Alternative Pathways into Teaching and Student Learning in Chile

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Abstract

How teacher characteristics relate to teacher effectiveness remains unsettled. This article examines the contributions to student learning made by traditionally trained teachers and teachers trained through an alternative program, Enseña Chile (eCh). Comparing teacher value-added, we find no evidence of effectiveness being different between both types of teachers. Pre-college aptitude and years of experience are positively associated with value-added estimates, and value-added estimates are mainly driven by teachers' pre-college ability (measured by college entrance exams). Evidence supports the idea that alternative pathways into teaching can complement the teacher workforce without diminishing its quality.

Keywords

Education Policy, Alternative Certification, Teacher Effectiveness, Teacher Education, Teacher Experience, Teach for America (TFA), Chile

Highlights

- Enseña Chile and traditional teachers' appear equally effective at raising student learning.
- Years of experience and pre-college academic ability are positively associated with teacher effectiveness.
- Alternative pathways into teaching can complement the teacher workforce without diminishing its quality.

1. Introduction

Teachers matter. Research has systematically evidenced that no other school factor has such a substantial impact on students' short and long-run outcomes (see Hanushek & Rivkin, 2006; and Jackson, Rockoff, & Staiger, 2014, for reviews of the literature). Having high-quality teachers is critical to improving student outcomes, but teacher quality varies widely, and identifying and attracting good teachers has proven to be difficult. Besides years of experience, few other observable characteristics consistently appear to have a positive correlation with student learning (Bau & Das, 2020; Boyd et al., 2008; Clotfelter et al., 2010; Harris & Sass, 2011; Papay & Kraft, 2015). Features such as education, certification, and test scores correlate with student learning in some settings but not in others, making it difficult for school systems to identify criteria for recruiting and selecting teachers (Goldhaber & Brewer, 2000; Hanushek & Rivkin, 2010; Kane et al., 2008).

Today, school systems around the world encounter inequitable distributions of teachers across schools and rising teacher shortages in specific geographic and subject areas. Also, in the US and other countries, college graduates with higher SAT or ACT scores are less likely to enter teaching (Bruns & Luque, 2015; Goldhaber & Liu, 2003; Hanushek & Pace, 1995; Manski, 1987; Vegas et al., 2001). To attract stronger candidates into teaching, countries have opened alternative pathways into the profession (OECD, 2014). Some alternative pathway programs have been evaluated with mixed results (see Antecol, Eren, & Ozbeklik, 2013, for a summary of the evidence). Because teachers are such an important factor affecting students' outcomes, it turns critical to understand how teachers from different preparations may impact students differently.

This paper studies the contributions to student achievement made by traditionally trained teachers, whom we refer to as traditional teachers from here on, and teachers trained by an alternative program called Enseña Chile (eCh). The program recruits talented university graduates from careers other than teaching and places them in high-need schools. This study looks to identify the contributions to student achievement eCh teachers make compared to traditional teachers. The study also is uniquely positioned to examine the relevance of the different components —teacher preparation pathway, ability, and experience— in determining teacher effectiveness, and is the first study of an alternative pathway program to include pre-college ability. Specifically, we address the following research questions:

1. How effective are Enseña Chile teachers at raising student learning, as measured by teacher value-added, compared to traditional teachers?
2. How does the value-added of alternatively-trained teachers change as they acquire experience?

To assess how much a teacher affects student learning in one year, we estimate each teacher's value-added. Existing methods of estimating teacher value-added have been found to generate unbiased and reliable estimates of student learning as influenced by their teachers (Bau & Das, 2020). Value-added estimates the ability teachers have to increase their students' learning during the school year and is also referred to as teacher effectiveness, performance, or productivity. The estimation requires data on student knowledge at the beginning and end of the school year. We conducted fieldwork by implementing student mathematics learning assessments at the beginning and end of the school year for a sample of almost 3,800 students taught by 104 teachers.

Our sample is comprised of traditional and eCh teachers working in eCh-partner schools, and traditional teachers working in schools with no eCh teachers (non-partner schools). Given the

lack of random assignment of teachers, we avoid forcing a causal interpretation to this exercise. Instead, we are cautious to label our findings as descriptive. However, we construct value-added estimates for both types of teachers using pre and post measures of the same outcome (math test scores) for the same students. Studies typically observe general demographic characteristics of teachers with limited human capital measures, and very few studies use teacher pre-college academic ability. This study is the first evaluation of a Teach For All partner organization to incorporate teachers' college entrance exam scores (PAA/PSU) as a measure of teacher ability.

Our main results suggest that Enseña Chile teachers and traditional teachers are equally effective at raising student learning. We examine the relevance of different components — teacher preparation pathway, pre-college skills, and years of teaching experience— in determining teacher effectiveness. Consistent with prior literature, we find a positive relationship between teacher value-added and years of experience (Clotfelter et al., 2010; Harris & Sass, 2011; Papay & Kraft, 2015). We find that value-added estimates are mainly driven by teacher ability as measured by their college entrance exams. Enseña Chile teachers have fewer years of experience, but significantly higher pre-college ability than the average traditionally trained teacher. Our results suggest that the net effect of these different components drives the average eCh and traditional teachers in our sample to make similar contributions to their students' learning.

1.1. Problem Statement: Teacher Shortages and Unequal Distribution

Teachers are unequally distributed throughout Chile geographically and between schools of different administration types. Teachers with no degree in education represent a larger portion of the teaching force in public municipal schools compared to private subsidized schools and purely private schools (MINEDUC, 2016). Regions farthest from the capital, Santiago, have the

highest proportion of teachers with no degree in education (regions 1-3, 10-12, and 14). Specifically, an average of 8.5% of all teachers in these seven regions do not have a degree in education, with the highest being 10.6% of teachers in the 14th region of Los Rios, one of the regions in which Enseña Chile has partner schools. In comparison, an average of 5.2% of teachers have no degree in education in the other eight regions (MINEDUC, 2016).

Teachers are also unequally distributed with regards to the type of students they teach, with disadvantaged students more likely to have less qualified teachers (Meckes & Bascopé, 2012; Ortúzar et al., 2009; Ruffinelli & Guerrero, 2009). Teachers with better initial training (from accredited programs with more years of study) and higher scores on their exit exams (Prueba Inicia) are more likely to work in schools with students of higher socio-economic backgrounds or with higher academic performance. Meanwhile, teachers with lower exit exam scores and lower socio-economic backgrounds tend to teach more disadvantaged students (Cabezas et al., 2017; Meckes & Bascopé, 2012). Inequalities exacerbate as teachers move beyond their first job. Teachers with more experience, higher PAA/PSU scores, and better training are more likely to work at private subsidized schools than at public municipal schools, thus teaching higher SES students (Cabezas et al., 2011). Moreover, teachers with high PAA/PSU scores have a higher probability of teaching at purely private schools than public municipal or private subsidized schools (Meckes & Bascopé, 2012).

Teacher shortages in Chile are most prevalent in sciences and mathematics. In 2016, 47% of all physics classes were taught by teachers that were not specialists in the subject. For chemistry and natural sciences, the value is close to 40% (Elige Educar, 2017). Combined with the unequal distribution of teachers, this means that urban schools serving more vulnerable students, and schools located in remote rural areas have a particularly hard time finding qualified

teachers to teach science and math. Thus, the already marginalized students in these schools have the additional burden of being taught by less qualified teachers.

