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Does an education major matter for teaching? The relationship between teachers' degree and student achievement

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December 2022

Abstract

It is unclear whether teachers with a degree in education are more effective than those who are not trained in an education-related field. To further examine this issue, we analyze the relationship between teachers' college major and student achievement by using unique data from Ecuador, which, for a period of time, allowed any graduate, regardless of their major, to apply for a teaching position in the country's centralized selection process. Results from all specifications indicate a non-significant relationship between degree type and student achievement, suggesting that teachers with and without an education degree are equally effective. We also found that teachers' content-related and pedagogical knowledge do not seem to mediate the relationship between having an education degree and student learning. Finally, we observe no heterogeneous effects across different student demographic and socioeconomic characteristics. Examining these claims empirically is crucial for ensuring that greater flexibility in teacher recruitment does not have negative effects on the quality of the education workforce.

JEL classification: I20, I21, I28

Keywords: Teacher quality, teacher credentials, teacher degree requirements, student achievement

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1 Introduction

Though there are many determinants of educational outcomes—e.g., the characteristics of students or the school—research consistently finds that teachers are the most important of the school-related factors. Studies show that teachers have a significant effect on students' test scores (Kane and Staiger, 2008; Rivkin et al., 2005), non-cognitive outcomes such as absenteeism and school suspension (Jackson, 2018; Ladd and Sorensen, 2017), as well as long-term outcomes, including college attendance, earnings, and teenage pregnancy (Chetty et al., 2014). Yet, there is less consensus on the importance of observable teacher attributes that can serve as proxies for quality. In this paper, we contribute to this debate by examining whether teachers with an undergraduate degree in education are more effective than those who are not trained in an education-related field.

In many school systems, an education degree is a basic requirement to become a teacher. In Latin America, a recent report finds that seven out of eleven countries in the region require prospective teachers to have an education degree (Bertoni, Elacqua, Méndez, Montalva, Munevar, Westh Olsen, et al., 2020). This requirement is also common in developed countries like the the United States, where most states require a minimum of a bachelor's degree in education to become a certified teacher (Goldhaber, 2011). Advocates maintain that teachers with an education degree are better prepared to apply effective teaching strategies and, therefore, to deliver quality instruction and improve student learning (Darling-Hammond, 2001; Goldhaber, 2011). Nevertheless, critics of such policies claim that this prerequisite prevents talented individuals from entering the teaching profession, where pedagogical skills can then be developed in the classroom (Angrist and Guryan, 2008; Goldhaber, 2011).

Whether or not an education degree is a proxy for effective teachers depends on different factors, including the quality of teacher education programs. In Latin America, teacher education programs have some of the least selective admission processes and tend to attract the lowest performing students compared to other college majors (Elacqua et al., 2018). According to data from the Programme for International Student Assessment (PISA), secondary school students who aspire to pursue a teaching degree have significantly lower test scores than those who are interested in other careers across all countries in Latin America (Elacqua et al., 2018). Moreover, value-added studies suggest that students in teacher education programs in the region have the lowest growth in content knowledge and skills over the course of their undergraduate studies compared to those in other degree programs (Dalmon et al., 2019; Elacqua et al., 2018). In this context, and considering the proven importance of teachers' own knowledge for their students' learning (Hill et al., 2005a; Santibanez, 2006), individuals who pursue non-education degrees may have greater content knowledge and, therefore, be more effective teachers than those who graduated from traditional teacher education programs.

Alternatively, teacher education programs may be more beneficial relative to other undergraduate programs in that they provide prospective teachers with strategies for classroom management and organization, known as "general pedagogical knowledge," as well as the capacity to apply instructional practices in specific fields, termed "pedagogical content knowledge" (Shulman, 1986). There is some evidence that teachers' general pedagogical knowledge as well as pedagogical content knowledge are positively associated with student achievement (Jacob et al., 2020). In par-

ticular, research on teachers' pedagogical content knowledge focusing on the field of mathematics suggests that it is not enough for teachers to simply know math; to successfully teach this subject to students it is also important that they use proven instructional strategies (Carnoy and Arends, 2012; Hill et al., 2005b). We might thus expect teachers with an education degree to have an advantage over teachers with other degrees, who may have the required content knowledge but may lack the pedagogical ability to effectively transmit that knowledge to their students. Several caveats should, however, be considered. First, studies document that pedagogical content knowledge can be acquired through experience (Jacob et al., 2020), implying that teachers without an education degree can learn effective instructional practices over time. Second, analyses of the coursework of teacher education programs in Latin America find that these are mostly focused on teaching pedagogical theories rather than pedagogical practices and strategies (Bruns and Luque, 2014; Cofré et al., 2015). Hence, in addition to lower levels of content knowledge, students from teacher education programs in Latin America might also lack adequate pedagogical skills.

