Does out-of-field teaching affects the quality of student learning? An analysis with panel data from the School Census

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In 2016, 21% of Brazilian high school teachers were only teaching out-of-field assignments. To what extent does this affect school results? Is it necessary for a teacher to have formal education strictly compatible with the subject taught, or is it that good teachers are capable of teaching any subject? Based on a panel built with the School Census of Basic Education and using a fixed school effects model, we estimate the impact of out-of-field teaching in four schools results seldom used in the literature: dropout rate, age-grade distortion, approval rate and retention. The main result points to a positive and significant relation with dropout rate and age-series distortion. Systematic issues such as dropout and age-grade distortion seem to be accentuated with out-of-field teaching. Results are robust to gradual addition of controls and persistent in the subsamples of schools run by states and located in urban areas. These results suggest that one of the mechanisms for understanding the lack of interest of young people in school can be found in the role of teachers.

Key words: Teacher training. Out-of-field teaching. School outcomes. School fixed effects.
JEL classification: I21, J21
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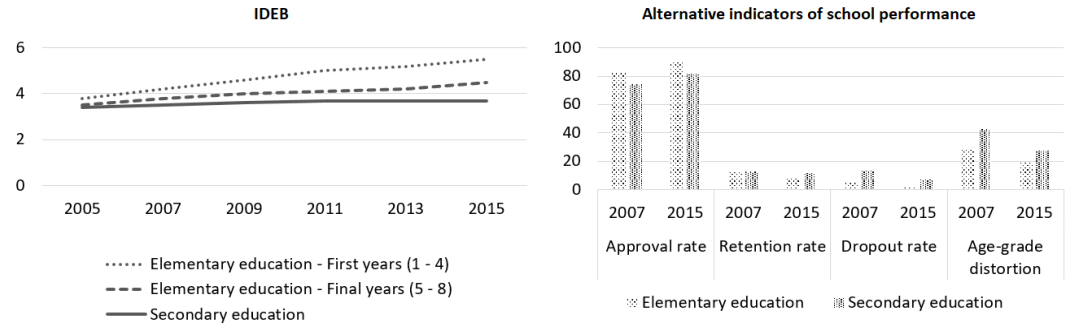
INTRODUCTION

In 2016, 21% of Brazilian high school teachers were only teaching out-of-field assignments, which means these teachers did not have an undergraduate degree in a field compatible with any of the subjects they taught. Based on a series of studies conducted in the United States, argues that out-of-field teaching has a negative impact on students and teachers, including teachers leaving the profession. One can, however, wonder whether this phenomenon really represents a problem: Is it necessary for a teacher to have formal education strictly compatible with the subject taught, or is it that good teachers are capable of teaching any subject?

In the last decade, secondary school has shown a poor performance, especially when compared to other educational levels. According to Figure 1, the Basic Education Development Index (IDEB - *Índice de Desenvolvimento da Educação Básica* in Portuguese) for secondary education remained stagnant at around 3.7.[1] Alternative indices of school performance, such as dropout rate, age-grade distortion, approval rate and retention rate, also indicate that secondary education is in a worse situation than elementary education in recent years.

Figure 1: Indices of school performance – Brazil, 2005 - 2015



Source: Own elaboration based on data from Inep.
INEP. **Cenário Educacional**. Retrieved 06 January 2017 from: https://goo.gl/WvmS2L.
INEP. **Indicadores Educacionais**. Retrieved 16 June 2017 from: https://goo.gl/FeCAKc.

Brazilian literature has studied different reasons that could explain why secondary education has worse results, but the possible impact resulting from out-of-field teaching hasn't been studied to its full potential. In addition, Brazilian education policy aims to reduce the incidence of this phenomenon, an effort reflected in one of the goals of the National Education Plan (PNE - *Plano Nacional de Educação* in Portuguese), which aims to ensure that basic education teachers have degree in the area of knowledge in which they work (BRASIL, 2014). In light of this, the goal of this paper is to investigate the impact of this phenomenon on different school results seldom used in the national literature.

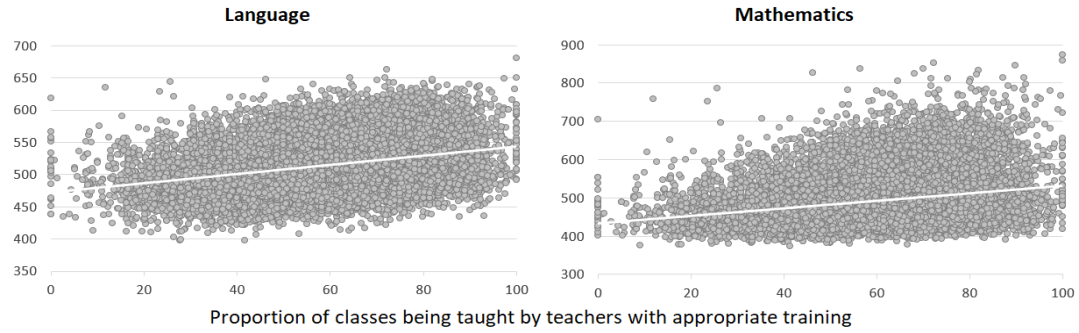
It is assumed that qualified teachers must have some training in the area taught, even though this does not necessarily guarantee a qualified professional (INGERSOLL, 2002). Content knowledge in the subject taught is essential because it allows teachers to understand the

[1] The terms secondary education and high school will be use to denote the last three years of basic education.

difficulties faced by their students. It also enables the teacher to be creative in designing learning opportunities that address the experiences, interests, and needs of each student. Even if teachers have curriculum guidelines to follow or teaching materials like textbooks, understanding content knowledge is still important to draw the full potential that an explanation, exercise or task can offer in terms of teaching (BALL, 2000).