Chile is not unique in its unequal distribution of teachers and teacher shortages. For example, in the United States, studies have found a higher proportion of less qualified teachers in low-income schools (Loeb & Reininger, 2004). Studies have also reported that mathematics, science, and special education are the hardest positions to staff, particularly in urban schools serving higher shares of low-income students, minority students, and students with disciplinary problems (Feng & Sass, 2018; Ingersoll & Perda, 2010; Sutcher et al., 2019). Likewise, school principals in OECD countries report concerns regarding the unequal distribution of teachers among schools and having problems staffing math and sciences (OECD, 2005). In Latin America, education systems have the most trouble staffing secondary education mathematics and sciences in schools with challenging environments, such as urban schools serving disadvantaged students or schools in remote rural areas (Bruns & Luque, 2015).

1.2. Program Details: Enseña Chile

Teach For America is one of the most well-known alternative pathways into teaching in the United States. The organization was established in 1989 to bring new leaders into the education sector. Under the belief that educational leadership begins in the classroom, the organization started recruiting and training talented university graduates and young professionals to teach for two years in high-need schools across the United States (Teach For America, 2020). In 2007, Teach For America and the UK's Teach First co-founded Teach For All, a global network of local partner organizations that share a common approach and the mission to increase educational opportunities for vulnerable students and develop future education leaders. The

network currently includes partner organizations in 54 countries around the world, eleven of which are in Latin America and the Caribbean (Teach For All, 2020).

Established in 2008, Enseña Chile was the first Teach For All partner in Latin America. Like Teach For America, Enseña Chile recruits talented university graduates and places them in high-need schools throughout Chile. The process relies on a rigorous selection process, a 4-week summer institute training, and ongoing support (Enseña Chile, 2012). For the ongoing field support and mentoring, eCh assigns tutors to each teacher during the two years of their teaching commitment, to support them by conducting monthly school visits, holding group meetings, and being available for one-on-one support as needed (Enseña Chile, 2016). In 2016 there were 195 Enseña Chile teachers in classrooms throughout Chile, representing less than 0.1% of all teachers in Chile that year.

As an indicator of the selectiveness of the selection process, eCh received 1,806 completed applications for the 2016 cohort, and only 105 became new eCh teachers that year. After screening applications and a first round of interviews, eCh invited 175 applicants to attend the summer institute, roughly 10% of applicants. Some applicants declined the invitation for various reasons (most applicants are concurrently completing their university degrees and applying to other jobs), some did not complete the summer institute training, and some decided not to teach for personal reasons. Ultimately, 105 applicants—less than 6% of the initial applicants—began teaching in March 2016.[1]

1.3. Evidence

A growing body of literature has studied the effects that teachers from alternative pathways have on student learning. Studies find that on average, Teach For America teachers do

[1] Data reported by Enseña Chile in personal communication (Feb 6, 2018).

better or as well as comparison teachers at raising student learning in math and science, and no different in reading (Antecol et al., 2013; Chiang, Clark, & McConnell, 2017; Clark, Isenberg, Liu, Makowsky, & Zukiewicz, 2017; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Glazerman, Mayer, & Decker, 2006; Kane et al., 2008; Raymond, Fletcher, & Luque, 2001; Xu, Hannaway, & Taylor, 2011). Researchers have suggested that Teach for America's rigorous recruitment and selection processes are largely responsible for these positive findings (Boyd et al., 2010). They have found that the criteria on which TFA staff rank applicants during the selection process (prior achievement, leadership experience, and perseverance) are strong predictors of teacher performance and student learning, particularly in mathematics (Dobbie, 2011).

Two early non-experimental studies compared the effectiveness of elementary and middle school TFA teachers with other teachers in Houston, Texas. One study found no significant differences between TFA and other teachers (Raymond, Fletcher & Luque, 2001). The other study found that after controlling for teacher experience, degrees, and student characteristics, uncertified TFA teachers performed as well as other uncertified teachers but were less effective than certified teachers (Darling-Hammond et al., 2005). Another group of researchers found that students of TFA teachers in North Carolina high schools had higher learning gains than students of traditionally-trained teachers, with particularly large differences in science (Xu et al., 2011).

Few experimental studies have estimated the effectiveness of TFA teachers, with similar results to non-experimental studies. One study randomly assigned first- through fifth-grade students to TFA and non-TFA teachers in schools in 6 different U.S. regions. Researchers found that students with TFA teachers performed better in math (0.15 of a standard deviation), but no

different in reading (Glazerman et al., 2006). A more recent study focused on elementary grades and randomly assigned students to TFA and non-TFA teachers in the U.S. The study found no significant differences in student learning outcomes for math or reading. In the high-poverty schools they were teaching, first- and second-year Teach For America teachers were as effective as other teachers (Clark et al., 2017). The most recent experimental study had a design similar to the previous two but focused on middle and high school students' mathematics learning. Researchers found TFA teachers were more effective than non-TFA teachers at raising student math learning and that the effect is larger for high school grades than middle school grades (0.13 vs. 0.06 SD) (Chiang et al., 2017).

In Latin America, an early study of eCh was conducted by Alfonso, Santiago, and Bassi from the Inter-American Development Bank in 2010.[2] To study Enseña Chile teachers (eCh), the researchers constructed a treatment and control group of Enseña Chile partner and non-partner schools by using propensity score matching to find the schools and students that are the most similar on observable characteristics. The study's implementation had to deal with some unfortunate events which affected testing rates. Applying the best possible adjustments and reducing the sample size, findings suggest that students with eCh teachers had higher math and language learning gains than students with traditionally-trained teachers in non-partner schools. The value-added point estimates for Enseña Chile teachers were unexpectedly high (between 0.17 and 0.43 SD in math and 0.22 and 0.25 SD in language), considering the short 4 to 6 month period between baseline and follow up tests, and the fact that the eCh teacher was not necessarily teaching the tested subject. Thus, the researchers are cautious to call the findings suggestive rather than causal (Alfonso et al., 2010; Alfonso, Bassi, & Santiago, 2012).

[2] The first cohort of Enseña Chile teachers began teaching in 2009.

Beyond student learning, studies have found that teachers in Teach for All partner programs impact other aspects of students' lives and that the program has effects on the recruits' own lives as well. In Chile, there is evidence that Enseña Chile teachers have a positive impact on their students' socio-emotional skills —self-esteem and social skills— compared to traditional teachers (Alfonso, Bassi, & Borja, 2012). A study in the US found small positive effects of TFA teachers on unexcused student absences and suspensions in elementary and middle school, and grade point average (GPA) in elementary school, but no impact on classes failed and grade repetition (Backes & Hansen, 2018). In the United States, researchers compared Teach for America applicants selected into the program to those not selected. They found that those who served as TFA teachers are more optimistic about future outcomes for poor children, are more racially tolerant, and are more likely to continue their careers in education (Dobbie & Fryer, 2015). Teach for America alumni also adopt positions more similar to those of the disadvantaged communities they served, and for example, are more likely to attribute the struggles of underprivileged communities to external causes instead of personal causes, and are more favorable of welfare (Mo & Conn, 2018).

In addition, studies have found that programs that involve less training specific in education,

1.4. Chilean Context

Primary and secondary schools in Chile have autonomy within a regulated framework established by the Ministry of Education with municipalities and private entities delivering education. There are three types of schools according to their administration and financing: public schools, government-subsidized private schools, and purely private schools. Municipalities administer public schools, private entities administer government-subsidized

private schools, and both are funded through public subsidies or vouchers. Purely private schools do not receive government funding. There is also a minimal share of schools administered by special corporations. The share of student enrollment across the three main types of school administration is largest for subsidized private and municipal schools that enrolled 54.7% and 35.9% of all students in 2016, respectively (MINEDUC, 2017).