Our paper sheds greater light on this issue by examining the relationship between teachers' degree type and student achievement in Ecuador. Since the enactment of the country's Education Law in 2013, any college graduate, regardless of their undergraduate major, can become a teacher if they successfully pass testing in a centralized selection process.[1] This setting thus provides a unique opportunity to compare the effectiveness of teachers with and without an education degree.[2] Moreover, Ecuador has used different types of assessments to evaluate its teachers, allowing us to explore the extent to which content-related and pedagogical knowledge mediate the relationship between having an education degree and student learning. The availability of rich administrative data with key student and teacher variables means that we can account for potential confounding factors related to the endogenous sorting of teachers and students. We also test the robustness of our results using a school fixed effects model. Our analysis focuses solely on math, a subject area where a considerable proportion of teachers do not have an education degree.[3]

Our results suggest that, in Ecuador, teachers who hold an education-related degree do not perform better or worse than those with non-education degrees. This finding is consistent across different specifications and after controlling for multiple student and teacher characteristics. Furthermore, although teachers' content knowledge has a consistently strong relationship with student learning, it does not seem to explain the relationship between teachers' education degrees and student achievement in math. Finally, we observe no heterogeneous effects across different student demographic and socioeconomic characteristics.

This paper provides an original contribution to the teacher effectiveness literature and policy discussions in developing countries by focusing on the influence of holding an education degree on teachers' performance. Since teachers are required to have an education degree in most education systems, isolating the influence of this factor from other teacher attributes is not an easy task. In

[1] This regulation very recently changed in 2022, with the result that, currently, only candidates with education degrees can apply to become a teacher.

[2] Although similar policies have been debated in other countries in Latin America, most places require prospective teachers to have an education degree (Bertoni, Elacqua, Méndez, Montalva, Munevar, Olsen, et al., 2020).

[3] Language teachers were ruled out as only a small percentage of teachers (10%) had a non-education degree. We excluded other subject areas such as science because the available student test scores include only one score for multiple subjects (chemistry, physics, etc.)

the United States, for example, researchers have evaluated the impact of teacher licensure systems on achievement and find only a modest positive association (Clotfelter et al., 2007). The results, moreover, tend not to be robust (Goldhaber, 2011). Generally, because college degrees with some education-related coursework are only one of the license requirements set by most states, isolating the effect of degree requirements on student outcomes has proved challenging.

Other studies have looked at the effectiveness of teachers who entered the profession through alternative routes, such as the Teach For America (TFA) program, and observe that fully licensed teachers perform similarly to those who were admitted through alternative pathways (Goldhaber, 2011). Here, we exploit an unique opportunity to compare teachers with and without an education degree who entered the profession through the same path, namely a centralized selection process required of all prospective teachers in Ecuador regardless of their undergraduate major. Moreover, the available data allow us to examine the potential channels through which an education degree can influence student learning, including proxies for teacher knowledge.

Our findings also have important policy implications. On the one hand, restricting entry into the teaching profession to those with an education degree might dissuade talented individuals from becoming teachers. This restriction can also make it harder to fill teaching vacancies in certain fields, such as those in technical-vocational high schools, where finding teacher candidates with both technical and education training is sometimes difficult. On the other hand, individuals without formal education training may lack certain knowledge and skills that are necessary to perform effectively in the classroom, such as general pedagogical knowledge (Darling-Hammond, 2016). Examining these claims empirically is crucial for ensuring that greater flexibility in teacher recruitment does not have negative effects on the quality of the education workforce.

The remainder of this paper is organized as follows. Section 2 describes in greater detail the law permitting Ecuadorians from diverse academic backgrounds to apply to teaching positions through a centralized selection process. Sections 3 and 4 present, respectively, the data and empirical strategy used in our analysis. Section 5 discusses the main results and interpretation. Finally, Section 6 concludes.

2 Institutional context

Over the last decade, Ecuador has implemented a series of policy changes aimed at improving working conditions for teachers and raising the status of the teaching profession. Most notably, in 2013, the country passed a new education law–the Organic Law of Intercultural Education (*Ley Orgánica de Educación Intercultural*, LOEI)–which established new requirements for a career in teaching.

Prior to 2013, the regulation (*Ley de Carrera Docente y Escalafón del Magisterio Nacional*) required individuals to hold an education degree to become a licensed teacher. By then, the Teacher Training Colleges (*Institutos Superiores Pedagógicos*, ISPEDs) were the institutions responsible for preparing most professionals pursuing a teaching career. The teacher recruitment and selection process was both decentralized and discretionary in nature. Lastly, teaching was one of the least valued professions in the labor market, with novice teachers receiving an average monthly salary

of USD 220, while teachers in the highest salary bracket earned an average salary of USD 660.

