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DETERMINANTS OF TEACHERS' PROFESSIONAL SKILLS IN ECUADOR

DETERMINANTES DE LAS COMPETENCIAS PROFESIONALES DOCENTES EN EL ECUADOR

Mauricio Chávez Charro [1 *]
E-mail: director@mbtu-bs.es
ORCID: https://orcid.org/0000-0001-8658-5772
Marta Portela [2]
E-mail: marta.portela@usc.es
ORCID: https://orcid.org/0000-0002-0399-0818
Jacobo Feás-Vázquez [2]
E-mail: jacobo.feas@usc.es
ORCID: https://orcid.org/0000-0002-3963-5228
Yoskira Naylett Cordero de Jiménez[3]
E-mail: ycordero@uteg.edu.ec
ORCID: https://orcid.org/0000-0003-0292-6897
[1] MBTU Business School
[2] University of Santiago de Compostela
[3] Universidad Tecnológica Empresarial de Guayaquil
* Corresponding autor

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ABSTRACT

Teacher evaluation in Ecuador is a product of the commitments made for Latin America at the World Education Forum in Dakar in 2000. Recent research generally suggests that there are many teacher characteristics and skills that, in combination, can predict teaching effectiveness. In this article we will analyse the results of the teacher knowledge assessment, as part of the teacher evaluation carried out in 2016, within the specific field of knowledge and educational level in which the teacher teaches. Using multilevel econometric models, we try to explain the level reached in the evaluation considering the individual characteristics of teachers, school and geographical aspects, for which we use a sample of 102,942 teachers belonging to 13,882 public and public-commissioned educational establishments throughout the country that teach Early Education, General Basic Education and General Unified Baccalaureate. The results of the teacher evaluations indicated that regarding the domain of knowledge in which they teach, in general, the teachers' levels were quite low. The national average was only 666.28 points on a scale of 0 to 1000 points. Teachers who actually continue studying obtain better results than those who do not. A teacher's level of education is an important factor in determining their mastery of specific skills. In Ecuador 4.88% of teachers still do not have any qualifications. The highest percentage (65,6%) have a university degree, and 15.6% have a master's or doctoral degree.

Keywords:

Teacher evaluation, Professional skills, Education in Ecuador, Econometric models, School performance.

RESUMEN

La evaluación docente en Ecuador es producto de los compromisos asumidos para América Latina en el Foro Mundial de Educación de Dakar en el año 2000. Investigaciones recientes sugieren, en general, que existen muchas características y competencias docentes que, en combinación, pueden predecir la efectividad docente. En este artículo analizaremos los resultados de la evaluación de conocimientos docentes, como parte de la evaluación docente realizada en el año 2016, dentro del campo de conocimiento específico y nivel educativo en el que el docente imparte docencia. Mediante modelos econométricos multinivel, tratamos de explicar el nivel alcanzado en la evaluación considerando las características individuales de los docentes, aspectos escolares y geográficos, para lo cual utilizamos una muestra de 102.942 docentes pertenecientes a 13.882 establecimientos educativos públicos y concertados de todo el país que imparten Educación Inicial, Educación General Básica y Bachillerato General Unificado. Los resultados de las

evaluaciones docentes indicaron que respecto al dominio de conocimiento en el que imparten docencia, en general, los niveles de los docentes fueron bastante bajos. El promedio nacional fue de tan solo 666,28 puntos en una escala de 0 a 1000 puntos. Los docentes que continúan estudiando obtienen mejores resultados que los que no lo hacen. El nivel de formación de los docentes es un factor importante para determinar el dominio de competencias específicas. En Ecuador, el 4,88% de los docentes aún no cuenta con título universitario. El porcentaje más alto (65,6%) posee título universitario y el 15,6% posee título de maestría o doctorado.

Palabras clave:

Evaluación docente, Competencias profesionales, Educación en Ecuador, Modelos econométricos, Rendimiento escolar.

INTRODUCTION

For several years now, the quality of teachers has been the subject of discussion in the academic world of the education sector, a debate that has also spilled over into the political sphere. The focus of the discussion has been on three aspects: the first refers to whether or not there are significant and systematic differences between schools and teachers in their ability to raise student achievement; the second point refers to the importance of differences in teacher quality in the achievement of student outcomes and the magnitude of their effects, if these differences between teachers can be captured by observable characteristics of schools and teachers; the third aspect discusses whether or not there are systematic differences between schools in their attributes that make a difference in student performance. Furthermore, teachers themselves often emphasize the significance of personal and professional characteristics such as motivation, communication skills, and the ability to establish a positive classroom environment, as key factors influencing student success, highlighting the importance of both individual teacher qualities and school leadership in fostering academic achievement (Ozcan, 2021; Bayar & Alkan Karaduman, 2021).

The exercise of teaching and its contexts of execution play a fundamental role when considering the knowledge required and the knowledge that teachers can formulate within the framework of their work, and the disciplinary knowledge that represents the possibility of transmitting, constructing or transforming knowledge—not only as an element for training people, but also as a fundamental element for humanity and social progress. Moreover, this knowledge is not static nor universally transferable; rather, it is actively produced and reconstructed by teachers through their everyday practices, deeply embedded in the specific social, institutional, and cultural conditions of their work. As highlighted in ethnographic research conducted in Latin American countries by Mercado & Espinoza (2022), where the teaching of knowledge emerges from a complex articulation of diverse sources and experiences, reflecting a situated and receptive engagement with the challenges of classroom realities.

So when teachers are said to increase their effectiveness, this would be the result of having been able to receive high-quality general education and in-depth content-specific and pedagogical knowledge, as well as experience as a teacher and opportunities for professional development. In the context of the Fourth Industrial Revolution (IR 4.0), this also requires equipping preservice teachers with 21st century skills, including digital competencies, creativity, critical thinking, and adaptability. Initial Teacher Training Institutions are thus called to deliver coherent and contextually responsive programs that integrate technological, pedagogical, and content knowledge to support teachers' capacity to navigate and respond to the evolving demands of education in a rapidly digitizing world (Cochran & Keefe, 2022; Teo et al., 2021).

