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An approach to the study of negative selection in access to teacher training.

Una aproximación al estudio de la selección negativa en el acceso a la formación docente

Covadonga Ruiz de Miguel[1] , María Sánchez Munilla, Delia Arroyo Resino and Inmaculada Asensio-Muñoz
Department of Research and Psychology in Education, Complutense University of Madrid (Spain).

Abstract

In an international line focused on the identification of the profile of access to the teaching profession as a relevant variable in the improvement of educational systems, this research aims to gather evidence about the hypothesis of negative selection in Spain, taking into account the possible unequal distribution of academic background. By means of a non-experimental study, carried out with a large sample of data in the comparable subjects of the university entrance examination, Spanish Language and Literature, Spanish History and Foreign Language, differences are found in the average mark in these subjects according to the degree to which one aspires and according to whether the students come from a scientific-technological baccalaureate or not. From this, we conclude that there is more evidence of negative selection in applicants to work as early childhood education teachers, in some cases with a significant effect size. On the other hand, differences between degrees tend to occur in the two groups of origin, so this is not a variable that can clearly explain the differences between degrees found.

Keywords: Negative selection; access profile; education professionals; STEM.

[1] **Correspondence:** Covadonga Ruiz de Miguel. Faculty of Education. c/ Rector Royo Villanova, s/n. 28040 Madrid. covaruiz@ucm.es

Resumen

En una línea internacional centrada en la identificación del perfil de acceso a la profesión docente como variable relevante en la mejora de los sistemas educativos, esta investigación pretende reunir evidencia acerca de la hipótesis de selección negativa en España, atendiendo a la posible distribución desigual del origen académico. Mediante un estudio no experimental, llevado a cabo con una muestra amplia de datos en las materias comparables de la prueba de acceso a la universidad, Lengua Castellana y Literatura, Historia de España y Lengua Extranjera, se encuentran diferencias en la nota media en las mismas según la titulación a la que se aspira y según si el estudiantado procede de bachillerato científico-tecnológico o no. A partir de ello se concluye que hay más evidencias de selección negativa en aspirantes a trabajar como docentes en educación infantil, en algunos casos con tamaño de efecto importante. Por otra parte, las diferencias entre titulaciones suelen darse en los dos grupos de procedencia, no siendo esta entonces una variable que pueda explicar claramente las diferencias entre titulaciones encontradas

Palabras clave: Selección negativa; perfil de acceso; profesionales de la educación; STEM.

Introduction and objectives

Teacher effectiveness is presented in educational research as a determinant of educational quality (Barber and Mourshed, 2007; Denzler and Wolter, 2009, Pina 2022). Its importance has been quantified by Hattie (2017) who, after synthesising the results of 913 meta-analyses over more than thirty years, obtains an average teacher effect size on student achievement of 0.47, higher than any other factor related to school learning.

Following the evidence found, the debate revolves around the requirements that teachers should meet in order to be a real element in improving the quality of teaching. In this regard, the study of the most successful education systems shows that, in addition to having effective teacher training programmes, it seems necessary for aspiring teachers to be capable and highly motivated, both during their training period and in their subsequent professional practice (Baier et al. 2019; Vinas-Forcade and Noé Seijas, 2021). With regard to cognitive and academic factors prior to initial training, although the existing evidence in this regard cannot be considered conclusive (Castro and Egido, 2022), teachers with high scores in secondary school or university entrance exams tend to achieve higher performance than those with low scores (Egido, 2020). On the other hand, regarding motivational factors and beliefs, which have been studied more extensively at the international level, it seems clear that vocational interests, especially social ones, and intrinsic and altruistic motivations emerge as the most important predictors of enrolment in a teacher education programme (González et al., 2023, Navarro et al., 2022).

The problem is that the most suitable and prepared candidates are not always attracted to teaching (Hanushek and Pace, 1995; Jiménez et al., 2021; Krieg, 2006; Roloff et al. 2020). On the contrary, there is evidence to support the idea that (a) the academic performance and cultural capital of those who choose to study teaching tend to be

lower than those who choose other studies, and (b) students with the best results in secondary education tend to prefer other professions (Corcoran et al., 2004; Guarino et al., 2006).