Further, an index of teachers in-field (INEP, 2014) allows to observe a possible association between appropriate training and school performance. Figure 2 shows a positive relation between the proportion of teachers in-field and the grades of the National Examination of High School (ENEM - *Exame Nacional do Ensino Médio* in Portuguese) of language and mathematics.

Figure 2: Performance on ENEM by classes being taught by a teacher in-field - Brazil, 2015



Source: Own elaboration based on data from Inep. INEP. **Enem Por Escola**. Retrieved 21 January from https://goo.gl/x1hmR9. Teachers in-field are the ones with *licenciaturas* (or bachelor's degree with pedagogical training) in the subject being taught (INEP, 2014).

Empirical evidences sugggests that teachers have a positive effect on the quality of education: students reach higher levels of learning with teachers at the top of the quality distribution (HANUSHEK; RIVKIN, 2006; LADD, 2008). However, there is no consensus on which attributes affect performance and the literature continues to investigate what characterizes a good teacher.

The empirical literature presents divergent results on the effects of out-of-field teaching on student performance. Among the subjects analyzed, mathematics is the one with the most consistent results. Monk (1994) and Goldhaber e Brewer (1996) find a positive and significant effect of teachers with majors in-field on the performance on mathematics and science, and Darling-Hammond (2000) finds the same result for mathematics. In contrast Dee e Cohodes (2008), Zuzovsky (2009) and Harris e Sass (2011) do not find statistically significant effects.

In the Brazilian literature, few studies examine the impact of out-of-field teaching on student performance. Among them, two use undergraduate courses and the other two examine teachers' standardized test scores. Fernandes (2013) shows that teachers' mathematics and language scores have a positive and significant effect, implying that students allocated to teachers with a higher level of content knowledge performed better in these subjects. While Guimarães *et al*. (2013) find this same result for math, Silva Filho (2017) finds no significant effect of teachers' training. Carmo *et al*. (2015), the only study focused on secondary

education, find a positive and significant impact on school performance using the index for teachers in-field (Figure 2).

The methodology used in this study is based on the construction of a panel of schools with the School Census of Basic Education from 2007 to 2016. The School Census contains four variables of school result, used in this work as dependent variable: dropout rate, age-grade distortion, approval rate and retention rate.

The variable of interest is the proportion of classes being taught by out-of-field teachers. A teacher is out-of-field when he does not have an undergraduate course compatible with the subject his is teaching, regardless of pedagogical training. The aim is to distinguish content and pedagogical knowledge (INGERSOLL, 1999). These two skills required for a good teacher, to know *what* to teach and *how* to teach, are affected by their training. In theory, content knowledge is affected by teachers' field while pedagogical knowledge would be more impacted by the type of training - that is, whether or not they have a pedagogical training.

One of the methodological difficulties in this type of estimation is the non-random distribution between teachers and students, which can result in a reverse causality between the dependent variables and the variable of interest. Although it is expected that the proportion of out-of-field teaching has a negative impact on school performance, it is plausible to suppose that schools with better results have a higher proportion of teachers teaching in-field. Numerous characteristics of schools may be affecting this relationship, including unobservable characteristics.

From a theoretical point of view, the fixed effects model is the most adequate to deal with this possible source of endogeneity by eliminating the heterogeneity of schools. Nevertheless, three types of models were estimated: an pooled ordinary least squares, a random effects model and a fixed effects model. After some tests, it was concluded that the fixed effects model is the most appropriate.

The main result points to a positive and significant relation with dropout rate and age-series distortion. Results are robust to gradual addition of controls and persistent in the subsamples of schools run by states and located in urban areas. These results suggest that one of the mechanisms for understanding the lack of interest of young people in school can be found in the role of teachers. The combination of lack of interest from students and out-of-field teaching can be a fertile ground for school delay and, even worse, for dropping out of school.

The article contains five sections in addition to this introduction. Section 2 provides an overview of the characteristics of the Brazilian teachers' labor market, followed by the methodology, in section 3. Section 4 presents the descriptive analysis of the database, while the results are exposed and discussed in section 5. The conclusions are in section 6.

MAIN CHARACTERISTICS OF THE BRAZILIAN TEACHERS' LABOR MARKET

The shortage of teachers in Brazil is a recognized issue that has reached a worse level due to the expansion of enrollment in basic education in the last decades. Throughout the decades of 1990 and 2000 the educational policies were focused on the expanding enrollment on

elementary education. Involuntarily, these policies also stimulated the expansion of enrollment in secondary education in this same period (at least until 2005, when enrollment dropped) through the demand of students finishing elementary education (COSTA, 2013; COSTA; OLIEIRA, 2011). Among its low performance and with the compulsory and gratuitous offer of education from 4 to 17 years established by Constitutional Amendment No. 59 of 2009, secondary education has more frequently been included in public policy efforts (COSTA; OLIEIRA, 2011).

In examining whether the shortage of teachers is due to the lack of trained teachers or due to the abandonment of the career Pinto (2014), concludes that the low attractiveness of the teaching career, including low remuneration, is responsible for the lack of teachers in classrooms. Rabelo e Cavenaghi (2016) arrive at the same conclusion when observing low retention rates of teachers in the classroom between 2009 and 2013.

Through questionnaires and discussion groups, the Fundação Carlos Chagas (2009) investigated the attractiveness of the teaching profession among high school students. Although they perceived teaching as a noble career, most of the young people in the sample had no intention of becoming a teacher and regarded teaching as a profession with unsatisfactory remuneration, especially in the face of poor working conditions and low social prestige.

Since 2014, the National Institute of Studies and Educational Research Anísio Teixeira (Inep - *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* in Portuguese) began estimating an index measuring the proportion of teachers in-field using the School Census of Basic Education (INEP, 2014). The index considers each class being taught by a teacher. This is necessary to aggregate the data, because a teacher can teach more than one subject in more than one class. For example, if a teacher teaches two different subjects in the same class, the index counts this as two events.