In recent years, Ecuador has made significant efforts to improve its education system, as evidenced by the implementation of the Ten-Year Education Plan 2006–2016, the enactment of the Organic Law on Intercultural Education, the development of teacher profiles and performance standards, and the introduction of teacher evaluation systems. These actions were part of a broader strategy of comprehensive educational transformation, conceptualized as a "whole system reform," which sought to enact deep and simultaneous changes across the entire system. By adopting a systemic and complexity-based approach, Ecuador aimed to achieve sustainable improvements in educational quality, equity, efficiency, and coverage (Aguerrondo & Chiriboga, 2023; Fabara Garzón, 2013).

However, despite the efforts made, many children, especially those from low socio-economic backgrounds, achieve low results in international assessments. For example, in a recent Latin American study of third grade students, 38.1% of children in Ecuador achieved the lowest of the four levels of performance in Mathematics. This persistent underachievement reflects broader regional challenges, where socio-economic disparities strongly influence student performance, and where educational reforms have yet to fully ensure equal opportunities in both access and learning outcomes. Addressing these gaps requires not only policies aimed at universal and equitable access but also deep pedagogical reforms, including strengthening teacher recruitment, training, and professional development, to improve the quality and equity of education for vulnerable populations (Gajardo, 2020).

The first teacher evaluation was carried out in 2008 and only in 2013 did the country have the legal framework to make evaluation mandatory. This legal framework establishes three moments to carry out the evaluation: for entry into the teaching career, during their permanence within the teaching profession and as an element to achieve the recategorisation of the teacher. The established Teacher Evaluation Model evaluates teacher performance, and also provides information on teachers' professional skills. For this purpose, it evaluates four components: disciplinary mastery of the field in which they teach, classroom learning management, socio-emotional and citizenship skills, and leadership competencies (INEVAL, 2017b; INEVAL, 2022). Within the percentage of contribution to the overall mark, disciplinary knowledge contributes the highest percentage, 45.0 %. At the time of the research, only the data from the knowledge assessment and the self-assessment score were available, as part of the teacher assessment called "Ser Maestro", applied to teachers who were part of the teaching profession in 2016.

It should be noted that in 2019 the "Quiero Ser Maestro", a recovery process took place of eligibility, aimed at those who lost their eligibility status in order to regain it and continue with the merit and opposition stage. After that, in 2020 the evaluation process "Quiero Ser un Maestro Intercultural Bilingüe", in which 966 applicants were qualified (INEVAL, 2022).

Literature review on teachers in the school system

It is now widely recognized that teachers are the most important contributors to student learning within the school system. Although different methods for measuring teacher quality reveal sometimes divergent information, evidence points to a central role for teachers in improving student outcomes (Potter, 2022).

Within the academic world, it is agreed that teachers can make a substantial difference to students' academic performance, so much so that the fact that teachers are the most important contributors to learning within the school system is widely acknowledged (Ramos & Roque, 2021). Thus, having a better teacher has effects that appear to be sustained and cumulative. Thus, the effects of a bad or good teacher transcend over time, influencing student learning. In the long run, they have an impact on a number of aspects during adulthood, such as the possibility of entering university, the salaries received, or the savings generated (James & Loeb, 2021). Teachers, and therefore schools, are very important elements of student achievement, as their professional, attitudinal, and environmental qualities significantly influence academic success. However, whether these factors cause substantial variation in achievement remains a subject of ongoing debate (Ozcan, 2021).

One of the issues on which the academic and political debate has increasingly focused in recent years is the quality of teachers. Meta-analytic evidence suggests that teachers' specific characteristics and competencies, such as reflective attitudes, professional development, and teacher self-efficacy, have notable but heterogeneous effects on student achievement, reflecting the complexity inherent in assessing teachers' contributions to educational outcomes (López et al., 2023; Martin, 2021). For example, taking the case of the United States research, teachers in the same school vary considerably with respect to their impact on student learning outcomes, varying considerably in their effectiveness (Glassow & Jerrim, 2022).

However, the knowledge that some teachers produce more learning than others does not provide clear guidance on which specific attributes make a teacher effective. Although efforts have been made to assess teacher quality through both subjective student evaluations and objective value-added measures, these approaches often capture different aspects of teaching and sometimes yield inconsistent results. This complexity highlights the challenges involved in identifying definitive characteristics that consistently predict teaching effectiveness (Potter, 2022).

Teachers have a dual role, one as experts in a certain field of knowledge and the second as specialists in the pedagogical interventions necessary for students to progress in the mastery of the knowledge of those fields (Cochran & Keefe, 2022). The literature refers to two components that form the backbone for the study of teachers' professional development: one is the critical characteristics that define effective professional development, which are fundamental to improving teaching practices and enhancing student achievement, namely content focus, active learning, coherence, sustained duration, and collective participation. The second is the operational theory explaining how professional development influences teacher and student outcomes by identifying key inputs, intermediate changes, and final impacts. However, recent models have emphasized that contextual, structural, and agency-related barriers can significantly hinder the translation of well-designed professional development into tangible classroom and student outcomes, thus highlighting the complex, non-linear nature of the professional development-to-impact trajectory (McChesney & Aldridge, 2019).

We focus our attention on the content focus of teacher learning, which is said to be the most influential characteristic based on existing evidence. It points to the presence of a link between activities that focus on subject content and how students learn that content, leading to increases in knowledge and, to a somewhat more limited extent, improved student achievement, a process mediated by the skills of the teacher. Moreover, recent research emphasizes that the effect of content-focused professional

development can be amplified when it is aligned with teachers' existing practices and contextualized within their specific curricular and classroom realities, thereby facilitating not only the acquisition of new knowledge but also more effective implementation in teaching practices and student learning outcomes (Azpillaga et al., 2021; Strat et al., 2024).

When talking about the content approach, we refer to what in some cases are called disciplinary knowledge, which is the knowledge belonging to a society about different fields and which is organized in the form of specialties or disciplines (INEVAL, 2017b, 2022). The practice of teaching and its contexts fundamentally shape the knowledge teachers need and develop through their work. Disciplinary knowledge enables the transmission, construction, or transformation of knowledge, serving not only to educate individuals but also as a key driver of social progress. Importantly, teaching knowledge is dynamic and situated, produced through daily practice within specific social and institutional contexts, and is crucial for fostering student learning, especially in challenging and unequal environments (Mercado & Espinosa, 2022).