Primary and secondary schools in Chile employed more than 200,000 teachers in 2016. Of these teachers, 44% taught in municipal schools, 46% in private subsidized schools, and 9% in purely private schools (MINEDUC, 2016). The vast majority of K-12 teachers in Chile (93.8%) have university degrees in education, but a non-negligible share (6.2%) does not. Of the 6.2% of teachers without a degree in education, two-thirds (4.47% of all teachers) have a degree in another field, and one-third (1.7% of all teachers) do not have a degree at all (MINEDUC, 2016).

The Chilean university system requires most applicants to take a national entrance exam by the end of their high school senior year. The exam has been carried out annually since 1967 and is called University Selection Test, known as PSU for its initials in Spanish (Prueba de Selección Universitaria) and previously as PAA (Prueba de Aptitud Académica). The most important public and private universities and professional institutes require applicants to submit their scores as part of their admissions process. The exam consists of two mandatory tests, mathematics and language, and two optional tests, science, and history, geography, and social studies. The exam scores are standardized to have a mean score of 500 points and a standard deviation of 110 points (DEMRE, 2017). Evidence has shown that PAA/PSU scores are systematically correlated with several measures of teacher qualifications and that teachers who score below average also score lower on other qualifications, but the relationship appears to be

concave (Gallegos et al., 2019). As the number of graduates from teaching programs has quintupled in the past twenty years (from 2,916 graduates in 1995 to 14,899 in 2009), the average PAA/PSU scores of the graduates have decreased significantly from 548 points (almost half a standard deviation above the mean) to 498 points (0.02 SD below the mean) (Gallegos et al., 2019). There is no evidence of the relationship between PAA/PSU scores and student learning, as researchers have not been able to match student assessments with individual teachers before.

2. Methodology and Data Sources

2.1. Data Sources

This study uses three sources of information: mathematics student learning assessments, administrative records on teacher characteristics, and publicly available records of school characteristics.

We conducted mathematics assessments at the beginning and the end of the 2016 school year for students in grades 9, 10, and 11. The tests are known as SEPA assessments, from the Spanish acronym of Learning Progress Assessment System (*Sistema de Evaluación de Progreso del Aprendizaje*). The Measurement Center of the Catholic University of Chile (MIDE UC) develops the SEPA tests since 2006 as a tool for schools to track student learning and progress. For this project, proctors external to the schools applied the tests under the supervision of the research team. The baseline test measured content knowledge of the previous grade (i.e., students who were starting 9^{th} grade tested their knowledge of 8^{th}-grade content). The follow-up test measured students' understanding of the material that they should have developed during the school year (i.e., 9^{th} graders tested their knowledge of 9^{th}-grade content). Even though exams are available for Language (Spanish) as well, we restrict the study to mathematics because the

majority of eCh teachers taught math, and the analyses of language tests would have been underpowered. To our advantage, research has found a greater variance in teacher effects on student mathematics achievement than on English (Kane et al., 2008) and that value-added measures are more reliable for mathematics than language (Staiger & Rockoff, 2010). Appendix A has more detail on the nature of the tests.

The second source of information is a unique administrative dataset of teacher characteristics, which includes college entrance exam scores and years of experience working as teachers. This dataset was constructed by digitizing historic college entrance exam scores as part of the work by Hastings, Neilson, and Zimmerman (2013). We complement the teacher and student data with publicly available administrative school data from the Ministry of Education's national evaluation program SIMCE (Sistema de Medición de la Calidad de la Educación).

2.2. Sampling

The combination we find in eCh classrooms of a high-ability novice teacher with markedly disadvantaged students is not common in the Chilean school system. To construct a comparison group that included teachers of similar ability and students from similar backgrounds to those found in eCh classrooms, we could not restrict the sample only to schools with similar characteristics of students and teachers as eCh schools. It was necessary to include a sample of more affluent schools to find higher-ability teachers.

Although Enseña Chile teachers are in schools in several regions across the country, due to funding limitations, we restricted the sample of non-partner schools (schools with no eCh teachers) to one geographic region. We selected the Metropolitan Region because it has the highest concentration of schools in Chile, with 40% of all Chilean students enrolled in schools there (MINEDUC, 2017).

To invite schools to participate in the study, we calculated the average PAA/PSU score of mathematics teachers of all schools in the Metropolitan Region, at the school level, and categorized them by deciles (ten being the highest and one the lowest deciles). We then generated a random draw of 30 schools per decile and began contacting schools in the randomized order. The objective was to have at least one school per decile. The final sample of 24 non-partner schools includes schools from all deciles. The group of eCh-partner schools in the Metropolitan Region includes schools from several deciles of teacher PAA/PSU scores (deciles 1, 4, 5, 7, 8, and 10). We describe our sampling process in more detail in Appendix B.

2.3. Descriptive Statistics

Our working sample consists of 3,454 students distributed in 157 classes taught by 104 teachers in 58 schools. Table 2.1 summarizes descriptive statistics according to whether students had an Enseña Chile teacher (column 1), a traditional teacher in eCh schools (column 2), or a traditional teacher in non-partner schools (column 3). The data shows that the average student in column 1 is taught by an eCh teacher with significantly fewer years of experience than traditional teachers. We expected eCh teachers to have almost no experience because half of them are novice teachers, and the other half only has one year of experience. Nonetheless, it is illustrative to learn that traditional teachers in eCh partner and non-partner schools have 14 and 22 years of experience, respectively. At the same time, eCh students have teachers with much higher levels of pre-college ability. In particular, their teachers achieved 680 points in mathematics on average, which is 51 points and 64 points (0.6 SD and 0.8 SD) higher than the scores obtained by traditional teachers in partner and non-partner schools, respectively. Similarly, eCh students have teachers who on average achieved 640 points in the language

portion of their college entrance exams, which is 114 and 75 points higher (1.33 SD and 0.87 SD) than for the two groups of students with traditional teachers, respectively.

Consistent with the objective of the Enseña Chile program, students with eCh teachers attend less affluent schools. Using the socioeconomic categorization of schools provided by the national evaluation program SIMCE, 95% of eCh students attend low or mid-low SES schools. Meanwhile, 49% of students with traditional teachers in non-partner schools attend low or mid-low SES schools. In the sample, all non-eCh teachers' students attend schools in the Metropolitan region. In contrast, eCh students are distributed across the country in eight different regions, with 31% of their students attending schools in the Metropolitan Region. In part because of the difference in geographic location, students taught by eCh teachers on average are in smaller classes than students taught by non-eCh teachers.

In terms of student academic outcomes, the results from the baseline and follow-up SEPA tests both show that students with traditional teachers on average attain higher scores than those with Enseña Chile teachers. These differences *in levels* (not in gains) are both important in magnitude (of about 0.46 SD) and statistically significant. However, this result is consistent with the fact that traditional teachers in the sample work at more affluent schools on average. Concerning gains in student achievement during the academic year (Difference in SEPA scores), we find that students of eCh teachers increase their scores by 7.2 points while students of traditional teachers increase by 6 points on average. While this mean difference of 1.2 points is not statistically different from zero at conventional levels, it suggests that eCh teachers are making at least a similar contribution to their students' learning gains compared to traditional teachers.

2.3. Empirical Strategy

Our strategy involves different methods for answering each research question. First, using a value-added framework, we estimate the determinants of individual student achievement as a function of prior test scores, teacher, school, and classroom characteristics. We estimate value-added following the general model proposed by Chetty, Friedman, & Rockoff (2014), using Michael Stepner's module for STATA (Stepner, 2013). The process has three steps: first constructing residual test scores (amounts to regressing the follow-up test scores on student characteristics including the baseline score and using within-teacher variation); second estimating the variance of individual and classroom-level residual test scores; and third estimating coefficients to predict value-added at the follow up based on mean test score residuals at baseline for each teacher.