This phenomenon, known as "negative selection" (Coultas and Lewin, 2002; Denzler and Wolter, 2009; Varga, 2007), which explores the hypothesis that female teacher candidates would exhibit less favourable academic, cognitive and personality characteristics than students in other areas (Denzler and Wolter, 2009; Guarino et al, 2006; Hanushek and Pace, 1995; Osada and Schaeper, 2021; Roloff et al., 2015; Vinas-Forcade and Noé Seijas, 2021). Especially in the USA, evidence supporting this hypothesis is obtained by finding that, in general, teacher candidates show lower academic performance and cognitive skills than students who do not enter teacher education (Guarino et al., 2006; Hanushek and Pace, 1995; Stinebrickner, 2001). Vinas-Forcade and Noé Seijas (2021) find evidence of negative selection in Uruguay, finding that among those who participated in PISA 2009 and graduated from secondary school between 2011 and 2013, and subsequently undertook teacher training, they had scored worse in all three areas assessed by PISA than their peers in other careers. These results are in line with the work of Corcoran et al., 2004; Varga, 2007. In other geographical contexts, the results are less conclusive (Osada and Schaeper, 2021), which may be attributed to methodological problems, among other reasons (Roloff et al., 2015).

On the other hand, in a broad line of research on the subject, the type of studies of origin is incorporated as an explanatory variable, differentiating between students who come from scientific-technological studies, henceforth referred to as STEM (Science, Technology, Engineering and Mathematics), and those who come from other types of training, henceforth referred to as Non-STEM. Along these lines, the so-called "hypothesis of the unequal distribution of academic background" suggests that there are differences between students whose studies belong to the STEM group and others (Bohndick, 2020; Perez-Felkner et al., 2012; Roloff et al., 2015). This factor could be playing an important role (Gold and Giesen, 1993), because the majority of those aspiring to the teaching profession are from non-STEM backgrounds. In Spain, Castro (2021) and Asensio et al. (2022) find that more non-STEM students enter the teaching profession, but it is students from scientific and technological baccalaureate backgrounds who show a higher level of entry. Roloff et al. (2015) find negative selection across studies (STEM and Non-STEM) but do not find empirical evidence for the hypothesis of negative selection of teachers in terms of cognitive ability and personality characteristics in Germany. However, also in Germany, Kaub et al. (2012), who focus on the study of spatial skills, do find that teacher candidates enrolled in the field of science have higher values than teacher candidates with studies in the humanities. Along these lines, in the US, Attit et al. (2018) conclude that secondary STEM teachers have better spatial skills than non-STEM teachers and pre-school/primary teachers. These authors highlight that the weaker spatial skills of pre-school and primary school teachers are of particular concern, as these are key skills for STEM learning at an early age.

The present research is situated along these lines and aims to provide evidence of what is happening in Spain, attempting to address at least two of the limitations affecting previous research. Firstly, the groups of interest are compared with a wide

variety of diverse university studies, unlike other research where only convenience samples of other students have been compared, usually comprising no more than one or two specific subject areas (Hanushek and Pace, 1995; Stinebrickner, 2001). And secondly, previous research focuses on the general teacher group, when, given the peculiarities of the educational stages involved, it is important to distinguish between pre-school and primary school, at least.

Consequently, in this research, as a complement to the studies carried out by Asensio et al. (2022) or Urkidi (2020), we aim to study, in the Spanish educational system, the hypothesis of negative selection, considering the possible unequal distribution of academic background and distinguishing between students who aspire to become teachers in the Infant Education (0 to 5 years) or Primary Education (6 to 12 years) stages. To this end, the following objectives are set out:

1. To approach the study of negative selection, describing and prioritising the overall average university entrance performance of students who choose degrees that qualify them to become teachers and students who choose other university degrees in the same branch of knowledge.
2. To approach the study of the unequal distribution of academic background by comparing the average university entrance performance of students from STEM and Non-STEM backgrounds in all selected degrees.
3. In the group accessing the Bachelor's Degree in Early Childhood Education, we gather evidence about the hypothesis of negative selection in the Spanish system, comparing their average academic level of access to university with that obtained by students of other degrees in each subgroup (STEM and Non STEM).
4. In the group that accesses the Bachelor's Degree in Primary Education, we gather evidence about the hypothesis of negative selection in the Spanish system, comparing their average academic level of access to university with that obtained by students from other degrees in the two groups of origin.