One of the measures of teacher effectiveness is knowledge of the disciplinary content about which the teacher is teaching. Teacher training institutions face the challenge of ensuring that future teachers not only master their subject matter but also develop the ability to foster critical thinking, creativity, and technological proficiency in their students, equipping them for rapidly evolving educational and workforce demands (Teo et al., 2021). Studies that investigated the impact of teachers' level of knowledge revealed that a lack of disciplinary content knowledge has detrimental consequences for student learning, often this results in unmotivating lessons. Furthermore, knowledge is not only essential for effective teaching, but also relates to a teacher's ability to deeply understand the concepts they are using, which fosters greater confidence in their teaching practice. This confidence, based on solid knowledge, allows teachers to better gauge their skills and knowledge, facilitating more effective and contextualized teaching and thus contributing to better student learning outcomes (Davis & Bernadowski, 2024). To the extent that a teacher's knowledge is the basis of his or her effectiveness, the most relevant knowledge will be that which relates to the particular subject being taught, as well as to the pedagogical strategies needed to teach specific types of learners (Cochran & Keefe, 2022).

Overall, in Latin America, teachers are said to vary considerably in their effectiveness. The region has low productivity, largely attributable to low skills in the workforce. According to recent analyses, this situation is linked not only to the quality of in-service teaching but also to structural issues in teacher recruitment and training. Addressing these challenges requires raising the selectivity and quality of teacher preparation and recruitment, as well as implementing ongoing professional development, to ensure that improvements in teaching effectiveness translate into higher workforce skills and productivity across the region Di Franco (2024). Within the literature reviewed, we have found two studies related to teachers in Ecuador; the first, from Araujo et al. (2016) shows that there are substantial differences in the degree of learning in Language and Mathematics and in executive function in kindergarten classrooms in Ecuador; these differences are associated with differences in teachers' behaviours and practices. The second study uses a sample of children in the second, third and fourth grades of General Basic Education to analyse whether students who are taught by teachers who obtained the highest marks in the merit-based competitive examination for entry into the country's teaching profession perform better in Mathematics and Language and found no evidence that this is the case (Cruz-Aguayo et al., 2017).

The salary situation of teachers in schools and colleges in Ecuador has always been quite complex; over time, the acute structural problems have not been solved and teachers have consistently found themselves on the lowest salary scale. Training to become a teacher does not guarantee a decent livelihood for the teacher and their family. Although recent education reforms led to a doubling of teacher salaries and a significant increase in public spending on education, teachers' pay remains relatively low compared to other professions, and deep-rooted structural challenges in the teaching career persist (Bruns et al., 2022).

The preparation of teachers depends on the level of education at which they teach, which is normally related to the age of the students. Thus, Early Education teachers are specialized in working with children from three to five or six years of age; teachers from 2nd to 7th grade of General Basic Education work with children from six to twelve or thirteen years of age; and, in the case of Ecuador, generalist teachers are those who teach most of the subjects in the different fields of knowledge. Teachers who teach from 8th to 10th grade of GBE and from 1st to 3rd grade of UGB, work with young people from twelve to nineteen years of age, and the training they have received qualifies them to teach a subject in a specific field of knowledge. There are also teachers of the so-called transversal axis, who are teachers of English, physical education, computer science, art and aesthetics education and special education, who work both with children in GBE and with young people in Baccalaureate.

MATERIALS AND METHODS

Description of data

For the study, we used data from two sources; one corresponds to the evaluation of knowledge carried out on early childhood education, general basic education and unified general baccalaureate teachers in public and state schools in Ecuador in 2016; The second source is the standardized tests applied by the National Institute for Educational Evaluation to students in the national education system, in the case of general basic education, through the sample-type test called "Ser Estudiante" applied to students in 4th, 7th and 10th grades of General Basic Education, In the case of the Unified General Baccalaureate, through the evaluation test "Ser Bachiller", a compulsory test that students in the 3rd year of GBU must take, and with the score obtained, apply for a place in public universities and technological institutes.

Among the didactic skills evaluated with respect to teachers is the mastery of the specific disciplinary knowledge of the teaching field, which explores the understanding of the contents of the different specializations. The instrument used was a structured basic test, with multiple-choice items in different forms and designs, which allow us to obtain data on teaching knowledge and skills (INEVAL, 2017b).

The number of teachers summoned for the knowledge test, as part of the "Ser Maestro 2016" assessment, was 140,915, which corresponds to 66.59 % of the total number of teachers in the country, with 102,942 teachers taking the test, equivalent to 48.65 %, and 37,973 absent. A breakdown of the number and percentage by type of educational institution is given in the table below.

Table 1 The teachers who took the knowledge test correspond to 13,882 educational institutions, belonging to the 24 provinces of the country, in addition to the non-delimited zone, the details are shown in the Table 2.

Table 1: Number of teachers called for the 2016 evaluation by type of educational institution

	State-commissional	Fiscommissioned	Municipal	Private	Total
Total number of teachers 2015-2016	146.524	11.806	1.972	51.308	211.610
Summoned to carry out the evaluation	131.115	8.917	115	538	140.915
Conducted assessment	96.094	6.369		381	102.942
Percentage who took the test	65,58%	53,95%	4,97%	0,74%	48,65%

Source: Own elaboration based on data from the Ministry of Education Ecuador (2016).

Table 2: Number of teachers evaluated by schools, cantons and provinces

	Teachers	Schools	Cantons	Provinces
Quantity	102.942	13.882	224*	25*

*Includes the undefined area.

Source: Prepared by authors

Characteristics of the evaluated teachers

Among the characteristics of the teachers evaluated, 67.39 % are women and 32.61 % are men, i.e., two thirds are women. In terms of age, the range is between 20 and 70 years of age, with most teachers (30.81 %) between 40 and 50 years of age and between 50 and 60 years of age (29.43 %). Regarding ethnic self-definition in terms of customs and traditions, the great majority, that is, 82.0 %, defined themselves as white-mestizo, 1.99 % as Afro-Ecuadorian, 3.58 % as Montubio, 3.85 % as indigenous and 0.13 % of another ethnic group.