The index connects the subject being taught in each class with teachers formal education, identifying if the training is appropriate or not to that subject. According to the legal dispositions, teachers with *licenciatura* (or a bachelor's degree with pedagogical training) in-field is the appropriate relationship between classes and formal education.[2] For instance, the appropriate training to teach mathematics would be a *licenciatura* in mathematics or a bachelor's degree with pedagogical training in mathematics. The index is calculated for each educational level and includes the teachers in-class and teachers responsible for on-line modules in distance learning. For secondary education, the index includes twelve subjects: Portuguese, foreign language, arts, physical education, mathematics, biology, physics, chemistry, history, geography, philosophy and sociology.

Regarding the formal education required to become a teacher, the Ministry of Education (MEC - *Ministério da Educação* in Portuguese), states that to teach in the high school level is necessary to be a licensed professional - that is, having a *licenciatura* in courses such as

[2] In Brazil, *licenciaturas* are undergraduate courses encompassing various fields that lead to the teacher profession. Teachers with *licenciatura* have pedagogical training during college, while a professional with a bachelor's degree can acquire pedagogical training after college to teach in basic education.

chemistry, physics, mathematics, geography or biological sciences[3] or having a bachelor's degree with pedagogical training.[4] The 1996 National Education and Guidelines Act (LDB - *Lei de Diretrizes e Bases da Educação Nacional* in Portuguese) prescribes that it is necessary to be licensed to teach at the high school level, but it also allows a professional with a bachelor's degree to obtain pedagogical training (BRASIL, 1996). The decree No. 3,276 of December 1999, which regulates LDB's articles on teacher training, requires teachers to have a higher education degree in the subject they teach.

Teacher training courses, in turn, have their limitations. On the one hand, education courses are extremely generic because they aim to train teachers, specialists in education and principals at the same time.[5] On the other hand, *licenciaturas* focus almost exclusively on the content knowledge in each area, leaving aside pedagogical knowledge (GATTI, 2010; SIQUEIRA DE SÁ BARRETO, 2015). And both courses do not have a link between the content and pedagogical knowledge (GATTI, 2010).

Added to these issues are the expansion of teacher training courses in the 2000s and their impact on the quality of teacher education, especially in education courses. In the first half of the 2000s, the government undertook efforts to increase enrollment in education courses in public institutions, including via on-line distance learning whose degree was equated to that of face-to-face education in 2005. The equivalence of the degrees results in the increase of enrollments in distance learning offered in private institutions in greater proportions than in public ones, becoming the main channel of the expansion of the education courses (SIQUEIRA DE SÁ BARRETO, 2015).

According to Barreto (2015), private institutions do not pay appropriate attention to teaching activities and the increase in enrollments in private institutions was not followed by an increase in the capacity to produce knowledge through research. Also, this process lacked the development of an adequate pedagogical project, and infrastructure of support for students.

Having in-field teachers becomes even more relevant for school performance when we observe the reality of Brazilian curriculum documents. According to the LDB, the secondary school curriculum must contain a common national base and a versatile part with regional and local content (BRASIL, 1996). The main institutional documents on high school curriculum are the 2012 National Curriculum Guidelines for High School (Guidelines) and the National Curriculum Parameters of the Secondary School Year 2000 (Parameters).

Both the Guidelines and the Parameters guide the curricular planning, but in thesis, the Guidelines define obligations, while the Parameters act like recommendations to the schools (EDUCAÇÃO, 2012). According to Moehlecke (2012), the autonomy of municipalities and states from the federative system causes the Guidelines to have a suggestive tone and orientation, resulting in its low power as a curricular policy. Thus it is up to the schools to decide whether

[3] Natural Sciences graduates can also teach chemistry, physics and biology in high school (INEP, 2014).

[4] MINISTÉRIO DA EDUCAÇÃO. *Formação*. Retrieved 05 January 2017 from: http://sejaumprofessor.mec.gov.br/internas.php?area=como&id=formacao.

[5] Education courses trains teacher for preschool and the first years of elementary education

to follow them or not. Although the 2012 Guidelines supersede the 1998 Guidelines, the author states that they do not change the organization of high school curriculum.

Based on a research on the curricular structures of eight countries[6] and seeking to understand how their experience could contribute to the national debate on the National Curricular Common Base (BNCC - *Base Nacional Comum Curricular* in Portuguese)[7], Louzano (2014) states that the General National Curricular Guidelines for Basic Education are generic when compared to those of other countries. Finland, for example, while granting broad autonomy to its schools, has a detailed national curriculum that guarantees a common knowledge base.

The General National Curricular Guidelines for Basic Education only define the areas of knowledge without directly addressing the content that should be taught within each area and the skills that should be developed by students at each educational level (DIRIGENTES MUNICIPAIS DE EDUCAÇÃO, 2014; EDUCAÇÃO, 2014). The lack of curriculum specification has led schools to use textbooks and external assessments (i.e., standardized tests) to fill this gap, instruments whose function is not to guide the development of the school curriculum (DIRIGENTES MUNICIPAIS DE EDUCAÇÃO, 2014). The 2012 Guidelines present these same limitations, not going beyond defining the four areas of knowledge in high school: languages, mathematics, natural sciences and humanities; and neither indicating what content students should master at each educational level.

There are three aspects that guide the content to be taught: the choice, the depth and when each subject should be presented and the curriculum documents of secondary education are lacking in theses aspects. Ultimately, responsibility for decision-making on the curriculum lies with teachers, who do not always have the financial and technical skills to make the best possible decision. Possibly, even less if he is teaching an out-of-field assignment. It is reasonable to think that an out-of-field teacher will have greater difficulty the less accurate the curriculum is, probably leading him to depend upon textbooks and external assessments.

