INVALSI DATA TO INVESTIGATE THE CHARACTERISTICS OF STUDENTS, SCHOOLS AND SOCIETY

IV Seminar " INVALSI data: a tool for teaching and scientific research"

edited by
Patrizia Falzetti

FrancoAngeli
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Introduction

by Patrizia Falzetti

Data are precious resources and as such an asset of the community. Collected, ordered, studied data become a tool that allows us to open debates and make most useful decisions. The INVALSI Statistical Service followed up, on this premise, with the organization of the IV Seminar "INVALSI data: a tool for teaching and scientific research". The Institute's databases, in fact, allow researchers and teachers to investigate in depth the theme of education in schools from different points of view and the event allows them to participate in a lively confrontation on the subject.

The authors of the contributions collected in this volume investigate in depth the characteristics of students, schools and society. School and society are the two social institutions outside home through which the individual begins its own socialization process. Furthemore, the school system plays a strategic role because it is where future citizens acquire knowledge and skills. Hence the importance of analyzing data to question and seek explanations and solutions to any critical issues in terms of learning.

In the first three chapters the main topic is about students' performance: in the first one, through spatial autocorrelation techniques, it is investigated which individual characteristics can affect the results of the INVALSI English tests. In the second, the authors reflect on the existence of a close relationship between the results achieved by students and the involvement of parents in preparatory learning activities. In the third chapter, however, we read about an in-depth analysis of the learning outcomes detected through the INVALSI Grade 10 tests of the IeFP in Trentino.

In the following three chapters the focus is mainly on the school. According to ISTAT projections, the number of primary and secondary school students in our country is expected to drastically decrease in the next years while the share of non-native students will increase, the author conducts an

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exploratory analysis. The aim is to reconstruct the geographic (provincial levels) and typological (with reference to the characteristics of individual schools) variability of any discriminatory assessment of foreign students (Chapter 4).

Chapter five reports the first phase of a research project carried out in a primary school in Southern Italy and aimed at implementing an interim assessment system. The contribution also critically reflects on how to convey and facilitate extensive use of data obtained from standard assessments for educational purposes. Identifying national training needs within schools and proposing guidelines for the improvement of practices relating to the use of INVALSI surveys, are the topic of the sixth chapter. The volume closes with a wide reflection on the theme of education that starts from one of the objectives of Agenda 2030, specifically Goal 4 "Quality education for all".

The work shows how the integration of data from various sources (INVALSI data on skills, ISTAT data provided to the survey for monitoring progress towards Sustainable Development and data from MIUR source) can give an overall picture of the situation in our country and allow us to intervene where necessary.

As a Statistical Service we hope that the reading of the volume confirms what has been written on the importance of data and their use, which will allow an ever-growing audience to enrich their knowledge on the subject of education and be a means of giving life to always new ideas for further reflection.

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1. Geographical differences in Italian students' English test performance: a role of individual and local characteristics

by Jana Kopecna, Cecilia Bagnarol, Silvia Donno, Michele Marsili

Several studies have been focused on the analysis of the factors that affect the school performance. It has been found that social, economic and environmental factors have an important role in determining the educational achievement, and that individual characteristics and family background affect the school performance more than school characteristics. The spatial statistical analysis has been used by many researchers to study educational achievement. Principally, these studies concentrated their attention on the relationship between school performance and socio-economic variables of the catchment areas from the spatial perspective, by using Geographically Weighted Regression (GWR).

The aim of this study is to investigate which individual characteristics may affect test scores in English Reading and Listening and which local characteristics of the catchment areas influence students' achievement in these tasks.

The data we used come from the National INVALSI Assessment of 8th grade for the 2018/2019 academic year and includes results of the standardized test in English Reading and Listening.

Firstly, through the simple correlation analysis, we defined the individual and local characteristics that were then used as the explanatory variables in our analysis. Secondly, the simple Ordinary Least Squares (OLS) regression was used to analyze the relation of students' performance in both tasks to previously selected characteristics.

To verify a presence of positive spatial autocorrelation within the Italian territory, we calculated a widely used spatial statistic Global Moran's I. It helped us to estimate the strength of spatial correlation, and to test also the significance of the spatial correlation.

The positive result of Moran's I endorsed our intention to include the territorial dimension into our study, and therefore, the GWR was used to model spatially varying relationships between the students' achievement and the explanatory variables tested with the OLS regression.

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However, the emphasis here is not so much to determine whether or not exist relationships between school performance and catchment area characteristics, but to determine if there are any interesting spatial variations in these relationships.

Numerosi studi hanno rilevato che le caratteristiche individuali degli studenti, lo status socio-economico e il luogo di origine influenzano i risultati scolastici molto più che le caratteristiche della scuola. Numerosi ricercatori hanno utilizzato l'analisi statistica spaziale per studiare gli apprendimenti scolastici. Tali studi hanno focalizzato l'attenzione sulla relazione esistente tra le performance scolastiche e le variabili socio-economiche del bacino di utenza da un punto di vista spaziale, facendo uso dei modelli di regressione Geographically Weighted (GWR). Le variabili più frequentemente impiegate in tali modelli di regressione sono relative alle caratteristiche dello studente, del docente e della scuola, ad esempio la percentuale di famiglie con più basso reddito, la percentuale di disoccupati, il titolo di studio dei genitori, il background familiare dei genitori (percentuale di famiglie monogenitore), l'ampiezza della classe degli studenti e la carriera dei docenti.

L'obiettivo di questa ricerca è investigare quali caratteristiche individuali possano avere effetto sui risultati delle prove INVALSI in Inglese Reading e Inglese Listening e quali caratteristiche locali del bacino di utenza della scuola influenzino gli apprendimenti scolastici in entrambe le materie.

I dati utilizzati provengono dalle Rilevazioni nazionali INVALSI relative all'a.s. 2018/2019 per il grado 8 (III secondaria di I grado) per Inglese Reading e Listening.

In primo luogo, attraverso un'analisi della correlazione semplice, abbiamo definito le caratteristiche individuali e locali da poter utilizzare come variabili esplicative nel modello di regressione spaziale. In seguito, un modello di regressione Ordinary Least Squares (OLS) è stato utilizzato per analizzare la relazione tra performance scolastiche in entrambe le materie di interesse e le suddette caratteristiche individuate.

Per verificare la presenza di autocorrelazione spaziale globale positiva sul territorio nazionale, è stato calcolato l'indicatore I di Moran, che consente inoltre di stimare la forza della correlazione spaziale e testarne la significatività. I risultati così ottenuti hanno confermato la nostra intenzione di includere nel nostro studio la dimensione territoriale e di conseguenza di utilizzare un modello di regressione GWR per studiare le variazioni territoriali nella relazione tra apprendimenti scolastici e variabili esplicative individuate e analizzate mediante la regressione OLS.

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1. Introduction

The issue of territorial inequalities has been widely discussed at a scientific and institutional level: a substantial part of literature (Braga and Checchi, 2010; Cipollone, Montanaro and Sestito, 2010; Montanaro, 2009; Falzetti, 2019; Argentin *et al.*, 2017) shows that the regional inequalities in economic growth and development along the North-South axis have had impact along the same axis even in a considerable discrepancy in efficiency-effectiveness of the school and education system.

The ability of schools to ensure the same teaching-learning conditions for all students is an important indicator of the degree of equity of the Italian educational system. Besides educational uniformity in the effectiveness of individual schools (*value added*) also weigh different territorial distribution of Economic, Social and Cultural Status index (ESCS) and the different migration background (INVALSI, 2010) of students and families.

The data from the National Institute for the Evaluation of the Education and Training System (INVALSI) show that students attending schools in the North of Italy have a higher level of skills than those who attend similar schools in the South of the country (INVALSI Report, 2019).

Since the 2017/2018 academic year, the students of the 5th of primary and 3rd grade of secondary school have been subjected also to tests of English Listening and Reading comprehension.

The students were evaluated in two ways: by assigning a score on the Rash scale and by assigning a level of proficiency in the language based on the standards defined by the Common European Framework of Reference for Languages (CEFR).

The INVALSI Report 2019 confirmed that in both Listening and Reading tests, as it has happened already for Italian and Mathematics, the northern regions, with the exception of Piedmont, obtained a significantly higher score respect to the Italian average (200), while the South and Islands regions had significantly lower scores, with the exception of Abruzzo and Molise.

Starting from these evidences, we analyzed the results of the INVALSI English tests of the 2018/2019 academic year of first grade secondary school students in all Italian regions. The aim was to identify the factors that, individually or in interaction with each other, have a determining role in achieving adequate school skills or in defining disadvantaged situations in some geographical areas. Initially, the geo-referencing of all Italian educational institutions was conducted, and the spatial autocorrelation analysis was applied. Through an OLS regression model we analyzed the impact of the selected individual and territorial factors, and finally the GWR model allowed us to

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evaluate the territorial differences in the relationship between these factors and student performance in English.

Thus, in this study, we will briefly review the literature on the topic, describe the INVALSI data used in the analysis, and rationalize decisions about different methodological approaches. Finally, we will present and compare the results obtained by applying selected methodologies on the data.

2. Literature review

Numerous researchers have focused their studies on the analysis of the factors that affect the school performance. Several studies have found that student individual characteristics and socio-economic variables and the location of origin affect student outcomes more than school characteristics (Taylor and Yu, 2009; Saifi and Mehmood, 2011). Various authors have used spatial statistical analysis to study educational achievement. Primarily, these studies focused on the relationship between school performance and socio-economic variables of the catchment area (Fotheringham, Brunsdon and Charlton, 2002; Gibbons, 2002; Gordon and Monastiriotis, 2007; Xiaomin and Shuosheng, 2011) from the spatial perspective, using Geographically Weighted Regression (GWR). The strong relationship between socio-economic status (SES) and school performance has been shown, pointing out that in the areas with worse socio-economic conditions, students still receive an inferior quality of education compared to their wealthier counterparts (Varadappa Naidoo *et al.*, 2014).

The most frequently analyzed variables are related to student, teacher and school characteristics: percentage of families with lower income, percentage of unemployment, parent educational level, parent family background (percentage of families headed by a single parent), class size or how experienced are teachers.

3. Data and methods

The dataset used for the analysis was composed by the results of the CBT (Computer Based Test) survey in English Reading and Listening. The tests were carried out by the students attending third classes of the lower secondary school (here after Grade 8) in the academic year 2018/2019.

We decided to follow the macro-themes presented in the INVALSI reports (INVALSI, 2018, 2019), in particular gender gap, socio-economic

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background and the importance of the origin of birth. We also included the regularity of studies as an indicator of academic performance.

For a further analysis, the dataset variables were associated also with the information provided by the Student Questionnaire, containing data of the students and their family background (e.g. the number of books available at home, the possibility to study in a quiet environment, a computer to be used for the study with the relative software, etc.), used for the calculation of the indicator on the student's socio-economic-cultural background (ESCS)[1] (Campodifiori *et al.*, 2010).

3.1. Notes on the geo-referencing of educational institutions

The process of geo-referencing means to assign to each observation a specific geographic position expressed by the relative Cartesian coordinates, latitude and longitude. For the geo-referencing of the Italian school institutions, a dataset has been created containing the following variables:

– school institution identification number;
– address;
– name of the city;
– postal code (CAP).

The process of converting the addresses into geographical coordinates was carried out through the Google Maps API (Application Programming Interface). The coordinates were obtained from the institutions addresses by querying the browser through the following URL address: https://maps.googleapis.com/maps/api/geocode/json?address=route+street number+city+postalcode&key=API key. In response to the request, the server returned the latitude and the longitude associated with addresses in JSON format.

Using KNIME Analytics Platform (Berthold *et al.*, 2008), an open-source data analytics, reporting, machine learning and data mining platform, the URL addresses were created by making use of the variables contained in the dataset (address, postcode, city). Subsequently, the software allowed us to make numerous "requests" simultaneously and thus we obtained as a "response", in JSON format, the coordinates for each school. Finally, the data in JSON format were converted into tabular format in order to prepare a new functional dataset for subsequent spatial statistical analyses.

[1] For further details about ESCS calculation please refer to the following links: https://www.istruzione.it/snv/allegati/01_A_INVALSI_escs_slide.pdf and https://www.invalsiopen.it/indicatore-escs-valutazione-equa/.

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3.2. Notes on the Univariate and Bivariate Global and Local Spatial Autocorrelation Indices

Spatial autocorrelation (or spatial association) is a concept that derives from the observation that the values assumed by a variable are not distributed independently over the territory but, on the contrary, tend to concentrate in certain areas (Demarinis *et al.*, 2011). In particular, we talk about:

– *positive spatial autocorrelation* when similar values of a variable tend to group close to each other;
– *negative spatial autocorrelation* when dissimilar values of a variable tend to group close to each other;
– *absence of spatial autocorrelation* (or spatial independence) when the distribution of values over the territory is random.

Generally, when applying spatial autocorrelation techniques, we distinguish the methods for measuring on the entire set of localities (*global measures*) and the methods for measuring on a spatially delimited subset of localities (*local measures*).

The most frequently used measure to test the degree of global spatial autocorrelation is the "Moran's I" statistic (Moran, 1948), expressed by the formula:

$$\mathrm{I} = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij} \, (x_i - \bar{x})\left(x_j - \bar{x}\right)}{\sum_i (x_i - \bar{x})^2}$$

where:

- N is the number of observations (i.e. localities or geographical units);
- x_i is the value of the observed variable in locality i;
- x_j is the value of the observed variable in the locality j;
- $\bar{x}$ is the sample mean;
- $(x_i - \bar{x})$ represents the deviation from the average of the observed variable;
- w_{ij} is a weight assigned to the relationship between locality i and locality j.

Moran's I statistic is structurally similar to the correlation coefficient and assumes values between -1 and +1. However, unlike the correlation coefficient, Moran's I index does not assume a theoretical null value in relation to the independence condition, but rather a negative value very close to zero and equal to:

$$E(I) = -\frac{1}{N-1}$$

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Therefore, to verify the presence of spatial autocorrelation it is necessary to compare values of I with the theoretical average $E(I)$:

– values of I greater than the theoretical average $E(I)$ indicate positive spatial autocorrelation;
– values of I lower than the theoretical average $E(I)$ indicate negative spatial autocorrelation.

The Moran's I can be extended to the multivariate case: in this way the index represents the systematic association between the values of a variable observed x in a given area of interest and the values of another variable y observed in neighbouring areas.

The *bivariate Moran index* of x with respect to y is thus obtained:

$$I_b = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}\, z_i v_j}{\left(\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}\right)\left(\sum_{i=1}^{N} z_i^2\right)\Big/ N}$$

Local measures, statistics for measuring the degree of *spatial autocorrelation at the local level*, allow us to identify the contribution of each location on global pattern and therefore allow to study the variations of spatial autocorrelation within the territory. By focusing on each location, these techniques can be used to identify the presence of spatial clusters.

Generally, a *Local Indicator of Spatial Association* (LISA) is any statistics characterized by the following features:

– for each observation, the LISA provides a measure of the significant spatial concentration of similar values around the observation itself;
– the sum of the LISA of all observations is proportional to a global spatial association indicator (Moran's I).

The most frequently used LISA index is represented by the local version of Moran's I index and it is defined by the relationship:

$$I_i = N\frac{x_i - \bar{x}}{\sum_i (x_i - \bar{x})^2}\sum_{i=1, i\neq j} w_{ij}\left(x_j - \bar{x}\right)$$

To verify the presence of local spatial autocorrelation it is necessary to compare the values of I_i with their theoretical average $E(I_i)$:

$$E(I_i) = \frac{\sum_j w_{ij}}{N-1}$$

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In particular, positive values indicate the presence of clusters in which the observations have similar intensities (i.e. they all have high values or low values). On the contrary, negative values indicate the presence of clusters in which the observations have different intensities (i.e. the observations with high values are located close to observations with low intensity or vice versa). Finally, when combining the significance information provided by the LISA in a map, we obtain the "Moran Significance Map" that reports the regions with significant LISAs associated with the relative positive or negative local spatial autocorrelation value (Anselin, 1995).

3.3. Notes on the OLS and GWR spatial regression models

The traditional OLS model is specified as a linear relationship between a dependent variable (y) and a set of explanatory variables (X) as follows:

$$y = X\beta + \varepsilon \; for \; \varepsilon \sim N(0, \sigma^2)$$

where y is the dependent variable (in vector form, with N rows), X is a matrix with observations on K explanatory variables (with N rows and K columns), β is a vector with K regression coefficients (i.e., of dimension K by 1), ε is a random error term (in vector form, with N rows), σ^2 is the population error variance, and I is an identity matrix of dimension N by N (Chasco, 2013).

The GWR is a non-stationary technique that models spatially varying relationships. Compared with a basic (global) regression, the coefficients in the GWR are functions of spatial location. Fotheringham, Charlton and Brunsdon (1998, 2002) give a general form of a basic GWR model as:

$$y_i = \beta_{i0} + \sum_{k=1}^{m} \beta_{ik} x_{ik} + \varepsilon_i$$

Where y_i is the dependent variable at location i; x_{ik} is the kth independent variable at location i; m is the number of independent variables; β_{i0} is the intercept parameter at location i; β_{ik} is the local regression coefficient for the kth independent variable at location i; and ε_i is the random error at location i. The GWR allows coefficients to vary continuously over the study area, and a set of coefficients can be estimated at any location-typically on a grid so

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that a coefficient surface can be visualized and interrogated for relationship heterogeneity. The GWR makes a point-wise calibration concerning a "bump of influence": around each regression point where nearer observations have more influence in estimating the local set of coefficients than observations farther away (Fotheringham, Charlton and Brunsdon, 1998).

With the GWR, each observation, or in our case each school, do not have the same weight as if all schools shared the same position (OLS approach); it is possible instead move over Italian territory and weight schools according to their proximity. So it is very crucial to choose the appropriate spatial weighting function or kernel of the GWR regression model. In heterogeneous areas an adaptive kernel is the most appropriate, since it can select an optimal adaptive number of neighbours according to the density of the area.

4. Results

The smallest statistical unit we used in our study was the school. Therefore, the students' individual scores were aggregated at the school level (for English Reading the average WLE for school is equal to 202.1 with SD equal to 16.5, while for English Listening the average WLE is equal to 199.3 with SD equal to 18.7).