One of the indispensable characteristics that we consider should be analysed is the qualification attained by each of the teachers. For this purpose, the categories considered were doctorate or master's degree (fourth level), bachelor's degree (third level), higher technician or technologist degree, and those with no degree at all. The data in Ecuador show that 15.6 % have a master's or doctorate degree, 65.6 % are graduates, 13.9 % are technical graduates and 4.9 % have no degree at all.

The knowledge assessment was applied in the different fields of knowledge and levels of education in which the teachers teach, therefore, we present the number of teachers and percentages, values that we detail in the table below. Table 3. Most teachers, 40.78 %, are generalists who teach in General Basic Education between 2nd and 7th grade.

Table 3: Number of teachers by level and speciality

Level	Speciality	Quantity per speciality	Percentage by speciality	Total per level	Percentage by level
Initial	Initial Education	16.923	12,01%	16.923	12,01%
GBE 2ND-7TH GRADES	General Basic Education	57.465	40,78%	57.465	40,78%
GBE 8TH-10TH GRADES	Natural Sciences from 8th to 10th grade of GBE.	5.528	5,37%	20.838	14,79%
	Social Studies from 8th to 10th grade of GBE.	5.147	5,00%		
	Mathematics from 8th to 10th grade GBE	3.530	3,43%		
	Language and Literature from 8th to 10th grade of GBE.	3.216	3,12%		
General Unified Baccalaureate (UGB)	UGB Mathematics	2.569	2,50%	18.171	12,90%
	UGB Language and Literature	3.180	3,09%		
	UGB Chemistry	902	0,88%		
	UGB Biology	919	0,89%		
	UGB Physics	607	0,59%		
	UGB History and Social Sciences	1.797	1,75%		
	UGB's Philosophical Thought	307	0,30%		
	UGB Entrepreneurship and Management	2.277	2,21%		
	UGB Citizenship Education	858	0,83%		
Transversal 2nd of GBE to 3rd of UGB	Various knowledge	19.388	9,97%	19.388	13,76%

Source: own elaboration based on data from the National Evaluation Institute (2016).

Characteristics of the schools where teachers teach

Regarding the location of the school, whether in urban or rural areas, in relation to the number of teachers, 71.58 % belong to the first group, while 28.26 % work in rural educational institutions. In the country, due to its natural characteristics, there are several geographical regions and the percentage of teachers who belong to schools located in the island region is 0.24 %, in the Amazon region 8.25 %, in the Sierra region 45.16 % and in the Coastal region 45.99 %.

One of the factors of interest is the number of students in the classroom, for which INEVAL considered the following groups: 1 to 15, 16 to 25, 26 to 35, 36 to 45, 46 to 55, and 56 or more. Thus, the majority of teachers teach groups ranging from 26 to 35 and 36 to 45 students**.** It is also necessary to know the number of groups of students or parallel groups assigned to the teachers, and the results show that 44.55 % are in charge of only one group.

RESULTS

INEVAL, the institution responsible for the assessment of knowledge, applied a structured test with multiple-choice items, whose evaluation scale ranges from 0 to 1,000 points, establishing performance levels that place teachers at a certain level of knowledge and mastery of specific knowledge within the field of knowledge in which they teach. There are three levels of performance that are considered general, and a category called "***in training***" for those who are below the categories considered. The scoring, citation and description of each of the categories is presented in the Table 4.

Table 4: Performance level of the knowledge assessment

Score	Mention	Description
950 - 1000	Excellent	Has achieved mastery of the disciplinary knowledge of the field he/she teaches and knows the fundamentals that help direct student learning in different settings and practices.
700 - 950	Favourable	Has developed sufficient disciplinary knowledge of the field he/she teaches and knows the fundamentals to manage the learning process of the students.

600 - 700	Fundamental	Possesses the fundamental knowledge of the field he/she teaches necessary for his/her performance
000 - 600	In training	Knowledge in their field needs to be broadened, refined and deepened.

Source: Adapted from Model of Teacher's evaluation (edition no. 1, p. 40) INEVAL, 2016, Editorial Publicaciones INEVAL. Public Domain Work

The results achieved by teachers in the knowledge assessment in the test carried out in 2016 show that 70.04 % obtained scores of between 600 and 700 points, within the "fundamental" performance level, and 6.93 % achieved a score of less than 600 points. For illustrative purposes, we present the Table 5 with the percentages achieved within each of the mentions.

Table 5: Performance achieved in the assessment of knowledge

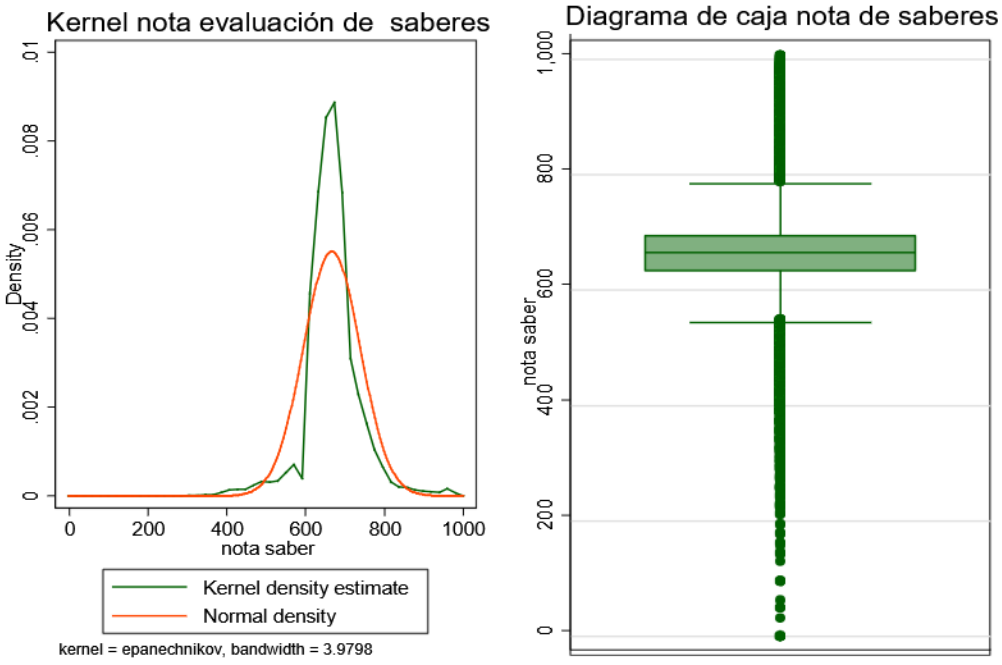
	In training	Fundamental	Favourable	Excellent
Quantity	7.132	72.102	23.124	584
Percentage	6,93%	70,04%	22,46%	0,57%

Source: own elaboration based on National Evaluation Institute (2016).