Method

This is a retrospective non-experimental multi-group study that explores the differences in average performance in access to initial teacher training in relation to that of other university degrees, including the baccalaureate of origin in the design.

Population and Sample

The data used were provided by the Integrated University Information System (SIIU) of the Ministry of Universities. The total sample is made up of students who took the entrance exam to study the studies listed in table 1 in any of the Spanish universities, both public and private, from the 2014-2015 to 2017-2018 academic years. They are therefore students who have graduated in the last 5 years or who are close to graduating if they are studying longer degrees.

Table 1.

Description of the simple

Qualification	N. Original	N. Final
G. Maestro/a E. Infant	45775	17376
G. Maestro/a E. Primary	75450	33760
G. Pedagogy	11963	4096
G. E. Social	18839	6268
G. Psychology	68980	22129
G. Logopedia	3536	1680
G. Nursing	47090	25992
G. Medicine	27361	17652
G. T. Occupational	3910	2192
G. T. Social	21466	8339
G. Trade	2589	1219
G. Tourism	24595	9990
G. Journalism	15203	10004
DG. Pre-school and Primary E. Primary	2878	1604
TOTAL	369635	162301

Source: Own elaboration based on SIIU data.

The importance of the baccalaureate of origin (STEM or Non-STEM) in the design explains most of the difference between the initial N (369635) and the final N (162301), mainly due to missing values.

On the other hand, and for reasons of feasibility, a selection of students was made from the SIIU database, taking exclusively the data corresponding to the degrees of interest for this study: the then aspiring teachers (the central object of study) and the then aspiring students of other comparable university studies, because they belong to the same branch of knowledge, Social and Legal Sciences, or because they have a professional profile of a helping or assisting nature. All these degrees have in common a concern for attending to people's basic or welfare needs in the broadest sense. It is assumed that those chosen from the branch of Health Sciences require, in addition to scientific knowledge, great social responsibility and a vocation for service, understood as a predisposition to satisfy the needs of others, which is why they can be considered careers in assistance. Although access from the baccalaureate marks a difference between them, the comparability is justified by a similarity between profiles, given that applicants to the chosen Health Science careers are generally sociable people, with a capacity for attention and listening, vocational and with an interest in helping others. On the other hand, applicants to the chosen Social Sciences degree programmes, who are interested in social and economic development, start from similar access

characteristics in terms of the scientific knowledge required and, in general, show good social skills, although some have a more pronounced caring character than others.

Variables

The variable under study (dependent variable) is the university entrance mark, operationalised in this study as the average mark obtained in the common subjects (Spanish Language and Literature, History of Spain and English), the only one available in all groups, since all students are examined in these subjects, regardless of the degree course they choose.

The main independent variable is the university degree chosen, which gives rise to 14 comparison groups and, as a control variable, the type of baccalaureate studied, which is dichotomised, considering the Health Sciences and Experimental Sciences as a STEM baccalaureate and the Humanities and Social Sciences as a Non-STEM baccalaureate.

Data collection and analysis procedure

The Student's *t-test was used for the* comparisons of means between degrees according to the type of baccalaureate of origin (STEM and Non-STEM) due to the normality of the data, using Microsoft Excel software version 2018 (Microsoft Corporation, 2018). The effect size of the differences was calculated using Cohen's *d* with the R software package *esc* (Lüdecke, 2019) version 4.1.2 (R Core Team, 2021). Values below 0.50 are considered small, medium between 0.50 and 0.80 and large when they exceed a value of 0.80 (Cohen, 1988). Finally, the graphs were also produced using R, with the *ggplot2* package (Wickham et al., 2016).

Results

With regard to the first objective, Table 2 shows the total average marks in the common subjects, which are between 5.490 for those applying to study Social Work and 8.334 for those applying to study Medicine. Ranking the degrees from highest to lowest in terms of total average marks, the Bachelor's Degree in Early Childhood Education is ranked second to last (13 out of 14), the Bachelor's Degree in Primary Education is ranked ninth and the Double Degree in Early Childhood and Primary Education is ranked fifth. Ahead of this double degree is the average of Medicine, Nursing, Journalism and Psychology, and ahead of the Double Degree in Primary Education are, in addition, the Double Degree in Occupational Therapy, Speech Therapy and Tourism. Below them are Commerce, Pedagogy, Social Education, the Bachelor's Degree in Early Childhood Education and Social Work.