A data cleaning was carried out in order to exclude non-representative schools (i.e. schools with less than 20 students, average number of all classes) and schools located on the little islands, since the distance from the mainland would affect the calculation of the Moran index. The study variables included:

1) the standardized test score in the English Reading (WLE ERE) and English Listening (WLE ELI) tests, expressed on a quantitative scale (Rash);
2) the values of the ESCS socio-economic and cultural status index aggregated at the school level;
3) the percentage of females calculated at the school level;
4) the percentage of regular students in the matter of the course of study calculated at the school level;
5) the percentage of native[2] students calculated at school level.

[2] Native students are born in Italy from parents born in Italy.

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4.1. Spatial autocorrelation analysis: Moran's I and LISA Cluster Map

To understand better the distribution of observed variables we applied the spatial autocorrelation methods, specifically Moran's I index, Moran's Scatterplot (Anselin, 1996) and Local Indicator of Spatial Association (LISA) (Anselin, 1995), using GeoDa, a software for analysis of spatial data (Anselin, 2003).

Moran's I provides an indication of the degree of linear association between the observed values of the study variable and the spatially delayed values.

Spatial autocorrelation measures such as Moran's I require the construction of the weight matrix that defines a *neighbourhood* for each geographical unit. The value of the study variable for each unit is compared with the average weight of the values of the neighbouring units.

To construct the matrix of weights, based on the spatial distances between two points expressed in terms of latitude and longitude, the "great circle distance" or "arc-distance" were used, taking into account the terrain curvature. The average number of analyzed "neighbours" was 145, the median 83.

The univariate Global Moran's I revealed the presence of spatial autocorrelation in the distribution of the English Reading and Listening scores, respectively $I \approx 0.4531$ and $I \approx 0.5799$, and in both cases the index was significant (the pseudo p-value is <0.001).

In order to investigate the factors that in some way affect the territorial patterns identified by the univariate spatial analysis, the exploration was extended to the bivariate analysis, taking into account the surrounding socio-economic context.

As previously mentioned, based on the assumption that in a given geographical unit the values of the observed variable show a systematic association with another observed variable in adjacent geographical units, the bivariate Moran's I was used to explore and analyze the spatial dependence between the WLE score and the socio-economic and cultural index ESCS.

The bivariate Global Moran's I revealed the presence of spatial dependence between the distribution of the ESCS and the WLE scores of Reading and Listening, respectively $I \approx 0.2656$ and $I \approx 0.2946$, in both cases the index was significant (the pseudo p-value is <0.001).

However, the Moran's I index does not allow to verify whether spatial dependence generates clusters of schools by level of educational performance, nor to identify geographical boundaries of these clusters. In order to overcome these limits, the Moran's Scatterplot and local autocorrelation measures were applied.

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The Moran's Scatterplot displays the values of the observed variable standardized on a Cartesian graph, expressed in standard deviation units (the average is set equal to 0 and the standard deviation equal to 1) on the x-axis and on the y-axis the corresponding spatially delayed values are also standardized. The index I represents the angular coefficient of the linear relationship between the two variables reported on the axes: if the points represented are dispersed between the four quadrants this would indicate the absence of a correlation (the angular coefficient is zero). If, instead, a correlation exists, the scatterplot would allow to distinguish the different types of spatial correlation (High-High, Low-Low, High-Low, Low-High).

Subsequently, the results of the scatterplots were displayed in the map in order to depict the areas with different types of correlation: this type of representation made it possible to verify the geographic proximity of the schools of the same type of correlation and to identify some homogeneous clusters.

Nevertheless, the Moran's Scatterplot does not provide information on the significance of the identified spatial clusters. Thus, the Local Indicator of Spatial Association (LISA) was calculated for each school, in order to measure the interdependence with other schools and to indicate the type of the spatial relationship (positive or negative) and its significance.

The results of the bivariate LISA indicator were displayed in the map in Fig. 1 and 2, in which 4 different clusters of educational institutions were identified:

- the first High-High cluster, is composed of schools that achieve WLE English scores above the national average and are surrounded by institutions whose ESCS is above the average; for both tasks, all regions of the Centre-North of Italy are involved, except for the region of Valle d'Aosta;
- the schools that form the second, Low-High cluster, are schools with low WLE scores that do not seem to benefit from their geographical location in areas where the surrounding schools have on average higher values of the ESCS. These schools are present in the Centre-North, especially in eastern regions like Piedmont, Lazio and Abruzzo;
- the third Low-Low cluster, is made up of schools that register low WLE scores and are adjacent to schools with the ESCS lower than the national average; primarily it includes the regions of Southern Italy and the Islands;
- the last High-Low cluster, is formed by schools with WLE scores above the national average that are surrounded by schools with the ESCS below the national average. The schools belonging to this cluster, we can define the *resilient* ones, are present mainly in the regions of the South and Islands, but also in some contexts of the Val d'Aosta, Trentino Alto Adige and the provinces of lower Lazio.

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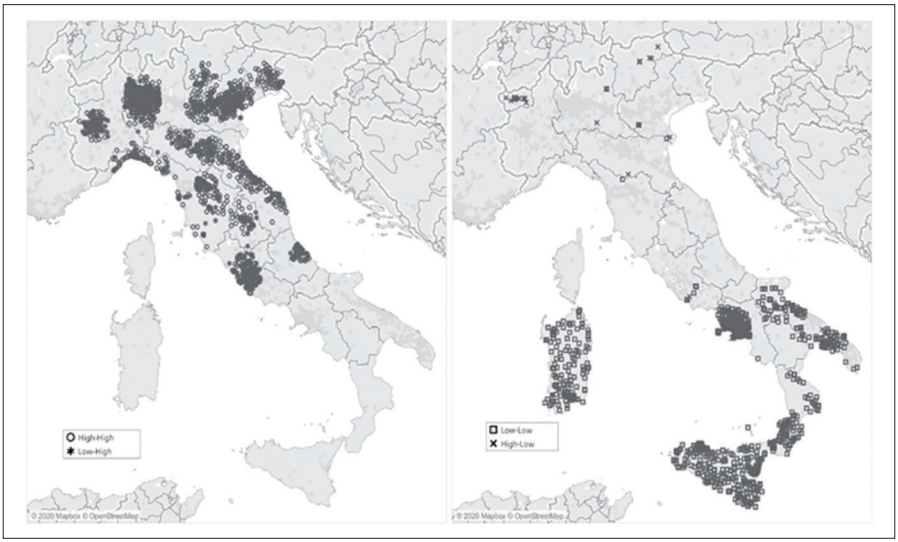

Fig. 1 – Bivariate LISA cluster map, WLE Reading and ESCS

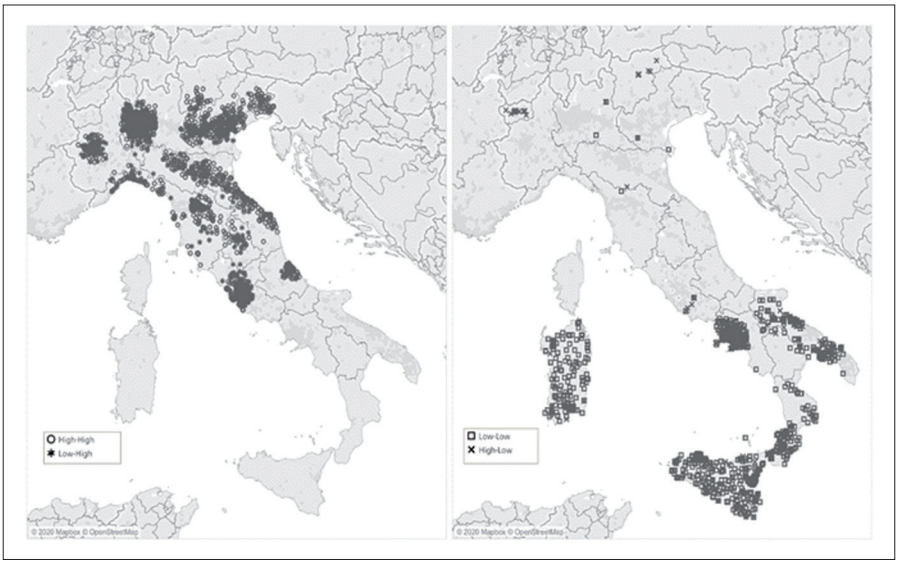

Fig. 2 – Bivariate LISA cluster map, WLE Listening and ESCS

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4.2. OLS and GWR Regression

Our analysis starts with a global approach: the data are used to compute a single statistic for each parameter for the entire observed area and the relationship between variables are stationary across the study area.

While, in the traditional OLS all places have the same weight as if all places shared the same location, in the GWR, as we move over space, observations are weighted according to their proximity to a location. The weighted calibration implies that the weighting of an observation is not constant but varies with i. In these cases, we speak about the local and global statistics.

Multivariate linear regression was performed on the data using OLS model. Subsequently, the GWR model was applied to deal with spatial non-stationarity (Varaidappa Naidoo *et al.*, 2014). For both global and local regression, the dependent variable was the students' score in English (Listening and Reading) tests. The four independent variables used in the study were the ESCS index, percentage of female, regular and native students calculated for each school. The analyses were performed using statistical software R v3.4.4, using the "spgwr" package (Bivand and Yu, 2012) and the results were imported into Tableau for spatial mapping.

The variables were standardized in order to make transversal comparisons, therefore, the unitary impact can be evaluated in terms of standard deviation. With all conditions being equal (average values of predictors), better performances are recorded in Reading than in Listening. The ESCS index has a great weight on both tasks, but greater on Listening: it is possible to hypothesize that more economic possibilities provide more tools (during their out-of-school time) to children to improve their learning such as speaking with native speakers, attending private English lessons or participating in a language course abroad. All these experiences have a substantial impact on performance in English Listening. As emerged from the national INVALSI Report (INVALSI, 2019), girls have better results in Listening test, thus schools with a higher percentage of girls have better results. As the percentage of natives increases, the school performance worsens: even the results of the INVALSI Report 2018 (INVALSI, 2018), infact, show that foreign children have a greater propensity to learn other languages. As the percentage of regulars or anticipators grows, performance improves especially in Reading.

All the coefficients are statistically significant and the fit of the OLS model is good, Adjusted R-square is equal to 0.49 for Listening and 0.48 for Reading (Tab. 1).

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Tab. 1 – OLS Regression Statistics

	Listening		*Reading*	
	Estimate	*Std. Error*	*Estimate*	*Std. Error*
Intercept	199.29***	0.17	202.08***	0.15
ESCS	12.59***	0.19	10.85***	0.17
Female (%)	1.16***	0.17	0.98***	0.15
Native (%)	-3.96***	0.20	-2.53***	0.18
Regular (%)	0.98***	0.22	1.72***	0.20
	= 0.49		= 0.48	
	Adjusted = 0.49		Adjusted = 0.48	

*** p-value <0,001.

In the correct OLS model residuals should not be clustered in location, however in our analysis the residuals were not spatially random (Fig. 3): the models tended to underestimate the North and overestimate the South.

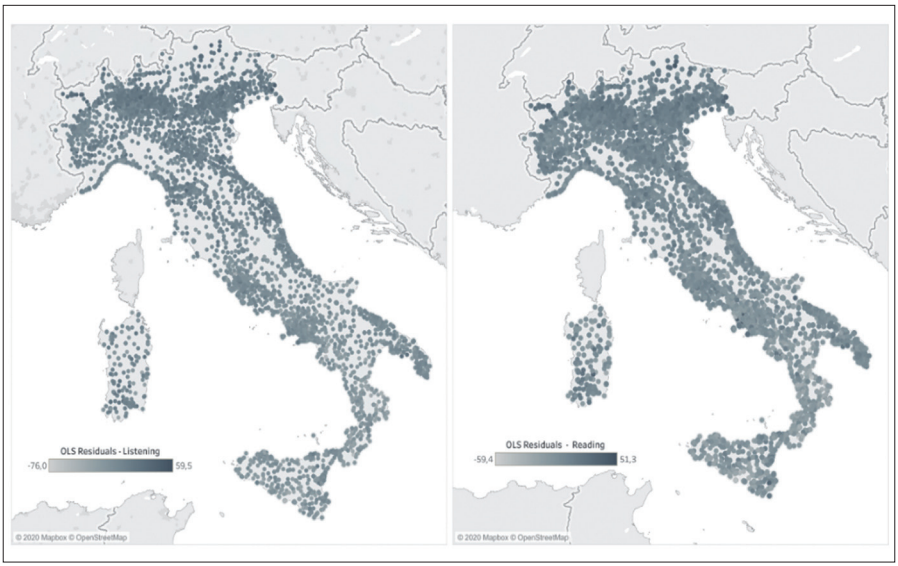

Fig. 3 – OLS Residuals distribution, Listening and Reading

We applied a GWR regression model using adaptive kernel with varying neighbourhood size: this GWR model was able to explain about 81% of the variation for Listening and 73% for Reading. The output from the GWR model revealed how the coefficients vary across Italy: the global coefficients are exactly the same as the coefficients in the previous OLS model (Tab. 2 and 3).

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Tab. 2 – GWR parameter summary results, Listening

Listening	*Min*	*1° Q*	*Median*	*3° Q*	*Max*	*Global*
Intercept	176.28	189.17	202.22	209.44	217.94	199.29
ESCS	1.75	6.98	8.54	10.04	14.46	12.59
Female (%)	-2.99	0.15	0.77	1.37	3.85	1.16
Native (%)	-8.83	-1.16	-0.38	0.50	6.38	-3.96
Regular	-2.79	1.02	2.11	3.13	7.98	0.98
			Quasi-global = 0.81			

Tab. 3 – GWR parameter summary results, Reading

Reading	*Min*	*1° Q*	*Median*	*3° Q*	*Max*	*Global*
Intercept	182.52	195.77	203.99	209.76	215.35	202.08
ESCS	3.54	6.44	7.74	9.05	13.26	10.85
Female (%)	-1.87	0.29	0.73	1.16	2.80	0.98
Native (%)	-3.40	-0.58	0.16	0.88	5.37	-2.53
Regular	-1.59	1.58	2.54	3.36	8.59	1.72
			Quasi-global = 0.81			

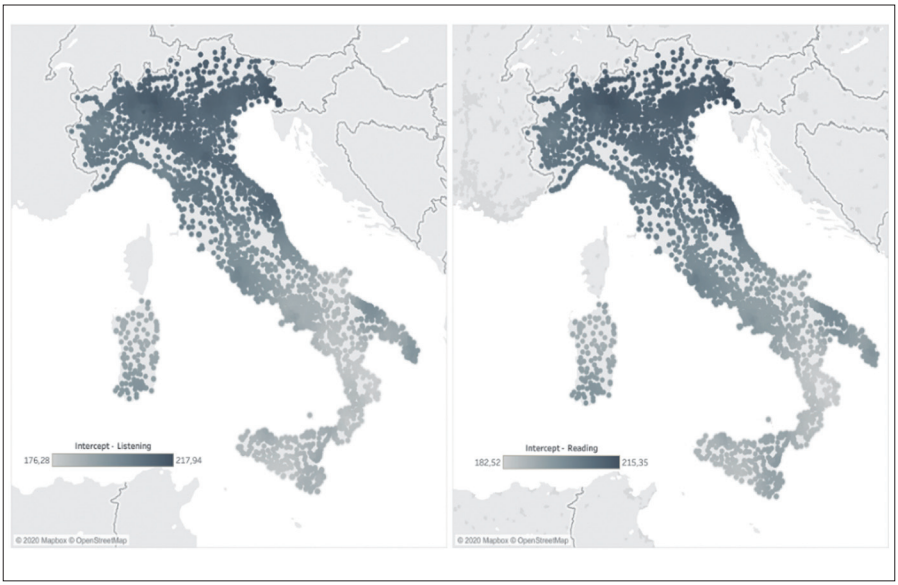

Fig. 4 – GWR Beta Estimated Coefficient – Intercept, Listening and Reading

The values of the GWR intercept show how substantially Italy has a sad score gradient from the North (schools in darker grey) to the South (schools

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in light grey). In the South we report a cluster of schools in Bari whose results are in line with the national average (Fig. 4).

High parameter estimates mean that the effect of the variables is higher in particular areas as compared to others.

From this point forward, we have decided to visualize in the map only those schools that had a statistically significant coefficient estimated. For the ESCS index, almost all the schools of the dataset (more than 99%) are statistically significant. The estimated coefficients are all positive as proof of the fact that the direction of the influence of this indicator, across the national territory, is the same. It is possible to identify important spatial clusters, the indicator has a greater impact on dark grey schools that are mainly located in the Centre-South of Italy with the exception of a range of schools that are from Foggia-Potenza-Matera-Salerno, of Sardinia and the western provinces of Sicily. In northern Italy we can find clusters of schools in which the indicator had greater weight in Milan and Turin in Listening when compared to Reading (Fig. 5).

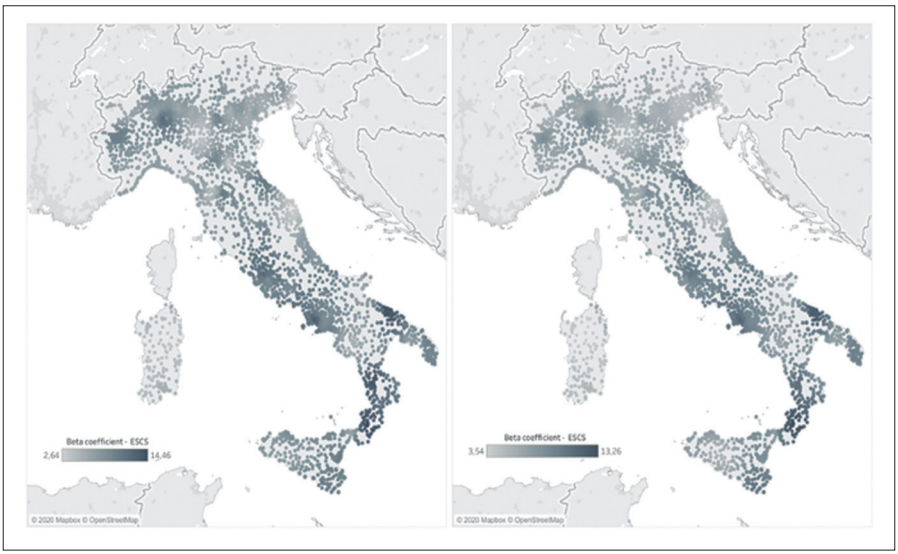

Fig. 5 – GWR Beta Estimated Coefficient. ESCS index, Listening and Reading

The map in Fig. 6 shows the statistically significant estimated coefficients for the variable percentage native which correspond to about 20% of the schools in Listening and 10% in Reading of the dataset. Also in this case we see that there are spatial clusters and a North-South gradient, it is possible to assume that the variable has a negative effect in the North where there are

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schools with a higher percentage of foreigners. We also reported a small group of schools in Lecce that had similar values to the Verona schools in Listening.