The mean score achieved by the teachers is 666.288, with a standard deviation of 72.3408. We present an overview of the performance of the teachers in the Figure 1, where we show the Kernel density estimation plot and the box plot of the knowledge test score.

Fig 1. Kernel density estimation plot and box plot of teachers' knowledge test score.

Kernel notes knowledge assessment Box diagram of the knowledge note



Source: own elaboration based on data from the National Evaluation Institute (2016).

Given that the evaluation of knowledge was oriented towards specific knowledge and the educational level at which the teacher teaches, it is necessary to present the means and standard deviations taking into consideration that the teachers of Initial Education and from 2nd to 7th GBE are generalists and that, in their case, only one mark is included and it is not presented by field of knowledge; while for those teachers of 8th to 10th GBE and Baccalaureate, the marks are presented based on the respective field of knowledge. From the results presented in the Table 6. The low level achieved

in Mathematics at both levels of education and in Physics, as well as in Language and Literature in the Baccalaureate, is striking; moreover, in all the cases mentioned, there is a fairly large standard deviation.

Table 6: Mean and standard deviation of the score of the knowledge assessment by teacher's speciality

Teacher's speciality	Initial		GBE 2nd to 7th grade		GBE 8th to 10th grades		Baccalaureate		Transversal Axis	
	Media	SD	Media	SD	Media	SD	Media	SD	Media	SD
Edu. Initial	668	60,68								
GBE 2nd to 7th grade			666	63,46						
Transversal Axis									680	73,56
Mathematics					639	78,99	628	85,35		
Language and Literature					695	76,44	675	77,00		
Social Sciences					677	79,69	642	91,15		
Natural Sciences					665	80,51				
Physics							617	92,04		
Chemistry							680	84,03		
Biology					658			68,78		

SD: Standard deviation

Source: own elaboration based on data from the National Evaluation Institute (2016).

In order to meet the objective of this research, we measure teacher quality based on the evaluation of their professional competencies and we seek to explain the relationships between the background and the performance obtained by teachers in the evaluation of disciplinary knowledge. The most appropriate models for this research are the multilevel models, which allow us to study teachers who are grouped into hierarchical structures such as schools, and these in turn are located within a territorial jurisdiction, which in the case of Ecuador we consider to be the most appropriate (Goldstein, 2011). In the case of Ecuador, we consider provinces.

Three-level variance components model (1)

$$\boldsymbol{achivement}_{ijk} = \beta_0 + v_k + u_{jk} + e_{ijk}$$

$$v_k \sim N(0, \mathfrak{o}_v^2)$$

$$u_{jk} \sim N(0, \mathfrak{o}_u^2)$$

$$e_{ijk} \sim N(0, \mathfrak{o}_e^2)$$

Where is the score obtained by teacher ***i (i = 1, ... ,n)*** in school ***j (j = 1, ...,m),*** in province ***k (k = 1, ...,25)***. is the average score of all provinces, is the variable effect of province ***k,*** is the variable effect of school ***j,*** and is the residual teacher-level error term, , , have zero mean and constant variance , , , respectively (Leckie, 2013).

Once the variance components model, known as the null model, has been determined, we propose the general model that allows us to answer our proposed questions and hypotheses (Flunger et al., 2019). Once the variance components model, known as the null model, has been determined, we propose the general model that allows us to answer our proposed questions and hypotheses, a model that includes the individual variables, the school variables and the geographical context. The model is:

General model with three levels..... *(2)*

$$\boldsymbol{logro}_{ijk} = \beta_0 + \sum_{p=1}^{P} \beta_p X_{ijk} + \sum_{q=P+1}^{Q} \beta_q X_{jk} + \sum_{r=Q+1}^{R} \beta_r X_k + v_k + u_{0jk} + e_{ijk}$$

$$v_k \sim N(0, \mathfrak{o}_v^2)$$

$$u_{jk} \sim N(0, \mathfrak{o}_u^2)$$

$$e_{ijk} \sim N(0, \mathfrak{o}_e^2)$$

To analyse the quality of teachers, we based our study on the test of teachers' disciplinary knowledge carried out in 2016, as part of the teacher evaluation process of the country's education system.

For the analysis of the results of the assessment of disciplinary knowledge carried out by teachers, we considered three levels: level one, teachers; level two, schools; and level three, provinces. The variables used to be able to answer our research questions are related to the established levels; thus, we have:

Teacher

- Socio-economic index
- Average obtained in the knowledge test
- Sex
- Age
- Ethnic identification according to culture and customs
- Field of knowledge and level of teaching
- Qualification achieved
- Studying for a degree
- Level of ICT proficiency
- Number of students per classroom
- Number of student groups assigned

School

- Type of school funding
- Rural/Urban Area
- *Geographical area*
- Natural region in which the school is located
- Province

To obtain the teacher's socio-economic index, which characterises individuals based on a series of economic and social variables, information on the individual, the family and the household is integrated (INEVAL, 2017a).

In order to analyse teachers' knowledge assessment, we used multilevel models that allowed us to investigate the relationships between the performance achieved by teachers in the knowledge assessment and with the individual characteristics of teachers and contextual factors; for this purpose, we considered a total of 99,133 teachers from different educational levels and fields of knowledge, belonging to 13,592 educational institutions, corresponding to 25 territorial jurisdictions. We call model 1 the null model because it only contains the variance components. Model II includes the individual effects variables. School effects are added in model III and, finally, model IV contains the geographical effects.