With regard to the second objective, table 2 also shows the results for each group according to the baccalaureate of origin, which is presented as a balanced variable, with 48.38% of the subjects coming from a STEM baccalaureate and 50.62% from a Non-STEM baccalaureate.

However, this variable is unevenly distributed across the chosen degrees. The highest disproportions are found in Nursing, Medicine and Psychology, where the number of applicants from STEM backgrounds is always higher, and in the simple degrees in Teacher Training and Journalism, where the number of applicants from STEM backgrounds is lower than those from other backgrounds. Other more minority STEM-dominated degrees, although not as marked, are Occupational Therapy and Speech Therapy. On the other hand, the following degrees are more in the minority, but predominantly non-STEM: Tourism, Social Education, Pedagogy, Social Work, the Double Degree of access to the teaching profession and Commerce.

Table 2 shows that, in all the comparisons made, a significantly higher mean is obtained for students from STEM bachelor's degrees, except when it comes to students who entered the Bachelor's Degree in Occupational Therapy, where the differences are not significant. Small effect sizes predominate, although in Nursing and Medicine a medium to large effect size is obtained, taking into account the limits of the confidence interval for d (Cohen, 1988).

Table 2.

Average in common subjects by degree and baccalaureate of origin.

	Total	STEM		No-STEM				
Order according to overall average and qualification	Mean (DT)	Mean (DT)	N	Mean (DT)	N	Cohen's *d*	Inter. Lower	Inter. Superior
(13) G. Teacher E. Infant	5.491 (1.272)	5.704*** (1.278)	3333	5.441 (1.271)	14043	0,207	0,017	0,245
(9) G. Teacher E. Primary	5.878 (1.309)	6.019*** (1.305)	9417	5.824 (1.311)	24343	0,149	0,125	0,173
(11) G. Pedagogy	5.634 (1.264)	5.846*** (1.217)	1007	5.565 (1.279)	3089	0,222	0,294	0,001
(12) G. E. Social	5.601 (1.295)	5.745*** (1.286)	1155	5.569 (1.297)	5113	0,136	0,072	0,2
(4) G. Psychology	6.500 (1.364)	6.662*** (1.315)	14391	6.198 (1.452)	7738	0,34	0,312	0,368
(7) G. Speech therapy	5.950 (1.230)	6.019*** (1.182)	1235	5.760 (1.354)	445	0,211	0,102	0,319
(2) G. Nursing	6.752 (1.380)	6.783*** (1.380)	25247	5.689 (1.380)	745	0,793	0,72	0,866
(1) G. Medicine	8.334 (1.011)	8.**337**** (1.009)	17604	7.264 (1.649)	48	1,061	0,778	1,345
(6) G. Occupational T.	6.069 (1.229)	6.084 (1.219)	1971	5.934 (1.315)	221			
(14) G. T. Social	5.490 (1.231)	5.643*** (1.253)	1482	5.457 (1.226)	6857	0,151	0,095	0,207
(10) G. Trade	5.831 (1.189)	6.061*** (1.171)	287	5.760 (1.195)	932	0,253	0,12	0,386
(8) G. Tourism	5.916 (1.287)	6.181*** (1.275)	1677	5.863 (1.289)	8313	0,248	0,195	0,3
(3) G. Journalism	6.589 (1.335)	6.812*** (1.298)	931	6.566 (1.339)	9073	0,184	0,117	0,252

(5) DG. Pre-school and Primary E. Primary	6.436 (1.332)	6.736*** (1.297)	411	6.332 (1.344)	1193	0,303	0,191	0,416

Note. Significant difference with a=.05 (*), a=.01 (**) and a=.001 (***). Source: Own elaboration based on SIIU data.

Next, we study the hypothesis of negative selection in the two main teacher training degrees, Bachelor's Degree in Early Childhood Education and Bachelor's Degree in Primary Education, disaggregating according to the variable baccalaureate of origin, STEM and Non-STEM, due to the importance of this variable derived from the results presented in Table 2.

