

Incidence of teacher curricular emphasis in reading achievement of uruguayan ninth-grade students

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ABSTRACT

Assessing Opportunities to Learn (OTL) implies the measurement of different aspects of the curricular implementation in the classrooms, such as the contents that the teacher selects for the course and the time of exposure and the frequency of the tasks proposed.

Based on recent studies that demonstrate the influence of this curricular dimension on students' performance, this work analyzes the relationships between the emphasis made by teachers of third grade of secondary school on different reading contents, and students' performance in reading tests. The aim of this research is to establish the effect of the emphasis with which teachers propose different types of reading activities (literal, inferential, and critical) on students' performance. From the analysis of compositional data, this study concludes that the students of those teachers who report working a greater extent on the critical dimension of reading obtains –on average– higher scores on the national reading test. This result holds even when socio-economic and cultural context and reading habits are controlled for.

Keywords

Compositional data, curriculum emphasis, opportunity to learn, reading performance, regression models.

1. INTRODUCTION AND BACKGROUND

Leonardo Moreno, Matias Núñez, Cecilia Emery, Inés Méndez, Elisa Borba and Eliana Lucían "Incidence of teacher curricular emphasis in reading achievement of Uruguayan ninth-grade students" In: *Proceedings of The 13th International Conference on Educational Data Mining (EDM 2020)*, Anna N. Rafferty, Jacob Whitehill, Violetta Cavalli-Sforza, and Cristobal Romero (eds.) 2020, pp. 480 - 486

The opportunities to learn (OTL) that the education systems offer to students are currently one of the central objects of educational evaluations. This implies, among other things, the measurement of various aspects of the curricular implementation in the classrooms, such as: a) the contents that the teacher selects to address in the course and b) their exposure time and frequency according to the tasks proposed. As such, OTL studies have the potential to contribute to the knowledge of what and in which way the curriculum is implemented in the classroom, and to curricular formulations.

One of the first organizations to use the concept of OTL in their studies was the International Association for the Evaluation of Educational Achievement (IEA) in the Second International Study in Mathematics (SIMS), showing the correlation between student performance and the opportunity to have tackled a certain curricular content in class, see [30]. Likewise, the research produced from the SIMS data showed –among other aspects– the centrality of curricular coverage, emphasis, and time devoted to its treatment in relation to students results in tests, see [7].

The OTL project that served as a source for the design of the instruments used in the International Study of Trends in Mathematics and Science (TIMSS), was carried out by the Mathematics and Science Opportunities Survey (SMSO) (see [32]), which formulates the concepts of prescribed curriculum (national goals or curricula), implemented curriculum and achieved curriculum (what students have actually learned, see [33]). In this sense, the evaluation of opportunities to learn proposes relevant information about the implemented curriculum that contributes to a better and more complete understanding of what students can learn.

Studies carried out by Cervini conclude that OTL affect stu-

dent performance even when controlling for variables such as socioeconomic status and socio-cultural context of the school: “students with the same social background who attend schools with a similar social composition, but some [have] a significantly higher performance level because their teachers gave them a greater opportunity to learn”, see [25].

Recently, and from the accumulation of evidence, greater importance has been given to the incidence of learning opportunities in student performances. Numerous studies realize the importance of considering these variables when identifying the aspects that influence student performance and that are also modifiable from the organization of schools and the pedagogical practices of the classroom, see [13].

Consequently, when evaluating the performance of students based on tests aligned to the prescribed curriculum (the regulations established to be taught in a school year) it is expected that different results will be observed for those who have had greater coverage of the contents or greater emphasis on its treatment, in addition to more exposure time to them (emphasis), than for those who have not had it, see [25]. The work that is developed in this article aims to give statistical evidence to this last hypothesis raised by Cervini in the Uruguayan classrooms.

On a large scale, there are few international experiences that evaluate learning opportunities in the classroom: the evaluations carried out by the IEA (SMSO and TIMSS), the International Study of Progress in Reading Comprehension (PIRLS), the Program for the International Assessment of Students (PISA) and the International Survey on Teaching and Learning (TALIS). Since 2017, the National Institute of Educational Evaluation (INEEd) of Uruguay, performs the national evaluation of achievements of the educational system (ARISTAS) that contemplates the measurement of OTL in classrooms of third and sixth grade of primary education and third grade of secondary education.