For the analysis of the teachers' performance in the knowledge test we considered the following groups: the first group includes the teachers of initial education and from 2nd to 7th GBE; for the second group of analysis we considered the teachers of 8th to 10th GBE, 1st to 3rd UGB and the teachers of the Transversal Axis from 2nd GBE to 3rd UGB, the number of teachers included in each group is shown in the Table 7.

Table 7: Number of teachers by level of education and discipline considered in the analysis.

Level of education	Scope	Observations
Initial Education	Initial Education	14.593
General Basic Education from 2nd to 7th grade	General Basic Education	45.252

Level of education	Scope	Observations
General Basic Education from 8th to 10th grades	Natural Sciences from 8th to 10th grade of GBE.	5.311
	Social Studies from 8th to 10th grade of GBE.	4.895
	Mathematics from 8th to 10th grade GBE	3.420
	Language and Literature from 8th to 10th grade of GBE.	3.130
General Unified Baccalaureate from 1st to 3rd grade	UGB Mathematics	2.394
	UGB Language and Literature	2.955
	UGB Chemistry	758
	UGB Biology	880
	UGB Physics	555
	UGB History and Social Sciences	1.722
	UGB's philosophy	291
	UGB Citizenship Education	823
	UGB Entrepreneurship	2.217
Transversal Axis from 2nd GBE to 3rd UGB	Various fields	9.837

Source: own elaboration based on data from the National Evaluation Institute.

The results of the estimations made for each of the models are shown in Table 8. For Early Childhood Education teachers and from 2nd to 7th grade of General Basic Education; and in the Table 9 for teachers of 8th to 10th grades of GBE, Baccalaureate and the Transversal Axis.

We began the analysis by estimating the variance components model, and all the variations were significant. For the first group analysed, when calculating the variance participation coefficient (VPC) we obtained the result that 68.4 % of the variance is due to the characteristics of the teachers themselves, 11.3 % is due to the schools and 20.3 % is due to the effects of the territorial jurisdictions. For the second group, the behaviour of the variance is completely different, the highest percentage, i.e., 86.5 % is due to teachers, and shows rather low values for school and province, with 5.7 % and 7.8 % respectively.

The results of the calculation of the intra-class correlation coefficient (ICC) indicate that the correlation for the provinces is lower for both cases than the correlation between the school and the province. This indicates that the knowledge assessment results of teachers in the same province are slightly correlated, while the same results are more highly correlated at the level of schools within a province.

Table 8: Results of the estimations of the knowledge assessment models of Early Childhood Education teachers from 2nd to 7th GBE.

Parameter	Teachers			
	Model I	Model II	Model III	Model IV
Fixed Effects				
Individual Variables				
Socio-economic index		0,0626***	0,0609***	0,0608***
		(0,00186)	(0,00186)	(0,00186)
Woman		-0,0206***	-0,0235***	-0,0235***
		(0,00580)	(0,00580)	(0,00580)
Ethnic identification				
Afro-Ecuadorian		-0,110***	-0,108***	-0,108***
		(0,0183)	(0,0182)	(0,0182)
Montubio		-0,000905	-0,000175	-0,0000764
		(0,0125)	(0,0125)	(0,0125)
Indigenous		-0,450***	-0,440***	-0,440***
		(0,0118)	(0,0118)	(0,0118)

Parameter	Teachers			
	Model I	Model II	Model III	Model IV
Other ethnicity		-0,179**	-0,178**	-0,178**
		(0,0641)	(0,0640)	(0,0640)
Field of knowledge and level of education				
Initial education		-0,115***	-0,118***	-0,118***
		(0,00573)	(0,00573)	(0,00573)
Technician or Technologist		-0,0864***	-0,0841***	-0,0841***
		(0,00581)	(0,00580)	(0,00580)
Master's or Doctorate		0,0982***	0,0963***	0,0962***
		(0,00811)	(0,00810)	(0,00810)
Other factors				
He is currently studying		0,0459***	0,0448***	0,0448***
		(0,00723)	(0,00722)	(0,00722)
Level of ICT proficiency		0,000291	0,000288	0,000288
		(0,000281)	(0,000281)	(0,000281)
Number of students per classroom				
More than 35 students		0,0153**	0,00862	0,00865
		(0,00575)	(0,00577)	(0,00577)
Number of groups handled				
More than four groups		-0,0585***	-0,0554***	-0,0555***
		(0,00815)	(0,00814)	(0,00814)
School variables				
Fiscal and fiscal school			0,0459**	0,0461**
			(0,0141)	(0,0141)
Rural school			-0,0712***	-0,0714***
			(0,00639)	(0,00639)
Geographical effects				
Costa				-0,347***
				(0,0944)
Amazon				-0,256*
				(0,0994)
Insular				-0,301
				(0,216)
Constant	6,605***	6,878***	6,915***	7,086***
	(0,0597)	(0,0508)	(0,0510)	(0,0599)
Random effects				
Province	0,0882***	0,0617***	0,0620***	0,0378***
	(0,0251)	(0,0176)	(0,0177)	(0,0109)
School	0,0493***	0,0274***	0,0264***	0,0264***
	(0,00179)	(0,00124)	(0,00121)	(0,00121)
Teacher	0,297***	0,275***	0,275***	0,275***
	(0,00189)	(0,00173)	(0,00173)	(0,00173)
Schools	12.478	12.462	12.462	12.462
Provinces	25	25	25	25

Parameter	Teachers			
	Model I	Model II	Model III	Model IV
ICC province	0,2031	0,1695	0,1706	0,1114
ICC sc./prov.	0,3168	0,2447	0,2434	0,1893
2LR		6659.8 (15 g.l.)	138,32 (2 g.l.)	12,06 (3 g.l.)

Standard error in brackets. * p < 0.05, ** p < 0.01, *** p < 0.001

Source: own elaboration based on data from the National Institute of Evaluation (2016).

Table 9: Results of the estimations of the knowledge assessment models GBE from 8th to 10th, UGB and teachers of the Transversal Axis.