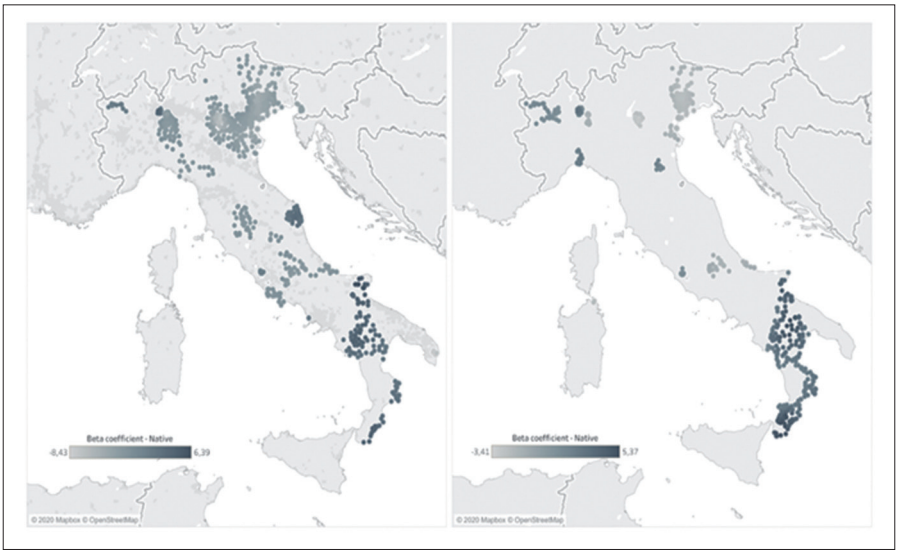

Fig. 6 – GWR Beta Estimated Coefficient. Native (%), Listening and Reading

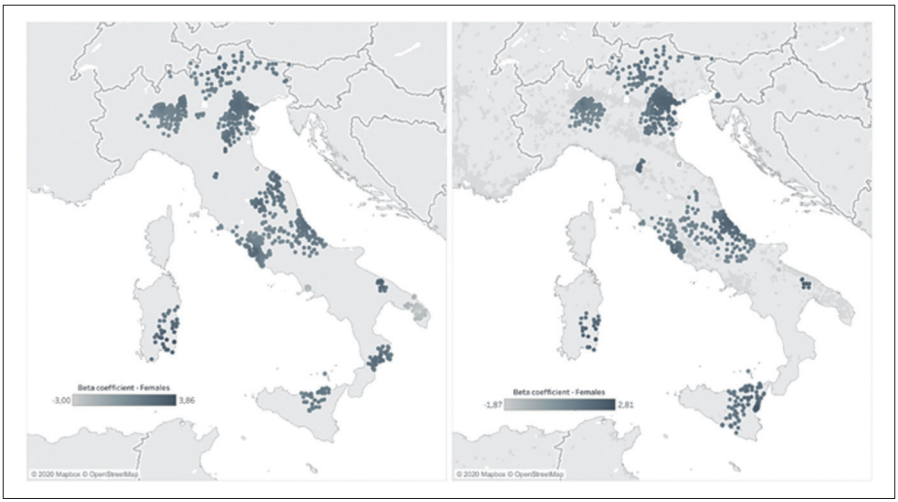

Fig. 7 – GWR Beta Estimated Coefficient. Females (%), Listening and Reading

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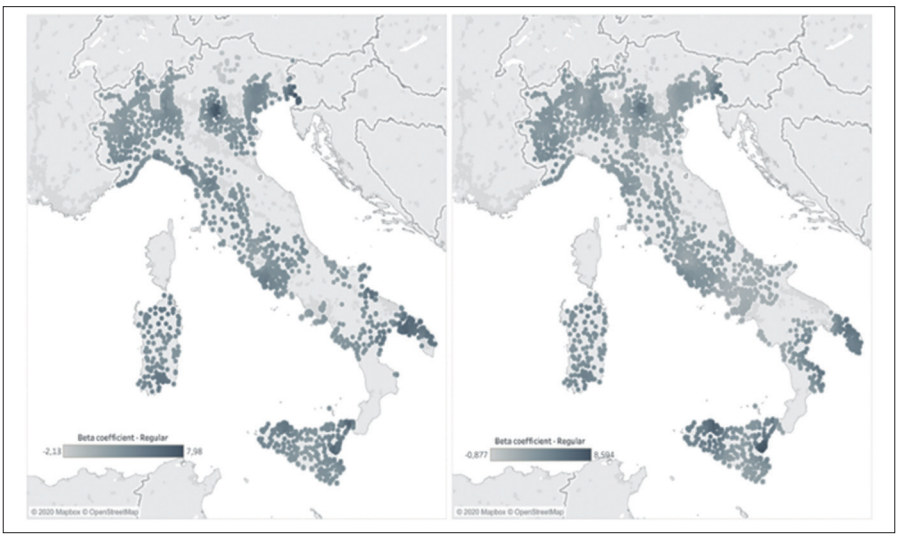

Fig. 8 – GWR Beta Estimated Coefficient. Regular (%), Listening and Reading

Maps in Fig. 7 and 8 report respectively the statistically significant estimated coefficients for the variable percentage of female and regular: maps show that there is a general positive impact throughout the national territory except in some schools in Lecce and Naples in the first case and in the province of Trento in the second one.

5. Conclusion

Nowadays, Italy still shows substantial differences in scholastic achievement. As a matter of fact, differences in skills and learnings are one of the main foundations of socio-economic development among territories.

In this perspective, it is crucial to perform analyses that include territorial complexity. Moreover, the schools that are closer have a bigger influence than those distant ones, referring to the "First Law of Geography" enunciated by Tobler in 1970: "Everything is related to everything, but near things are more related than distant things".

Therefore, the local approach is a useful tool to study territorial differences in the educational field, since spatial thinking will have an increasingly important role to play.

Starting from geo-referencing of schools in the Italian territory, it was possible to reveal a heterogeneous structure in the geography of learning. All

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the analyses carried out showed that this spatial heterogeneity identifies new and changing territorial continuums.

The aim of this research was to study in detail this heterogeneity by using data at the student level and subsequently aggregated at the school level. Indeed, we demonstrated, in conformity with the evidence in the literature, that students' individual characteristics play a greater role than school characteristics.

The results of univariate and bivariate spatial autocorrelation analyses showed that there are spatial clusters in Italian territory that reveal a sad score gradient in educational performance from the North to the South.

However, going deeply, beyond the administrative boundaries, it is possible to find, for example, schools in high performing clusters (located in the North of Italy) that perform worse respect to the other schools in the same cluster, and vice versa. These observations constitute clusters of spatial outliers.

Given these premises, the use of a local approach, in addition to the global one, is the best option because it allows us to better understand the phenomenon. In fact, the geographically weighted model provided the best fit to the data. While in the traditional OLS model a global parameter is estimated, with the GWR approach we obtain single local parameters. Thus, instead of calibrating a single regression equation, the GWR generates a separate regression equation for each observation (school) contained in the dataset. As we move over space, schools are weighted according to their location in the territory.

We found spatial heterogeneity in the effects of the predictors on English performance, especially related to the ESCS index. The examination of geographical variations could help us to better understand the uncover relevant variables for improving model performance and better understand the Italian complexity in order to identify new spatial patterns. The identification of these spatial clusters and also their important exceptions can provide new tools to manage new future challenges in this complex field.

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2. How important is the time spent with children on their performance?[*]

by Valeria F. Tortora, Patrizia Giannantoni, Paola Giangiacomo

A significant advantage at school and in life is certainly represented by the time spent by parents with their children, especially in their schooling. Being able to motivate and stimulate their children, nurture a real interest and actively engage are a remarkable added value for improving school performance.

Helping to undertake school challenges together does not necessarily mean helping children do their homework, but, as demonstrated by an analysis of the OECD PISA 2009 data on the data collected through the family questionnaire, there is no need for a PhD title or a very large amount of time for parents to make a difference.

In the international survey IEA PIRLS 2016 all parents in the sample were asked about extracurricular activities (such as reading books, telling stories or playing with forms) carried out together with their parents. The main purpose of this work is to develop a reflection, supported by empirical evidence, on the existence of a close relationship between the involvement of parents with children in preparatory activities for learning and the attitude of the latter towards reading, as well as their performance in reading and in Italian in class II and V of elementary school (grade 4 and 5).

Grade 4 performance is obtained from IEA PIRLS 2016 surveys, while grade 2 Reading and grade 5 for Italian from respectively the 2013/2014 and 2016/2017 INVALSI Survey; therefore, the study uses the longitudinal database obtained by merging IEA PILRS 2016 and INVALSI tests through longitudinal data match. Students who have taken all the tests are the refer-

[*] This chapter is the output of a joint work of the three authors. Nonetheless, V. F. Tortora and P. Giangiacomo contribute substantially to section 1 "Introduction", section 2 "Objective of the research" and section 5 "Discussion", P. Giannantoni contributes substantially to section 3 "Data and Methods" and section 4 "Results".

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ence population. The spread and characteristics of parental involvement with children will be outlined with descriptive analysis in the first part of this contribution. In a second part, the connection between parental involvement and academic performance will be deepened by regression models, controlling for the student's gender, educational level of the family, previous attendance of kindergarten.

Un notevole vantaggio a scuola e nella vita è sicuramente rappresentato dal tempo trascorso da parte dei genitori con i propri figli, in particolar modo nel loro percorso scolastico. Riuscire a motivare e stimolare i propri figli, nutrire un vero interesse e impegnarsi attivamente rappresentano un valore aggiunto inestimabile per migliorare le performance scolastiche. Contribuire a intraprendere insieme le sfide scolastiche non significa necessariamente aiutare i propri figli nel fare i compiti a casa ma, come si è dimostrato attraverso un'analisi dei dati dell'OCSE PISA 2009 sui dati raccolti tramite il questionario famiglia, non serve un dottorato di ricerca o un numero illimitato di ore per far sì che i genitori facciano la differenza. Nella rilevazione internazionale IEA PIRLS 2016 venivano rivolte ai genitori degli studenti partecipanti, attraverso la somministrazione di un questionario famiglia, alcune domande concernenti le attività extrascolastiche svolte insieme ai figli, come ad esempio leggere libri, raccontare storie o giocare con le forme. La principale finalità di questo lavoro è quella di sviluppare una riflessione, sostenuta dall'evidenza empirica, sulla esistenza di una stretta relazione fra il coinvolgimento dei genitori con i figli in attività propedeutiche all'apprendimento e l'atteggiamento di questi ultimi verso la lettura, oltre che la loro performance in Lettura e in Italiano nelle classi IV e V della scuola elementare. La performance in classe IV è ottenuta dalle indagini IEA PIRLS 2016, mentre in classe V dalla Rilevazione INVALSI 2016/2017; dunque lo studio utilizza come base dati quella della IEA PILRS 2016 e quella INVALSI 2016/2017, evidenziando solamente gli studenti che avranno svolto entrambe le prove. La diffusione e le caratteristiche del coinvolgimento genitoriale con i figli verranno delineati in una analisi descrittiva nella prima parte di questo contributo. In una seconda parte il legame che intercorre tra coinvolgimento genitoriale e rendimento scolastico verrà approfondito tramite modelli di regressione, controllando per genere e origine dello studente, livello socio-economico della famiglia, frequenza pregressa di asilo nido e scuola dell'infanzia.

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1. Introduction

The most of studies have signaled the beneficial effects of parental involvement in children's educational lives and have examined the possible impact of parental characteristics, such as family income and parental education, on children's educational outcomes (Castro *et al.*, 2015).

This paper evaluates the levels of parental involvement as well as the relationship of involvement with cognitive (reading performance) outcomes.

Studies have suggested that parental involvement in children's activities may signal the route through which a parent's skills and motivations are transferred to children and should be positively associated with children's cognitive and other development (Baker and Scher, 2002).

Several studies have also noted the differential effects of parental expectations and parenting behaviours on children's education. They indicated that parental expectations and attitudes, rather than specific behaviours such as involvement in school activities, better explained children's academic outcomes (Fan and Chen, 2001; Reynolds and Gill, 1994).

The idea that parental involvement has positive influence on students' academic achievement is so intuitively appealing that society in general, and educators in particular, have considered parental involvement an important ingredient for the remedy for many problems in education.

Society in general, and educational researchers in particular, have long been interested in the positive effect that parental involvement may have on students' academic achievement (OECD PISA, 2018). The perception that parental involvement has positive effect on students' academic achievement is so intuitively appealing that policy makers, school board administrators, teachers, parents and even students themselves, have agreed that parental involvement is critical for children's' academic success.

Although parental involvement is often simplistically perceived as unidimensional, in reality, it is probably better to conceptualize this construct as being multifaceted in nature, because parental involvement subsumes a wide variety of parental behavioral patterns and parenting practices (Hill and Taylor, 2004). Such an approach has been adopted in several recent empirical studies (Singh *et al.*, 1995). Furthermore, there is evidence indicating that certain dimensions of parental involvement may have more noticeable effect than some other dimensions on students' academic achievement (Singh *et al.*, 1995).

Findings suggest that some forms of parental involvement are more strongly related to cognitive outcomes than others. These include reading to children when they are young (OECD PISA, 2018).

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Students whose parents often read books with them during their first year of primary school show markedly higher scores in PIRLS 2016 than students whose parents read with them infrequently or not at all (Mullis *et al.*, 2017).

The performance advantage among students whose parents read to them in their early school years is evident regardless of the family's socio-economic background. Parents' engagement with their children is strongly associated with better performance (Mullis *et al.*, 2017).

Most parents know, instinctively, that spending more time with their children and being actively involved in their education will give their children a good head-start in life. But as many parents have to juggle competing demands at work and at home, there never seems to be enough time. Often, too, parents are reluctant to offer to help their children with school work because they feel they lack some of the skills that would make a difference to their children's success in school. The good news coming from analyses of PIRLS data is that it does not require a PhD or unlimited hours for parents to make a difference. In fact, many parent child activities that are associated with better reading performance among students involve relatively little time and no specialized knowledge. What these activities do demand, though, is genuine interest and active engagement.

The parents' responses show a close relationship between their own involvement with their child and their child's engagement in reading-related activities during the first year of primary school. Students whose parents reported that they had read a book with their child "every day or almost every day" or "once or twice a week" during the first year of primary school have markedly higher scores in PIRLS 2016 than students whose parents reported that they had read a book with their child "never or almost never" or only "once or twice a month" (Mullis *et al.*, 2017).

2. The reasons for a research on parental participation and some studies

School and family represent two educational systems within which the child grows and forms, two systems that have always interacted even if with sometimes different purposes, times and methods. As explained in the "Introduction" paragraph, the correlation between parental involvement and student performance is significant, but despite this, in the literature this relationship has been addressed in international surveys, promoted by IEA and OECD, only through the administration of some questions on questionnaires for students and families.

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There are no large-scale surveys that photograph the effects of parents' active participation in their children's school life or on their academic performance. There are several local initiatives, promoted by both schools and universities, which investigate whether, and to what extent, parents participate in school life and which strategies can improve this relationship.

Some studies were carried out using data from the OECD PISA international survey. Among the most relevant a mention is for the study carried out by Borgonovi and Montt, they studied parental involvement using PISA 2009 data, analyzing the relationship between parental involvement in school, parental involvement at home, early parental involvement in school life and children's reading literacy, among other results (Borgonovi and Montt, 2012).

Analyzing the data of 14 countries participating in the administration of the family questionnaire, they identified 3 types of involvement: academically oriented involvement, non-academically oriented involvement and parents' reading habits. The authors have underlined the importance of early involvement of parents to skills; some forms of home-based involvement, both academic and non-academic; and positive parents' reading habits and attitudes showed a positive relationship with reading performance for 15-year-old children, even after controlling for the ESCS of the family.

Again with PISA data but in the 2015 edition some Italian authors evaluated the relationship between parental involvement and student science achievement (Caponera *et al.*, 2019). The Italian data were compared with data from EU countries in the Mediterranean area which are culturally similar to Italy and which participated in the optional family questionnaire, namely France, Malta, Portugal and Spain.

The results showed that ESCS contributed to the prediction of science achievement; furthermore, the results evidenced the positive, significant effects of parental involvement, factors mediating the relationship between ESCS and PISA test achievement, especially in France, Malta and Portugal (Caponera *et al.*, 2019).

There are no studies on Italian data of the international PIRLS survey. Therefore, aware from the literature that in the fourth year of schooling preschool activities are predictors of understanding the language, and driven by a strong interest in understanding to what extent parental support has effect already at the very beginning of the academic career, we projected this research, used for the first time data from PIRLS matched with the National Survey promoted by INVALSI.

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3. Objective of the research

The aim of the study is to investigate the relationship between involvement of parents in preparatory activities for learning with their children and the attitude and performance of the latter in language subjects. Particularly we looked at children's attitudes towards reading, self-confidence when facing test, as well as performance in Reading and in Italian in class II and V of primary school (grade 2 and 5), making use of a joint database constructed by the longitudinal match of PIRLS 2016 data on Italian students attending grade 4 of primary school and INVALSI data of grade 2 (a.y. 2013/2014) and grade 5 (a.y. 2016/2017).

4. Data and methods

In order to investigate the topic of our research, we built up an "ad hoc" dataset through a linkage between different surveys: International data from PIRLS 2016 Survey (students in the fourth year of primary school – grade 4) and INVALSI data from census survey of year 2013/2014 (students in second year of primary school – grade 2) and year 2015/2016 (students attending the fifth year of primary school – grade 5). More specifically, using the "SIDI INVALSI" code as linkage key it was possible to match information on the same student stemming from different surveys (national and international) and different academic years (2013/2014, 2015/2016, 2016/2017).