For our first research question, we compare the value-added estimates across teacher types. Our general equation of interest is:

$$VA_{tcgs} = \beta_0 + \beta_1 D(eCh)_t + \beta_2 X_s + \beta_2 Y_c + \beta_3 PAA_t + \beta_4 exp_t + \beta_5 exp_t^2 + \varepsilon_{sgty}$$

where $D(eCh)_i$ is an indicator of whether teacher *i* is eCh or not. In these models, our hypothesis test of interest is whether β_1 is different from zero, meaning that teachers from different preparation have different value-added, or not. VA_{tcgs} represents value-added for teacher *t,* in school *s,* classroom *c,* grade *g,* with teacher *t,* at the end of the school year *y*; X_{st} represents a vector of school characteristics; Y_c is class size; Z_t represents a vector of teacher characteristics; and ε_{sgty} is a random error term. School characteristics include school location (Metropolitan Region or not), average student socioeconomic status at the school, and school dependency (if the school is public or government-subsidized private). Teacher characteristics include years of experience exp_t, years of experience squared exp_t^2, and college entrance exam scores

(PAA/PSU scores) PAA_t . We cluster the standard errors at the school level to account for within-school correlations in the errors.

Value-added estimates are measures of relative teacher effects. In this study, we construct the value-added estimate of one teacher in comparison to all other teachers in the sample. A positive value-added estimate for teacher *t* suggests that teacher *t* adds more value than the average teacher in our sample.

Because we have two potential comparison groups, traditional teachers in eCh-partner schools, and traditional teachers in non-partner schools, we employ two separate models –one with random effects and the other with school-level fixed effects. The random-effects models effectively compare all three groups of teachers, while the school-level fixed effects models only compare eCh teachers to traditional teachers within their same schools.

For the second research question, trying to decompose value-added and explore the relationship between teacher characteristics (exam scores and years of experience) and value-added, we first examine the relationship descriptively running correlation analysis. We then run the model above, excluding the teacher type indicator, and including years of experience and college entrance exam scores one at a time.

Finally, for our third research question examining how value-added changes for Enseña Chile as they acquire experience, we run the above regression only for Enseña Chile teachers. We also visually observe the change in value-added as eCh teachers gain experience, moving from their first to their second year.

Limitations

This study has a relatively small sample of 105 teachers and is not intended to be representative of all Enseña Chile and traditional secondary math teachers in partner and non-

partner schools. Also, we recognize that teachers impact students well beyond academics, but this study focuses on the academic impacts, specifically as measured by standardized assessments. The value-added framework defines teacher effectiveness as the impact teachers have on student learning, measured by standardized tests. In this study, we rely on SEPA mathematics tests. Thus, our VA estimates are a limited representation for the broader concept of interest, which is student learning.

In the study, it is not possible to control for positive or negative spillover effects within eCh partner schools. The introduction of a novice math eCh teacher likely has some impact on other math teachers in the same grades, but the direction of the effect again is uncertain. Traditional teachers could be exerting additional effort if they feel the need to "prove themselves" as better than the eCh teachers, or their value-added could be affected positively or negatively if they are spending time mentoring the eCh teacher. The study's sample included traditional teachers from non-partner schools, which can be considered a "non-contaminated" comparison group.

3. Results

Finding 1 –We find no evidence of differences in Enseña Chile teachers' effectiveness at raising student learning compared to traditional teachers.

We present our value-added estimates in Table 2.2. We computed measures of value-added (VA) for the 105 teachers in our sample using the overall SEPA scores. Table 2.2 shows that overall, Enseña Chile teachers have lower VA than traditional teachers, with the distribution of value-added by group displayed in Figure 2.1. Enseña Chile teachers have a tighter distribution, meaning that the VA estimates among eCh teachers are more similar than within the other two groups of teachers. Traditional teachers in non-eCh partner schools have the widest

distribution with VA estimates spanning from -2.3 to 3.2 standard deviations from the mean. None of the teachers in eCh-partner schools have VA estimates that are two standard deviations higher or lower than the mean.

Table 2.3 displays the results from the regression models with random and fixed effects. The random-effects regression that does not control for ability or experience (column 1) shows no evidence of statistically significant differences in teacher quality between teachers of the different groups. The results for the same regression with school fixed effects (column 3) suggest that compared to traditional teachers in their same schools, Enseña Chile teachers are less effective, with eCh teachers presenting 0.38 SD lower VA ($p<0.1$). Controlling for experience and pre-college ability (column 4), the effect disappears. In both the random and fixed effects models (columns 2 and 4), there is no evidence of eCh teachers having different value-added than the average traditional teacher in eCh partner schools and non-partner schools. Value-added estimates are mainly driven by teachers' ability as measured by their college entrance exams. Controlling for experience and pre-college ability, we find no evidence of differences in value-added between eCh and traditional teachers.

There is a strong positive relationship between ability and teacher value-added. A one standard deviation change in PAA/PSU scores is associated with a 0.63 standard deviation change in teacher VA ($p<0.01$) (column 2). The relationship also appears in the school fixed effects model with a smaller coefficient (0.18 standard deviations, $p<0.1$). The smaller effect could be because the relationship between PAA/PSU and value-added appears to be weakest for the traditional teachers in eCh-partner schools and strongest for traditional teachers in non-partner schools whom we omit in this model.

It is worth discussing what the most appropriate comparison group for Enseña Chile teachers is: Who would be teaching the students had it not been the eCh teacher? Given the summary statistics from Table 2.1, it seems improbable that the counterfactual teacher would have the same college entrance exam and experience as the average Enseña Chile teacher. Most likely, the teacher that would be in their place resembles the average traditional teacher we find in Enseña Chile partner schools, with significantly lower PAA/PSU scores and more years of experience than eCh teachers. In some cases, especially in the most remote schools, the alternative may be not having a teacher at all. To simulate more realistically the alternatives school administrators face when filling a vacancy in their schools, the comparison would not control for years of experience or college entrance exam scores.[3] We found that in doing so, the difference in effectiveness between eCh and traditional teachers in eCh-partner schools is statistically significant, suggesting that eCh teachers are less effective than traditional teachers within eCh-partner schools (column 3). This difference does not appear with traditional teachers in non-partner schools (column 1).[4] In this study, we could not include science teachers because SEPA tests are only available for math and Spanish language arts. Considering the higher shortages for high school science teachers and the high proportions of science classes taught by non-specialist teachers, the value of an alternatively certified teacher may be higher.

[3] The most recent experimental study on TFA is one of the few to not control for teachers' experience (Chiang et al., 2017), a caveat is that they randomly assign students to teachers.

[4] One thing to note about this exercise is that regardless of the number of years of teaching experience, additional years within a same school are likely to provide teachers with better knowledge of important factors such as the school culture, the students and community, that impact their teaching effectiveness. When comparing to the average teacher in the same type of school, ideally we would control for the number of years the teachers are in school, to take into account the effect of being a new hire (regardless of years of experience), but unfortunately we lack the data to do so in this study.

Finding 2 – Years of experience and pre-college academic ability are positively associated with value-added measures.

