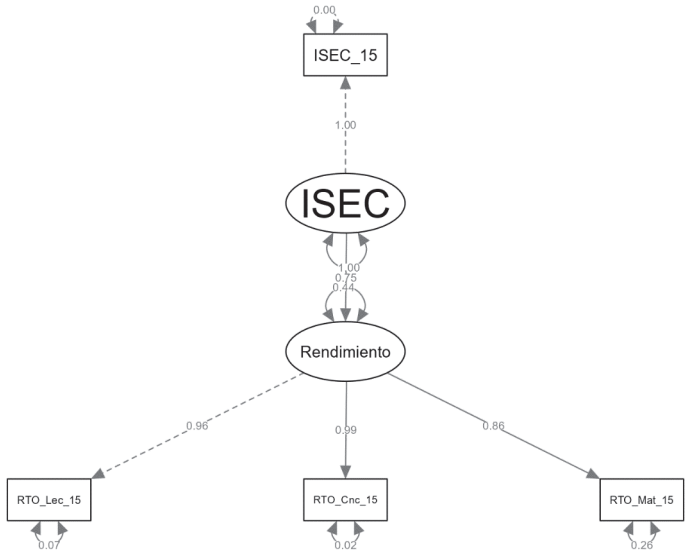
These standardised coefficients, along with their confidence intervals and significance values, provide information about the quality and strength of the relationships modelled. In general, Table 4 empirically supports the validity of the proposed model.

TABLE 4. Estimates of parameters and measurement model for the relationship between academic performance, language, and ESCS in the PISA 2015 results.

Dependent variable	Predictor variable	Estimate	Standard error	CI 95% (low/high)		β	*z*	*p*
Performance	ESCS	48.3	10.3	28.1	68.4	0.748	4.70	<.001
Latent variable	**Observed variable**							
ESCS	ESCS_15	1.00	0.00	1.00	1.00	1.000		
Performance	Per_Sci_15	1.00	0.00	1.00	1.00	0.992		
	Per_Mat_15	0.99	0.14	0.71	1.27	0.861	6.84	<.001
	Per_Rea_15	0.90	0.07	0.76	1.03	0.965	12.69	<.001

Figure 1 presents the path model illustrating the impact of ESCS on performance in PISA 2015. The SEM with data from PISA 2015 underlines the importance of ESCS in predicting academic performance, supporting the hypothesis that higher ESCS is positively linked to better performance in science, mathematics, and reading.

FIGURE 1. Path model of the relationship between ESCS and academic performance in PISA 2015.



3.3. The predictive value of the language variable with regards to performance in PISA

A bivariate linear regression analysis was performed to analyse the impact of the language variable on academic performance in PISA 2022. Table 5 presents key metrics that illustrate the connection between the two variables. The multiple correlation coefficient displays a weak relationship, while the low R^2 values indicate that only a small proportion of the variability in performance is attributed to language.

TABLE 5. Regression statistics.

Multiple correlation coefficient	0.17
R^2 coefficient of determination	0.03
R^2 adjusted	-0.02
Standard error	26.14
Observations	21

Table 6 shows the global evaluation of the model in greater depth. The lack of statistical significance ($F = 0.59$, $p > .05$) and the modest sum of squares in the regression point to a generally weak direct relationship between language and performance. Furthermore, the coefficients associated with the intercept and the language variable did not achieve sufficient significance.