Research based on PISA data (see [17]) has shown, for a large group of countries, a significant association (of moderate to strong) between reading habits (students’ taste for reading, time dedicated to it in their free time and the diversity of texts they read) and their reading performance.

Similar findings were reported for Uruguay by ANEP, 2004. In this study, the relationship between certain attitudinal variables regarding students’ reading habits and the results of reading and math tests is analyzed. In concordance with international findings, this study shows better reading results for women than men. Nonetheless, it is also women who show greater taste for reading. Among the findings of this study, it is noted that as performance in reading improves, so does the taste for reading, while the dislike of it decreases on average.

Although there is evidence that links student reading habits with their reading performance. This can happen since student reading habits allow some teacher practices, that in turn influence student performance. However, there is little evidence that links these qualities of students with teacher practices (see [4]) and their performance. Thus, this research focuses on the relative effect of teaching practices on

the reading performance of students, when certain student qualities (such as socioeconomic and cultural level; and student reading habits) are controlled for.

Based on data from the 2018 national evaluation of the Uruguayan educational system –Aristas– carried out by the National Institute of Educational Evaluation (INEEd), the aim of this work (considering recent studies that demonstrate the influence of curricular implementation on student performance) is to analyze the relationships between the emphasis made by nine grade teachers on different reading dimensions (literal, inferential and critical) and their student performance on reading.

One possible explanation is that the students whose teachers report working the critical dimension of reading on a greater extent, achieve –on average– higher scores in the reading test, even when socio-economic and cultural context; and reading habits, are controlled for.

This paper is organized as follows. In Section 2 the theoretical framework and the main linguistic concepts used are introduced. Section 3 provides the implemented methodology and the statistical tools used: Compositional Data Analysis (CoDA). The most relevant results obtained from the statistical analysis are enumerated in Section 4. In Section 5 the final discussion and conclusions are established.

2. THEORY

As Zakaryan (see [35]) indicates, in general terms, the nature of classroom teaching significantly affects the level of student learning. In this relationship, the analysis of the teaching practice is key, since the teacher determines the learning opportunities through the activities he proposes in the classroom and the qualities of his or her teaching. Thus, the content, format and cognitive demand of the tasks that teachers pose in the classroom constitute “the main vehicle to provide school children with learning opportunities”, see [28], p. 113.

One of the questions which OTL studies attempt to respond is whether the curriculum implemented by teachers in the classrooms effectively covers the contents established in the nationally prescribed curriculum. Within this research perspective, three approaches are identified: the coverage of the contents, the exposure to them –measured through the time dedicated to them– and the emphasis on their implementation, that is, what contents are treated with priority in the classrooms over others in the program, see [26].

In this way, it is possible to approach the institutional and pedagogical mechanisms that contribute to the distribution of learning opportunities not only among schools, but also between classrooms. Likewise, it is relevant to know the form of said distribution, that is, if all children and young people receive from the school system –or not– the same opportunities to learn.

This work follows the definition of opportunities to learn (OTL) carried out by the INEEEd, see [15]. In this, the study of the OTL not only seeks to analyze the alignment between the prescribed and the implemented curriculum, but also to what extent this alignment and other school conditions in-

fluence the performance of the students. Among the dimensions of the OTL assessed by the INEEed, this paper focuses on coverage and sequence of the contents, which refers to the degree of implementation of the curricular contents, as well as their didactic sequence and emphasis, see [15], p. 14. In particular, the emphasis on curricular content is measure as the percentage of classroom pedagogical time that teachers devote to the work of curricular content corresponding to a school grade, see [15], p. 15.

3. METHOD

This study uses data from the evaluation of the uruguayan education system (Aristas) carried out by the INEEed in secondary education in 2018 nationwide. This evaluation gathers information on various actors of the education system: school principals, teachers and students, through self-administered online surveys. Aristas is applied to a representative sample of nine grade middle school students of the Uruguayan urban region. Besides this contextual questionnaires, each student has to take two multiple choice tests to assess reading and math performance (Students' abilities are estimated based on test results using item response theory, and in particular the Rash model).