We examine if the differences in teacher effectiveness (measured by VA estimates) can be explained by teachers' observable characteristics such as ability assessed in their college entrance exams PAA/PSU, years of experience, and preparation –whether they are eCh teachers or not. We first examine the descriptive relationship between value-added and experience and ability separately using Spearman correlations. We find a positive correlation of $r=0.25$ between PAA/PSU scores and teacher VA estimates ($p<0.001$), displayed in Figure 2.2. Separating the mathematics and verbal components of the exam, we find a stronger correlation between mathematics scores and teacher VA estimates compared to verbal scores (correlation of $r=0.35$, $p<0.001$ for math compared to $r=0.11$, $p<0.001$ for verbal). This finding concurs with prior evidence that teacher content knowledge predicts value-added, particularly in mathematics (Hill et al., 2005, 2011). We also find a positive correlation ($r=0.17$, $p<0.001$) between years of experience and VA estimates (Figure 2.3). In line with prior research (Papay & Kraft, 2015), experience enhances the productivity of teachers for both Enseña Chile and traditional teachers.

Table 2.4 displays the regression models presented above, excluding the teacher type variable. Overall, we see that both ability and experience have significant effects on teacher estimated VA. Comparing effect sizes is not straightforward because of the different scales and because we include a quadratic term for years of experience. Ultimately, one standard deviation higher PAA/PSU scores is associated with a 0.61 SD increase in VA, while five years of experience are associated with a 0.31 SD increase in VA.

Finding 3 – Enseña Chile teachers' value-added increases significantly from their first to second year teaching.

Figure 2.4 displays the value-added distribution of eCh teachers and shows a substantial increase in value-added between first and second-year teachers across the whole distribution. The average teacher value-added estimate jumps from -0.51 for first-year eCh teachers to 0.17 for second-year eCh teachers. The entire distribution moves to the right, which means the group is improving as all teachers on average are improving.

To take a closer look at Enseña Chile teachers, we run the same model as above only for Enseña Chile teachers. The results displayed in Table 2.5 indicate that ability and experience are strong indicators of value-added, even in this high-ability group of teachers. The magnitude of the effect of experience is substantially larger in this group, which has only 0 and 1 years of experience. One standard deviation higher PAA/PSU scores is associated with 0.553 SD higher value-added ($p<0.01$). In terms of experience, going from their novice first year to their second year teaching increases eCh teachers' value-added by 0.619 standard deviations on average ($p<0.001$).

Finally, Table 2.6 shows the Value-Added for traditional and eCh Teachers by school socioeconomic status. Within eCh teachers, those who work in low SES schools attain higher levels of value-added than those working in higher SES schools. Traditional teachers perform worst in low-SES schools. These results may be explained by the specialization of the eCh program to prepare their teachers for more vulnerable contexts.

Ultimately, the models indicate a strong positive effect of years of experience and ability —as measured by PAA/PSU scores—, and both findings agree with the previous literature. In terms of comparing the value-added of Enseña Chile teachers with traditional teachers, because

the differences are not statistically significant, we cannot conclude that on average one group of teachers has higher VA than another.

4. Discussion

The results presented suggest that there are no statistically significant differences in the contributions Enseña Chile and traditional teachers make to student math achievement, within eCh-partner schools, and across all schools. Importantly, eCh teachers in their first year are still catching up to the training and practical experience traditional teachers go through during their preparation programs. By their second year teaching, eCh teachers have made a big leap in terms of the contributions to student learning compared to first-year eCh teachers.

A salient finding is the gains eCh teachers experience from their first to their second year teaching. First-year eCh teachers have an average VA estimate of -0.51 standard deviations while second-year eCh teachers average 0.17 standard deviations, equaling traditional teachers. Although within our sample we cannot compare to novice traditional teachers because traditional teachers in our sample are more experienced, this stark increase concurs with recent findings that the first two years of teaching have the most substantial increases in teacher value-added (Bau & Das, 2020). Unfortunately, we have no eCh teachers in their third year teaching in the sample, and our data is only for one year, but we would expect another significant increase in value-added by their third year. This remarkable difference suggests that Enseña Chile's ongoing field support and mentoring, which are essential elements of the eCh teacher training program, are helping teachers increase student learning. The tutors' visits for observation and feedback, the periodic regional training and meetings, the constant monitoring through student surveys, and the

accessibility and availability of tutors and eCh staff for support, appear to help teachers improve their ability to raise their students' learning.

One policy implication from this study is that it is worth exploring if similar elements of ongoing training could boost the effectiveness of all novice teachers. The training model Enseña Chile and its partners carry out includes some of the main characteristics researchers find of effective professional development programs —being specific to the subject being taught, including lesson enactment, and face-to-face training. These characteristics have also been found to be lacking in at-scale professional development programs around the world (Popova et al., 2018).

This study is the first evaluation of a Teach For All partner that includes a measure of teacher pre-college academic ability. The availability of college entrance exam scores allows us to decompose the selection and training components of the Enseña Chile program. When we control for PAA/PSU in our models, a large portion of teachers' value-added is absorbed. This may partially explain the lack of significant effects found for teacher preparation path when controlling for experience and PAA/PSU, which differs from the positive effects of Teach For All math teachers found in prior studies. Because we include PAA/PSU, the eCh status does not include the high prior ability of teachers, but instead only the eCh training and support, and teachers' unobserved characteristics such as high expectations of their students. Because teacher effectiveness is determined by a teacher's pre-college ability, training, and unobserved teacher characteristics, controlling for pre-college ability is like isolating a crucial part of the recruitment component of eCh and seems to reduce the effect of the eCh pathway.

Enseña Chile teachers teach disadvantaged students of lower socioeconomic backgrounds that have lower test scores at the start of the school year, and that live in more remote geographic

areas. Our analysis does not control for unobservables such as expectations and the value placed on education, and these factors could be driving part of the results. Enseña Chile establishes partnerships with the highest need schools, which in many cases are also harder to staff schools, and eCh teachers are assigned to harder to staff subjects. We found evidence that eCh teachers perform best in low SES schools, suggesting that eCh may have a comparative advantage in these schools.

Furthermore, student surveys conducted together with the end of the year assessments but not described in this paper, show that eCh teachers and their classroom learning conditions are consistently perceived more positively by their students than traditional teachers. Student-teacher interactions are important determinants of student motivation and engagement, which is one of the largest mediators of academic and non-academic outcomes (Allen et al., 2011). For example, the socio-emotional benefits of students feeling that they are valued and encouraged by their teachers, especially for disadvantaged students, could easily have a life-long impact that extends beyond learning gains (which have been found to wash out) (Chetty et al., 2014). Non-cognitive outcomes are beyond the scope of this study, but further research should further examine the effects Enseña Chile teachers have beyond student learning.

Our results suggest that policies establishing alternative pathways for professionals from other areas to enter teaching have the potential to complement the traditional teacher workforce without diminishing its quality. However, our findings are particular to the recruiting, training, and support provided by eCh and Teach for All partner programs. Both the quality of eCh's processes and the unobserved characteristics shared by those who become eCh teachers (like motivation, grit, preferences) likely play a role in determining teacher effectiveness and the extent to which eCh teachers can compensate for having less experience and pedagogical

training than traditional teachers. An interesting avenue for future research is to disentangle the effects of those different unobserved components and quantify their relative importance in determining teacher effectiveness.

5. Conclusions

In this study, we have documented the effectiveness of eCh teachers and compared them to traditional teachers with similar characteristics in a range of schools. Findings include confirming that experience has a positive effect on teacher value-added, that pre-college academic achievement has a strong positive effect on teacher value-added, that Enseña Chile teachers have no statistically significant difference in value-added than traditional teachers, and that eCh teachers have a large jump in effectiveness from their first to their second year.