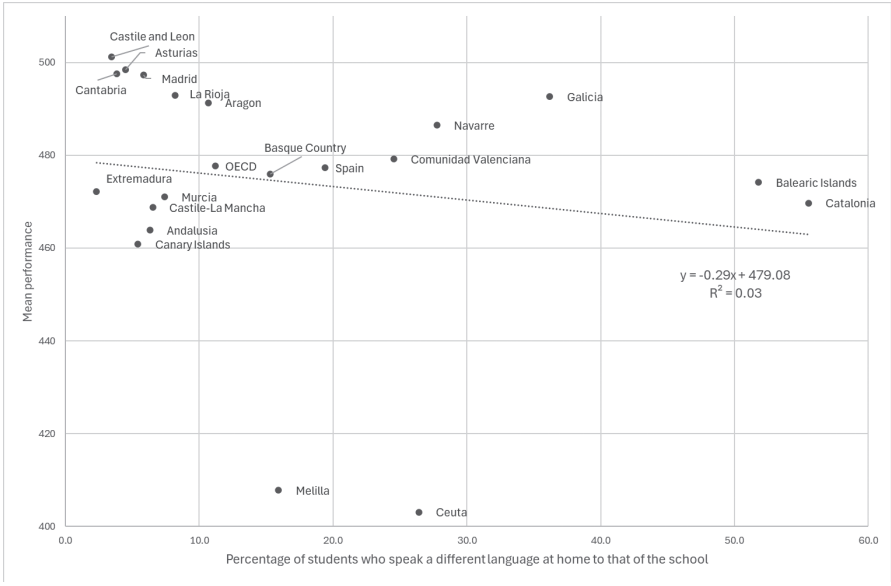
TABLE 6. Analysis of variance and coefficients.

	Degrees of freedom	Sum of squares	Mean of the squares	*F*	*p*
Regression	1	404.42	404.42	0.59	0.45
Residuals	19	12984.62	683.40		
Total	20	13389.03			

	Coefficient	Standard error	CI 95% (low/high)		*t*	*p*
Intercept	479.07	8.47	461.33	496.81	56.53	0.00
Variable X 1	-0.29	0.38	-1.08	0.50	-0.77	0.45

Although the Language variable does not show a statistically significant impact on the PISA 2022 performance scores, graphical analysis of this weak relationship (see Figure 2) shows an inverse trend between the two variables: performance in PISA 2022 and use of language in samples at OECD, national, and sub-national levels.

FIGURE 2. Linear regression analysis of PISA 2022 performance vs language on the OECD, national, and sub-national samples.



3.4. Structural equation model corresponding to PISA 2022

Finally, the SEM focus applied to 2015 was replicated by means of a model that operates on the results of PISA 2022. This analysis again establishes a relationship between ESCS and performance in science, mathematics, and reading, but the results relating to the percentage of students who speak a language at home that is different to the one used at school (language) are also included. Although a non-significant relationship was established in the previous section, interpreted as absence of direct impact, it is important to note than an SEM has the capacity to model more complex relationships between variables, considering indirect effects and mediations.

The application of the SEM analysis using the maximum likelihood method with non-linear optimisation has evaluated a model that includes latent variables (ESCS, language, and performance) and observed variables. This model finds significant relationships between ESCS_22 and academic performance, as well as between the percentage of students who speak a different language to that of the schools (language), supported by statistical tests and an adequate fit.

In relation to the fit of the model, the indicators in Table 7 show that the proposed model displays a reasonable fit, considerably higher than that of a reference model ($\chi^2 = 204.6$, $p < .001$). Indices such as SRMR (<0.05), RMSEA (<0.05), AGFI (>0.95), CFI (>0.90), and TLI (>0.85) support the robustness and validity of the model.

TABLE 7. Fit indices of the SEM model in PISA 2022.

	Values obtained
Value of *p* in $\chi 2$	.01
$\chi 2/df$	2.65
GFI	1
AGFI	0.999
SRMR	0.04
RMSEA	0.014
CFI	0.939
TLI	0.869
NFI	0.909
PGFI	0.259
PNFI	0.424
AIC	642.657

Table 8 shows the parameter estimates as well as the measurement model for the relationship between academic performance, language, and ESCS in 2022. In the section relating to academic performance, an increase of 1 ESCS unit is seen to be associated with an estimated increase of 166.78 units in academic performance, with a confidence interval of 95% between 98.78 and 234.78. This coefficient is significant (p <.001), indicating a positive relationship between ESCS and academic performance. Likewise, for the language predictor, it is found that an increase of 1 unit in the percentage of students who speak a language other than that of the school is related with an estimated reduction of 0.43 units in academic performance, with a confidence interval of 95% between -0.81 and -0.04. This coefficient is also significant (p <.05), signalling a negative relationship between language and performance.