To obtain information on curricular implementation, Aristas asks teachers if they have covered and with how much emphasis, a series of curricular activities that can be classified into three reading dimensions: literal, inferential and critical.

As defined by INEEed in the OTL framework for secondary education (see [14] and [15]), the emphasis with which teachers work the curricular contents in the classroom is a composite measure based on their reports on: i) the total number of classes taught and ii) the number of classes dedicated to addressing each type of activity in the course. Both measures refer to the period between the beginning of the school year (March 2018) and the time the evaluation was carried out (October 2018).

In order to address this, teachers are presented with a list of 10 activities (corresponding to the three different dimensions of reading –literal, inferential, critical–) and are asked to indicate the number of classes dedicated to each activity. Each of the dimensions in which the activities are grouped implies differences in their cognitive complexity, see Table 1. Thus, the number of classes reported per dimension is counted as the average number of classes declared for each of the listed activities. That is, the number of classes reported by a teacher in one dimension is the sum of classes that the teacher declares to dictate for the activities that integrate that dimension, over the total of activities that compose it.

From the self-report declared by nine grade teachers in secondary education, an overestimation of the effective number of classes in the school year is generally observed. That is, when the maximum total number of classes in the year is 72%, 70.2% report dictating above that threshold. This inconvenience in the instrument is a frequent problem due to various causes, see [10] and [4].

To approach this over report problem, the classes reported are relativized by each teacher for the activities of each di-

	Literal dimension	Inferential dimension	Critical dimension
Kinds of activity	Recognize basic elements of the enunciation situation	Recognize the subject of the paragraph or statement	Evaluate and / or interpret the facts, situations or concepts posed by the text
	Locate explicit information	Summarize the general idea of the text and draw conclusions	Recognize items complexes of the enunciation situation (assumptions, implications, reasons, ideological position of the enunciator, intertextuality, parody, irony, exaggeration)
	Recognize the thematic progression	Recognize narrative, descriptive, argumentative or expository intentionality	
		Match information of sentences and paragraphs	
		Hierarchize data or events and establish relationships between texts when it has different formats (eg tables and text)	

Table 1: Activities classified according to the dimension they conform. Source: own elaboration.

mension of reading to the total of classes according to the school calendar. It is assumed that the relative weight that the teacher reports in each activity is a valid measure of the real time spent in class.

The classes reported by the i -th teacher to the literal, inferential and critical reading respectively are called L_i , I_i and C_i , so the normalized vector is

$$X_i = (LR_i, IR_i, CR_i) = \frac{1}{L_i + I_i + C_i} (L_i, I_i, C_i).$$

Let S^2 be the unit simplex of \mathbb{R}^3 ($S^2 = \{(x, y, z) \in \mathbb{R}^3 / x + y + z = 1, x \geq 0, y \geq 0, z \geq 0\}$). It is true that $X_i \in S^2 \forall i = 1, \dots, N$, where N is the total number of teachers in the sample ($N = 364$). In this way, conclusions can be drawn about the behavior in relative but not absolute terms. The isometric transformation is then given by $\phi : R_{\geq 0}^3 \rightarrow S^2$, where $\phi(x, y, z) = \left(\frac{x}{x+y+z}, \frac{y}{x+y+z}, \frac{z}{x+y+z} \right)$ y $R_{\geq 0}^3 = \{(x, y, z) \in \mathbb{R}^3 / x, y, z \geq 0\}$.

This means that the class proportions dictated (on average) in each of the three dimensions of reading (literal, inferential and critical) are thought of as compositional data. In this sense, the vector is made up of three components, each of which represents the proportion of classes dictated in that dimension, therefore the components of the vector of proportions are non-negative and add to 1. This vector indicates the relative emphasis the teacher reports assigning to each of the dimensions. This type of compositional data analysis doesn't allow for classical or hierarchical regression models as its assumptions don't hold.

The analysis of compositional data dates back to Pearson 1987, but the basis of statistical theory for this type of data has been developing since the middle of the last century, see [12], [8] and [9]. The association that exists between the components of the vector determines a series of methodological difficulties (see [34]) that lead to the need for specific techniques for this type of data.