The teaching profession substantially changed with the introduction of the LOEI. Particularly important for this study, the ISPEDs were closed and anyone could apply for a permanent teaching job as long as they had an undergraduate degree and successfully passed a centralized selection process called "I want to become a teacher" (*Quiero Ser Maestro*, QSM).[4]

Since 2013, there have been seven QSM selection processes and two special selection processes, one targeting rural schools (2018) and another focusing on intercultural and bilingual schools (2021)—the *Quiero Ser Maestro Intercultural Bilingüe*. The QSM includes three phases: the eligibility phase, the "merits and public examination" (*méritos y oposición*) phase, and the application phase. In the eligibility phase, teacher candidates are required to pass a psychometric test comprised of personality and reasoning questions, and a knowledge test that is specific to the specialty area to which they are applying (e.g., general primary education, secondary school math, etc.). In the "merits and public examination" phase, candidates are evaluated on their academic and professional credentials (the "merits" portion), and a mock lesson based on their teaching skills (the public examination). If teacher candidates achieve a minimum score in each of these phases, they can apply to up to 5 school vacancies anywhere in the country using an online platform. A more in-depth description of the QSM selection process is provided by (Drouet Arias and Westh Olsen, 2020).

Originally, the LOEI stipulated that teachers admitted through the QSM who did not have an education degree had to complete teacher training courses in order to secure their position. However, the norms that regulated the QSM processes prior to 2019 did not specify the mechanisms to enforce this training requirement. Moreover, although the Ministry of Education offered professional development courses to teachers over the years, these did not specifically target teachers without an education degree. Since 2019, the teacher training requirement has been enforced more strictly. More specifically, after this year, teachers who were admitted to the system without an education degree were granted a temporary position until they completed a graduate degree in education, and had a period of three years to do so.[5] Here, we use data from the 2018-19 school year, meaning that the teachers in the sample participated in the QSM during a period when in-service education training for teachers without an education degree was not strictly enforced.

In addition to making the basic eligibility requirements to become a teacher more flexible and implementing a centralized selection process to fill teaching positions, the LOEI also increased teachers' salaries. The average starting monthly salary for public school teachers is now USD 820, while the top of the salary scale is USD 1,680, much higher than under the previous teacher pay scale.

[4]Furthermore, following the passing of the LOEI in 2013, prospective teachers who did not participate in the QSM or did not pass the selection process could still teach under a temporary contract. The relaxation of the education degree requirement also applied to these temporary teachers.

[5]As previously mentioned, more recently, due to political pressure from teachers' unions, a new regulation was passed specifying that only teachers with an education degree can participate in teacher selection processes.

3 Data

Our analysis focuses on the 2018-19 school year and combines multiple administrative records from Ecuador's school system. Our main outcome—students' test scores—comes from the *Ser Bachiller* exam. The National Institute for Educational Evaluation (INEVAL) administers this exam to high school students at the end of their final year, measuring abilities in language, mathematics, and sciences. Taking this high-stakes test is a requirement to graduate and to apply to higher education institutions. As mentioned, we look specifically at the math test scores.

The information on teachers' degrees comes from the administrative records of the National Secretary of Higher Education, Science, Technology and Innovation (SENESCYT). We are specifically interested in teachers' undergraduate degrees, which we classified into "education" and "non-education" majors based on their names.[6] We further categorized degrees into "math-related" and "non-math related" degrees.[7]

Math teachers who did not major in education (mostly engineers) may have greater content knowledge than teachers with an education degree. To explore this hypothesis, and to examine the extent to which content knowledge mediates the relationship between teachers' degree type and student achievement, we use data on teacher content knowledge, proxied by their test scores on the *Ser Maestro* ("Being a Teacher") exam.

Since the enactment of the LOEI in 2013, the *Ser Maestro* test has been administered to teachers as part of a series of efforts by the Ministry of Education to improve the quality of Ecuador's teacher workforce by monitoring the performance of all permanent teachers and some temporary teachers.[8] Originally, the government planned to administer the *Ser Maestro* test on a regular basis and assess teachers in a variety of domains (e.g., content knowledge, pedagogical skills, and self-evaluation). However, to date, the test has only been administered once, in 2016, to approximately 110,000 teachers, with just a single content knowledge component that was specific to teachers' subject area. Though designed to be high-stakes, with the potential for teachers to lose their job if they performed poorly twice on the *Ser Maestro* test, these regulations were never implemented, mainly due to pressure from the teachers' union and the single implementation of the assessment.

Another hypothesis is that teachers with an education degree are more effective in the classroom because they acquire valuable pedagogical skills during their post-secondary training, which has been shown to have a positive impact on student learning (Jacob et al., 2020). To analyze the relationship between pedagogical ability and student test scores, we use teachers' scores on the practical component of the *Quiero Ser Maestro* (QSM) assessment as a proxy of their pedagogical

[6] We focus on undergraduate degrees because graduate programs vary significantly in length and type of delivery (remote versus in person). Moreover, as discussed in the results section, considering teachers with a graduate degree in education does not change our main conclusion that an education-related degree is not associated with student achievement in Ecuador.