The findings also suggest the mechanism through which the results arise. This study decomposes the elements that determine teacher value-added —experience, pre-college academic ability, and teacher preparation—and how they vary across types of schools. We find that teachers in the eCh program are predicted to have higher value-added due to their higher levels of pre-college academic achievement. Still, they also have minimal experience, so this second factor appears to counter the effect on expected value-added. The net effect is that an average eCh teacher's contribution to their students' learning is no different from the contribution traditional teachers make.

A corollary to this finding is that teacher recruiting, training, and support by eCh may be compensating for the traditional teachers' pedagogical training period during college. It is important to note that this is true even after considering that eCh teachers come from a higher initial talent pool but have lower experience. This evidence suggests that recruiting talented

individuals helps improve the average value-added of teachers in the eCh program but does not say anything regarding whether unobservable characteristics of eCh candidates may also be important determinants of teacher performance. Teachers recruited through eCh pass several predetermined filters that could also be playing important roles in other dimensions.

Considering the unequal distribution of teachers in Chile and the shortage of teachers in specific areas and subjects, policies that establish alternative pathways for professionals from other areas to enter teaching have the potential of helping fill these gaps and improving the quality of education for students, particularly the most disadvantaged. This study provides evidence that Enseña Chile offers a successful alternative pathway program to remedy the impactful teacher shortages within and beyond Chile and insights into how the program can be further improved. Even though the ultimate goal should be to improve the teaching workforce overall, this is only achievable in the long-term. Meanwhile, shorter-term improvements should also be considered, a point other researchers have made before (Bold et al., 2017). The Teach for All/Enseña Chile model combines the immediate goal of providing quality education and expanding the opportunities for students in under-resourced schools, with the long-term goal of investing in teachers as long-term leaders that will work for children within and beyond the education sector throughout their careers. The immediate goal has the advantage that it does not require system-wide changes; thus, it is relatively quick to implement. By temporarily replacing the full teacher certification process with a combination of subject-specific university degrees, an intense but short training period, and temporary teaching licenses, teacher vacancies could be filled with qualified teachers relatively quickly. Filling vacancies can be especially valuable in remote areas and in subjects where there is a shorter supply of teachers.

Further research can expand on several aspects of this current study. The first is to understand better the heterogeneity in results for the eCh sample and look to further improve the recruitment process by examining the predictive content of other teacher characteristics on value-added. Delving into Enseña Chile's recruitment process can shed light on other determinants of teacher performance. A second avenue is to understand better the role of the eCh training and support program, as it seems that combined with the college degrees eCh teachers have, the training and support have a comparable effect to formal pedagogical preparation. Both of these dimensions would be useful for potentially taking innovations made by eCh and scaling them up as broader public policies.

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Tables and Figures

Table 2.1 – Summary Statistics, Student-level data

	(1) Enseña Chile Teachers	(2) Traditional Teachers	(3) Traditional Teachers	(4) Total
		eCh schools	non-eCh schools	
Teacher Characteristics				
Experience (years)	0.46	14	22	14
	(0.5)	(7.3)	(7.7)	(11)
Language PAA/PSU Score	638	526	567	583
	(60)	(73)	(74)	(80)
Math PAA/PSU Score	679	615	631	644
	(85)	(78)	(75)	(83)
PAA/PSU Overall Score	659	570	599	613
	(63)	(68)	(69)	(74)
School Covariates				
Metropolitan Region	0.31	0.45	1.00	0.69
Public School	0.29	0.23	0.12	0.19
Low SES School	0.5	0.31	0.16	0.29
Mid-Low SES School	0.45	0.58	0.31	0.40
Mid SES School	0.05	0.07	0.20	0.13
Med-High SES School	0.00	0.04	0.33	0.17
High SES School	0.00	0.00	0.00	0.00
Class Size	21	23	28	25
	(6.6)	(7)	(7)	(7.9)
SEPA scores				
Baseline	627	636	650	640
	(34)	(37)	(41)	(40)
Follow up	634	643	656	647
	(31)	(34)	(40)	(38)
Gain	7.3	7	5.9	6.5
	(28)	(30)	(28)	(28)
Observations				
N Students	1,106	553	1,757	3,416
N Classes	63	27	67	157
N Teachers	37	24	44	105
N Schools	30	17	24	58

Notes: Standard deviations are reported in parentheses.
(*) The school Socioeconomic Status (SES) comes from SIMCE data, which uses parent surveys to calculate school-level SES.
(**) the total of school adds to 58 instead of 71 because 13 schools have classes with both eCh and traditional Teachers.

Table 2.2 – Teacher Value-Added Estimates, by teacher type

		Teacher Type			
		Traditional Teachers	Traditional Teachers in eCh Schools	eCh Teachers	Total
Value-added (standardized)	mean	0.15	0.028	-0.19	0.00
	std. err.	0.18	0.19	0.12	0.098
	N	44	24	37	105

Figure 2.1 – Distribution of Teacher Value-Added Estimates

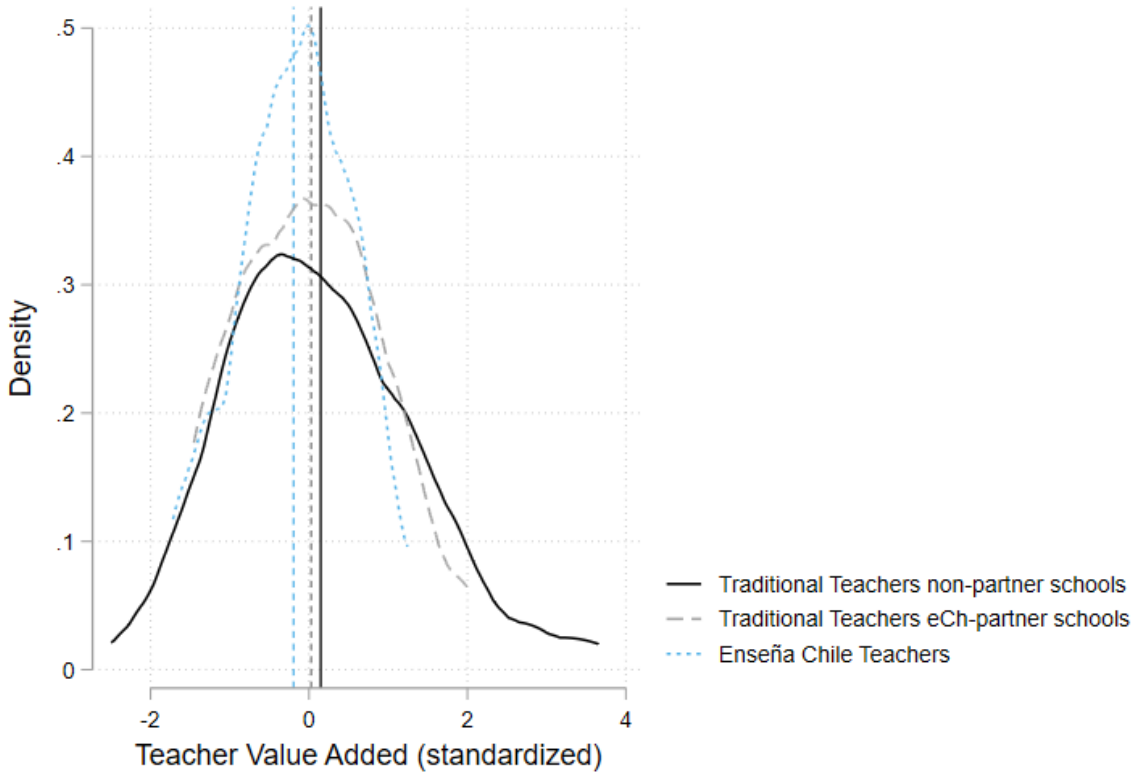


Table 2.3 – Regressions predicting Value-Added

Dependent variable: Value-added (standardized for study sample)