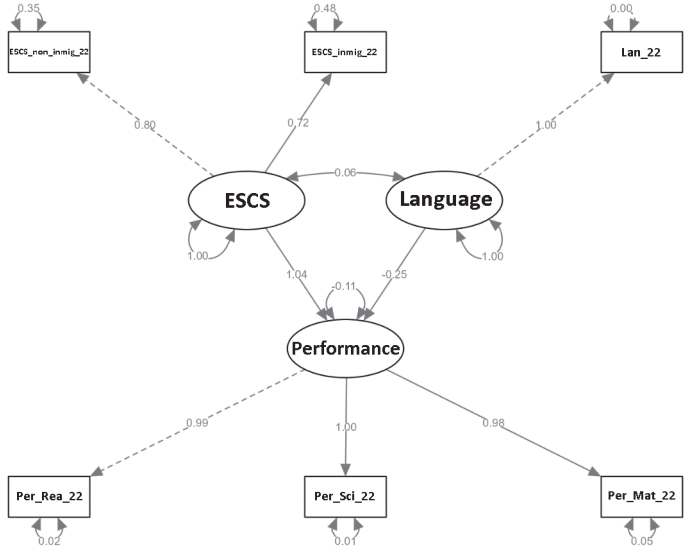
TABLE 8. Estimates of parameters and measurement model for the relationship between academic performance, language, and ESCS in the PISA 2022 results.

Dependent variable	Predictor variable	Estimate	Standard error	CI 95% (low/high)		β	*z*	*p*
Performance	ESCS	166.78	34.69	98.78	234.78	1.037	4.81	<.001
Performance	Language	-0.43	0.20	-0.81	-0.04	-0.245	-2.16	<.05
Latent variable	**Observed variable**							
ESCS	ESCS_non_immig_22	1.00	0.00	1.00	1.00	0.805		
	ESCS_immig_22	1.53	0.38	0.78	2.28	0.723	3.99	<.001
Language	%_languages_22	1.00	0.00	1.00	1.00	1.000		
Performance	Per_Mat_22	1.00	0.00	1.00	1.00	0.977		
	Per_Rea_22	0.92	0.05	0.82	1.02	0.992	18.18	<.001
	Per_Sci_22	0.94	0.05	0.85	1.05	0.995	19.09	<.001

With regards to the latent and observed variables, it should be noted that the relationships between ESCS and its components, as well as between language and the percentage of students who speak different languages, are significant and coherent with the model proposed. The observed variables of performance in the specific subjects also display positive and significant relationships with the latent performance variable. As a whole, these detailed estimates offer a deeper understanding of the interactions between the key variables in the context of the SEM model applied to the year 2022.

In summary, regarding the specific relationships from PISA 2022, a positive and strong association has been observed between ESCS and performance, as is a negative relationship of moderate but significant intensity between language and academic performance. These conclusions are supported visually by the path model in Figure 3.

FIGURE 3. Path model of the relationship between ESCS and language with academic performance in PISA 2022



4. Discussion

As a preliminary question, we must underline here that the present work is aligned with re-evaluation of the path analysis [proposed by Judea Pearl (Pearl & Mackenzie, 2020)] as a procedure that goes beyond a mere statistical exercise, even though it contains one. It is based on an understanding of the problem by each scientist that is reflected in a causal diagram and is then submitted to the test of whether it matches reality, measured by the data and by quantitative analyses (pp. 99–100).