[7] Examples of degrees that were classified as math-related include mathematics, engineering, accounting, and economics.

[8] In Ecuador, there are three types of teacher contracts: permanent contracts (*nombramientos definitivos*), temporary contracts for teachers to provisionally cover permanent positions (*nombramientos provisionales*), and contracts for temporary teachers with specific and short-term appointments (*contratos ocasionales*). The *Ser Maestro* evaluation is only required for teachers employed under the first two types of contracts.

skills. As mentioned in the previous section, the QSM is a centralized teacher selection process in Ecuador. One of its stages consists of a practical examination of teacher candidates that includes two components: a demonstration lesson and an interview. During the demonstration lesson, candidates are evaluated on their ability to teach a class on a subject in their area of specialization. This evaluation focuses on different skills, such as the candidates' ability to engage students, deliver the content with clarity, use different materials to support learning, and employ effective strategies to evaluate students. During the interview, candidates are asked about different aspects of the teaching profession, such as their motivations ("Why do you want to work as a teacher?"), their lesson plan strategies ("How would you plan your classes?"), problem-solving skills ("How would you deal with behavioral problems in the classroom?"), and pedagogical strategies ("What do you think about group-based learning?"). Both the demonstration lesson and the interview are evaluated by a four-member committee: a school principal, a teacher at the same level and specialty area, a parent representative, and a student representative. The "practical evaluation" test scores used in this study as a proxy of teachers' pedagogical skills combine both the demonstration lesson and the interview. Notably, the demonstration lesson is weighted higher than the interview, accounting for 70% of the total combined score.

Although we use test scores on the QSM practical evaluation as a proxy for teachers' pedagogical skills, we acknowledge that these scores might be correlated with other abilities, including teachers' content knowledge. However, by controlling for teachers' *Ser Maestro* scores, we attempt to separate teachers' content knowledge from their pedagogical skills on the QSM exam.[9]

Experience is another teacher characteristic that is associated with teacher effectiveness (Podolsky et al., 2019), and the QSM data includes a score to this regard based on teachers' overall experience instructing at different schools (public or private) and at different education levels (preschool, primary or secondary education). This indicator includes six categories ranging from "0" (less than one year of experience) to "10" (more than 9 years of experience).

To estimate the relationship between teachers' degrees and student achievement, we first include all math teachers who teach the final year of high school, regardless of whether they entered the school system before or after the enactment of the LOEI in 2013 (which we term the *full sample*). However, in an effort to make the groups of teachers with and without an education degree more comparable, we also estimate the models using a sub-sample of teachers who entered the profession through the QSM selection process after the LOEI came into effect (the *restricted sample*). Before 2013, teachers were selected in a decentralized manner, via a more discretionary process, and only teachers with an education degree were able to obtain a teaching position. As a result, teachers with an education degree who joined the profession before and after the policy was instituted may differ in important ways, such as years of experience. To restrict the sample, we only consider teachers who were admitted through the QSM selection process.[10] This is also

[9]The *Quiero Ser Maestro* exam also has a content knowledge test during the initial phase of the selection process (the eligibility phase). Because we only have data for teachers who passed the eligibility phase, their scores on this knowledge test are generally similar, since they all scored above the cut-off score of around 700 points. We therefore use data from the *Ser Maestro*, which captures greater variation in teachers' content knowledge.

[10]Note that this restriction does not include individuals who became teachers after 2013 but failed to secure a permanent position through the QSM. Therefore, our results cannot be generalized to teachers granted a temporary appointment after the enactment of the law.

important because solely teachers who entered the system after 2013 will have completed both the *Ser Maestro* (content knowledge) and the QSM (pedagogical skills and experience) tests.

Table 1 presents descriptive statistics of teacher characteristics by degree type for the full and restricted samples. In the full sample, teachers with and without an education degree differ in most characteristics. However, when we restrict the sample to those who became teachers after 2013, the two groups become very similar. An important exception is their different levels of experience: teachers with an education degree tend to have more teaching experience, probably because they held temporary positions before participating in the QSM to obtain a permanent position. Moreover, it is important to mention that all teachers in the restricted sample have permanent contracts because they were admitted through the QSM selection process. Meanwhile, the full sample includes teachers with different types of contracts, which recent work has shown to affect student learning (Marotta, 2019).[11]

Teachers with an education degree have lower levels of content knowledge (as measured by scores on the *Ser Maestro* exam) than their counterparts without an education degree. The difference, however, is only significant for the full sample. Interestingly, teachers without an education degree also obtain higher marks on the practical evaluation (demonstration lesson and interview portions of the QSM exam) than teachers with an education degree, although the difference is not statistically significant.