With regard to the third objective, which compares the average performance of those students who access the Bachelor's Degree in Early Childhood Education with that of those who access the other degree programmes, it is obtained that the former obtained a significantly lower average in the common subjects than the rest of the degree programmes considered in this study in 23 of the 26 comparisons carried out. With a significance level of .05, the average mark obtained in the common subjects of the University Entrance Examination (EvAU) by students entering the Bachelor's Degree in Early Childhood Education is statistically different from the average mark obtained in these subjects of the EvAU by students coming from a Baccalaureate, Both STEM and Non-STEM, in almost all degrees, except for those who access the Bachelor's Degree in Social Education, where it is only significant in students coming from a STEM baccalaureate and in Social Work, where there are no significant differences for any group. The amount of the difference, ordered from largest to smallest, is shown in Figure 1. It can be seen that the largest difference in those who access the Bachelor's Degree in Early Childhood Education (2,633) is in the STEM subgroup that accesses this degree (5,704) with respect to the students who also come from a STEM baccalaureate who access Medicine (8,337). In second place, in terms of size, is the difference between Non-STEM students entering the Bachelor's Degree in Early Childhood Education and the Bachelor's Degree in Medicine. Also important, in the two groups of origin, is the difference between aspiring teachers for the Early Childhood Education stage and those accessing the Bachelor's Degree in Journalism. And it is worth highlighting the difference found with regard to those who are applying for the Double Degree in Early Childhood and Primary Education and the Degree in Psychology. In the Bachelor's Degree in Nursing, the highest differences with respect to our group of interest are found in students coming from the STEM baccalaureate.

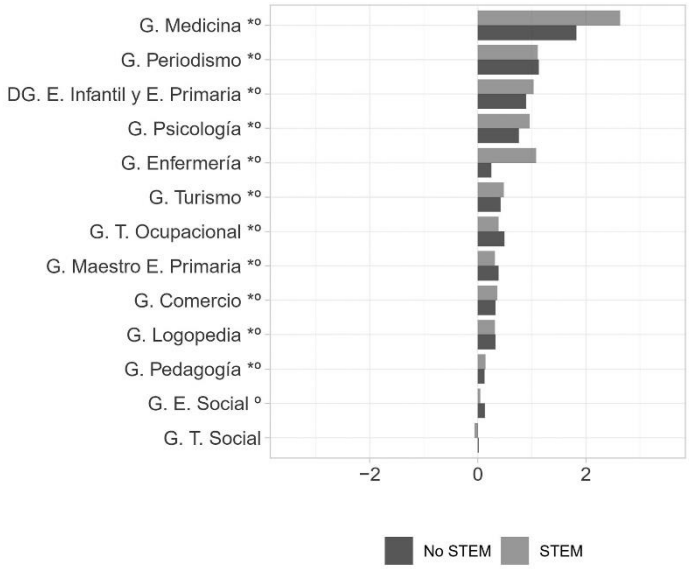

Figure 1. Differences in average performance in access to the Bachelor's Degree in Early Childhood Education and other degrees in the two groups of origin (STEM/No-STEM).

Table 3 shows the differences and the calculated effect sizes, which are large in the STEM group between the Bachelor's Degree in Early Childhood Education and the Bachelor's Degree in Medicine (2.124), Bachelor's Degree in Journalism (0.856), Bachelor's Degree in Nursing (0.841), and medium with the Double Degree in Early Childhood Education and Primary Education (0.797) and with the Bachelor's Degree in Tourism (0.673). In the Non-STEM groups, large effect sizes are found with the Degree in Medicine (1.106) and with the Degree in Journalism (0.856) and a medium effect size with the Double Degree in Early Childhood Education and Primary Education (0.665) and with the Degree in Psychology (0.543).

Table 3.