Students in all the three surveys constituted the reference population for this research (see Fig. 1).

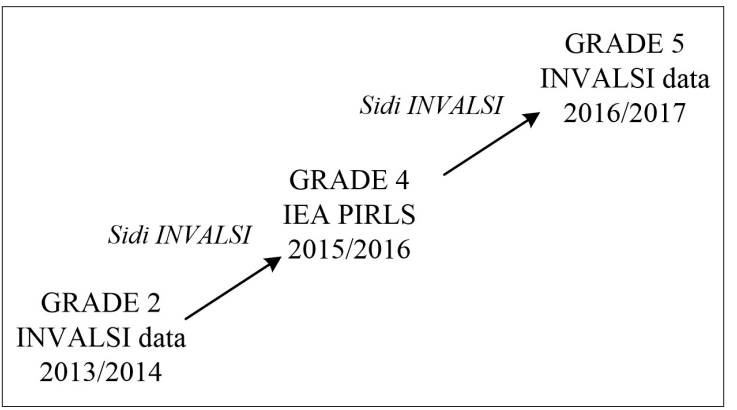

Fig. 1 – Longitudinal scheme of the final sample

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The dataset created collected from PIRLS:

– information about frequency of early parental literacy activities before school, the key explanatory variable of our analysis;
– socio demographic information, (e.g. gender, education of parents, attending kindergarten), used as control variables.

From INVALSI tests we derived standardized scores in Reading and Literacy come from INVALSI grade 2 and grade 5 tests.

Furthermore, we included in the analysis specific indexes about attitude toward reading (i.e. pleasure for reading and confidence in reading) from PIRLS, together with Question 11 of INVALSI student Questionnaire which asks: "How much did you feel calm before the test?". Standardized scores together with attitudes measurements represent the outcome variables of all the work presented in this paper.

Table 1 illustrates the variables used, their characteristics and the survey from which they are originated.

Tab. 1 – Scheme of variables included in the analysis

Name	*Label*	*Typol.*	*Categories*	*Source*
ELA-Scale	Early Literacy Actitivites Scale	Quant		PIRLS G4
ELA-Index	Early Literacy Actitivites Index	Categ	Often Sometimes Never	PIRLS G4
Like Read-Index	Student Like Reading Index	Categ	Often Sometimes Never	PIRLS G4
Conf Read-Index	Student Confidence Reading Index	Categ	Often Sometimes Never	PIRLS G4
Feel Calm Test	Feeling Calm during Italian Test	Categ	Not at all A little Enough Very much	INVALSI G5
Gender	Gender of the student	Categ	Girl Boy	PIRLS G4
Parent Univ	Parental University degree	Categ	No Yes	PIRLS G4
Preschool 2+	Preschool at least 2 years	Categ	No Yes	PIRLS G4
Reading score G2	INVALSI Reading score grade 2	Quant	–	INVALSI G2
Italian score G5	INVALSI Italian score grade 5	Quant	–	INVALSI G5

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In order to give a more specific frame to the analysis, we decided to look to the relationship between pre-school activities only related to literacy and reading/language development, therefore we selected from the list of PIRLS item concerning parent-child activities only those related to language development and excluded those more related to numeric skills. Final items from PIRLS 2016 included in the analysis were nine (see Fig. 2), with 3-points scale answer: "often", "sometimes" and "never or almost never".

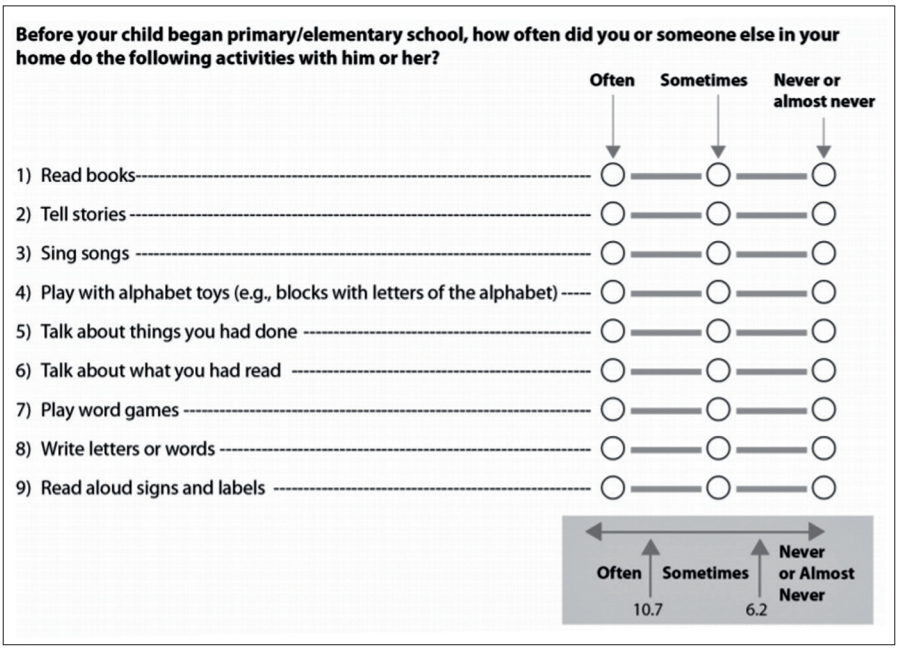

Fig. 2 – Items composing Early Literacy Activities before beginning primary school

Source: IEA PIRLS 2016 Methods and Procedure

PIRLS Survey scored students were scored according to frequency of being exposed to the nine activities with their parents, using Item Response Theory, resulting in an Early Literacy Activities Scale (ELA-Scale). From this scale an Early Literacy Activities Index (ELA-Index) is derived, whose categories are: often, sometimes and never or almost never. The category "often" in the ELA-Index corresponds to scores higher than 10.7 in the ELA-Scale and represents a situation where students were "often" engaged in at least five of the nine activities with their parents and "sometimes" engaged in the remaining four. On the opposite, the category never/almost never" in the ELA-Index collects students with scores lower than 6.2 in the ELA-Scale, which corresponds

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to all those situations where five or even more activities have never been performed by parents with their children, before beginning primary school.

A first part of analysis was directed to provide a description of frequency and typology of early literacy activities performed by Italian parents before school age of their children, highlighting those aspects that are more frequently practiced among parent-child activities. For all descriptive analyses sampling weights produced by PIRLS Survey were used.

A second step of analysis was devoted to gain a first overview of the association between early literacy activities and attitude towards reading and standardized tests during primary school. We made use of PIRLS Early activities Index to classify children in those who had been exposed to parent-child activities before school age "often", "sometimes" or "never/almost never" and used the PIRLS Index of "pleasure for reading" and "confidence in reading", together with INVALSI Question from student questionnaire "How much did you feel calm before the test?". Association significance was tested through chi-squared test.

A final section of the work is directed to explore the effect of early activities on school performances, first by looking at mean differences between those exposed and not to ELA activities, then controlling for possible confounder factors, in regression models. We decided to use INVALSI test score as a measure of abilities. In grade 2 INVALSI score is a quantitative variable on a scale from 0 to 100 (percentage of correct answers); in grade 5 we made use of WLE scores, which is a score estimated based on Rasch model, centered on an average value of 200 and a standard deviation of 40. Significance of mean differences in scores was tested through ANOVA test. Since both the outcome variables (Reading and Literacy) were quantitative we opted for a linear regression.

5. Results

5.1. Frequency of occurrence of items of Early Literacy Activities

Starting from the whole sample of 3063 students in PIRLS 2016 – grade 4, we performed a first match retrospectively with INVALSI Reading test at grade 2 (2013/2014) and a second match forward with INVALSI Italian test at grade 5 (2016/2017), using as key variable a longitudinal code for students ("SIDI INVALSI").

Students who took part of all the tests were the reference population. Furthermore, we excluded from the analysis those students for whom Italian

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was not the first language, and all the students with missing values in any of the variable in the analysis, resulting in a final not-weighted sample of 2,260 students.

Based on this sample, we looked at the exposure to Literacy activities students had before beginning primary school, according to the nine items composing the PIRLS ELA-Index (Fig. 3). We can clearly observe as all the activities are frequently performed with a specific prevalence for "talk of what you have done", followed by "tell stories" and "sing songs", which can easily be seen as a part of the daily routine in Italian families. At the opposite, the least performed are activities such as "Book discussion" and "play word games" which are probably more challenging for children at a pre-school age.

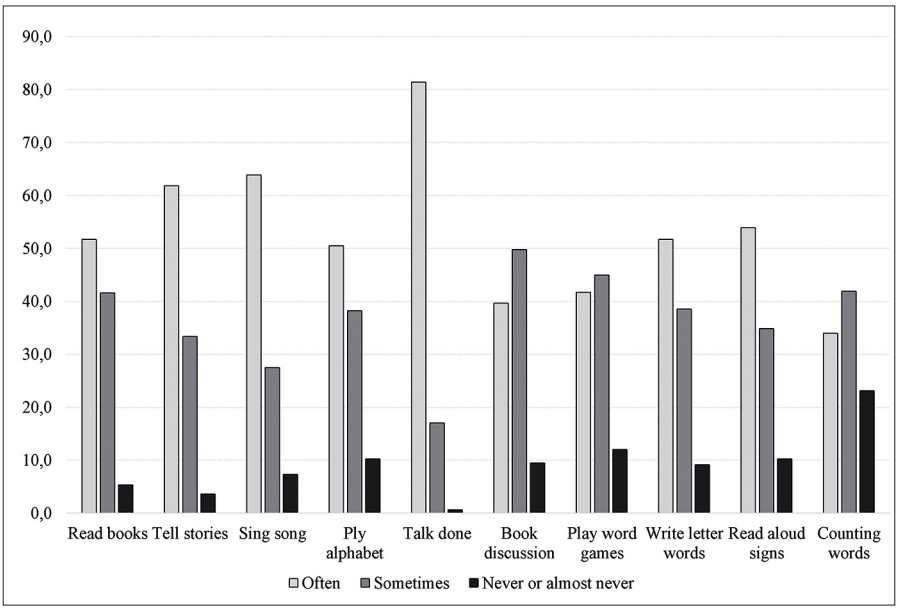

Fig. 3 – Frequency of different items of parental early activities with children

5.2. Association of ELA with attitudes towards reading and test anxiety

Before looking to the effects of parental Early Literacy Activites on skills, we decided to explore the association of these same pre-school activities with attitudes towards reading and self-confidence of students in front of the test.

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Table 2 illustrates a gradient (significant with chi-squared test) in the proportion of kids who "very much like reading" moving from students who had experienced frequent early literacy activities (44% like very much reading) to those who had never been engaged in this kind of activities in their families (21% like very much reading). On the opposite, the dislike for reading among these 10-year students is about one over five (19%) in the group never engaged in Early Literacy, 6 percentage points higher than among those exposed to parent-child literacy experiences (13%).

Tab. 2 – Association between parental early literacy activities and "Student like reading" index (%)

	Students like reading – Index			
ELA-Index	*Very much like reading*	*Somewhat like reading*	*Do not like reading*	*Total*
Often	44	43	13	100
Sometimes	38	45	17	100
Never/almost	21	60	19	100

An even sharper polarization can be observed for "confidence in reading" (Tab. 3). More than a half (55%) of students exposed to ELA in pre-school time feel very confident in reading at time of PIRLS Survey; whereas less than one over four (21%) among those not exposed to ELA have strong confidence in reading in grade 4 of primary school. The central category is quite stable, whereas the proportion of students not confident in reading is four times higher (42% against 9%) among those never engaged in pre-school literacy activities with respect to those often engaged.

Tab. 3 – Association between Parental early literacy activities and "Student confident in reading" index

	Students confident in reading – Index			
ELA-Index	*Very confident*	*Somewhat confident*	*Not confident*	*Total*
Often	55	36	9	100
Sometimes	44	40	16	100
Never or almost never	21	37	42	100

The last association observed was about the ability to control anxiety in front of standardized test, reacting with calm and self-confidence. This ability seems more frequent among students who benefited of parental shared activities, compared to those who did not. In fact, although in Table 4 we can

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see a quite similar distribution of students with different exposition to ELA in the extreme categories, looking at the intermediate category ("a little" calm and "enough" calm), we can detect a very uneven distribution in favor of those with parental activities background.

Tab. 4 – Association between parental early literacy activities and feeling calm during the INVALSI test (%)

	Feeling calm during the test				
ELA-Index	*Not at all*	*A little*	*Enough*	*Very much*	*Total*
Often	12	26	37	25	100
Sometimes	12	26	39	23	100
Never or almost never	14	71	0	15	100

Note: The value of zero in one category is due to the small number of students in the category of never or almost never in the early literacy activity index in the original sample population.

5.3. Reading and Italian performance according to ELA exposure

The average scores at INVALSI test for Reading and Italian has a sharp decline from students with an experience of early parent-child activity and those who did not (Tab. 5).

Percentage of correct answers in Reading declines from 89.2 to 81.

We should consider that the distribution of Reading percentage scores is highly asymmetric, with over 70% of students with a score higher than 85, very close to the top performance (which is obviously 100). Thus, the gap between students exposed and not exposed to parental activities appears extremely meaningful, as confirmed by Anova test, significant at 0.05 level.

Tab. 5 – Mean scores at INVALSI Reading Test (grade 2) according to different categories of ELA-Index

	INVALSI Reading score(%) – Grade 2		
EARLY Lit Act Index	*Mean*	*N*	*Std Dev*
Often	89.2	157,816	15.8
Sometimes	87.1	139,419	16.4
Never or almost never	81.0	1,866	16.6
Total	88.2	299,102	16.2

Notes: Anova test is significant at level 0.05; number of students is weighted.

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Looking at Table 6 we can see that WLE scores in Italian have a 20 points difference (significant at the Anova test with a level of 0.05) between the two extreme categories "Often" and "Never/Almost Never" ELA activities, which corresponds to 0.5 standard deviation in the WLE scale. It is interesting to note that the overall mean scores in the sample is quite high (207.1), but kids never engaged in Early literacy activities before school significantly underperform with respect to this average value.

Tab. 6 – Mean scores at INVALSI Italian Test (grade 5) according to categories of ELA- Index

	INVALSI Literacy score (WLE) – Grade 5		
Early Lit Act Index	*Mean*	*N*	*Std Dev*
Often	209.3	157,816	36.5
Sometimes	204.9	139,419	37.9
Never or almost never	188.0	1,866	28.7
Total	207.1	299,102	37.2

Note: Anova test is significant at level 0.05, number of students is weighted.

Aware that these differences can be driven by many other factors linked together with parent-child preschool activities, we tried to correct for this potential bias examining the effects of Early Literacy Activity in a Linear regression model together with control variables: gender, frequency of 2 years or more of pre-school, university degree of at least one parent. The Early Literacy activity is here measured by the ELA-Scales, as quantitative variables, in order to encompass the shortcoming of very small number of students in the category of those who experience "never or almost never".

The first model (Tab. 7) is built to predict Reading scores at INVALSI test of grade 2 based on both characteristics of the student and his/her family (gender, education of parents, experience of kindergarten) and exposure to Early Literacy Activity (ELA-Scale).

Findings about gender and parental education were entirely in line with the literature that has consistently documented lower performance in reading and literacy for male students and for those coming from less educated families. We reported a disadvantage of -1.70 points for boys and ad advantage of 2.13 points for students with a least one parent with university degree. No effect was found associated with kindergarten attendance net of other variables. Controlled for the variables included in the model, the Early Literacy activity scale shows a linear significant effect on reading scores, with an increase of 0.5 points in percentage score at INVALSI reading test for each point increase of Literacy Activity.

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Tab. 7 – Regression model estimating the impact of parental activities during preschool on reading ability of students in grade 2 (INVALSI test)

	Reading G2	
Variables	*Coeff.*	*Sign.*
Early Lit Activities		
Quantitative	0.47	0.02
Gender		
Girl	Ref	Ref
Boy	-1.70	0.02
PARENT_Univeristy degree		
No	Ref	Ref
Yes	2.13	0.02
Preschool 2+years		
No	Ref	Ref
Yes	-1.27	0.47
Intercept	85.73	0.00

Tab. 8 – Regression model estimating the impact of parental activities during preschool on Italian skills in grade 5 (INVALSI test)

	Literacy G5	
Variables	*Coeff.*	*Sign.*
Early Lit Activities		
Quantitative	0.94	0.03
Gender		
Girl	Ref	Ref
Boy	-1.27	N.S.
PARENT_Univeristy degree		
No	Ref	Ref
Yes	12.83	0.00
Preschool 2+years		
No	Ref	Ref
Yes	13.53	0.00
Score in Reading G2 (1314)		
Quantitative	0.35	0.00

Note: The higher magnitude of coefficients with respect to model for Reading is due to the different scale of the score variable for Italian, WLE score, which has mean 200 and standard deviation 40.

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In Table 8 results of model for predicting Italian scores at INVALSI test at grade 5 are summarized. This model includes all control variables already described for the previous regression, but also the score obtained by each student at reading test three years before. This variable allows us to take into account the "baseline" skills at grade 2 and to model the ability in Italian at grade 5 being equal the starting point at grade 2. This is interesting because we can detect whether the pre-school ability influences Italian performances, independently form the effect already had on reading at grade 2. From what we can see in Table 8, Reading abilities predict a higher score three years later, but ELA before school add another piece of advantage, net from that already registered in reading scores, with a cumulative effect.

In this model Parent university degree and attending pre-school for at least 2 years show the highest effects, whereas gender is no longer significant.

6. Discussion

The findings of this paper are consistent with previous studies demonstrating that the parental involvement is positively related to children's educational performance: parents' engagement with their children is strongly associated with better performance.

All parents can help their children achieve their full potential by spending some time talking and reading with their children – even, perhaps especially, when their children are very young.

This study shows that the earlier parents become involved in their children's literacy practices, the more profound the results and the long-lasting the effects (Mullis *et al.*, 2004).

Furthermore, at this age, reading is among the most important subjects as it is transversal to acquire other skills, for this reason it is important to involve parents in the development of their children's literacy (Senechal and LeFevre, 2002).