METHODOLOGY

The ideal estimation would be to use an index of student performance as a dependent variable, and as a variable of interest a dummy indicating if the teacher is out-field. However, the only educational database that provides detailed information about teacher's training and the subjects the teach is the School Census of Basic Education, which does not contain performance per student. Since it is not possible to identify the same student in different bases, there is no way to merge the School Census with another database with this type of information. Considering the limitation of the national databases, the possible estimation consisted of using the school as an observational unit and the proportion of classes being taught by out-field-teachers as a variable of interest.

[6] Australia, Chile, Cuba, USA, Finland, Mexico, New Zealand and Portugal (DIRIGENTES MUNICIPAIS DE EDUCAÇÃO, 2014).

[7] The BNCC was approved in December 2017 and establishes the curricular components of preschool and elementary education.. Source: MOVIMENTO PELA BASE NACIONAL COMUM. A BNCC é homologada. 20 de dez. de 2017. Retrieved 28 January 2018. from: <https://goo.gl/Uq5FSV>.

Data

The database used was a panel of schools constructed with the School Census of Basic Education from 2007 to 2016. The School Census also gathers data on educational establishments, classes, students and school professionals, in addition to four outcome variables: dropout rate, age-grade distortion, approval rate and retention rate. These four rates were used as dependent variables.

The age-grade distortion rate is the proportion of students over the age of recommended age. The rates of approval, disapproval and dropout represent a percentage of total enrollment, considering transfers, admissions, and reclassifications (reassignment of students between grades).[8]

Both literature and educational policy-making use the result of standardized tests to evaluate the effectiveness of schools. However, maximizing student learning, defined by specific metrics captured by these tests, may not be the only goal pursued by a school or educational system. Rumberger e Palardy (2005) argue that using only standardized tests provides an incomplete view of school performance and may result in erroneous conclusions about which schools are effective and which characteristics promote effectiveness.

Using multiple indices is also interesting because schools can be effective for different purposes. This may be especially true if each school goal is affected by different inputs. For instance, school characteristics that promote learning may not be the same as those that promote low dropout rates. There are few studies investigating the relationship between different school outcome variables and the determinants of alternative indices. Given that most of the Brazilian literature uses standardized test results (FELICIO, 2008), using alternative indices is relevant because it encompasses other school aims (RUMBERGER; PALARDY, 2005).

Standardized tests are generally considered to be good index of school performance because they are external evaluations of the school and are not influenced by the school professionals directly responsible for the instruction of the students. The same cannot be said of approval rate and retention, even though retention remains a relevant issue in the Brazilian educational system (OLIVEIRA; SOARES, 2012). Despite being affected by schools, age-grade distortion and dropout rate are more exogenous results, which makes them more interesting for analysis.

Some schools were excluded from the dataset because they are different in the way they are organized and run from the rest of the schools: schools with enrollment in vocational education (technical and teaching), schools not organized in grades or with secondary education structured in four years, and federal and municipal schools. Schools that changed location or administration between 2007 and 2016 were excluded because it is not possible to guarantee the compatibility of the data.

Only school professionals with a teaching role were considered. Teachers are classified as the professionals responsible for a class and they are the only one who inform which subjects they

[8] INSTITUTO NACIONAL DE ESTUDOS E PESQUISAS EDUCACIONAIS ANÍSIO TEIXEIRA. Dicionário de Indicadores Educacionais: Fórmulas de cálculo. pág. 20. 2004. Retrieved 17 February 2018.from: <https://goo.gl/XyMz1G>.

teach. The aim is to investigate if school results are affected by out-of-field teaching, and not by their level of education. Therefore, teachers with no higher education were excluded, since keeping them in the database could lead to an overestimation of the variable of interest. At any rate, teachers with higher education are the majority of the sample in each year (over 90%). The result after the exclusions is an unbalanced panel with 230,571 observations (29,571 schools). This sample represents about 86% of all secondary schools, 75% of teachers and 81% of students each year.

The variable of interest, proportion of classes being taught by out-of-field teachers, was based on the methodology used by Inep (2014) in the construction of the index of teachers in-field. A teacher is out-of-field when he does not have an undergraduate course compatible with the subject his is teaching, regardless of pedagogical training. In addition, a teacher is only in-field if the higher education course in the area has been completed.

For 2011 and the following years, it was used the compatibility between higher education and subjects taught used by Inep in the construction of Group 1 of the index of teachers in-field (INEP, 2014, Table 2). For the previous years it was necessary to adapt the information, since the School Census codified the information in a different way. The proportion of classes being taught by out-of-field teachers encompasses twelve subjects: language, foreign language, arts, physical education, mathematics, biology, physics, chemistry, history, geography, philosophy and social studies/sociology. Up until 2011, the School Census only informs if a teacher teaches social studies or sociology jointly. This variable also exists in the other years and was used in this way to maintain compatibility.

Model

The fixed effects model was used for its characteristic of eliminating the heterogeneity of the schools in order to reduce the endogeneity in the estimation. In addition to possible omitted variables and the level of aggregation of the analysis, it is possible that there is bias arising from the non-random distribution between teachers and students at two levels: between schools and within the school (LADD, 2008). Overall, the best teachers tend to seek the best schools and can be assigned to the best students inside the school (CENTROS DE PÓS-GRADUAÇÃO EM ECONOMIA, 2017; HANUSHEK; RIVKIN, 2006). There are no variables in the School Census that allow capturing the allocation between teachers and students within the school, so it is not possible to control the non-random distribution within the school.

Although it is expected that the proportion of classes taught by out-of-field teachers will negatively affect school performance, it is possible that better performing schools present a greater proportion of classes taught by in-field teachers. Numerous characteristics of schools may be affecting this relationship, including unobservable characteristics. For instance, the school manager's ability to allocate resources, the relationship between teachers and the principal, the pressure of the students or those responsible for teachers with training compatible with the subject taught, etc. Moreover, these non-observable characteristics may be related to characteristics captured by the control variables. Increased pressure on the part of students or their parents may be associated with the school being private, for example.