Parameter	Teachers			
	Model I	Model II	Model III	Model IV
Fixed Effects				
Individual Variables				
Socio-economic index		0,0620***	0,0599***	0,0598***
		(0,00315)	(0,00315)	(0,00315)
Woman		-0,118***	-0,119***	-0,119***
		(0,00792)	(0,00791)	(0,00791)
Ethnic identification				
Afro-Ecuadorian		-0,152***	-0,154***	-0,154***
		(0,0272)	(0,0271)	(0,0271)
Montubio		0,00996	0,0135	0,0138
		(0,0190)	(0,0190)	(0,0190)
Indigenous		-0,526***	-0,505***	-0,503***
		(0,0237)	(0,0237)	(0,0237)
Other ethnicity		0,00768	0,00473	0,00539
		(0,0853)	(0,0852)	(0,0852)
Field of knowledge and level of education				
Social Studies from 8th to 10th grade of GBE.		0,154***	0,154***	0,154***
		(0,0144)	(0,0144)	(0,0144)
Mathematics from 8th to 10th grade GBE		-0,370***	-0,371***	-0,371***
		(0,0160)	(0,0160)	(0,0160)
Language and Literature from 8th to 10th grade of GBE.		0,283***	0,282***	0,282***
		(0,0164)	(0,0164)	(0,0164)
UGB Mathematics		-0,456***	-0,459***	-0,459***
		(0,0181)	(0,0181)	(0,0181)
UGB Language and Literature		0,188***	0,186***	0,186***
		(0,0168)	(0,0168)	(0,0168)
UGB Chemistry		0,0775**	0,0724**	0,0723**
		(0,0268)	(0,0268)	(0,0268)
UGB Biology		-0,148***	-0,153***	-0,153***
		(0,0266)	(0,0266)	(0,0266)
UGB Physics		-0,630***	-0,637***	-0,637***
		(0,0327)	(0,0327)	(0,0327)
UGB Social Studies		-0,247***	-0,252***	-0,252***
		(0,0203)	(0,0203)	(0,0203)

Parameter	Teachers			
	Model I	Model II	Model III	Model IV
UGB's philosophy		0,140**	0,134**	0,133**
		(0,0437)	(0,0437)	(0,0437)
UGB Entrepreneurship		0,0760***	0,0731***	0,0732***
		(0,0187)	(0,0186)	(0,0186)
UGB Citizenship Education		0,0291	0,0245	0,0246
		(0,0273)	(0,0273)	(0,0273)
Cross-sectional area from 2nd GBE to 3rd of UGB		-0,0334**	-0,0384**	-0,0385**
		(0,0129)	(0,0129)	(0,0129)
Qualification achieved				
It has no title		-0,316***	-0,311***	-0,310***
		(0,0221)	(0,0221)	(0,0221)
Technician or Technologist		-0,238***	-0,235***	-0,234***
		(0,0174)	(0,0174)	(0,0174)
Master's or Doctorate		0,139***	0,137***	0,137***
		(0,0101)	(0,0101)	(0,0101)
Other factors				
He is currently studying		0,0690***	0,0677***	0,0679***
		(0,0131)	(0,0131)	(0,0131)
Level of ICT proficiency		0,000353	0,000358	0,000357
		(0,000449)	(0,000449)	(0,000449)
School variables				
Fiscal and fiscal school			0,0722***	0,0730***
			(0,0182)	(0,0182)
Rural school			-0,0954***	-0,0961***
			(0,0109)	(0,0109)
Geographical effects				
Costa				-0,185*
				(0,0745)
Amazon				-0,217**
				(0,0792)
Insular				-0,137
				(0,178)
Constant	6,611***	6,984***	7,024***	7,135***
	(0,0474)	(0,0420)	(0,0418)	(0,0507)
Random effects				
Province	0,0545***	0,0346***	0,0334***	0,0228***
	(0,0159)	(0,0103)	(0,00985)	(0,00704)
School	0,0398***	0,0267***	0,0247***	0,0248***
	(0,00264)	(0,00194)	(0,00187)	(0,00188)
Teacher	0,602***	0,513***	0,512***	0,512***
	(0,00452)	(0,00383)	(0,00383)	(0,00382)
Schools	5.410	5.404	5.404	5.404
Provinces	25	25	25	25
ICC province	0,0782	0,0603	0,0585	0,0408
ICC sc./prov.	0,1354	0,1068	0,1018	0,0851

Parameter	Teachers			
	Model I	Model II	Model III	Model IV
2LR		6959.9 (27 g.l.)	96.6 (2 g.l.)	8.18 (3 g.l.)

Standard error in brackets. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: own elaboration based on data from the National Institute of Evaluation (2016).

Once we estimated the individual effects model in which we incorporated a series of variables corresponding to teachers, the results of which we show in Model II in Tables 8 and 9, when compared with the variances obtained in this model and those of the estimates of the variance effects model, for the two groups analysed there was a decrease in the variance of teachers of 7.4 % and 14.8 %, but they are still high. In addition, there were decreases in the variances of schools and provinces, with much larger percentages than for teachers; these percentages range from 30.0 % to 45.0 %. On the other hand, the model with individual effects proved to be significant, as the LR values obtained were 6.659.8 with 15 degrees of freedom and 6.959.9 with 27 degrees of freedom, values that are above the Chi-square distribution p-value for their respective degrees of freedom.

The variables incorporated allow us to test the hypotheses that seek to explain the relationship between the different aspects of the socio-economic realities of the country and the results of the knowledge test, within the framework of teacher evaluation.

The socio-economic factor was significant for both groups, the coefficient for this variable is positive and allows us to affirm that the higher the socio-economic level of the teachers, the higher their results in the knowledge test, which could be explained by the fact that when there are more material means, such as a space to study or prepare their classes, and when the homes have basic services and access to technological resources, the conditions are right for teachers to keep up to date in the knowledge in which they teach their classes. It is necessary to point out that, in Ecuador, salary is one of the factors that influence the socio-economic level of teachers. Statistics show that 2/3 of teachers are women, and when the female variable is included in the model, the coefficient of the female variable is significant.