Differences in the average performance *in access to the Bachelor's Degree in Early Childhood Education and other degrees in the two groups of origin (STEM/No-STEM).*

	STEM			No-STEM		
Qualification	Diff. Averages	t	Cohen's *d*	Diff. Averages	t	Cohen's *d*
G. Maestro/a E. Primary	0.315***	12,145	0,245	0.382***	28,032	0,297
DG. Pre-school and Primary E. Primary	1.032***	15,241	0,797	0.890***	22,046	0,665
G. Pedagogy	0.142***	3,202	0,115	0.123***	4,858	0,097
G. E. Social	0,041	0,931		0.127***	6,04	0,099
G. Psychology	0.958***	38,756	0,745	0.756***	38,383	0,543

G. Medicine	2.633***	112,423	2,124	1.822***	7,651	1,106
G. Nursing	1.079***	45,636	0,841	0.248***	4,794	0,18
G. T. Occupational	0.380***	10,764	0,306	0.492***	5,524	0,375
G. T. Social	-0,062	-1,562		0,015	0,827	
G. Trade	0.357***	4,918	0,302	0.318***	7,846	0,265
G. Journalism	1.108***	23,09	0,856	1.124***	63,55	0,856
G. Tourism	0.476***	12,465	0,673	0.421***	23,719	0,328
G. Logopedia	0.315***	7,82	0,261	0.318***	4,893	0,236

Note. Significant difference with α=.05 (*), α=.01 (**) ψ α=.001 (***).
Source: Own elaboration based on SIIU data.

Finally, with regard to the last objective, which compares the average performance of students who access the Bachelor's Degree in Primary Education with that of those who access other degree qualifications, according to the type of baccalaureate from which they come (STEM, Non-STEM), the amount of the difference, ordered from highest to lowest, is shown in Figure 2. It can be seen that, as in the comparison derived from the second objective, the greatest difference between those who access the Bachelor's Degree in Primary Education is in the STEM subgroup that accesses this degree with respect to the students who also come from a STEM bachelor's degree who access Medicine. In second place, there is a difference between Non-STEM students who enter the Bachelor's Degree in Primary Education and those who enter the Bachelor's Degree in Medicine. Also important, in the two groups of origin, is the difference between aspiring primary education teachers and those who access the Bachelor's Degree in Journalism. And it is worth noting the difference found with regard to those who are applying for the Double Degree in Early Childhood and Primary Education and the Degree in Psychology. In the Bachelor's Degree in Nursing, the biggest differences with respect to our group of interest are found in students coming from STEM baccalaureate.

However, unlike the Bachelor's Degree in Early Childhood Education, the Bachelor's Degree in Primary Education has higher access averages than other degrees, such as the Bachelor's Degree in Early Childhood Education, Bachelor's Degree in Pedagogy, Bachelor's Degree in Social Education and Bachelor's Degree in Social Work. In all these cases, as shown in Table 4, the effect sizes found are small. On the other hand, with a confidence interval of 95%, the two groups of the Bachelor's Degrees in Commerce and Speech Therapy, as well as the STEM group of the Bachelor's Degree in Occupational Therapy do not show significant differences with the Bachelor's Degree in Primary Education.

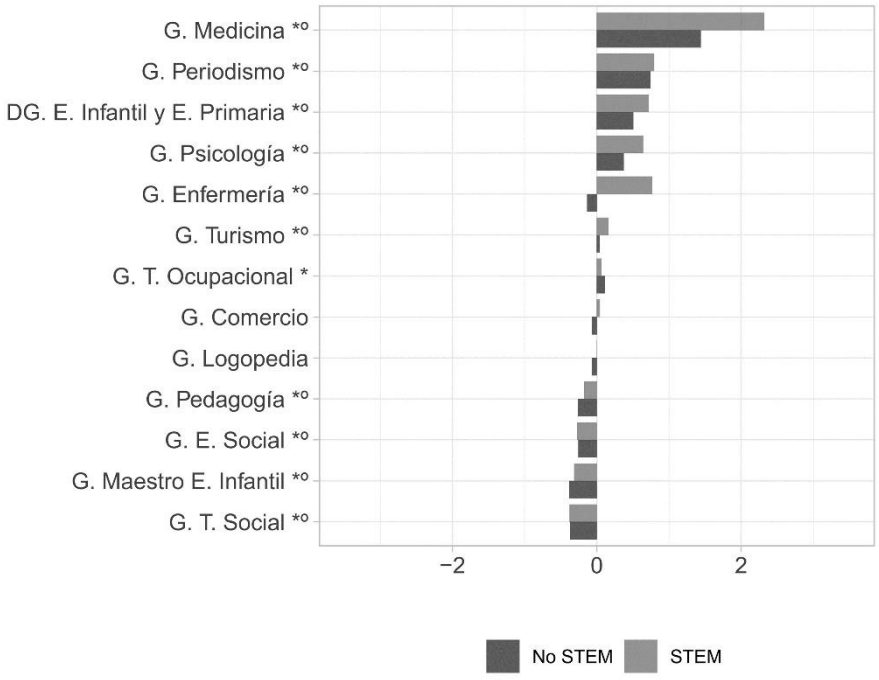

Figure 2. Differences in the average performance in access to the Bachelor's Degree in Primary Education and to other degrees in the two groups of origin (STEM/No-STEM).