Therefore, from a theoretical point of view, the school fixed effects model seems to be more adequate because it allows the regressors to be correlated with the fixed part of the error. Estimated models have the structure below.

$$RL_{i,t} = \beta_1 X_{i,t} + \beta_2 Z_{i,t} + \beta_3 W_{i,t} + \delta_t + \gamma_i, where$$

y = Dropout rate, age-grade distortion, approval rate and retention rate
i = School
t = Year

X= Proportion of classes being taught by out-of-field teachers

Z_i= School controls

W_i= Teachers controls

δ_t= Year fixed effects

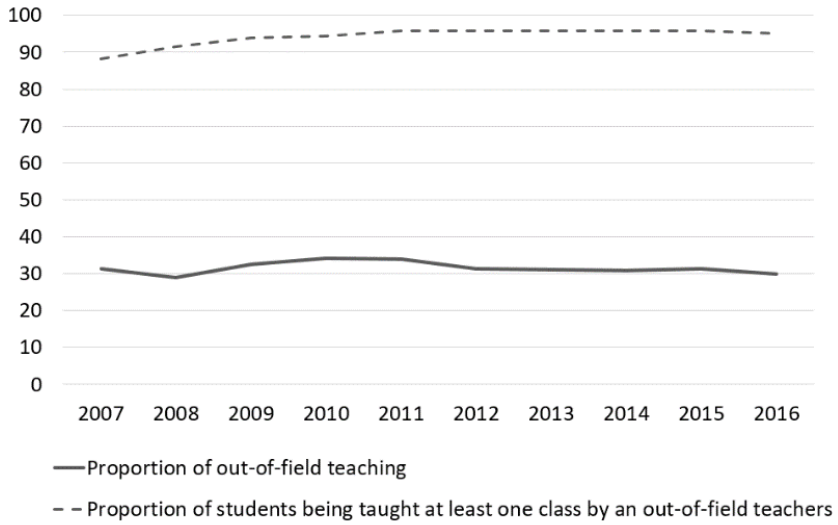
γ_i= School fixed effects

In any case, three types of model were estimated for the complete sample, for each of the four outcome variables: a pooled ordinary least squares, a random effects model and a fixed effects model. We performed tests between the three models in order to find out which model is the most appropriate for the database.

DESCRIPTIVE ANALYSIS

In as much as out-of-field teaching seems to be a disadvantage to teachers and students, Figure 3 shows that a considerable number of teachers and almost all Brazilian high school students are affected to some extent by the phenomenon. Specifically, after an increase between 2007 and 2011, the proportion of out-of-field teaching and of students with at least one teacher out-of-field has remained somewhat stable.

Figure 3: Out-of-field teaching across the years - Brazil, 2007 - 2015



Source: Own elaboration based on data from the School Census 2007 – 2016, Inep.

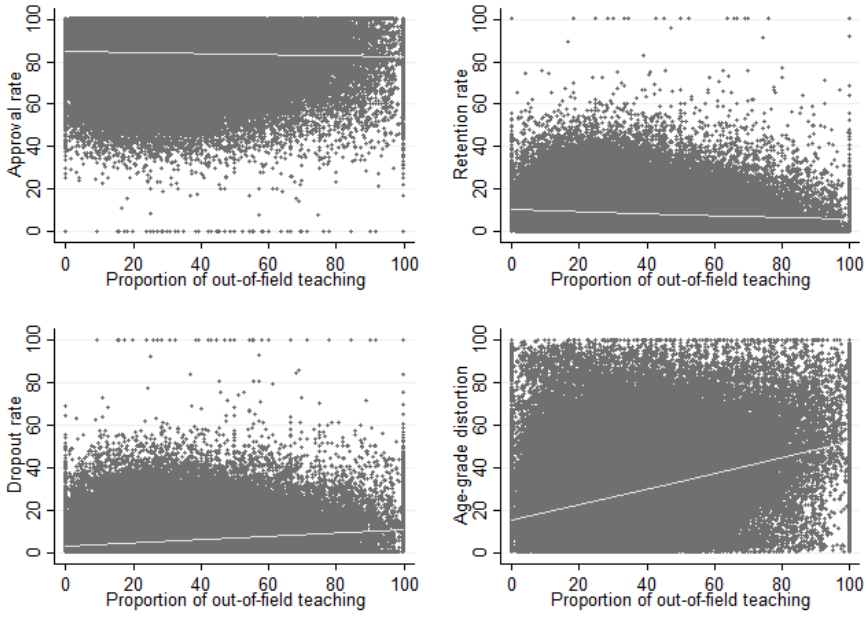
Figure 3 presents the variable of interest for different subsamples. The proportion of out-of-field teaching is more prevalent in state schools than in private schools and is higher in schools located in urban areas than in rural areas. Despite this, rural schools show an increase in the proportion of out-of-field teaching.

Figure 4: Proportion of out-of-field teaching by subsamples - Brazil, 2007 - 2016

Source: Own elaboration based on data from the School Census 2007 – 2016, Inep.

Figure 5 shows the relation between out-of-field teaching and the school performance in secondary education. Except for the age-grade distortion rate, all the lines are slightly sloped. The dropout rates and age-grade distortion are higher when out-of-field teaching is higher. The approval rate is negatively related to out-of-field teaching. This means that the higher the proportion of out-of-field teaching, the lower the approval rate. Nevertheless, the same is true for the retention. It is important to note that both rates have a weak relation to out-of-field teaching.

Figure 5: Indices of school performance by out-of-field teaching - Brazil, 2007 - 2016



Source: Own elaboration based on data from the School Census 2007 – 2016, Inep.