Table 2 shows student characteristics broken down by teacher degree type for different samples to explore potential student sorting across teachers. Overall, students taught by teachers with an education degree have, on average, higher socioeconomic status (SES) and are more likely to be white or mestizo. Though students with teachers who have an education degree are less likely to attend a rural school in the full sample, they are more likely attend one in the restricted sample. The share of female students is similar for teachers with both types of degrees and in both samples.

As discussed in the next section, we estimate a school fixed effects model in order to address student sorting across the two types of teachers (with and without an education degree). Table 3 displays the distribution of student characteristics controlling for these school fixed effects and using only the sample of schools used in the fixed effects analysis—that is, a sample of schools with more than one classroom and variation across teachers' degree. Results show that our school fixed effects strategy does help mitigate the sorting of students between teachers with different degrees.

4 Methods

We analyze the relationship between teachers' degree type and student test scores by estimating the following regression model:

[11] In Table 1, the number of teachers without an education degree in the full sample is not the same as in the restricted sample. Although teachers without an education degree could enter the system after 2013, not everyone admitted since that year participated in or passed the QSM selection process, which is the mechanism used to restrict the sample. In other words, teachers with a non-education degree in the full sample may have entered the profession after the enactment of the law, but might be teaching under a temporary contract.

Table 1: Teacher characteristics by degree type

	Full sample			Restricted sample		
	Education degree		p-value	Education degree		p-value
	No	Yes		No	Yes	
Math-related degree	0.87	0.83	0.005	0.87	0.87	0.913
	[0.33]	[0.38]		[0.34]	[0.33]	
Female	0.34	0.39	0.015	0.34	0.47	0.006
	[0.47]	[0.49]		[0.48]	[0.5]	
Year of the degree	2009.07	2006.85	<0.001	2008.87	2008.76	0.812
	[4.45]	[4.54]		[4.04]	[4.82]	
Teacher content knowledge (Ser Maestro)	0.14	-0.03	<0.001	0.23	0.16	0.237
	[0.55]	[0.64]		[0.48]	[0.56]	
Teacher Pedagogical Skill (QSM - practical)	0.23	0.07	0.168	0.23	0.07	0.168
	[0.79]	[0.97]		[0.79]	[0.97]	
Teacher Experience (QSM - Experiencia)	3.84	5.89	<0.001	3.84	5.89	<0.001
	[3.1]	[3.5]		[3.1]	[3.5]	
QSM - Year	2014.4	2014.52	0.28	2014.4	2014.52	0.28
	[1.19]	[1.02]		[1.19]	[1.02]	
N	735	1449	-	200	245	-

Note: The restricted sample only includes teachers who were admitted into the school system after the passing of the LOEI law in 2013 and who were selected through the QSM process. The sample is also restricted for those teachers who applied for a math-related vacancy in the QSM contest.

Table 2: Student characteristics by type of teachers

	Full sample			Restricted sample		
	Education degree		p-value	Education degree		p-value
	No	Yes		No	Yes	
Female	0.5	0.51	0.213	0.52	0.52	0.89
	[0.5]	[0.5]		[0.5]	[0.5]	
White/Mestizo	0.84	0.85	<0.001	0.85	0.87	<0.001
	[0.37]	[0.36]		[0.36]	[0.33]	
Attending a rural school	0.22	0.2	<0.001	0.13	0.18	<0.001
	[0.41]	[0.4]		[0.33]	[0.38]	
SES index	-0.22	-0.12	<0.001	-0.2	-0.12	<0.001
	[0.94]	[0.94]		[0.92]	[0.92]	
N	43228	95339	-	13390	17701	-

Note: The restricted sample only includes teachers who were admitted into the school system after the passing of the LOEI law in 2013 and who were selected through the QSM process. The sample is also restricted for those teachers who applied for a math-related vacancy in the QSM contest.

Table 3: Student characteristics by type of teachers controlling by classroom FE

	Full sample			Restricted sample		
	Education degree		p-value	Education degree		p-value
	No	Yes		No	Yes	
Female	0.52	0.52	0.074	0.54	0.58	0.378
	[0.5]	[0.5]		[0.5]	[0.49]	
White/Mestizo	0.85	0.87	0.481	0.9	0.89	0.2
	[0.35]	[0.34]		[0.29]	[0.31]	
Attending a rural school	0.13	0.15	0.469	0.02	0.05	0.142
	[0.34]	[0.35]		[0.14]	[0.22]	
SES index	-0.1	0.02	<0.001	0.01	0.02	0.007
	[0.94]	[0.91]		[0.89]	[0.88]	
N	16305	22659	-	1290	1734	-