The calculated effect sizes are large and medium in the STEM groups of the Medicine (1.915), Journalism (0.610), Nursing (0.584) and the Double Degree in Early Childhood Education and Primary Education (0.553); and in the Non-STEM groups again in Medicine (0.874) and Journalism (0.557).

Table 4.

Differences in the average performance in access to the Bachelor's Degree in Primary Education and to other degrees in the *two groups of origin (STEM/No-STEM).*

	STEM			No-STEM		
Qualification	Diff. Averages	T	Cohen's *d*	Diff. Averages	T	Cohen's *d*
G. Maestro/a E. Infant	-0.315***	-12,145	-0,245	-0.382***	-28,032	-0,297
DG. Pre-school and Primary E. Primary	0.717***	10,969	0,553	0.508***	12,757	0,378
G. Pedagogy	-0.173***	-4,253	-0,141	-0.259***	-10,55	-0,202
G. E. Social	-0.274***	-6,818	-0,213	-0.255***	-12,747	-0,196
G. Psychology	0.643***	37,055	0,491	0.374***	20,174	0,263

G. Medicine	2.318***	149,979	1,915	1.440***	6,049	0,874
G. Nursing	0.765***	48,379	0,584	-0.134**	-2,619	-0,097
G. T. Occupational	0.065*	2,125	0,053	0,11	1,241	
G. T. Social	-0.376***	-10,68	-0,299	-0.367***	-21,549	-0,295
G. Trade	0,042	0,601		-0,064	-1,589	
G. Journalism	0.793***	17,768	0,61	0.742***	45,297	0,557
G. Tourism	0.162***	4,765	0,126	0.039*	2,37	0,03
G. Logopedia	0	0,009		-0,064	-0,982	

Note. Significant difference with α=.05 (*), α=.01 (**) ψ α=.001 (***).
Source: Own elaboration based on IUSIS data.

Discussion and conclusions

As a general conclusion in relation to the first objective, this article shows that students who have entered teaching careers occupy a different position depending on whether they are aspiring to work at pre-primary level (13th place) or primary level (9th place). Only those who have taken the Double Degree in Early Childhood Education and Primary Education are in an intermediate position (fifth place) in the 14 degree programmes chosen. This is a first approximation to the study of negative selection, which, with the results of this study, is more evident in the case of future early childhood teachers.

With regard to the unequal distribution of academic origin (second objective), it is concluded that those who come from scientific-technological studies show a higher score in the common subjects. This phenomenon occurs in the degree courses leading to teacher training and, in general, in all the degree courses selected, except for one, the Bachelor's Degree in Occupational Therapy, which is from the Health Sciences branch and, therefore, with more students from STEM backgrounds. The effect size attributable to background is moderate and even large in the degree programmes where the disproportion between STEM and Non-STEM students is greater, which is mainly the case in Medicine and Nursing.

As the number of students from STEM backgrounds is higher in the Health Sciences degree programmes, the higher average obtained in students who have entered these degrees could be fundamentally due to this variable. In order to further clarify this evidence, we proceed in the following studies to compare the degrees, always considering the two subgroups, STEM and Non-STEM, mainly based on the results of Roloff et al. (2015) who, although they found differences between the individual characteristics of those who aspire to teaching and students from other subjects, did not find evidence of negative selection into the teaching profession when controlling for the students' background.

With reference to the third objective, the empirical study compares those who have entered teacher training for the pre-primary level with those in 13 other similar degrees by branch of knowledge or by vocation of service. Negative selection is obtained in both STEM and Non-STEM groups, so that always, except in the case of

the Bachelor's Degree in Social Work and in the STEM group of Social Education (11.2% of the comparisons), the average in the degree under study is lower. This finding is important, because although the effect sizes found are mostly small (50%), some, both in the STEM and Non-STEM groups, are moderate (15.4%) and large (19.2%) and occur in a design that was intended to include only comparable degrees, so it is not a selection that tends to maximise the effects of the independent variable.