Parental involvement in education should be a key focus of current policies and programs aimed at improving the academic outcomes of students at risk for academic underachievement. Teachers, schools and education systems should explore how they can help less supportive parents to play a more active role in their children's education, both in and out of school.

Policy implications should report the possibility that promoting higher levels of parental involvement may increase students' cognitive outcomes,

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and that high-quality parental involvement may help reduce performance differences across socio-economic groups. The development of reading proficiency in children is perhaps the highest-ranking educational objective of legislators, administrators, teachers, parents, and the community. Researchers who plan to examine the relationship between parental involvement and students' academic achievement should pay special attention to the operational definition and measurement of parental involvement, and should carefully document such definition and measurement.

Future perspectives of this study will include analyzing the amplifying effect of other forms of parental involvement later on in the student's academic career and a better understanding of parental characteristics that favor early literacy parent-child activities (e.g. work conditions).

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3. Vocational Education and Training Courses in Trentino Using INVALSI Data

by Chiara Tamanini, Mattia Oliviero, Luciano Covi

This chapter aims to provide an in-depth analysis of the performance of 10th grade students of vocational education and training institutes (IeFP) in Italian and Mathematics INVALSI tests in Trentino. It aims to: outline their trends compared with the other provincial school types, examine how IeFP students perform compared with the other upper secondary school types at national level (technical institutes and licei), and compare the results with other vocational schools in Italy, with a focus on the North-East area to identify points of attention and foster self-improvement processes. The relevance of these research questions lies in the peculiar organization of the Trentino school system. Starting in 2011, Trentino has simplified upper secondary education into three main school types: "Licei" (High Schools), "Istruzione Tecnica" (Technical Schools), and "Istruzione e Formazione Professionale" (Vocational Education and Training) by gradually suppressing the "Istituti Professionali". As a result, IeFP witnesses an increase in the share of students enrolled in vocational schools (from 21% in 2005/2006 to 27% in 2017/2018), while in the last school year the share of students in the "Licei" and "Tecnici" was 42% and 31% respectively. Within the Trentino school system, IeFp is part of a vertical curriculum which involves students aged 6 to 16 in a continuum that, besides professional development, aims to provide essential performance levels as well as fundamental skills for developing active citizenship and civic competences. Consequently, starting in the school year 2012/2013 all the IeFP schools have participated in the Italian language and Mathematics INVALSI tests thanks to an agreement between the Autonomous Province of Trento, IPRASE and INVALSI. Therefore, it is particularly relevant to evaluate the performance of this important educational sector, especially after the introduction of computer-based testing and INVALSI tests at grade 13. To investigate the research questions mentioned above, it

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is essential to have information about the performance of students at several time points (longitudinal perspective). Using multilevel regression models (two levels: schools and students), this paper aims to examine to what extent the differences observed between different school types are due to students' (self-)selection into upper secondary schools. This line of research is feasible only if we have access to the students' performance at grade 8 and 10 to investigate the level of association, controlling for other individual characteristics, between the two points in time for the last three school years.

Il capitolo propone un approfondimento sugli esiti degli apprendimenti rilevati attraverso i test INVALSI di grado 10 della IeFP in Trentino allo scopo di: delinearne l'andamento rispetto agli altri indirizzi di studio provinciali, cercare di capire come si collochino rispetto al quadro complessivo degli esiti delle prove INVALSI nel secondo anno della SSSG (indirizzi liceali e tecnici), confrontare i loro risultati con altri indirizzi professionali a livello nazionale, con particolare rifermento al Nord-Est, con l'intento di individuare punti di attenzione per attivare processi di auto miglioramento. L'interesse delle domande di ricerca fa leva sulla particolare organizzazione del sistema scolastico in Trentino, unico in Italia, che dal 2011 ha scelto di semplificare i percorsi del secondo ciclo scolastico con riferimento a "tre gambe": i licei, l'istruzione tecnica la IeFP, sopprimendo gradualmente l'istruzione professionale. La conseguenza è stata la costante crescita della percentuale di studenti e studentesse che si sono iscritti ad un corso professionalizzante, passando dal 21% dell'a.s. 2005/2006 al 27% dell'a.s. 2017/2018. In quest'ultimo anno scolastico la percentuale di iscritti agli indirizzi liceali è stata del 42% e quella degli istituti tecnici del 31%. Nel quadro scolastico del Trentino gli istituti di IeFP rientrano nell'impianto complessivo dei Piani di Studio Provinciali e realizzano il curricolo verticale dai 6 ai 16 anni, unitario e integrato garantendo, accanto allo sviluppo di una dimensione professionale, lo sviluppo dei livelli essenziali di prestazioni nelle skills *fondamentali per la formazione di cittadini consapevoli e attivi. Di conseguenza, attraverso un accordo tra Provincia Autonoma di Trento, IPRASE e INVALSI, dall'a.s. 2012/2013 tutti gli IeFP partecipano alla somministrazione delle prove INVALSI in Italiano e Matematica. È pertanto rilevante per la Provincia di Trento, ma anche per il sistema scolastico nazionale, cercare di fare il punto sugli esiti di questa sezione scolastica, anche in relazione all'innovazione della somministrazione delle prove online e all'introduzione delle prove INVALSI nell'ultimo anno del ciclo secondario. Per poter sviluppare le domande di ricerca sopra indicate è fondamentale disporre delle performance scolastiche degli studenti in più punti nel tempo*

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(prospettiva longitudinale) integrandole con le caratteristiche individuali. Il contributo intende infatti indagare in quale misura le differenze osservate tra gli indirizzi siano frutto di un effetto di (auto)selezione avvenuto al momento della scelta della scuola secondaria di II grado tramite modelli di regressione multilivello (due livelli: studente e scuola). Questi approfondimenti possono concretizzarsi solo avendo a disposizione gli esiti degli studenti al grado 8 in modo da indagare il grado di associazione tra gli esiti al grado 8 e al grado 10 e la serie storica di esiti degli ultimi tre anni scolastici.

1. Introduction

This paper proposes an in-depth analysis of the results of the INVALSI (i.e. National School Assessment Programme) tests on learning in the 10th grade of vocational education and training institutes (Italian acronym: IeFP) in Trentino, in order to:

– present their trends compared with other school types in the Province (licei, i.e. grammar or general schools, and technical institutes);
– compare their performance with the learning outcomes of vocational schools at national level and specifically in North-East Italy, which serves as the actual benchmark, in order to identify elements that might deserve more attention and take measures to improve, if needed.

The research question is of interest due to the special organization of the Trentino school system, which is unique in Italy and which decided in 2011 to simplify the upper secondary school cycle and keep "three legs", i.e. the licei, the technical institutes and the IeFP, while gradually eliminating vocational training (only) courses. As a consequence, the percentage of students enrolling in vocational education continued to increase and went from 21% in the 2005/2006 school year to 27% in 2017/2018 (this is the highest percentage in Italy). In the same school year, the percentage of students in the licei was 42% and in technical institutes 31%. Parallel to this, attendance of the former vocational training schools went down to approximately 2% (Fig. 1). In fact, the Autonomous Province of Trento has only kept those vocational training courses that could not be included in technical education courses, i.e. those in the social care and health sectors[1].

[1] This concerns the "Don L. Milani" upper secondary education provincial institute in Rovereto, which has vocational courses in the field of social care and health services, and the "I. De Carneri" private, state-recognised institute, which offers vocational courses for dental technicians.

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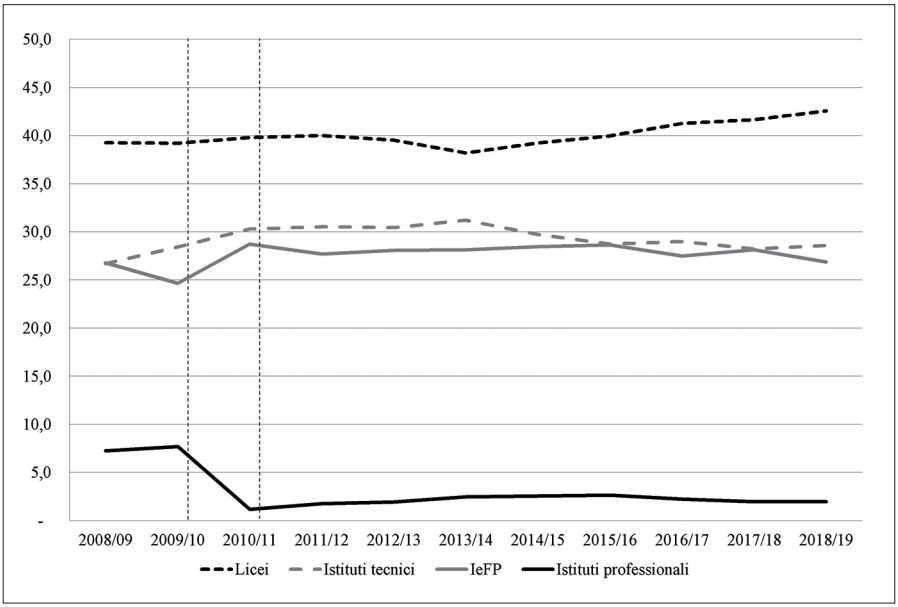

Fig. 1 – Percentage of students enrolled in upper secondary education, by school type, in Trentino, over the course of time

Source: Our own analysis of data supplied by the Education Department of the Autonomous Province of Trento

The choice made by the Autonomous Province of Trento to create a "three legged" system and to eliminate vocational training (only) schools followed a national debate on the reform of upper secondary education in the 2005-2009 period. This ended with the decision to keep vocational training schools as part of the overall upper secondary education system and transform them into five-year courses, in line with the duration of the technical institutes and of the licei. This entailed that three-year qualification courses would no longer exist as such and that they would remain only as "subsidiary courses", next to the educational paths offered by institutes accredited at regional level.

In this transformation, the pre-existing tradition of and focus on a practical and workshop-oriented type of vocational training, that is also the result of the Austrian-Hungarian cultural legacy (Antonelli, 2013), enabled the Trentino education system to buck the national trend and basically be the only place in Italy where Vocational education and training courses have been strengthened, in terms of their quality, their organization and the number of teaching hours. A 2009 provision established that the cours-

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es of state vocational training schools would be integrated into the new technical or vocational education and training courses as of school year 2010/2011[2].

As a result, in Trentino the vocational education and training sector (IeFP) has become an integral part of the overall school system, is part of the second cycle and its educational offer is on the same level as the education provided in the licei and in the technical institutes[3]. Vocational education and training paths are included in the overall structure of the provincial curriculums and in the vertical, unified and integrated curriculum for pupils aged 6 to 16 years old. The development of vocational skills and the attainment of the essential performance levels in the fundamental skills are guaranteed, in order to educate mindful and active citizens.

Therefore, also in the light of the special attention devoted by the provincial school system – also following the activity of IPRASE[4] − to the assessment of pupil learning and the monitoring of the consequences of its decisions, the Autonomous Province of Trento, IPRASE and INVALSI entered into an agreement so as to have all IeFP students participate in national tests starting in the 2012/2013 school year. The results of the INVALSI tests are indeed one of the instruments that can help us understand what level of proficiency has been reached by students in specific sectors and processes related to skills in the Italian language and in Mathematics, which are over-arching skills. They are essential both for students who start working after obtaining their secondary school degree and for those who decide to continue their training/specialisation in the same segment (within the framework of four-year courses and/or higher education courses) or to move on to a new school path.

Also in this case, the situation of Trentino is unique within the Italian scenario: no other Italian region or province performs the INVALSI tests in the IeFP sector in such a systematic and extended way. On the contrary, at national level, the IeFP system struggles to advance in terms of the amount

[2] Decision No. 2220, 11 September 2009.

[3] Cf. Provincial Law No. 5 of 2006 on the School System, art. 54, which defines the education and training cycles in the Provincial education system and that, with reference to the second cycle, declares that it «includes five year educational paths as well as vocational education and training courses lasting three, four and five years, in line with applicable national laws; these courses are divided into two two-year periods plus an additional one-year course if the entire duration is five years». Art 36 of the same Provincial Law establishes the way by which vocational training paths are assigned.

[4] Since the very beginning of its activity, IPRASE has promoted the culture of assessment and has seen to the testing of learning, and especially INVALSI tests, for the Autonomous Province of Trento.

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of standardized testing of learning outcomes (Zagardo, 2019)[5]. This made it possible in Trentino to report on the overall outcomes of the vocational education and training system, as was the case in 2014, when 1,335 IeFP students took the INVALSI tests, and in 2016, with 1,388 students (INVALSI, 2014, 2016; Falzetti, 2015)[6]. Furthermore, the annual feedback on the results to all the provincial IeFP institutes enables each institute to constantly evaluate and monitor its own outcomes.

In the end, the special structure of the Trentino education system makes its secondary cycle schools special vis-à-vis the rest of the country (Arici, Covi and Oliviero, 2019) and this explains why we focus so much on the need for a thorough and rigorous analysis of the results of the INVALSI tests in relation to the IeFP segment. It is especially important to answer a number of questions: how do the outcomes of IeFP students compare to those of students in the other types of schools? And: what level do they achieve in terms of skills that are fundamental in order to be active citizens and in particular in skills in the native language and in Mathematics (Council recommendation on key competences for lifelong learning, 2018)?

How does the choice of the different schools relate to one's previous skills and socio-economic background? What national or regional school type can we compare the Trentino IeFP outcomes with, since no other Italian region or province boasts such a high percentage of students in vocational courses? Do Trentino students score so well in the INVALSI tests for upper secondary schools (INVALSI, 2018, 2019) due to the special organization of their education system or can we generalize this evidence and include IeFP as well? Can these outcomes improve? In short: What advantages derive from the decision made in Trentino to attach such an important role to vocational education and training within the Trentino school system[7]?

[5] Nevertheless, it is important to underline that INVALSI has increased its focus on vocational education, so much so that in recent years specific tests have been devised for the 10th grade of Vocational education and training courses (IeFP). These tests consist of tasks that are relevant for the vocational environment while their level of difficulty is the same of the tests administered to pupils attending the second year of the other upper secondary schools. Their intent is to assess the attainment of those fundamental skills in the Italian language and in Mathematics that every young person needs to have at the end of compulsory schooling.

[6] Since the Trentino school situation is special and unique, obtaining the results for IeFP courses entails that a specific agreement be made each time with INVALSI, while results are directly reported to each school by INVALSI.

[7] This is also true in the light of the continuous decrease in the percentage of students enrolling in the first year of vocational training (only) schools, that went from almost 19% of the total to just over 13%.

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These are the important questions this paper strives to provide an answer to (albeit not a final and exhaustive one), taking also into consideration the fact that the special autonomy enjoyed by the Province of Trento permits "to test" solutions that can turn out to be of interest also for other areas in the long run[8]. Therefore, analysing the learning outcomes in the IeFP sector based on the INVALSI test results can prove relevant not only for the Province of Trento but also in view of what can be adopted more in general and at national level, especially in relation to the innovation of administering tests online and to the introduction of national tests in the last year of upper secondary school.

2. The effects of the interaction of one's social background and prior performance

Given this scenario, the transition from lower to upper secondary education represents a key moment in one's educational career in Italy since one's future occupational outcomes and life chances are significantly influenced by the type of education attained.

Previous research on the topic shows that in Italy students' educational choices are influenced by the educational background of their parents. Children of highly educated parents have higher chances to enrol in academic tracks, while those with low parental education show higher transition rates to technical and vocational schools (Schizzerotto and Barone, 2006; Triventi and Trivellato, 2009; Contini and Scagni, 2013; Ress and Azzolini, 2014; Contini and Triventi, 2016).

In the light of the differences in performance we observed in students, based on their upper secondary education, it seems relevant to investigate whether social-background differentials in transition rates to both general schools and vocational training courses change at different levels of competence. Specifically, the extension of the analysis to vocational training courses is an important contribution, because social-background differences are particularly pronounced for the enrolment in vocational programmes (Barone, 2012; Ress and Azzolini, 2014). Moreover, our study contributes to a better understanding of this topic by analysing two different types of

[8] C. Tamanini highlighted these aspects in "Le prove INVASI nell'a.s. 2016/17 nella Provincia di Trento: i risultati di un anno che conclude un ciclo" (The INVALSI tests in the 2016/17 school year in the Province of Trento: the results of a year that completes a cycle), pp. 6-9, retrieved on March, 11, 2021, from www.iprase.tn.it (https://bit.ly/39IaexR).

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licei separately: those that specialise in scientific subjects and in classical studies on the one hand and those that focus on foreign languages, human sciences and the arts on the other. The analysis the Province of Trento where vocational education and training courses are a significant component of the education system could also provide important information for the entire national education system (Ress and Azzolini, 2014).

3. Data and methods

To this purpose, we used data from INVALSI about the whole student population enrolled in the 10th grade to shed light on such an important branch of the Trentino education system in two distinct ways. First, we looked at the differences in terms of test scores in Trentino in relation to the different school types and compared Trentino vocational education and training institutes (IeFP) with the vocational schools (Istituti professionali) in Italy at large and in North East Italy. Second, our work examined the impact of the previous performance of students (in the 8th grade) on the transition from lower to upper secondary education and considered their social background.

Data included standardized test scores in Italian and Mathematics and information on the students' family background. We used the SIDI (i.e. Education Information System) code to link the students' scores in the 8th grade, in school year 2016/2017, with their scores in the 10th grade, in school year 2018/2019. By doing so we included in our analysis only those students who attended school regularly from grade 8 to 10, i.e. those who did not fail a year. Table 1 shows the percentage of students included in the analysis by type of school.

Tab. 1 – Number of students included in the analysis

Type of school	*Students for whom information about their school choice was available, included in the analysis*	*% of students*
Scientific/classical licei	1,099	92.0
Other types of licei	927	81.1
Technical institutes	1,228	80.3
IeFP	800	57.5

We analysed data using multinomial logistic regressions and the results are presented in terms of predicted probabilities separately by gender[9]. The dependent variable for the transition from lower to upper secondary educa-

[9] See Tab. A1 and Tab. A2 in the appendix for the descriptive statistics.