$$A_{ijs} = \alpha + \beta C_{js} + \theta X_j + \eta S_i + e_{ijs}, \tag{1}$$

where A_{ijs} is the math test score of the ith student in the jth school. C_{js} is a dummy variable that indicates whether the ith student is taught by a teacher with an education degree. X_j is a matrix with other teacher characteristics (math-related degree, test scores in the *Ser Maestro* and the QSM exams, gender, year of graduation). We also control for the number of schools at which a teacher works, which has been found to influence their performance in the classroom (Elacqua and Marotta, 2020). S_i is a matrix with student characteristics (gender, race, socioeconomic index, attending a rural school). The error term ε is clustered at the school level. Our parameter of interest is β, which indicates the association between teachers' education degree and student test score.

We estimate this regression for the full and restricted samples described in the previous section. To check the robustness of our results, we also estimate the same model with school fixed effects to minimize potential selection biases from the non-random sorting of students and schools. For the school fixed effects model, we restrict the sample to only schools with two or more classrooms in order to leverage variation in teacher degree within the same school.

5 Results

One argument against strict degree requirements for teachers is that they may dissuade talented individuals from pursuing a teaching career. In the case of mathematics, for example, teacher candidates with a non-education but math-related degree—e.g., engineering, economics or statistics—may have strong content knowledge allowing them to effectively teach this subject, especially at more advanced grade levels such as high school. To explore this claim, we first examine whether content knowledge measured on the *Ser Maestro* exam varies between teachers with and without an education degree. As Table 4 suggests, teachers with an education degree have lower levels of

content knowledge, though the coefficient is only significant for the full sample. We also look at the relationship between teachers' degree and two other important mechanisms, namely teachers' pedagogical skills (proxied by their scores on the practical evaluation of the QSM) and their years of experience. Consistent with the descriptive results in Table 1, teachers with an education degree tend to have lower test scores on the QSM practical evaluation, although they do have more years of teaching experience, on average.

Table 4: Teachers' degree and knowledge

	Samples			
	All	Restricted *(QSM)*		
		Teacher exam		
	Content	Content	Practical	Experience
	(1)	(2)	(3)	(4)
Education degree	−0.146***	−0.050	−0.203*	2.249***
	(0.035)	(0.056)	(0.119)	(0.397)
Math component in the degree	0.012	0.072	0.321*	0.687
	(0.042)	(0.081)	(0.174)	(0.580)
Female teacher	−0.024	−0.093	0.059	−0.844**
	(0.032)	(0.057)	(0.119)	(0.396)
Number of schools working	0.131**	0.095	−0.092	−0.712
	(0.055)	(0.078)	(0.164)	(0.547)
Year of the degree	0.012***	0.015**	0.021*	−0.308***
	(0.004)	(0.006)	(0.013)	(0.042)
Constant	−23.453***	−29.425**	−42.093*	624.055***
	(7.522)	(12.899)	(25.166)	(83.938)
Observations	1,501	354	243	243
Adjusted R^2	0.022	0.019	0.018	0.255

Note: This table shows the associations between teacher knowledge and teacher characteristics. The first column includes all teachers in our dataset. The remaining columns restrict the sample for teachers we participated in the (*Quiero Ser Maestro* selection process).

Table 5 shows the relationship between teachers' degree type and student test scores on the *Ser Bachiller* exam for the full sample, controlling for different teacher and student characteristics. In all specifications, teachers with an education degree are positively associated with student performance, but the correlation is not statistically significant. Moreover, as we add control variables to correct for endogenous sorting of teachers and students, the magnitude of the relationship between education degree and test scores decreases. Interestingly, in our preferred model with all controls (column 6), having a math-related degree is not significantly associated with higher student achievement and the interaction between education and math degrees is not significant. A consistent and significant result is that teachers' content knowledge, as measured in the *Ser Maestro* exam, is positively related to student performance.

As previously discussed, we only focus on teachers' undergraduate major, since there is greater variation among graduate programs in terms of their length and delivery. However, to explore the influence of teachers' graduate training on their performance, we looked at whether having a graduate degree and, more specifically, having a graduate degree in education would be associated with student achievement by adding these two variables to model 6 of Table 5. We found that graduate training and graduate training in education are positively associated with student achievement but, like our main results, these two coefficients are not statistically significant–results are not displayed but available upon request.