In general, the results obtained in this study for Spain are consistent with those found in Guarino et al. (2006); Hanushek and Pace (1995); Stinebrickner (2001), already discussed, or with those of Ruffinelli and Guerrero (2009), Boado and Fernández (2010), Elacqua et al. (2018) or Vinas-Forcade and Noé Seijas (2021), who find that the performance of aspiring teachers in large-scale assessments such as PISA and in national university entrance exams is lower. This is true in most of the cases studied, both for students with STEM backgrounds and others.

With regard to the fourth objective, when comparing students who have entered teacher training for the primary level with those who enter similar degrees, the negative selection is not so evident. STEM students who have taken this degree outperform on average those in 4 of the 14 degrees chosen, and in 2 there are no significant differences. In the Non-STEM group, they outperform students from 5 degrees on average and in 3 the differences are not significant. That is, in more than half of the comparisons made (53.8%) the selection is not negative, being positive in 34.6%. But large and moderate effect sizes occur in cases where the difference is in favour of other degrees, such as Medicine or Journalism in both groups (STEM and Non-STEM) and in Nursing and the Double Degree in Early Childhood Education and Primary Education, only in the STEM groups. Thus, it can be concluded that there is no clear evidence of negative selection in the case of aspiring primary school teachers. These results are more in line with Roloff et al. (2015).

In general terms, this research provides evidence of the existence of differences in prior performance between students from the STEM pathway and others in practically all degree programmes. If the importance of this variable were such that, when controlling for it, the evidence of negative selection would disappear, it would be expected that the few teacher training students whose baccalaureate is of a technological-scientific orientation would have similar characteristics to those from other STEM-type university degrees, and the same would happen with teacher training students with a social or humanistic baccalaureate with respect to students from non-STEM-type degrees. However, the results obtained do not support this hypothesis. In view of this, we could ask ourselves what differential characteristics STEM students who are studying for a teacher training degree have. One possible hypothesis would be that STEM students who enter teacher training are those who have had some negative experience at the end of their baccalaureate studies and have left the '*STEM-pipeline*' (Sass, 2015) at a late point in their previous education. This is an interesting prospective research topic to explore further.

The main limitations of this study are that, given its essentially exploratory purpose of an academic variable, it is a simple analysis in which the choice of variables of interest has been very limited, which entails the use of simple statistical tests, which are the most appropriate for the type of data and objectives set. This study is limited to the analysis of the average score in one part of the university entrance exam, and it

remains, consequently, prospective to use multivariate analysis models in which other types of cognitive or non-cognitive skills that may be relevant are included, such as personality (Kaub et al., 2012; Kim et al., 2019; Klusmann et al., 2009), intrinsic motivation (Denzler and Wolter, 2009; Klusmann et al., 2009) or extrinsic (INEEd, 2016; Vinas-Forcade and Noé Seijas, 2021), classification variables such as socio-economic status or type of school (public or private) of origin or gender, which are also important according to the results reached, for example, by Denzler and Wolter (2009), Dronkers and Robert (2007), Han et al. (2020), Melo and Machado (2018), Moreau (2019), Ortega (2010) or Vaillant (2011). But the results found regarding the level of access to teaching careers in Spain support the concern about negative selection in the profession. This concern is also behind research on the individual characteristics of teacher candidates, which, according to Roloff et al. (2015), suggests that women are more present in teacher education programmes and that teacher candidates have a lower socio-economic status, tend to have lower cognitive abilities, high social interests and are less open to new experiences. Along these lines, another research prospect is to work on complex models that can identify variables of this type that are associated with negative selection, in order to ultimately have a more complete profile of access to teacher education that allows for evidence-based decision making for improvement.

Finally, among the contributions of the study, it should be noted that, by differentiating in the sample between future teachers in two different educational stages, this work provides evidence that negative selection is not equally evident in one case and in the other. In this sense, it is a large sample approach, which is in line with Denzler and Wolter (2009), who advocate using representative samples of all potential student teachers, as well as including as comparison groups a wide variety of applicants to other types of university studies retrospectively, i.e. before they entered university.

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