A large number of applications of compositional data theory are found in the literature for different fields (see for example [5], [23], [20] and [27]). However, there are few applications in reference to educational data and in particular in the area

of educational evaluation, see for example [31], [19], [21] and [6].

On the other hand, reading achievement is assessed through a standardized reading test developed by INEEd. The test is designed based on a general statement of reading (reading competence) which is successively broken down into statements (dimensions of said competence: literal, inferential and critical) and subaffirmations (knowledge and skills). Test items are designed to assess students mastery of the subaffirmations. From a psychometric perspective, the Item Theory Response (TRI) method is used for the calibration and construction of the items. For the purpose of this study, the group performance or ability (Y_i) is the average of the scores assigned by TRI to all the students of the i th-group.

4. RESULTS

Data from Aristas 2018 in Uruguay shows a relationship between socioeconomic level and reading habits of the group, and the emphasis the teacher assigns to certain reading activities over others, see [4]. Higher socioeconomic levels and more frequent reading habits of the group are associated with more teacher emphasis on the dimension of critical reading. Even when socioeconomic level is controlled for, the reading habits of the group have a significant effect over teacher emphasis.

Figure 1 shows, by means of box plot, the strong relationship between the quintiles of the socioeconomic level of the group (ESCS) and the average reading performance obtained by the group of students (left panel). Moreover, higher reading habits of the group also have an effect, (not as pronounced as ESCS) on student performance (right panel).

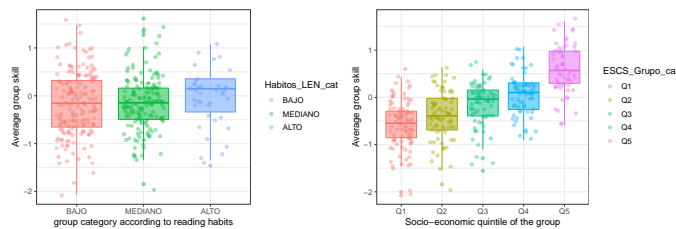


Figure 1: Left Panel: Box plot of the average performance of the group in the reading test according to the socioeconomic quintile of the group. Right Panel: Box plot of the average performance of the group in the reading test according to the level of reading habits of the group.

The relationship between reading test results and emphasis placed by teachers on each of the three dimensions of reading, is evaluated. As Figure 2 shows, groups who perform better on the test devote more time to activities that involve critical reading. Moreover, as group performance improve, the proportion of classes dedicated to literal reading decreases. These trends don't appear to apply to inferential reading.

However, these results are a) only descriptive of the sample and b) they are marginal, that is, the joint effect of the activity vector on student performance and its relative importance vis-a-vis other variables of the study (ESCS and

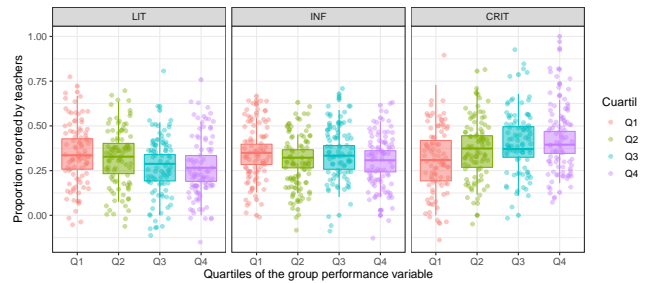


Figure 2: Box diagrams of the proportion in each of the activities (literal-inferential-critical) according to the quartiles of the group's performance variable.

reading habits) is not observed.

To model the problem, a non-parametric regression model (kernel method, see [18]) and a parametric regression model (Dirichlet regression, see [29] and [24]) are considered, see Figure 3. This figure reflects the average percentages of emphasis placed on each dimension as a function of the group's performance. On average, according to the non-parametric model, the emphasis on literal reading is among 20% and 35%, decreasing as Y increases. The influence of Y on the proportion of activities in critical reading varies between an average range of 27% to 50% increasing as Y increases. The inferential reading is the one with the least variation as a function of Y , between 30% and 38%.