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tion is measured by the type of school each student is enrolled in. Specifically, four types of schools are included: Scientific licei – and classical licei only for the Italian language test – other types of licei, technical institutes and IeFP (vocational education and training courses). The crucial independent variable we included in the analysis is the students' INVALSI test scores in the 8th grade, which act as a proxy for prior performance. Given our interest in investigating the possible effects of one's social background on the type of school chosen, we used the information on parental education taking into consideration the highest level of education reached by any of the two parents. We coded this variable into three categories: lower secondary education, upper secondary education, and tertiary degree.

4. Descriptive results

We first examined differences in the various types of schools in the Province of Trento. Fig. 2 and Fig. 3 show the performance in Italian and Mathematics of the same students in the 8th and 10th grade in relation to the school type they chose. As we might expect, students show consistent differences based on the types of upper secondary schools they chose. In particular, results show that students with the highest performance enrol in scientific licei. However, what is more interesting here is that we can observe a considerable reduction in the differences in the test scores in Italian and particularly among students enrolled in vocational education and training courses in the 10th grade; while in Mathematics the gap between the licei and the technical institutes and IeFP schools remains quite large.

The second step entailed comparing the performance of students in vocational education and training courses in Trentino with the national context. Given the difference in their organizational structure, we compared the results of IeFP with those of vocational schools in Italy and in the North-East of Italy in 2018 and 2019[10]. The results (Fig. 4) show that vocational education and training courses in Trentino are comparable with vocational schools in terms of performance and, in particular, in 2019 they showed higher test scores both in Italian and Mathematics.

[10] For this comparison the results include all the students in the 10th grade and not only students for whom we have information on their type of school as well as their test scores in the 8th grade.

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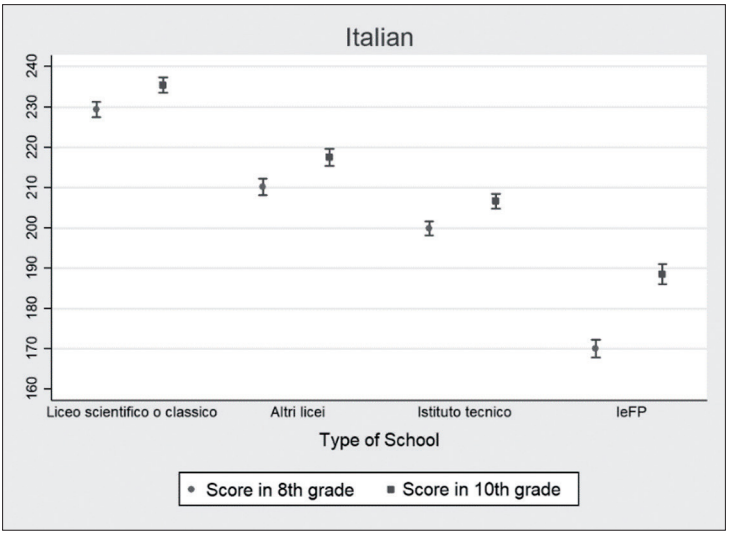

Fig. 2 – INVALSI Italian test scores in the Province of Trento (95% confidence interval) in the 8th and 10th grade by type of school

Source: Our own analysis of data from INVALSI, 2017 and 2019

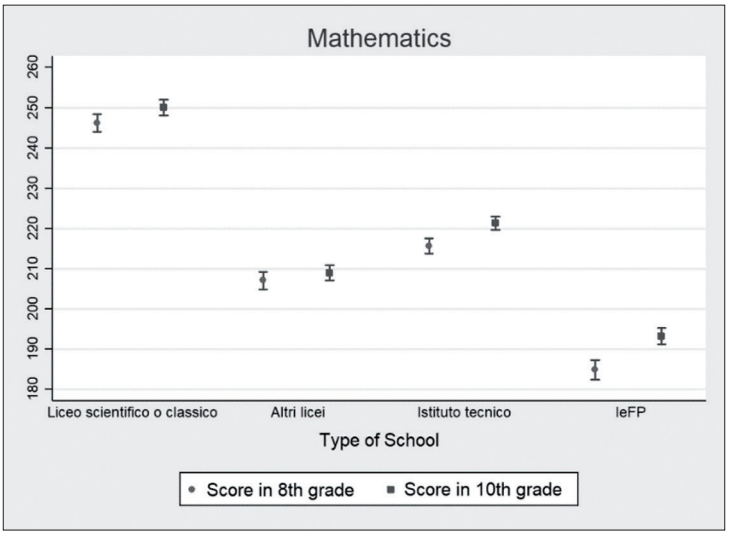

Fig. 3 – INVALSI Italian test scores in the Province of Trento (95% confidence interval) in the 8th and 10th grade by type of school

Source: our own analysis of data from INVALSI, 2017 and 2019

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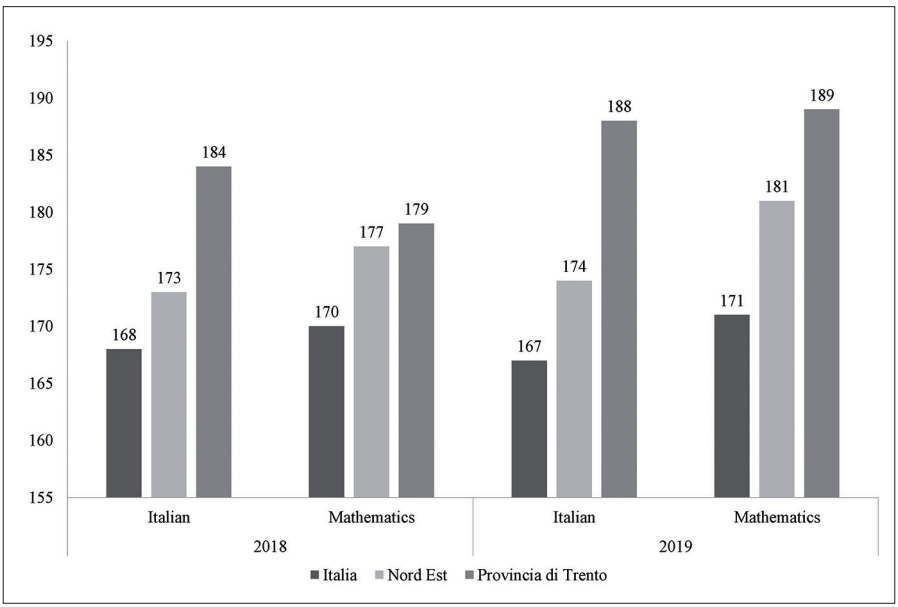

Fig. 4 – Average test scores in Italian and Mathematics by geographic area

Source: our own analysis of data from INVALSI, 2018/2019

5. Results

In this section, we examine the role of the students' social background and level of competence in the transition to different programmes of upper secondary education. The results are presented in the form of predicted probabilities from multinomial logistic regressions[11] for upper secondary school transition. The analyses include the interaction between parental education and INVALSI test scores in Italian in the 8th grade, separately for males and females.

The results for Italian (Fig. 5) clearly show that for all social groups, and for both girls and boys, the higher the level of competence, the higher the likelihood that they enrol in the licei and the lower the likelihood that they enrol in Vocational education and training courses. However, the graph also shows that social disparities in relation to the enrolment in the licei do not disappear among top-performing students.

For instance, among low performing students, the sons of tertiary-educated parents show a 20 percent probability to enrol in licei compared with

[11] See Tab. A3 and Tab. A4 in the appendix for details of multinomial logistic regressions.

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less than 10 percent among sons of parents who completed lower secondary education. This difference becomes even larger among better-performing students. Sons of highly educated parents, who achieve high scores, have almost 80 percent chances to enrol in licei, whereas equally high-performing students whose parents have attained lower secondary education reach 20 percent. The trend is similar for females.

However, what considerably differentiates females and males is the enrolment in the other types of licei – which include courses focussing on foreign languages, human sciences, and the arts – and, to a lesser extent, in the technical institutes. Specifically, the category of the other types of licei appears to be a highly gender-segregated programme, with a percentage of female students enrolled in these programmes totalling 82%. The probability to enrol in one of these programmes is particularly high among low-performing females with highly educated parents. The probability for this group is approximately 50 percent while low-performing females whose parents are less educated show a probability of approximately 20%-30%. Among males, the risk of transition is negligible.

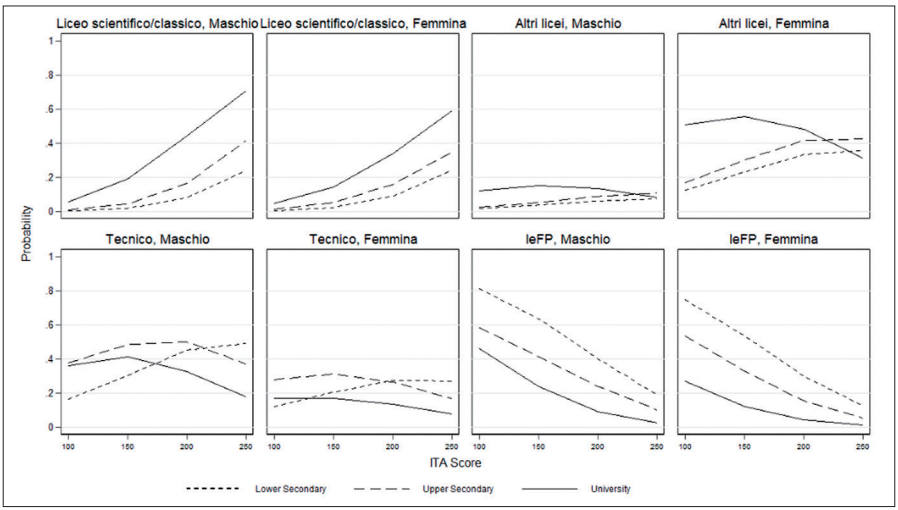

Fig. 5 – Multinomial logistic regression of probability of choice of the type of upper secondary school in the 10th grade: predictive margins from a model with interaction between parental education and INVALSI test scores in the 8th grade (Italian)

Source: our own analysis of data from INVALSI, 2017 and 2019

The results also show that high scores in the INVALSI test almost completely eliminate the likelihood of vocational training course enrolment for

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all groups. For example, the probability of choosing vocational training courses for boys and girls who got an average score (200) on the Italian test is approximately 10%, if their parents completed a tertiary education while it is approximately 40% if their parents attained lower secondary education.

The probability of attending technical institutes differs little among low-performing students with different social backgrounds, whereas among high-performing students it is larger for those with low educated parents but in general lower among females who are more likely to enrol in the other licei.

The results for Mathematics (Fig. 6) are very similar to the results for Italian, the differences can be summarized in three major points.

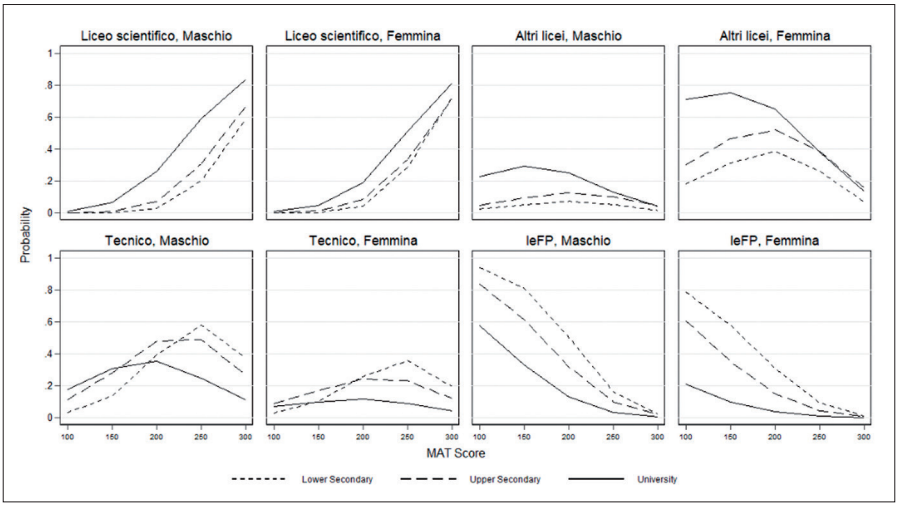

Fig. 6 – Multinomial logistic regression of probability of choice of the type of upper secondary school in the 10th grade: predictive margins from a model with interaction between parental education and INVALSI test scores in the 8th grade (Mathematics)

Source: Our own analysis of data from INVALSI, 2017 and 2019

First, the differences in the enrolment in the licei are smaller among students with different social backgrounds when compared with the Italian test scores. Specifically, the differences are smaller among top-performing students: the chances to enrol in the licei are higher for students with less-educated parents – approximately 50% – if we compare them with the Italian score – approximately 30%. Second, the probability to enrol in other types of licei in the case of low test scores in Mathematics is higher for females with highly educated parents – 70% vs. 50% for the Italian score. This is counter balanced by a low probability to enrol in technical institutes and vocational

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education and training courses. Third, top-performing students in Mathematics are more likely to enrol in the licei and to a much lesser extent in technical institutes, with small differences between different social backgrounds.

6. Conclusions

Fig. 7 below provides a graphical representation of the peculiarity of the Trentino school system in comparison with the geographical benchmark of North-East Italy and Italy as a whole.

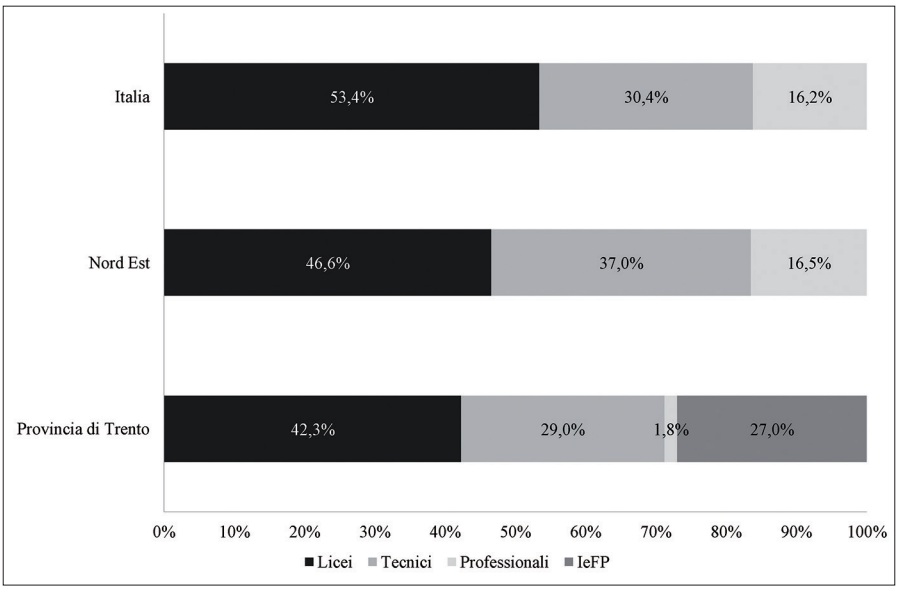

Fig. 7 – Percentage of students enrolled in upper secondary education by school type (s.y. 2017/2018)

Source: Our own analysis of data supplied by the Education Department of the Autonomous Province of Trento

After completing lower secondary school, students in the Province of Trento can choose between three different types of schools: licei, technical institutes and vocational education and training courses (IeFP). Our analysis confirms previous findings by showing that the transition from lower to upper secondary education is still largely influenced by the students' family background. Students with lower INVALSI scores and parents who did not attend tertiary education have a higher probability to enrol in IeFP schools,

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while students with higher test scores and with parents with a tertiary degree are more likely to enrol in classical or scientific licei[12]. As evidenced in several research works[13], it is especially the family's socio-economic background and gender that influence the choice of schools.

The Trentino school system, therefore, enables students who already encounter problems in lower secondary education to continue their general education while attaining a vocational qualification. What about the INVALSI test results of IeFP female and male students in the 10th grade compared with the outcomes of their counterparts in the licei and technical institutes? Fig. 8 and 9 below show more clearly what already emerged from Fig. 2 and 3, with reference to the test scores in the 2017/2019 period.

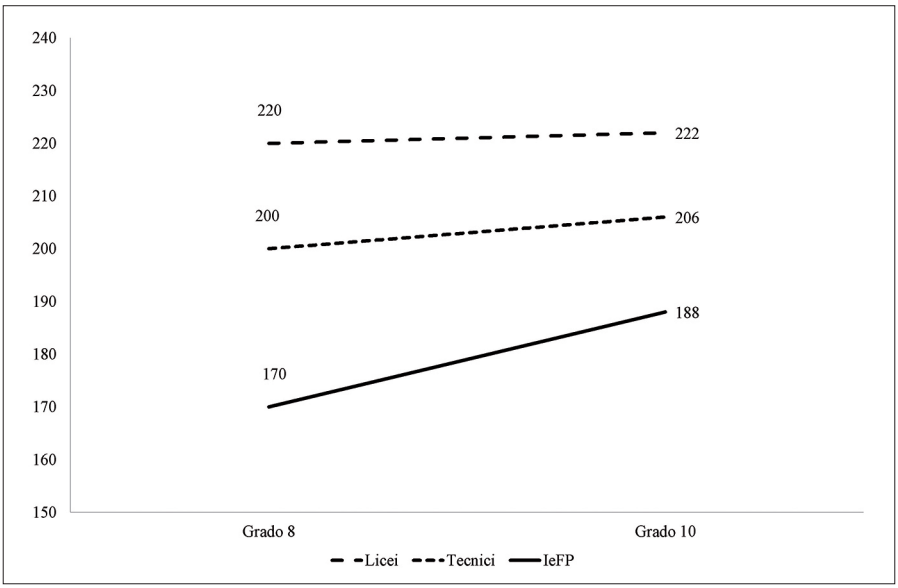

Fig. 8 – Average test scores in Italian

Source: Our own analysis of data from INVALSI, 2017 and 2019

[12] Other investigations of the learning outcomes at the end of primary school, including the results of the school-leaving state exam, showed the same trend (Tamanini, 2007) and, once again, the relation between school evaluations and the scores in national tests is evidenced.

[13] See, among others, the Alma Diploma analyses of the profile of school graduates.