At first glance, there seems to be an incompatibility in the data regarding retention and age-grade distortion - if retention falls as out-of-field teaching increases, the age-grade distortion should probably follow this same direction.

Even considering that the literature indicates the existence of a relationship between retention and school delay (LEON; MENEZES-FILHO, 2002; OLIVEIRA; SOARES, 2012), this is not the only way by which it can manifest itself. School delay may be due to consecutive retention, late entry into the education system, or a discontinuity in schooling.

It is important to clarify that the two rates capture and express different phenomena. A one time retention may be an eventuality, but consecutive retention points to a systemic problem. Age-grade distortion translates into a more systematic and troubling problem than retention, even though it may be admitted that retention may be the first step towards age-grade distortion, or even dropout.

The descriptive statistics are shown on Table 1. The age-grade distortion rate is the dependent variable with the greatest variability and the retention rate, with the lowest. Most of the sample schools are state run and located in urban areas. With the exception of the last four variables, school controls are dummies, most of which regarding the presence of equipment and infrastructure.

The age-series distortion rate is the dependent variable with the greatest variability and the retention rate with the lowest. Most of the schools in the sample are state run schools and urban located. With the exception of the last four variables, school controls are dummy variables, most of which are infrastructure and equipment. The proportion of white students enrolled was included as proxy for the socioeconomic situation of the school. This is not the ideal variable for this purpose, but the School Census does not have any more appropriate variables such as family income or parental schooling.

Table 1: Descriptive statistics

Variables	Observations	Mean	Std. Dev	Min	Max
Year	230.571	-	-	2007	2016
Variable of interest					
Proportion of out-of-field teaching	228.161	33,2	19,2	0	100
Dependent variables					
Approval rate	126.114	84,0	13,7	0	100
Retention rate	126.831	9,0	9,1	0	100
Dropout rate	153.451	5,5	8,6	0	100
Age-grade distortion rate	147.872	27,5	21,4	0	100
School controls					
State	230.571	-	-	11	53
Private school	230.571	32,0	0,5	0	1
Urban school	230.571	92,5	0,3	0	1
School building	230.571	98,6	0,1	0	1
Drinkable water	230.571	90,5	0,3	0	1
Electrical energy - nonexistent	230.571	0,1	0,0	0	1
Precarious sewage system (nonexistent or septic tank)	230.571	35,6	0,5	0	1
Periodic garbage collection	230.571	95,1	0,2	0	1

Variables	Observations	Mean	Std. Dev	Min	Max
Principal's office	230.571	94,6	0,2	0	1
Teacher's room	230.571	94,0	0,2	0	1
Computer lab	230.571	85,0	0,4	0	1
Science lab	230.571	48,6	0,5	0	1
Room for working with children with special needs	230.571	16,3	0,4	0	1
Sports court	230.571	76,0	0,4	0	1
Kitchen	230.571	88,9	0,3	0	1
Library	230.571	73,3	0,4	0	1
TV set	230.571	96,1	0,2	0	1
DVD	230.571	92,0	0,3	0	1
Parabolic antenna	230.571	49,4	0,5	0	1
Copy machine	230.571	68,5	0,5	0	1
Retroprojetor	230.571	78,7	0,4	0	1
Printer	230.571	94,2	0,2	0	1
Internet	228.288	92,6	0,3	0	1
School provides food	230.571	68,6	0,5	0	1
Number of computers for student use *per capita**	209.224	0,2	0,6	0	129
Number of employees *per capita**	230.565	0,5	2,1	0	636
Student-teacher ratio***	223.857	13,8	8,6	1,333333	57
Classes per teacher (school mean)**	226.076	4,2	1,8	1	10,1
Proportion of white students enrolled	230.571	27,9	25,7	0	100
Controles de professores					
Average age of teachers	228.357	39,9	4,3	20	91
Proportion of teachers with *licenciatura*	228.357	0,9	0,1	0	1
Proportion of teachers with some degree postgraduate studies (specialization, master's or PhD)	228.357	36,1	25,0	0	100

Source: Own elaboration based on data from the School Census 2007 - 2017, Inep. The variables listed from federal to "school provides food" are dummies which assume a value of 1 if the school has the listed attribute.
*The variables are \textit{per capita} in relation to the high school enrollment in the sample.
**1% of upper bound was excluded due to outliers. The 1% lower was not excluded because the values in the lower tail represent school realities, such as teachers having only 1 class. The results have not changed.
***1% of upper and lowers bounds were excluded due to outliers. The results have not changed.

RESULTS

Three types of model were estimated for the complete sample, for each of the four outcome variables: a pooled ordinary least squares, a random effects model and a fixed effects model.[9] The necessary tests were performed between the three models and it was concluded that the fixed effects model is the most appropriate, so only its estimates are reported and analysed.

The fixed-effects model for the whole sample was also estimated for a balanced panel and little variation in estimates and standard errors was observed, indicating that the loss of school information over time is random and uncorrelated to observed variables or to the residue.

[9] The pooled OLS is not appropriate when compared to the random effects model since the null hypothesis of the Breusch-Pagan test was rejected in all models at the significance level of 1%. Therefore, there is evidence of unobservable effects and the random effects model is more appropriate (PARK, 2011). The OLS is also not appropriate when compared to the fixed effects model, since the null hypothesis that the fixed effects are significantly equal to zero was rejected in all models at the significance level of 1% (PARK, 2011).

The comparison between the random and fixed effects models was performed through an overidentification test, whose null hypothesis is that the random effects estimators are consistent (WOOLDRIDGE, 2002). The null hypothesis was rejected in all models at 1 % significance. The null hypothesis was rejected in all models at 1% significance. Considering that the fixed effects model was the most suitable for the database, only its estimates are reported and analyzed.