Table 5: Teachers' education degree and student test scores

	Dependent variable:					
	Student test scores (z-score)					
	(1)	(2)	(3)	(4)	(5)	(6)
Education degree	0.037	0.041	0.061*	0.029	0.017	0.024
	(0.036)	(0.036)	(0.036)	(0.037)	(0.036)	(0.092)
Math-related degree		0.103**	0.084*	0.064	0.061	0.067
		(0.049)	(0.048)	(0.048)	(0.047)	(0.078)
Education × Math degree						−0.008
						(0.101)
Teacher Content Knowledge			0.177***	0.181***	0.169***	0.169***
			(0.031)	(0.030)	(0.029)	(0.029)
Female teacher				0.075**	0.065**	0.065**
				(0.032)	(0.031)	(0.031)
Number of schools working				0.028	0.012	0.012
				(0.052)	(0.049)	(0.049)
Year of the degree				−0.012***	−0.010***	−0.010***
				(0.004)	(0.004)	(0.004)
Female student					0.042***	0.042***
					(0.012)	(0.012)
White/Mestizo student					0.110***	0.110***
					(0.022)	(0.022)
Student SES					0.156***	0.156***
					(0.010)	(0.010)
Student in rural school					0.045	0.045
					(0.037)	(0.037)
Constant	−0.025	−0.118**	−0.156***	24.188***	19.842***	19.888***
	(0.030)	(0.053)	(0.053)	(7.667)	(7.429)	(7.482)
Observations	138,567	138,567	138,567	138,567	137,895	137,895
Adjusted R^2	0.0003	0.001	0.012	0.017	0.040	0.040

Notes: Standard errors clustered at the school level. *p<0.1; **p<0.05; ***p<0.01

As Table 2 documents, teachers with an education degree in the full sample are likely to be assigned to more privileged students with higher socioeconomic backgrounds. To minimize potential biases from the non-random sorting between students and teachers, Table 6 compares the results with and without school fixed effects. The reduction in the number of observations between Table 5 and Table 6 is due to the latter being restricted to schools with more than one

classroom. After adding the fixed effects, the association between teachers' education degree and student achievement becomes positive though the coefficient remains non-significant. In other words, math teachers holding an education degree do not seem to perform better or worse than those with other college degrees.

Table 6: Teachers' education degree and student test scores - school FE model

	Dependent variable:	
	Student test scores (z-score)	
	(1)	(2)
Education degree	−0.009	0.027
	(0.050)	(0.031)
Math-related degree	0.118	0.131**
	(0.093)	(0.060)
Teacher Content Knowledge	0.197***	0.037
	(0.056)	(0.033)
Female teacher	0.048	−0.087***
	(0.055)	(0.030)
Number of schools working	−0.013	−0.097**
	(0.056)	(0.045)
Year of the degree	−0.001	0.008*
	(0.007)	(0.004)
Female student	0.082***	0.050***
	(0.025)	(0.012)
White/Mestizo student	0.079*	0.056***
	(0.048)	(0.020)
Student SES	0.170***	0.135***
	(0.018)	(0.008)
Constant	2.254	
	(13.622)	
School FE	No	Yes
Observations	38,786	38,786
Adjusted R^2	0.045	0.295

Notes: Standard errors clustered at the school level. *p<0.1; **p<0.05; ***p<0.01

Another potential bias in our analysis may be the various differences between teachers with and without an education degree in the full sample (Table 1). Most importantly, the latter includes teachers who were admitted before and after the enactment of the LOEI, which made degree requirements for teachers more flexible. To control for these differences, and in an attempt to isolate the influence of an education degree from other teacher characteristics, we estimate our main model using a restricted sample of teachers who entered the profession after 2013 through the QSM selection process. Table 7 shows the estimates based on this restricted sample. The results do not

change: the association between education degree and test scores is positive but non-significant. Moreover, teachers' content knowledge as measured on the *Ser Maestro* exam continues to have a significant influence on student performance. However, neither teachers' pedagogical skills (as proxied by their performance on the QSM practical evaluation) nor their experience have a significant relationship with student achievement. In column 4, we also add a school fixed effects term to control for student and teacher sorting. The "education degree" coefficient is still not significant. These results should, however, be interpreted with caution as the sample size is reduced considerably when restricted to include only teachers who entered the system through the QSM, schools with two or more classrooms, and some degree of variation in teachers' degrees.

Table 7: Teachers' education degree and student test scores - restricted sample

	Samples				
	All	Restricted			
	(1)	(2)	(3)	(4)	(5)
Education degree	0.017	0.057	0.018	0.066	0.044
	(0.036)	(0.066)	(0.064)	(0.108)	(0.187)
Math-related degree	0.061	0.122	0.136	−0.082	0.154
	(0.047)	(0.106)	(0.102)	(0.190)	(0.109)
Education × Math degree					−0.031
					(0.198)
Teacher Content Knowledge	0.169***	0.221***	0.232***	0.203	0.231***
	(0.029)	(0.064)	(0.062)	(0.329)	(0.062)
Teacher Pedagogical Skill			−0.047	−0.194*	−0.046
			(0.040)	(0.102)	(0.041)
Teacher Experience			0.012	−0.049**	0.013
			(0.013)	(0.020)	(0.013)
School FE	No	No	No	Yes	No
Observations	137,895	30,977	30,977	3,012	30,977
Adjusted R^2	0.040	0.044	0.057	0.217	0.057