	(1) Teacher Type	(2) Teacher Type, Skill, and Experience	(3) Teacher Type FE	(4) Teacher Type, Skill, and Experience FE
Traditional Teacher (in eCh-partner school)	0.268 (0.325)	0.382 (0.352)	0.380* (0.218)	0.469 (0.415)
Enseña Chile teacher (in eCh-partner school)	0.010 (0.311)	-0.071 (0.802)		
PAA/PSU standardized		0.628*** (0.139)		0.181* (0.092)
Experience (years)		0.040 (0.066)		0.019 (0.039)
Experience^2 (years)		-0.001 (0.001)		-0.001 (0.001)
Additional controls	Yes	Yes	Yes	Yes
School Fixed Effects	No	No	Yes	Yes
Students	3416	3416	3416	3416
Classrooms	157	157	157	157
Teachers	105	105	105	105

Standard errors in parentheses
Standard Errors are clustered at the classroom level.
Additional controls: Teacher Experience, Class Size, School SES, School Type (Public or Private), School Location.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

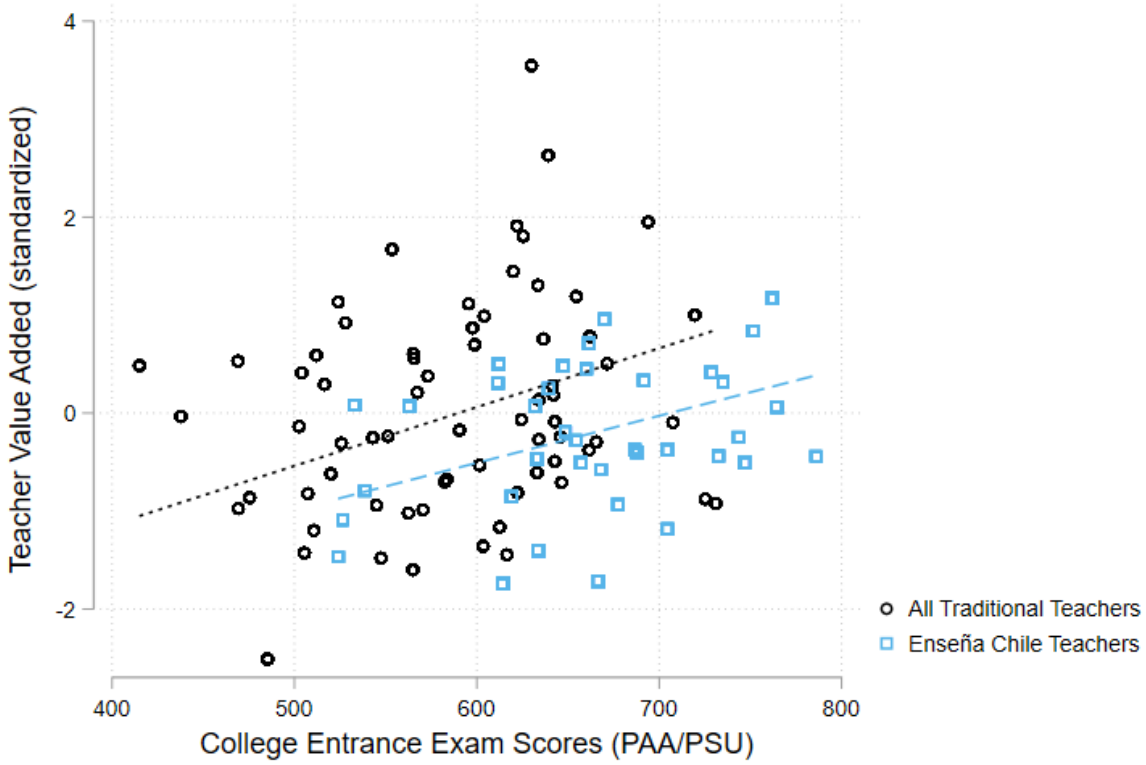
Table 2.4 – Regressions predicting Value-Added

Dependent variable: Value-added (standardized for study sample)

	(1) All teachers Skill	(2) All teachers Experience	(3) All teachers Skill and Experience
PAA/PSU standardized	0.477***		0.611***
	(0.121)		(0.149)
Experience (years)		0.001	0.067**
		(0.024)	(0.030)
Experience^2 (years)		0.001	-0.001*
		(0.001)	(0.001)
Controls	Yes	Yes	Yes
Students	3416	3416	3416
Classrooms	157	157	157
Teachers	105	105	105

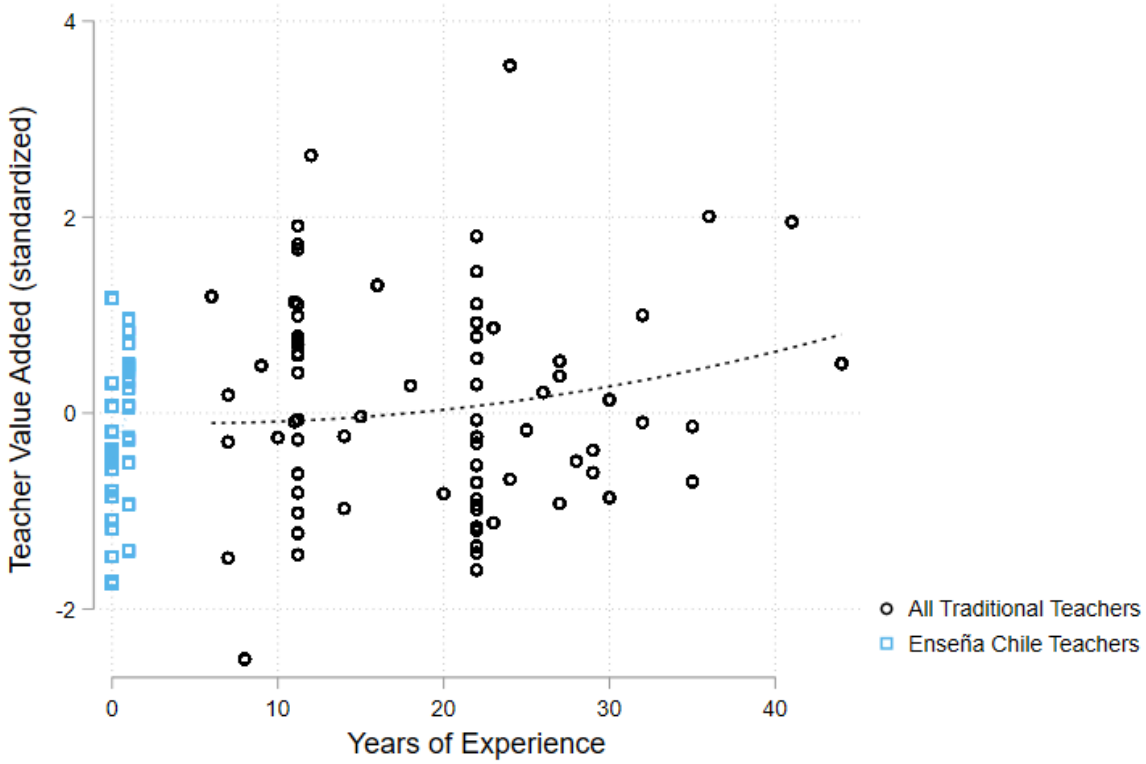
Standard errors in parentheses
Standard Errors are clustered at the classroom level.
Controls: Teacher Experience, Class Size, School SES, School Type (Public or Private), School Location.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 2.2 – SEPA Value-Added positively correlates with PAA/PSU Scores:



Note: Dotted lines show the best quadratic fit.