Estimates with the complete sample

The tables 2, 3, 4 and 5 present the estimates of the fixed effects models for the complete sample. The variable of interest presented low magnitude in all four models. Nevertheless, the signs found confirm the descriptive analysis presented in the previous section. The results are robust to the gradual addition of controls in the estimation, positive and significant at 1% in all specifications in the models that have dropout rate and age-grade distortion rate as dependent variables (table 2 and 3). For a given school, as the proportion of out-of-field teaching varies over time by 1 percentage point, the drop-out rate increases by 0.0069 percentage points, while the age-grade distortion rate increases by 0.0151 percentage points.

Table 2: Impact of out-of-field teaching in secondary school results – 2007 - 2016 - Complete sample - Dependent variable: Dropout rate (%)

	(1)	(2)	(3)	(4)	(5)
Out-of-field teaching (%)	0.0722***	0.0126***	0.0080***	0.0068***	0.0069***
	(0.0020)	(0.0019)	(0.0018)	(0.0018)	(0.0018)
School fixed effect	No	Yes	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes
School controls	No	No	No	Yes Yes	Yes
Teachers' controls	No	No	No	No	Yes
N	152.499	152.499	152.499	134.523	134.523
F-test	1357,3997**	45,4398***	497,5708***	126,3962***	117,0707***
R^2	0.0247	0.7666	0.7163	0.7392	0.7392

Source: Own elaboration based on data from the School Census 2007, 2011 e 2015 - Inep.
Standard robust errors with cluster at the school level in parentheses.
* p < 0.1, ** p < 0.05, *** p < 0.01.

Table 3: Impact of out-of-field teaching in secondary school results – 2007 - 2016 - Complete sample - Dependent variable: Age-grade distortion rate (%)

	(1)	(2)	(3)	(4)	(5)
Out-of-field teaching (%)	0.3714***	0.0392***	0.0240***	0.0141***	0.0151***
	(0.0050)	(0.0027)	(0.0023)	(0.0025)	(0.0025)
School fixed effect	No	Yes	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes
School controls	No	No	No	Yes Yes	Yes
Teachers' controls	No	No	No	No	Yes
N	145.942	145.942	145.942	128.197	128.197
F-test	5506,5316**	210,3909***	1340,8183***	289,1155***	267,7052***
R^2	0.1118	0.9005	0.9223	0.9269	0.9269

Source: Own elaboration based on data from the School Census 2007, 2011 e 2015 - Inep.
Standard robust errors with cluster at the school level in parentheses.
* p < 0.1, ** p < 0.05, *** p < 0.01.

The economic literature has started investigating the reasons why young people do not participate in school. Neri (2009) shows that 18% of 15-17 year olds, the recommended age at high school, had dropped out of school. The author verifies that the lack of intrinsic interest is the main reason these young people are out of school. When analyzing the reasons that compose this lack of interest, the author observed that these young people simply did not want to attend school.

What is the teachers' role in the students' lack of interest in school? The estimates presented in the tables 2 and 3 show systematically positive effects: the higher the proportion of out-of-field teaching, the higher the drop-out rates and the age-grade distortion in secondary education. Such results suggest that one of the mechanisms for understanding students' lack of interest in school may be found in teachers' role within the classroom.

A teacher who does not master the content knowledge of the subject taught may face difficulties in all his or her activities, such as exposing the content in a clear form, capturing the interest of the class or academically challenging their students (BALL, 2000). These difficulties can be enhanced by an ill-defined curriculum structure. The combination of lack of interest from students and out-of-field teaching can be a fertile ground for school delay and, even worse, for dropping out of school.

The negative relation between the proportion of out-of-field teaching and retention rate observed in Figure 5 is also reflected in the estimates and may reflect a finding from Dee and Cohodes (2008): teachers in-field can be more demanding. Despite the signal change and the loss of significance in specifications (2) and (3), the variable of interest is negative and significant at 1% in the model with all the controls (5) with the retention rate (Table 4). For a given school, as the proportion of out-of-field teaching varies over time by 1 percentage point, the retention rate decreases by 0.0054 percentage points.

Table 4: Impact of out-of-field teaching in secondary school results – 2007 - 2016 - Complete sample - Dependent variable: Retention rate (%)

	(1)	(2)	(3)	(4)	(5)
Out-of-field teaching (%)	-0.476*** (0.0019)	-0.0006 (0.0020)	-0.0017 (0.0020)	-0.0036* (0.0021)	-0.0054** (0.0021)
School fixed effect	No	Yes	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes
School controls	No	No	No	Yes Yes	Yes
Teachers' controls	No	No	No	No	Yes
N	126.110	126.110	126.110	109.890	109.890
F-test	647,8180**	0,0921	168,3268***	64,7262***	61,4977***
R^2	0.106	0.6409	0.6464	0.6788	0.6793

Source: Own elaboration based on data from the School Census 2007, 2011 e 2015 - Inep.
Standard robust errors with cluster at the school level in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Impact of out-of-field teaching in secondary school results – 2007 - 2016 - Complete sample - Dependent variable: Approval rate (%)

	(1)	(2)	(3)	(4)	(5)
Out-of-field teaching (%)	-0.0290*** (0.0032)	-0.0140*** (0.0026)	-0.0063*** (0.0025)	-0.0021*** (0.0026)	-0.0006*** (0.0027)
School fixed effect	No	Yes	Yes	Yes	Yes
Year fixed effect	No	No	Yes	Yes	Yes
School controls	No	No	No	Yes Yes	Yes
Teachers' controls	No	No	No	No	Yes
N	125.528	125.528	125.528	109.423	109.423
F-test	81,7107*	29,0161***	418,6116***	118,3329***	111,4693***
R^2	0.0016	0.7666	0.7816	0.8012	0.8013

Source: Own elaboration based on data from the School Census 2007, 2011 e 2015 - Inep.
Standard robust errors with cluster at the school level in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In the case of the approval rate (Table 5), the variable of interest maintains the negative sign in all specifications, but loses significance with the inclusion of the controls in the last two models (4) and (5). The coefficients of the variable of interest in the models with the approval and retention rates are lower than with dropout and age-series distortion, confirming the uncorrected unconditional relations between the variable of interest and the approval and retention rates, shown on .