In both cases it is observed that increasing group's performance is associated to an increase in the proportion of classes in which critical reading activities are taught.

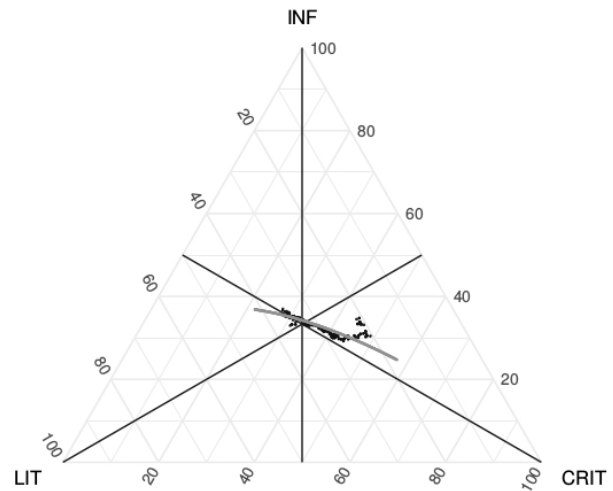


Figure 3: Non-parametric regression by kernel method (points) and Dirichlet regression (continuous line) in S^2 where the independent variable is the performance of the group (Y).

This result holds for the Dirichlet model. In this case the decrease of literal reading emphasis is associated with higher test results but with a moderate statistical significance (p -value = 0.07), see Table 2.

Coef.	ANOVA		
Lit.	Coef.	Error	p-value
Int.	0.86	0.06	< 2e-16
Y	-0.14	0.08	0.07
Inf.	Coef.	Error	p-value
Int.	0.97	0.06	< 2e-16
Y	0	0.07	0.99
Crit.	Coef.	Error	p-value
Int.	1.12	0.06	< 2e-16
Y	0.46	0.07	8.94e-11

Table 2: ANOVA of the Dirichlet regression where the independent variable is the performance of the group (Y).

A possible mistake when interpreting these results is to infer a direct association between emphasis and student performance when, strictly speaking, it could be an indirect effect caused by student reading habits and socio-economic and cultural level of the group, see [4]. Figure 4 shows these interactions.

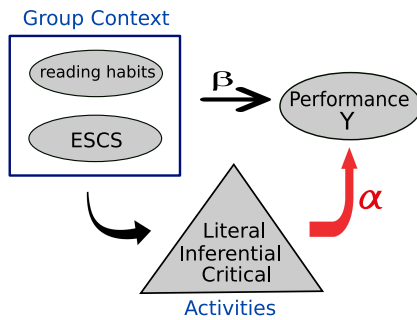


Figure 4: Diagram on the relationship between activities and performance controlling for ESCS context variables and study habits.

To control the effect of socioeconomic status and reading habits on performance, two step regression is estimated. The performance of the group in reading Y can be decomposed as the sum of a β (hypothetical or latent) score generated by certain context variables (in this model they are the $ESCS$ and reading habits noted as H) and another α associated with the emphasis of classes in each activity, that is

$Y = \text{Intercept} + \beta + \alpha + \epsilon$, where ϵ is a random error centered and independent of α and β . In this case, student performance is considered as the dependent variable (as opposed as in Figure 3).

The strong relationship between β and Y has already been widely studied, see [14]. If the last term α is also significant to explain performance, this indicates that emphasis on a certain type of activities also influences performance, even controlling for certain group context variables. To “extract” the effect of the context, the following procedure is performed. As a first step, to avoid the ipstative effect (see [11]) between the components of the vector in S^2 an isometric transformation is carried out that goes from S^2 to \mathbb{R}^2 . This is called the log-ratio isometric transformation (ilr), see [1]. The image of (LR, IR, CR) is noted by (ilr_x, ilr_y) .

The first adjustment is then a linear model of the form,

$$Y = a_0 + a_1 ilr_x + a_2 ilr_y + b_1 ESCS + b_2 H + \epsilon \quad (\text{Model 1}).$$

Table 3 shows how all the variables are significant in this model, with the variables of S^2 tolerating the inclusion of H and $ESCS$ in the model.