Notes: Results in column 1 replicate those presented in column 5 of Table 5 and use all math teachers in our analytical sample. Columns 2-4 show the results employing the same specification as column 1 (i.e., controlling for teacher and student characteristics), but only using teachers that passed the QSM exam. Standard errors are clustered at the school level. *p<0.1; **p<0.05; ***p<0.01

Lastly, using the full sample, we analyze whether the influence of teachers with an education degree varies for students with different characteristics—namely, gender, SES, and whether they attend a rural or urban school. The point estimates indicate that the relationship between teachers' education degree and student test scores is slightly stronger for boys, high SES students, and pupils in urban schools. Nonetheless, these differences are not statistically significant.

Table 8: Teachers' education degree and student test scores - heterogeneous effects

	Subgroups of students					
	Boys	Girls	Low-SES	High-SES	Rural	Urban
	(1)	(2)	(3)	(4)	(5)	(6)
Education degree	0.028	0.004	−0.012	0.040	−0.096	0.045
	(0.037)	(0.038)	(0.040)	(0.046)	(0.065)	(0.042)
Math-related degree	0.039	0.081	0.045	0.090	0.129*	0.046
	(0.047)	(0.052)	(0.052)	(0.061)	(0.070)	(0.057)
Teacher Content Knowledge	0.178***	0.161***	0.163***	0.203***	0.163**	0.171***
	(0.030)	(0.032)	(0.035)	(0.034)	(0.071)	(0.032)
p-values of the differences		0.105		0.278		0.095
Observations	67,985	69,910	45,870	46,066	28,087	109,808
Adjusted R^2	0.041	0.040	0.015	0.024	0.039	0.042

Notes: All regressions include teacher and student characteristics as covariates. Standard errors clustered at the school level. *p<0.1; **p<0.05; ***p<0.01

6 Conclusion

The evidence on the relationship between strict degree requirements and teacher quality is unclear. On the one hand, requiring an education degree for a career in teaching may deter talented individuals from entering the profession, with potentially negative consequences for the quality of the education workforce. On the other hand, individuals with non-education degrees may lack the pedagogical skills necessary to perform effectively in the classroom. To explore these claims, we examine the relationship between teachers' college degrees and student achievement in Ecuador, which in 2013 enacted an education law—the LOEI—that made degree requirements for new teachers more flexible. Specifically, the LOEI stipulated that any graduate, regardless of their major, could apply for a permanent teaching position as long as they passed a rigorous centralized selection process called *Quiero Ser Maestro* (QSM).

Results from all specifications indicate a non-significant relationship between degree type and student achievement, suggesting that teachers with and without an education degree are equally effective. However, there are several notable caveats to this finding. First, enforcing strict degree requirements for teachers may be less important when there is a rigorous teacher selection process in place, such as the QSM. Indeed, this selection process may serve as an effective screening mechanism so that all candidates who pass the exams share very similar characteristics. Secondly, there might be considerable heterogeneity within degree types. For example, teachers who hold an education degree from top teacher education programs might be more effective than those who

were trained in low-quality institutions.[12] Unfortunately, due to data limitations, we cannot test this hypothesis. Lastly, we focus here solely on the relationship between teachers' degree and student achievement in high school. The effect of the pedagogical skills acquired in teacher education may be greater on other dimensions of learning, such as students' socio-emotional skills, or at different levels of schooling (e.g., primary or preschool).

The data used in this paper also allow us to examine whether teachers' content-related knowledge mediates the relationship between an education degree and student achievement. Although there is a positive and significant correlation between teachers' content knowledge—as measured by their test scores on the *Ser Maestro* test—and student performance, adding teachers' content knowledge to our models does not seem to significantly change our results. Interestingly, we also find that teachers with a degree in education have lower scores on the QSM's practical examination (demonstration class), which we use as a proxy of teachers' pedagogical skills. This is consistent with previous research showing that, in Latin America, teacher education programs generally fail to provide their students with effective pedagogical tools (Bruns and Luque, 2014; Cofré et al., 2015).

Our study leverages a unique policy in Ecuador to explore the implications of relaxing degree requirements for teachers. This is a crucial empirical question because, although it is well established in the literature that teachers matter, less is known about the observable attributes that are associated with teacher quality. On the other hand, a better understanding of these characteristics is key for policy makers, in their efforts to recruit the best candidates and build an effective teacher workforce. Our findings make an important contribution in this direction, but additional evidence is needed to analyze the causal effect of teachers' degrees on multiple student outcomes.

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[12] Similarly, individuals who do not major in education and study at a high-quality university may be more effective than colleagues who hold a non-education degree from a less competitive institution.

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