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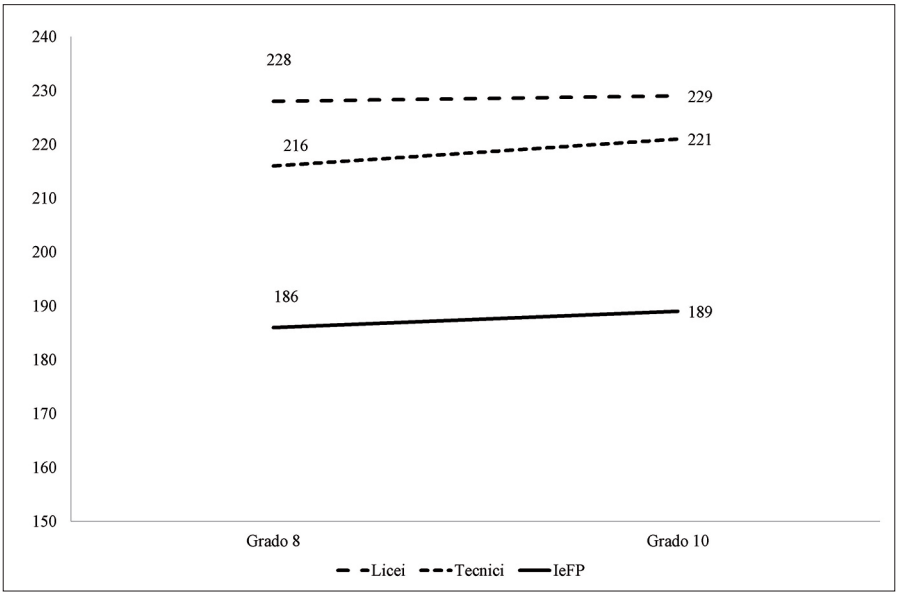

Fig. 9 – Average test scores in Mathematics

Source: our own analysis of data from INVALSI, 2017 and 2019

The test results of IeFP students are lower than their counterparts attending the licei or technical institutes, but we notice a smaller disadvantage in the Italian language score and a marked improvement of this score compared with the 8th grade. The trend should be monitored over several years; nevertheless, there is clearly room for improvement in the learning outcomes for Mathematics and a slightly positive trend for the Italian language, also in light of the fact that the percentage of students of foreign origin attending IeFP is higher, especially among first generation migrant children (14.8% vs. 6% in the licei and technical institutes).

With regard to the school effect of the IeFP, it will be important to deepen the issue with further study to better understand the quality of this upper secondary school path (Ricci, 2020).

Differences between IeFP results and other school orders in terms of levers are also confirmed by the trends outlined in the PISA international surveys (cf. Fig. 10), which indicate a progressive improvement in the IeFP sector in the past ten years, despite an evident differential compared with the licei and the technical institutes.

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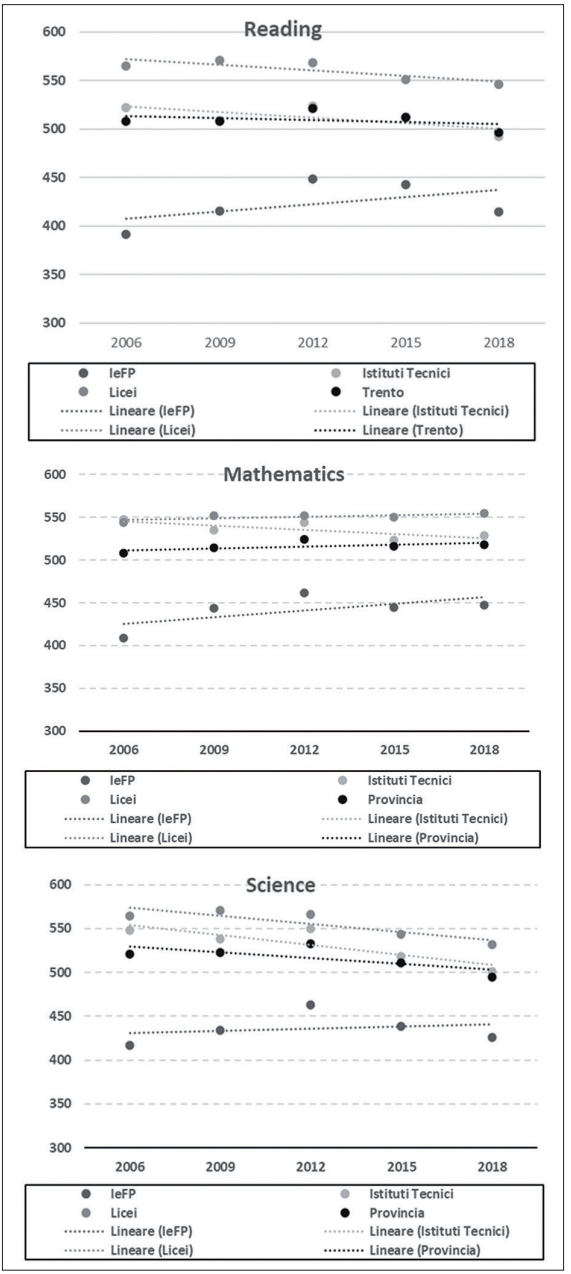

Fig. 10 – Linear trends of average scores in the three areas of competence, by school type

Source: INVALSI: PISA tests in different years

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Results also highlight that Trentino IeFP schools show higher score in Italian and Mathematics compared with the national average of vocational schools in the 2017/2018 and 2018/2019 school years (cf. Fig. 4) and that the same applies when the Trentino system is compared with the area of North-East Italy, even though in this case the difference is smaller. Vis-à-vis North-East Italy, in 2018 only results in Mathematics were identical and in 2019 they were back to being better. Trends will need to be monitored over the years; nevertheless, this result too might indicate that there is room for improvement in the teaching and learning of Mathematics in the IeFP sector.

Moreover, a positive aspect of the "three legged" organization of the Trentino school system is the question of the drop-out rates, that clearly decreased after introducing the new model (from 11.7% in 2012 to 6.7% in 2018), thereby making Trentino one of the best areas in Italy in terms of controlling explicit and implicit early school-leaving (cf. Figure 11 and Ricci, 2019).

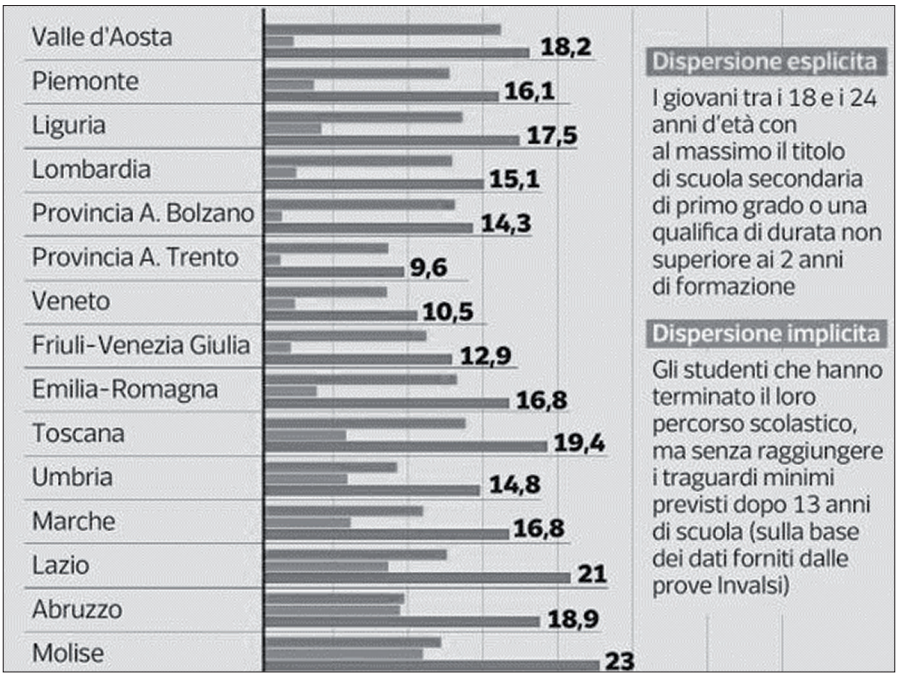

Fig. 11 – Explicit and implicit early school-leaving in Italian regions

Source: Ricci (2019)

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Indeed, enhancing the IeFP system on a socio-cultural level and making it an integral part of the upper secondary education and training cycle of the Province of Trento has allowed to prevent and limit drop-out phenomena, especially among low performing students at the end of the first cycle, while increasing their level in the fundamental skills. This increase is guaranteed over the course of time, with no "ceiling effect" thanks to:

– the possibility to change type of school during or after the first two years of upper secondary school, which coincide with the end of compulsory schooling;
– the progressive construction over the years of a system which has further developed vocational qualification three-year programmes and has added a fourth year, at the end of which a vocational degree is obtained, an annual course for the vocational education State exam (called CAPES in Italian), which makes it possible for students completing the fourth year to take a special State exam based on a protocol signed by the Italian Ministry for Education, University and Research and the Autonomous Provinces of Trento and Bolzano and, more recently, the activation of higher vocational education courses, i.e. non-academic tertiary education programmes, formally equal to the Higher technical institutes pursuant to article 8 of Ministerial decree No. 8327 of 7 September 2011, for students who completed the fourth year in an IeFP school and who obtained a vocational degree.

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Appendix

Tab. A1 – Descriptive statistics for the Italian test

	Scientific and Classic Lyceums		*Other Lyceums*		*Technical Schools*		*VTC*		*Total*	
Variables	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Italian Score 10th grade	234.1	32.0	215.5	33.0	203.8	32.8	188.5	36.1	211.8	36.7
Italian Score 8th grade	229.4	32.0	210.2	31.6	199.9	31.0	170.4	31.6	203.5	37.7
Female	0.50	0.50	0.83	0.38	0.36	0.48	0.39	0.49	0.51	0.50
Lower sec.	0.10	0.30	0.20	0.40	0.26	0.44	0.45	0.50	0.24	0.43
Upper sec.	0.37	0.48	0.44	0.50	0.46	0.50	0.34	0.48	0.41	0.49
Tertiary degree	0.40	0.49	0.23	0.42	0.13	0.33	0.05	0.21	0.21	0.40
N	1,099		927		1,228		800		4,054	

Tab. A2 – Descriptive statistics for the Mathematics test

	Scientific Lyceums		*Other Lyceums*		*Technical Schools*		*VTC*		*Total*	
Variables	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Math Score 10th grade	249.3	32.8	206.2	31.2	218.5	31.7	193.3	29.4	218.9	37.1
Math Score 8th grade	246.1	36.3	207.0	33.4	215.6	34.3	185.5	34.6	215.2	40.8
Female	0.50	0.50	0.83	0.38	0.36	0.48	0.39	0.49	0.51	0.50
Lower sec.	0.10	0.30	0.20	0.40	0.26	0.44	0.45	0.50	0.24	0.43
Upper sec.	0.37	0.48	0.44	0.50	0.46	0.50	0.34	0.48	0.41	0.49
Tertiary degree	0.40	0.49	0.23	0.42	0.13	0.33	0.05	0.21	0.21	0.40
N	950		1,058		1,223		800		4,031	

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Tab. A3 – Multinomial logistic regression on the choice of upper secondary school in the 10th grade versus Technical track with interaction between parental education and INVALSI test scores in the 8th grade (Italian)

Variables	*Scientific and Classic Lyceums*	*Other Lyceums*	*VTC*
Italian Score 10th grade	0.02***	0.00	-0.03***
	(0.00)	(0.00)	(0.00)
Highest Parental Education (ref. Lower sec.)			
Upper Secondary	0.06	-0.58	-0.85
	(0.99)	(0.79)	(0.72)
Tertiary Degree	1.12	1.05	-0.50
	(1.13)	(1.03)	(1.34)
Upper secondary * Italian Score 10th grade	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
Tertiary Degree * Italian Score 10th grade	0.00	-0.00	-0.00
	(0.01)	(0.00)	(0.01)
Female	0.43***	2.16***	0.37***
	(0.10)	(0.11)	(0.10)
1st generation immigrant	-0.29	-0.09	-0.25
	(0.37)	(0.28)	(0.26)
2nd generation immigrant	-0.30	-0.03	-0.22
	(0.21)	(0.19)	(0.18)
Grade repetition (ref. never)			
At least one year	-1.89***	0.52*	1.15***
	(0.57)	(0.27)	(0.21)
Intercept	-6.08***	-2.46***	5.39***
	(0.84)	(0.63)	(0.52)
Observations	4,054	4,054	4,054

Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Source: Our own analysis of data from INVALSI, 2017 and 2019

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Tab. A4 – Multinomial logistic regression on the choice of upper secondary school in the 10th grade versus Technical track with interaction between parental education and INVALSI test scores in the 8th grade (Mathematics)

Variables	*Scientific and Classic Lyceums*	*Other Lyceums*	*VTC*
Mathematics Score 10th grade	0.02***	-0.01*	-0.03***
	(0.00)	(0.00)	(0.00)
Highest Parental Education (ref. Lower sec.)			
Upper Secondary	0.45	-0.75	-1.62**
	(0.95)	(0.72)	(0.70)
Tertiary Degree	1.95*	0.47	-1.70
	(1.08)	(0.92)	(1.25)
Upper secondary * Italian Score 10th grade	0.00	0.01*	0.00
	(0.00)	(0.00)	(0.00)
Tertiary Degree * Italian Score 10th grade	0.00	0.00	0.00
	(0.00)	(0.00)	(0.01)
Female	0.84***	2.12***	-0.13
	(0.10)	(0.10)	(0.10)
1st generation immigrant	-0.29	-0.24	-0.08
	(0.38)	(0.28)	(0.25)
2nd generation immigrant	-0.25	-0.17	-0.20
	(0.21)	(0.18)	(0.18)
Grade repetition (ref. never)			
At least one year	-1.86***	0.41	1.16***
	(0.62)	(0.27)	(0.22)
Intercept	-6.31***	-0.78	5.53***
	(0.83)	(0.60)	(0.53)
Observations	4,031	4,031	4,031

Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Source: Our own analysis of data from INVALSI, 2017 and 2019

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4. Finding Forrester. An empirical study on foreign students penalty in Italian high schools

by Lorenzo Maraviglia

Knowledge doesn't start from perceptions or observations or the collection of data or facts but it starts, rather, from problems.
(K.R. Popper)

According to updated projections (ISTAT, 2020), the number of students attending Italian primary and secondary schools will sharply decline in the next few years; in the meanwhile, the share of immigrant pupils is about to increase constantly. Successful educational integration of the latter will become pivotal for the prospective performance of the overall social and economic system. This issue is part of the wider challenge of tackling diversity and growing complexity within the framework of our educational system. In such context, great attention should be paid to divergent clues. In this perspective, following Kiss (2013) contribution and drawing on INVALSI data, Pini and Triventi (2016) have shown that, individual test scores being equal, immigrant students tend on average to receive lower midterm marks than natives in Italian and Math. In a school where enrollment of foreign born teachers (other than language teachers) is still far to come, such signal must be considered seriously and with scientific attitude. The present work contributes to the discussion leveraging the extraordinary extension and coverage of INVALSI data in order to describe geographic (at NUTS3 level) and typological (with reference to school features) variation in potential discriminatory evaluation of immigrant students. Although exploratory, such work is a necessary premise for more structured causal analysis and identification and for the objective assessment of the extension of a possible emerging problem. More specifically, we show that risk of discrimination is higher in lyceal institutions and, more generally, in schools where students are strongly selected according to social features (positive selection).

Alla luce delle proiezioni più recenti (ISTAT, 2018), il numero di studenti delle scuole primarie e secondarie del nostro Paese è destinato a ridursi drasticamente nei prossimi anni. Contemporaneamente aumenterà la quota

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di alunni immigrati e/o figli di immigrati e l'integrazione di tali soggetti assumerà un'importanza centrale per la performance del sistema sociale ed economico. La questione è parte della più ampia sfida relativa a come affrontare condizioni di crescente diversità e complessità all'interno del sistema educativo nazionale. A questo proposito, traendo ispirazione dal lavoro di Kiss (2013) ed attingendo ai dati INVALSI, Pini e Triventi (2016) hanno mostrato che, a parità di risultati nei test somministrati, gli studenti immigrati nel nostro Paese tendono ad avere una valutazione mediamente più bassa rispetto ai nativi in Italiano e Matematica nelle pagelle del primo trimestre. In una scuola in cui l'inserimento di insegnanti stranieri/immigrati (fatta eccezione per i docenti di lingue) è ancora di là da venire, questo segnale dovrebbe essere considerato con attenzione e con attitudine scientifica. Il presente lavoro contribuisce alla discussione sfruttando la straordinaria estensione e copertura dei dati INVALSI, con l'intento di ricostruire la variabilità geografica (a livello di province) e tipologica (con riferimento alle caratteristiche delle singole scuole) di un'eventuale valutazione discriminatoria degli studenti stranieri. Seppur esplorativa, questa analisi è una premessa necessaria per ricerche più strutturate, volte ad indagare il tema sotto il profilo dei processi causali. Più specificamente, mostreremo che il rischio di discriminazione è più elevato nei licei e, in generale, nelle scuole in cui gli studenti tendono ad essere fortemente selezionati in base a caratteristiche di status (selezione positiva).

1. Introduction

Foreign students account for a growing share of Italian school population (MIUR, 2019). In some of the most productive areas of the country, the incidence of this group exceeds 20% among primary school pupils and such figure is expected to increase in the future. Following this epochal change, concerns begin to emerge about the model of integration of these students. The issue is exacerbated by the fact that almost all teachers – at any school level – are native Italians, often lacking specific training on this subject.

The risks of possible, subtle, forms of penalization of students belonging to ethnic or national minorities have been highlighted in the international literature. The problem has been thoroughly discussed in Anglo-Saxon countries (Heckman and Cuhna, 2010) and Northern Europe (Kiss, 2013). Building on this strand of literature, and taking advantage of the great cognitive potential of INVALSI data, Pini and Triventi (2016) find that «INVALSI score being equal, foreign students tend to receive lower marks than their

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Italian peers, especially in primary school [...] foreign students born in Italy are generally less penalized than those born abroad but the differences are small [...] the under-assessment varies according to the subject, being more pronounced in Mathematics than in Italian».