4.1. The influence of ESCS on performance

When analysing the evolution of ESCS between 2015 and 2022 and interpreting the advances experienced by all autonomous communities and by Spain as a whole, it is necessary to take into consideration the fact that ESCS is a normalised indicator (based on the set of the member states of the OECD) with a mean value equal to 0 and a standard deviation equal to 1 (OECD, 2023). In this time period, four countries with a lower level of development were added [Latvia in 2016,

Lithuania, and Colombia in 2018, and Costa Rica in 2021] something that would, at least partly, explain why Spain's ESCS value has improved relative to the mean.

On the other hand, and given the predictive value of the ESCS on performance, this would need to have resulted in a corresponding improvement in results with regards to the OECD mean, something that is not observed (see Table 2). This plausibly indicates that other factors with the opposite value have been at play in this period.

The results derived from the first model, despite being based on clusters of data grouped by autonomous communities, are coherent with the empirically established relationship in the successive editions of PISA that confirms the predictive value of ESCS in relation to performance. For example, the value of the correlation coefficient between these two variables established in PISA 2015 for the group of all participating countries was 0.129 (OECD, 2016). Our own linear regression analysis, limited to Spain in the area of science, gave a value of R = 0.38 (López-Rupérez *et al*, 2018, 2019a).

According to the final PISA 2022 report (OECD, 2023), 20 PISA points represent the "annual pace of learning" and so the figures above ultimately reflect estimated delays in the order of two years for each ESCS point (according to Table 4, one ESCS unit is associated with an estimated increase of 48.3 PISA units in academic performance). Even when the figure for the pace of the lag that the OECD provides is the mean of the participating countries, it provides a basis to make an approximate estimate of from which observed differences regarding ESCS between autonomous communities are predicted (see Table 2). So, for example, the differences between Andalusia (-0.86) and the Community of Madrid (-0.01), in line with the results described above, would represent imbalances between the two regions equivalent to around two school years. This indicates a need for state-level policies regarding inter-regional equity.

4.2. The results of using SEM (structural equation modelling)

The analysis of the predictive value of the percentage of students who speak a language at home other than the one they use at school with regards to the average scores in PISA 2022, has provided insufficient results. Consequently, if other intervening variables are not considered, the language variable on its own has limited predictive value for performance in PISA. Nonetheless, it is crucial to note that more detailed analyses, such as those using SEM models, have modified this first conclusion, enabling a more complete understanding of the underlying relationships.

Applying the SEM model to PISA 2022 not only replicates the relationships identified in 2015, but it also expands comprehension when including the language variable, thus enriching the analysis by exploring how linguistic dynamics can influence academic performance. This inclusion strengthens the empirical basis compared with the 2015 model, and also implicitly introduces the time variable by

considering the situation seven years later. According to the results mentioned above, the impact of the differences between autonomous communities, in terms of socio-economic and cultural level measured by the ESCS in 2022, has multiplied by 3.5 compared with 2015. In relative terms, this suggests a loss of inter-regional equity in Spain's education system.

This conclusion is compatible with the evolution in the territorial imbalances observed in other studies for variables with similar and different results. For example, the imbalance relating to the impact parameter (measured by the slope of the performance *vs*. ESCS regression line) increased from 11.3 to 14 points between 2015 and 2022 (López-Rupérez *et al.*, 2018, 2019b; López-Rupérez & García-García, 2023). Although it refers to different variables, a study on early school leaving by Soler (2022), carried out in the 2005–2021 period with two different analysis methodologies, consistently revealed "a lack of convergence between the different regions of Spain in the period analysed, above all in the case of males" (p. 153, own translation).