Figure 2.3 – SEPA Value-Added positively correlates with Years of Experience:



Note: Dotted lines show the best quadratic fit.

Figure 2.4 – Distribution of Teacher Value-Added Estimates – Enseña Chile Teachers

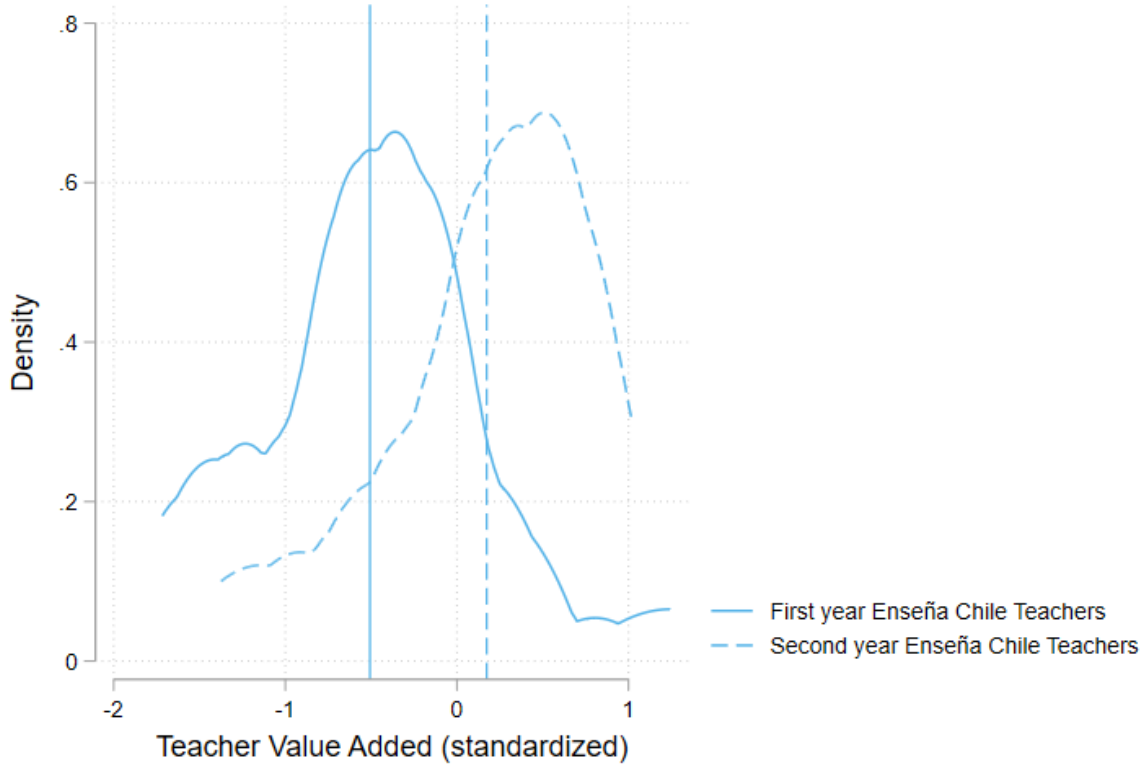


Table 2.5 – Additional Regressions predicting Value-Added

Dependent variable: Value-added (standardized for study sample)

	(1) Only eCh Teachers
PAA/PSU standardized	0.553***
	(0.166)
Experience (years)	0.619***
	(0.176)
Experience^2 (years)	
Controls	Yes
School Fixed Effects	No
Students	3416
Classrooms	157
Teachers	105

Standard errors in parentheses
Standard Errors are clustered at the classroom level.
Controls: Teacher Experience, Class Size, School SES, School Type (Public or Private), School Location.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.6 – Value-Added by Teacher Type and School SES

School Socioeconomic Status (SES)	Stats	Traditional Teacher	eCh Teacher	Total
Low	Value-Added	-0.054	-0.11	-0.082
	N Teachers	19	20	39
	N Students	456	549	1005
Low-Mid	Value-Added	0.23	-0.28	0.044
	N Teachers	24	14	38
	N Students	864	500	1364
Mid	Value-Added	0.083	-0.36	-0.0059
	N Teachers	12	3	15
	N Students	395	57	452
Mid-High	Value-Added	0.12	--	0.12
	N Teachers	13	0	13
	N Students	595	0	595
Total	Value-Added	0.045	-0.24	0.00
	N Teachers	68	37	105
	N Students	2310	1106	3416

Appendix A - SEPA Tests

The SEPA standardized mathematics tests are developed by the Measurement Center of the Catholic University of Chile (MIDE UC) since 2006. The name SEPA comes from the acronym in Spanish of Learning Progress Assessment System (*Sistema de Evaluación de Progreso del Aprendizaje*). The tests are offered as an external evaluation tool that schools can use to collect information on their students' learning.

The data for this project was collected during the 2016 school year, which in Chile runs from March to December. Schools were invited to participate at the beginning of the school year. Baseline tests were conducted during the first two weeks of May, and follow-up tests were conducted during the first two weeks of November. The tests are written exams consisting of multiple-choice questions. The math and language tests for grades 8 through 11 have 50 questions and take 70 minutes to be completed. The full implementation of the assessment takes 90 minutes, including passing out and collecting tests and giving instructions. SEPA tests are constructed by a team of specialists at MIDE UC through a rigorous process, which includes examining the national curriculum, constructing questions, expert review, pilot testing, psychometric analysis, and assembly of final tests. The tests aim at providing information regarding student achievement during the school year and student progress across years.

It is worth noting that Chile has a national curriculum for Mathematics, meaning that nationwide all students in the same grade are expected to learn the same material. This allows the present study only to require one math test per grade tested, for a total of 4 tests used (8-11 grades math).

Appendix B – Participating Schools

Sample of Enseña Chile Schools. All eCh schools with math teachers (53 schools) were invited to participate with three classes –one class per grade 9th-11th grade– with the understanding that the tests would have no cost for the school and that reports with results of both tests would be available to each school in January 2017. Of the 53 schools, 38 accepted to participate, while 15 declined participation, several because their students had already taken SEPA tests at the end of the 2015 school year. The eCh partner schools in the sample are located throughout Chile, 11 are in the Metropolitan Region, six are in the adjacent region (V), one is in the north (I region), and 17 are in southern regions (VIII, IX, X, XI, and XIV).

Table 2A.1 below compares the characteristics of participant and non-participant schools, in terms of socioeconomic status (SES) index[5] and average standardized test scores in 10th grade. We found no significant differences between participant and non-participant eCh partner schools, suggesting no sampling bias on observable characteristics in the eCh participant schools.

Table 2AB.1 – Descriptive Statistics and T-test Results of SES and SIMCE test scores for Enseña Chile partner schools by participant status

	Participant School		Non-participant school		Differences		
	Mean	SD	Mean	SD	Diff	Std. Error	t-stat
SES (1 to 5)	1.71	0.72	1.88	0.62	0.168	0.204	(0.82)
Reading Comp	232.59	24.65	233.75	25.19	1.165	7.309	(0.16)
Mathematics	235.56	33.28	250.25	37.7	14.689	10.182	(1.44)
Sciences	223.61	21.85	228.94	20.14	5.328	6.308	(0.84)

[5] The index comes directly from the government agency that implements the standardized exams in Chile. They state that the index is computed using students' parental education, household income and vulnerability score. See MINEDUC (2013), which can be accessed here http://archivos.agenciaeducacion.cl/Metodologia_de_Construccion_de_Grupos_Socioeconomicos_Simce_2013.pdf