Estimates with subsamples

The results for type of administration and location subsamples are not shown due to space limitations. The variable of interest is not significant with the approval rate in any of the subsamples. In fact, the results for the rural and private schools subsample are not statistically significant either.

The variable of interest is significant with the drop-out rates, age-grade distortion and retention in the estimation for the sub-sample of state and urban schools. The signals are identical to those of the full sample estimates and, although still small, the magnitudes of the coefficients are larger in these subsamples. These results follow the descriptive analysis, considering that out-of-field teaching is more prevalent in state and urban schools.

Other studies about out-of-field teaching have also found low magnitudes (FERNANDES, 2013; MONK, 1994) and there are possible reasons that explain this. Teachers can study in their free time to teach a subject in which they have no training, an option that becomes more feasible the less demanding the curriculum to be taught. Estimates may be biased downward if teachers have the same out-of-field assignments for some time.

One possible explanation is that content knowledge is best assessed with other variables. Using, for example, the number of courses taken in higher education compatible with the subject taught can yield more accurate results (DARLING-HAMMOND, 2000). Content knowledge can have a positive effect up to some level of basic competence in the subject or to the limits of the demands of the curriculum taught (DARLING-HAMMOND, 2000). However, this type of information is not available in Brazilian databases. When it comes to content knowledge, it may be that the distinction between the curriculum of higher education institutions is relevant to their relationship with school performance (HARRIS; SASS, 2011).

verifies that undergraduate courses in Portuguese, Mathematics and Biology do not have a link between content and pedagogical knowledge. If the positive effects of content knowledge work interacting with pedagogical skills (BALL, 2000; DARLING-HAMMOND, 2000), the Brazilian teacher training courses are not adequately training future teachers. In general, it is possible that the poor quality of teacher training courses are affecting results. It is important to emphasize that the students attracted to the teaching career have poorer educational performance in basic education (CENTROS DE PÓS-GRADUAÇÃO EM ECONOMIA, 2016; CHAGAS, 2009; LOUZANO et al., 2010), reaching higher education with deficiencies that the teacher training must deal with. Both of these questions may result in teachers with low proficiency in content knowledge, which in turn may explain the low magnitudes encountered. Regardless of the reasons, it is necessary to recognize that the magnitudes of the effects are

low and any type of intervention that considers to act in the teaching without specific formation would benefit from cost-benefit analyzes.

FINAL REMARKS

The economics of education literature presents strong evidence that promoting teacher quality is a key element in improving basic education. However, there is no agreement on the desirable characteristics of a good teacher. One dimension relevant to teaching quality may be content knowledge. The present work contributes to the national literature by showing that out-of-field teaching, a topic that has not been studied in detail, affects the dropout rate and the age-grade distortion in high school.

The impact of out-of-field teaching in the school results was estimated through a fixed effects model with the School Census of Basic Education from 2007 to 2016. Systematic problems such as dropout and school delay appear to accentuate whit out-of-field teaching. The results are robust to the gradual addition of controls and persistent in the subsamples of state and urban schools. Teachers in out-of-field assignments face different difficulties in their teaching activities (BALL, 2000) and the results suggests that raising young people's interest in school is among them. However, the magnitudes of the effects are low.

The results can provide information for debates about the relationship between content and pedagogical knowledge. They may indicate that having proficiency over content as measured by the compatibility between teachers' undergraduate course and the subject taught does not necessarily mean that the person is able to teach the content. Ball (2000) states that teacher education addresses content and pedagogical knowledge separately, hoping that teachers will learn to integrate these two skills in the context of their work. According to the author this is not a simple task and the best way to train good teachers is to integrate these two skills, because in the case of a teacher, *knowing the content of a subject means knowing how to teach it*. This has clear implications for teacher training courses that do not articulate content and pedagogical knowledge.

Economics of education literature has yet to explore how out-of-field teaching affects teachers. An extremely qualified teacher in the subject in which he or she has formal training may be extremely disqualified when assigned to a subject for which he or she does not have an academic qualification (INGERSOLL, 2002). This can be a source of frustration in a career already marked by numerous difficulties, leading, even, to the abandonment of the career (INGERSOLL, 1999). Qualitative research with teachers in early career shows that they are dissatisfied with out-of-field assignments. Teaching out-of-field influences teachers' sense of effectiveness. In addition to the increased workload due to the need to prepare classes for subjects they do not master, they fear that their students are being harmed (JOHNSON; BERG; DONALDSON, 2005).

Teaching is recurrently linked to the idea of vocation or gift, rather than a profession that requires instruction and training (CHAGAS, 2009). The low social prestige attributed to the profession contributes to this thinking because it perpetuates the notion that teaching is something that requires a lower level of skill than other professions (INGERSOLL, 1999). The

idea that anyone can be a teacher can be propagated by out-of-field teaching or even by the neglect of the educational system in recognizing this as a problem. Even the possibility of working in different areas of your training can be detrimental to career attractiveness. Educational policy interventions should consider cost-benefit analyzes that address the effects of this phenomenon on both students and teachers.

Maintaining a qualified teacher in each classroom is an goal of Brazilian society, demonstrated by the four goals of the National Education Plan (PNE - *Plano Nacional de Educação* in Portuguese) aimed at improving the conditions of the teaching career. To the extent that educational policy seeks to reduce the incidence of out-of-field teaching, understanding its effects on school outcomes provides important information for educational debates.

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