Despite this tendency, previous research and the OECD's own analyses (OECD, 2023; Sanz & Tena, 2023) have identified the partial effect of the covid-19 pandemic on the fall in scores in PISA 2022. It is also possible to surmise, on the basis of available evidence, that this effect has not only has been felt in the mean scores but that it has done so on disadvantaged sectors in particular, which would explain the notable increase in the impact of ESCS on performance described in this research. So, the study by Woessmann *et al.* (2020) concluded that students from socio-economically disadvantaged backgrounds were most affected by the pandemic. Chetty *et al.* (2020) have established a reduction of 60% in advances in academic performance of the students from the lowest quartile of income. And Bacher-Hick *et al.* (2021) provided evidence that could explain the previous results, namely that the highest growth in use of online educational resources occurs in urban areas with higher incomes.

In addition to the statistically significant relations between ESCS_22 and academic performance, the model reveals the connection between this and the percentage of students who speak a language other than that of the school at home (language). These associations support the idea that socio-economic context and linguistic variables both contribute significantly to student performance.

Regarding the language predictor within the corresponding SEM model, we found that an increase of 1 unit in the percentage of students who speak a language other than that of the schools is related to an estimated reduction of 0.426 units in academic performance, with a moderate but negative association between language and performance that is statistically significant. This means that the percentage of students who speak a different language at school to the one they use at home results in differences in academic performance measured by means of the PISA tests, thus contributing to generating gaps in

performance between autonomous communities. Although other factors will probably be at play in the relationship between these two variables, there is no doubt that in this order of ideas, full immersion linguistic models are associated with a significant difference between the regions in performance when the socio-economic and cultural level is considered. For example, the difference in these percentages between Catalonia and Madrid is approximately 50 percentage points (see Table 2, Language), which, according to the SEM model, corresponds to 21 PISA academic performance points and results in an academic delay for this reason alone (according to Table 2, the total difference is 27 PISA points) of something more than one academic year between these two autonomous communities. This highlights the advisability of reviewing models of linguistic immersion in school, taking into account their impact on academic performance.

5. Conclusions

Despite the sophistication of the SEM model used, the correlation identified between the variables does not necessarily imply direct causality. These limitations open the door to future research that tackles these methodological restrictions. Moreover, although the model considers key variables such as ESCS, language, and performance, other potentially influential factors have been omitted, such as the quality of teachers (Castro & Egido, 2024), the quality of school leadership (Gairín, 2024), and other empirically relevant factors (Hattie, 2023) that, along with the previous variables, might affect academic performance. For this reason, a more complex model incorporating additional variables would be a fruitful direction for future research.

This necessary caution, along with the recommendation for future research above, do not prevent us from noting that the results of this research agree with others already consolidated in the specialist literature, some of which are cited above.

So, the models used for both the 2015 and 2022 editions of PISA suggest that an increase in ESCS is associated with better academic performance at the time of the evaluation, as a significant relationship was consistently found between a higher ESCS and better academic performance. This agrees with the repeated and positive association between students' socio-economic and cultural level and their academic performance that the different editions of PISA have repeatedly shown (OECD, 2016, 2023), as has another research relating to Spain (López-Rupérez *et al*., 2019c).

When using a model that takes into account the ESCS variable as well as the language and performance variables, speaking a language at school other than the one used at home can, in strong immersion models, have a significant negative impact on academic results from PISA 2022. This is consistent with the extensive body of research that has confirmed that education based on the mother tongue improves academic results and significantly increases chances of educational success, as underlined by UNESCO (2021) and the Council of Europe (Parliamentary Assembly, 2006) among other institutions.

Ultimately, and beyond arguments that can be invoked alongside education, applying this principle of precaution [formulated in accordance with the classical *dictum*, *primun non nocere* ('first do no harm') and which is not only a deontological requirement in the field of health but also in education] points to the need to align educational policies and their results with the demands of equity and of the best interest of the child.

Authors' contributions

Francisco López-Rupérez: Conceptualisation; Project administration; Supervision; Writing (original draft).

Álvaro Moraleda-Ruano: Conceptualisation; Data curation; Visualisation; Writing (original draft).

Isabel García-García: Data curation; Visualisation.

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