The 82.0 % of the teaching population defines itself as white-mestizo in terms of its culture and customs, with Afro-Ecuadorians, Montubios, indigenous people and other ethnic groups being in the minority, with percentages of no more than 4 %. To analyse this variable, we have taken white-mestizos as a reference, and the model estimates, based on the coefficients obtained, tell us that the coefficients of teachers belonging to the Afro-Ecuadorian and indigenous groups are significant and negative. This means that they obtain lower results than those of the white-mestizos, the difference being greater with indigenous teachers; while for the Montubio teachers, in the two groups studied, the coefficients were not significant, for the group called other ethnicity, for the first group of teachers the coefficient was significant with a negative sign, and for the second group the coefficient was not significant.

Considering that the assessment was specific to each of the fields of knowledge and level of education, it is necessary to know which fields show the greatest differences, after controlling for socio-economic, ethnic and qualification-related factors. The model that includes Early Childhood Education and 2nd to 7th grade GBE teachers takes GBE teachers as a reference, finding that the corresponding coefficient was significant and of negative sign, this does not say that Early Childhood Education teachers achieve lower grades than teachers in the reference group.

In the estimations where we took into account teachers from 8th to 10th grades of GBE, UGB and of the Transversal Axis, we placed as a reference group the teachers of Natural Sciences from 8th to 10th grades of GBE. The results show that teachers of Mathematics at all levels, Biology at UGB, Physics at UGB, Social Studies at UGB and those of the Transversal Axis, achieve lower results in the evaluation of knowledge, the difference being greater for Mathematics and Physics; for teachers of Citizenship Education, the coefficient was not significant.

It can also be observed that the higher the degree attained, the higher the level of the specific knowledge in which teachers teach. Teacher effectiveness is greatly enhanced when teachers have had many opportunities to learn, including high quality general education, deepening of specific knowledge and pedagogical knowledge, teaching experience and opportunities to develop specific practices through professional development. (Darling-Hammond ***et al.,*** 2009) which would be reflected in better assessment results. For our analysis we include the variable “whether you are studying for a new qualification”. When estimating the model, we find that the variable is significant and positive, indicating that teachers who do indeed continue to study obtain better results than those who do not; and a possible explanation could be that this circumstance allows them to keep their knowledge up to date.

The results of the application of the model indicate that teachers in the fiscommissioned schools obtain higher results than teachers in public schools, with the difference being greater for the higher levels of education and the Transversal Axis. The results of the incorporation of this variable indicate that teachers who teach in educational institutions in rural areas obtain lower results in the evaluation than their peers in urban schools. Teachers from the Coast achieved lower results, as did those from the Amazon region; given the number of teachers in the Island Region, the results were not significant.

School effects

To analyse the effect of the schools where teachers work, we incorporate school-related variables, such as whether the school is in a rural or urban area, as well as the type of school, funding and management, where schools can be public or public-commissioned. The results of the estimation of school effects are presented in Model III of the Table 8 and Table 9 where we observe that the variance explained by the school has only decreased by approximately 4 % for the first group of analysis and by 7.5 % for the second group. In other words, the variables considered do not sufficiently explain the effect of educational institutions on teachers' knowledge test results. When performing the 2LR test of the school effects model, we obtained values of 138.32 and 96.6 with 2 degrees of freedom, therefore, the models are significant.

Effects of the geographical context

When we incorporate into the multilevel model the geographical conditioning factors, such as the natural region to which the province belongs, the results of which we show in Model IV of the Table 8 y Table 9 the 2LR values obtained are 12.06 and 8.18 with 3 degrees of freedom, we say that the model is valid. Regarding the behaviour of the variances of the provinces, there was a decrease of 39.0 % for the first group and 16.2 % for the second group studied, i.e., by incorporating these variables, the variations that occur between the provinces are largely explained.

CONCLUSIONS

The results of the teacher evaluations indicated that regarding the domain of knowledge in which they teach, in general, the teachers' levels were quite low. The national average was only 666.28 points on a scale of 0 to 1000 points. The average had very little variability, and the standard deviation was 72.34. If performance levels were considered on a scale of three general levels and one category below them, 70.04% of teachers in Ecuador are in the lowest general category classified as "fundamental". The lowest marks were achieved by mathematics teachers of the eight to tenth grades of basic general education and baccalaureate, as well as teachers of physics, which is only taught at general unified baccalaureate. There was much greater variability in these subjects than for the other fields of knowledge.

Based on these results, teacher training in Ecuador is not adequate for the specific fields of knowledge instructed in schools. The pedagogical institutes and universities, which are the institutions that prepare teachers, do not develop professionals with the necessary knowledge to be able to teach their students. In addition, the authorities and the bodies responsible for education policy have not encouraged programmes that would update the knowledge of teachers who are already part of a school's teaching staff, nor has there been an individual willingness on the part of current teachers to train and keep themselves up to date in their fields.

Teachers who belonged to an ethnic minority group generally had lower results than their white-mestizo peers, who constitute the majority of teachers. This has implications for schools, especially those in rural areas where, in most cases, intercultural bilingual education is taught (i.e., subjects are taught in Spanish and in the native language), resulting in lower educational outcomes for students in these schools. The government has invested heavily in educational infrastructure in rural areas to eliminate single-teacher schools and has created so-called "millennium schools". However, the results of standardised evaluations of these schools show that the policies have not improved the situation that has existed since 2008, the year in which the programme to strengthen education began (Drouet, 2019).

A teacher's level of education is an important factor in determining their mastery of specific skills. In the country, 4.88% of teachers still do not have any qualifications. The highest percentage (65.6%) have a university degree, and 15.6% have a master's or doctoral degree. The results of the estimations indicate that, when controlling for socio-economic status, gender and ethnic aspects, the higher the degree a teacher has attained, the better their knowledge in the area in which they teach, a situation similar to that of teachers who are studying for a new degree. The difference in knowledge between those with no degree and those with a master's or doctoral degree is quite large. The information regarding teachers' level of education makes it possible to identify the gap between teaching competences and the national requirements that students are supposed reach. The results obtained allow the design of in-service teacher training policies, according to the needs of specific groups of teachers.

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