Coef.	ANOVA		
Model 1	Coef.	Error	p-value
Intercept	-0.11	0.025	4.06e-06
ilr_x	0.15	0.050	0.01820
ilr_y	0.12	0.042	0.00586
$ESCS$	0.68	0.04	< 2e-16
H	0.32	0.082	0.00013
Model2	Coef.	Error r	p-value
Intercept	-0.10	0.026	< 3.44e-05
ilr_x	0.15	0.053	0.00465
ilr_y	0.14	0.044	0.00146

Table 3: ANOVA considering $ESCS$ and H as control variables.

Second, after estimating the coefficients of the equation for maximum likelihood, the effect on the performance of the context variables is extracted, that is, $Y_i^* = Y_i - \hat{b}_1 ESCS_i + \hat{b}_2 Habitos_i$. The final model (model 2) that allows us to deduce the effect of emphasis on each dimension is,

$$Y^* = d_0 + d_1 ilr_x + d_2 ilr_y + \epsilon^* \quad (\text{Model 2}).$$

The ANOVA results of the Model 2 are also found in Table 3.

If the inverse ilr transformation is performed to the estimated coefficient vector of Model 2, the coefficient vector in S^2 is obtained, $(LIT, INF, CRIT) = (0.28, 0, 35, 0, 37)$ which allows to conclude that the emphasis on certain activities allows to obtain a better performance, still subtracting the effect of the context.

Figure 5 shows the level curves of the estimated regression function in Model 2. Even when controlling for the context variables, teachers who emphasize the activities of critical reading versus literal reading obtain –on average– a better group performance in the reading test. Higher intensities of gray indicate larger group performance.

It is important to highlight that Model 2 has high variability, which makes it possible to conjecture that other group, school or teacher variables that influence performance are not being accounted for in the model.

5. DISCUSSION AND CONCLUSIONS

This paper analyzes the relationship between the emphasis placed by teachers on different classroom reading activities (literal, inferential and critical reading), and the reading performance of their nine grade students in Uruguay. This makes it a novel contribution to educational policy in Uruguay as the topic has never been studied, and it is also a contribution to educational evaluation, as it applies the analysis of compositional data to this field of research.

Findings show a relationship between reading test scores and the emphasis placed by teachers on different reading

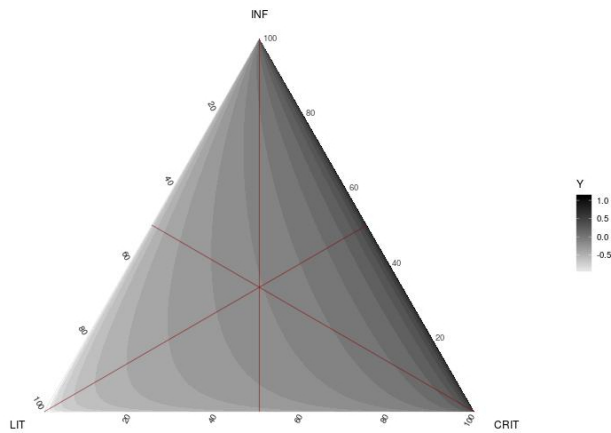


Figure 5: Level curves set of the estimated regression function in Model2.

dimensions. Better test results are associated with teacher emphasis on critical reading activities. Nonetheless, this relationship is not direct as it is affected by other variables such as the socioeconomic and cultural level of the group of students and their reading habits. However, even when controlling for these variables, the evidence holds: greater emphasis placed on critical reading activities versus literal reading is associated with higher group results on the reading test.

Moreover, findings also suggest the omission of certain variables that can be relevant to explain reading performance by students. It could be the case of prior reading achievement. Although it could be argued that teachers place more emphasis on critical reading activities when their students are better prepared for that (when they have higher prior reading achievement), evidence from primary school students from Uruguay shows that is not necessarily the case, see [16]. Nonetheless, this will be explored in future research.

In Uruguay, the differences in academic achievement are strongly related to socioeconomic factor, see [23], [2] and [3]. This study shows that having those factors controlled, the OTL offered to student variable is still relevant on achievement data. The dimension of this finding has implications not only on the teaching profession but also on public educational policies.

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