Obviously, this statement requires further investigation. Thanks to their standardized nature and controlled methods of administration, INVALSI scores provide an important test for the ability of the national school system to integrate foreign students, guaranteeing the same chances of success reserved for their Italian mates. The fact that a possible penalization tends to appear more pronounced in lower grades could depend on heterogeneity of teachers[1], but also on differences in qualitative composition of foreign students, due to the fact that national structure of migration flows has changed over time; or it could be a consequence of the existing tracking mechanisms, resulting in more homogeneous secondary classes.

This empirical study places itself in the wake outlined by Pini and Triventi and tries to develop some of the ideas raised by them, in particular by exploring some aspects of territorial (between local systems of our country) and school (between types of high schools) variability of gaps between INVALSI results and curricular marks.

2. Data

The data that form the subject of our empirical analysis come from the INVALSI questionnaire administered in the second classes of Italian high schools in the year 2017/2018. Specifically, we will focus on the comparison between students' results in the Math test (INVALSI score in MAT) and marks received at the end of the first quarter (first term mark in MAT). The distribution of the two variables in the sample is shown in the upper panels of Figure 1.

Students distribution by school type (bottom-left panel) exhibits a certain balance[2] whereas that by citizenship shows a clear prevalence of the Italian

[1] For example, this could depend on the fact that primary school teachers receive less training on subjects that help in managing linguistic and cultural differences. However, this point is controversial and we will not address it specifically in the following.

[2] Lyceums are divided into those implementing a scientific curriculum (LIC_S) and all the others (LIC_A). Unfortunately, the analysis suffers from the high level of aggregation with which information about the school attended by students is made available in the micro-data accessible to researchers outside INVALSI.

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component[3]. Ethnic imbalances are highly variable across schools and territories – a point that will be taken up in the discussion.

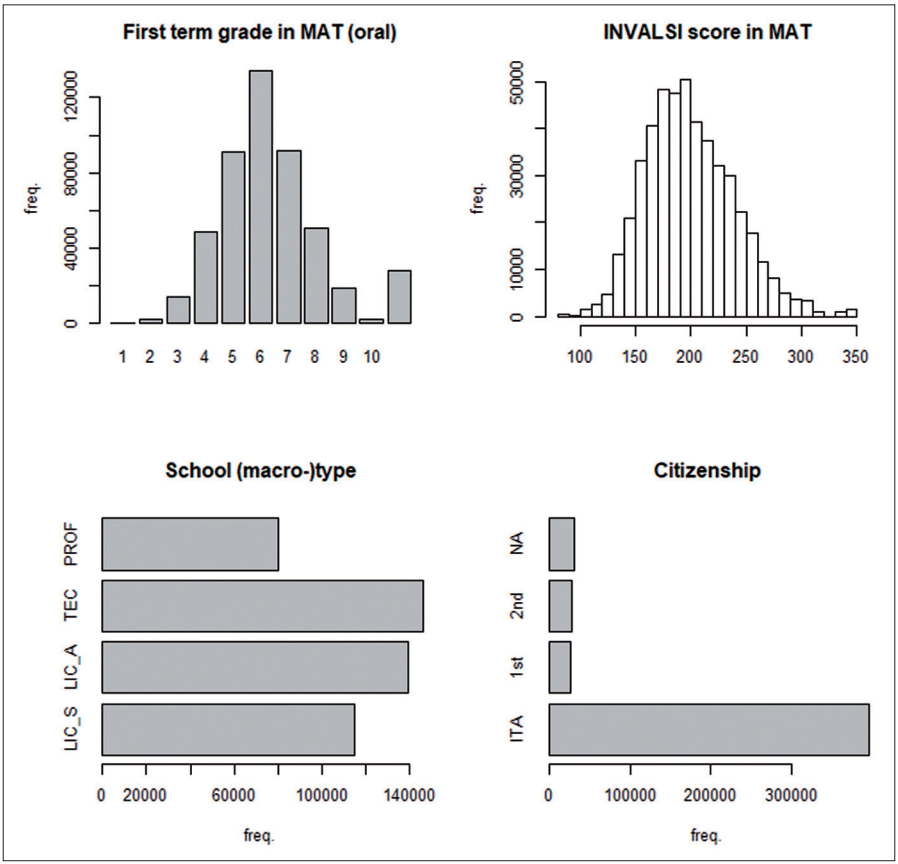

Fig. 1 – Descriptive statistics

Source: elaboration on INVALSI micro-data

[3] Students for whom nationality is not available (coded "NA") were treated as a separate category in the regression models; the results with respect to this group are not presented in the following tables and graphs. The overall sample size (including Nas) is 452,792 cases.

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3. Analysis

Our analytical strategy is based on regression. We start by estimating a linear model in which the mark in Math received at the end of the first quarter is regressed on students' citizenship, type of school attended and INVALSI score:

$$mark_i = a + b * citizenship_i + c * score_i + d * school_i + e_i$$

with e_i being the error component assumed to be normally distributed, with zero mean and s standard deviation.

The predictor we are most interested in is, obviously, students' citizenship. Since citizenship is a categorical variable, the regression coefficients associated with it provide an estimate of the average difference in Mathematics marks between Italian students (reference category) and, respectively, first and second generation foreign students, after controlling for type of school attended and INVALSI score. Territorial variability is not taken into consideration at this level, but will be discussed later in the analysis. The results (parameters) are shown in table 1. Instead of just the final parameters, we report the results of a series of models of increasing complexity, starting from the intercept-only model (Mod. 0) and ending with the one including all main effects plus an interaction term between citizenship and school type (Mod. 4). This allows to appreciate the variations in the coefficients – in particular in those associated with citizenship – as new stratification criteria are added to the analysis.

The difference in the average oral Math mark between Italian and foreign students is about 1/3 of a point (Mod. 1). This result is obtained before controlling for any other variable, therefore it has a purely descriptive value. In the second model (Mod. 2) the INVALSI score is added to the predictors; this allows to adjust for heterogeneity in the actual average Mathematics skills of the two groups, thus revealing a possible penalization of foreign students.

The point is delicate and potentially controversial. Assuming that the INVALSI score captures the true state of things, while the judgment expressed by teachers might be affected by prejudices, is a very strong position which we do not intend to support. We only want to draw attention to an aspect which, where confirmed by the analysis, should raise doubts and stimulate discussion within the community of scholars and teachers.

Therefore, we simply record that, INVALSI score being equal, the average difference between marks of Italian and foreign students shrinks to about one tenth of a point (0.10 per first generation, 0.15 for second generation), while remaining statistically significant.

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Tab. 1 – Regression models coefficients

	Mod_0		*Goodness-of-fit statistics*		
Parameters	*Est.*	*S.E.*	*N. obs*	*AIC*	*R-squared*
(Intercept)	6.04	0.00	452,795	1,612,962	
	Mod_1		*Goodness-of-fit statistics*		
Parameters	*Est.*	*S.E.*	*N. obs*	*AIC*	*R-squared*
(Intercept)	6.09	0.00	452,795	1,609,688	0.01
Italian (reference)					
First generation	-0.38	0.01			
Second generation	-0.31	0.01			
	Mod_2		*Goodness-of-fit statistics*		
Parameters	*Est.*	*S.E.*	*N. obs*	*AIC*	*R-squared*
(Intercept)	6.05	0.00	452,795	1,521,648	0.17
Italian (reference)					
First generation	-0.10	0.01			
Second generation	-0.15	0.01			
INVALSI mat score (centered)	0.13	0.00			
	Mod_3		*Goodness-of-fit statistics*		
Parameters	*Est.*	*S.E.*	*N. obs*	*AIC*	*R-squared*
(Intercept)	5.73	0.00	452,795	1,506,594	0.20
Italian (reference)					
First generation	-0.11	0.01			
Second generation	-0.14	0.01			
INVALSI mat score (centered)	0.17	0.00			
Science Liceum (reference)					
Liceum (other)	0.61	0.01			
Technical school	0.16	0.01			
Professional school	0.58	0.01			
	Mod_4		*Goodness-of-fit statistics*		
Parameters	*Est.*	*S.E.*	*N. obs*	*AIC*	*R-squared*
(Intercept)	6.11	0.00	452,795	1,506,415	0.20
Italian (reference)					
First generation	-0.14	0.03			
Second generation	-0.22	0.02			
INVALSI mat score (centered)	0.17	0.00			
Science Liceum (reference)					
Liceum (other)	0.61	0.01			
Technical school	0.16	0.01			
Professional school	0.54	0.01			
Interaction terms					
First gen. * Liceum (o.)	-0.11	0.03			
Second gen. * Liceum (o.)	0.02	0.03			
First gen. * Technical	0.04	0.03			
First gen. * Professional	0.16	0.03			
Second gen. * Technical	0.11	0.03			
Second gen. * Professional	0.15	0.03			

Source: elaboration on INVALSI micro-data

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In the next model (Mod. 3), school type is introduced among the predictors. School is an important element because, at high school level, Italians and foreigners tend to make different choices – foreigners are strongly under-represented in lyceums – and a possible inclination to penalize the latter could vary according to the type of institution attended. To fully grasp this point, we do not limit ourselves to considering the main effects of the type of school but we also introduce the interactions between school and citizenship (Mod. 4). Given the difficulty of interpreting the coefficients of a model with interactions, we plot results (Fig. 2).

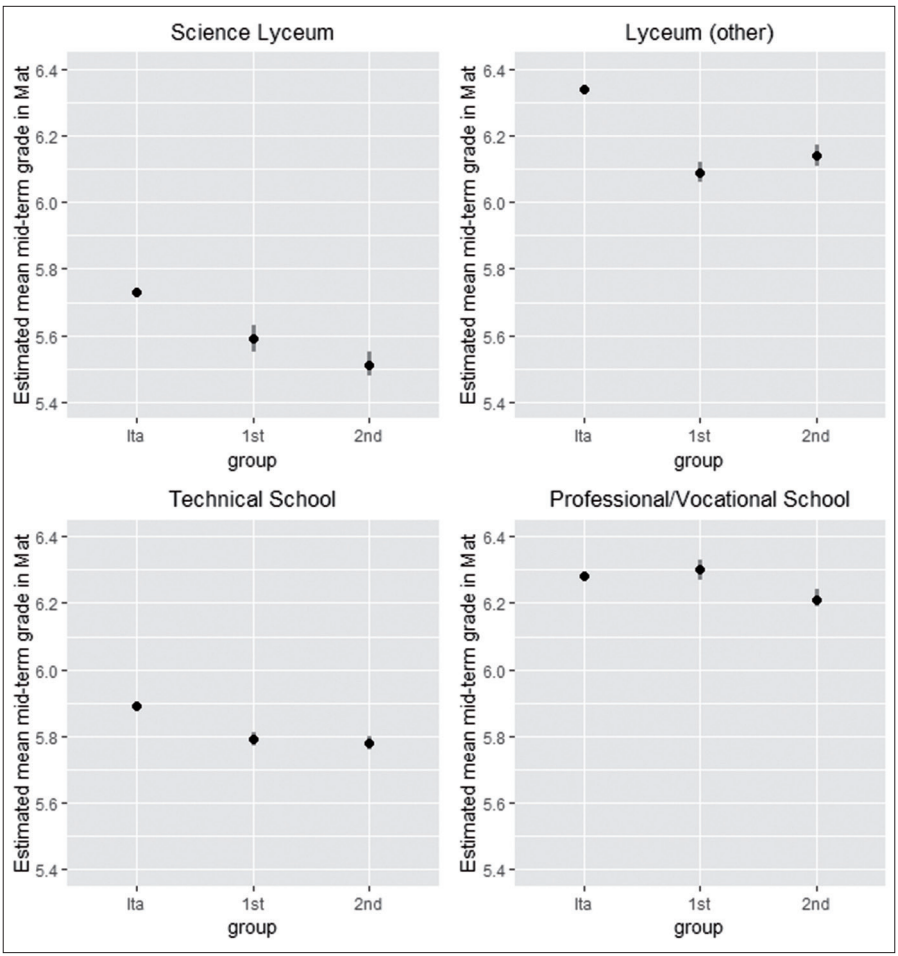

Fig. 2 – Regression model with interaction term between citizenship and school type

Source: elaboration on INVALSI micro-data

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As it can be seen, the penalty factor is marked in lyceums, both scientific and other type, and more limited in technical and professional schools; the latter are also the types of schools in which foreign students are more represented. Therefore, the penalty tends to be maximum where presence is minimal, and vice versa.

4. Territorial heterogeneity

So far, the issue of geographical heterogeneity has not been addressed in our models. It is however clear that, since school outcomes vary greatly from place to place (and the same holds for characteristics of immigrant population), the topic deserves attention. The following is a first attempt to organically include the territorial dimension in the systematic study of the penalization of immigrant students. The choice of the territorial level of analysis is extremely important. In the majority of available studies, the students population is generally stratified by NUTS1 or, at most, by NUTS2 region. In this way, however, much of the local variability that characterizes our country is lost. A very promising type of geographical aggregation, made possible by the level of detail with which the INVALSI micro-data are provided, is that of the Local Market Areas (LMAs) defined by ISTAT on the basis of the census results. Local Market Areas are groups of adjoining municipalities which contain within their aggregated borders a predefined share of commuting flows. In practice, LMAs are relatively homogeneous socio-economic areas, identifying sort of local labor markets; given the connection between characteristics of the labor market, composition of the immigrant population and training choices made by young people and their families, it can be understood how relevant this dimension is for the purposes of our study.

To encompass the territorial element in our analysis, we adopt a multilevel framework by estimating the following model in which both the intercept (a) and the angular coefficient of citizenship (b) are allowed to vary according to the Local Market Area:

$$mark_i = a_j + b_j * citizenship_i + c * score_i + u_j + e_i$$

where $_j$ index students residence in one of over six hundred LMAs identified by ISTAT.

Given the complexity of the model and the large number of parameters implied by it, we provide a summary representation of the results by reporting average differences in marks between Italian and foreign students, INVALSI score being equal, on a map.

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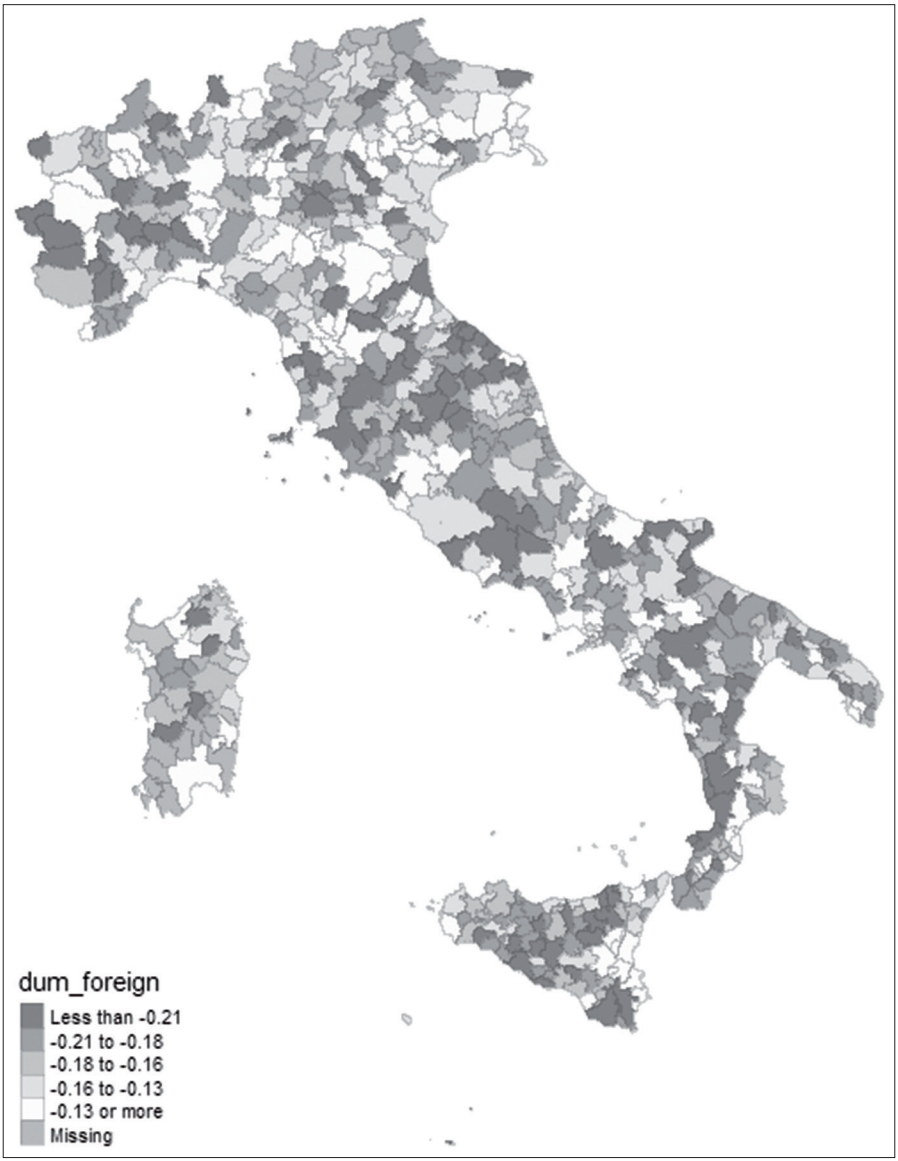

Fig. 3 – Differences in Math marks between Italian and foreign students, INVALSI being equal; geographic distribution at LMAs level

Source: elaboration on INVALSI micro-data

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On average, the penalization of immigrants tends to be lower in the North-East (Veneto, Emilia Romagna) and higher in Central and Southern Italy. There are however exceptions which certainly deserve to be investigated in more detail. In general, what can be drawn from the observation of the map is that the phenomenon has a significant level of geographic correlation; this points to the possible existence of contextual factors (social, economic, cultural) that can interact with some more general elements depending on the way teachers are selected and trained[4].

5. Discussion

Pini and Triventi conclude their study (2016) observing that they cannot rule out that «some kind of "statistical discrimination" is at work: professors, in case they are uncertain about how to evaluate foreign students, could be influenced by stereotypes ethnic, ending up penalizing them compared to their Italian companions». Obviously this is a strong statement; however, as the two authors write, this cannot be excluded in the presence of a persistent evaluation gap after controlling for auxiliary elements, such as INVALSI scores.

This study has tried to further explore the issue of penalization by deepening the investigation with respect to the heterogeneity of types of schools and territories. Especially for the latter, further development possibilities are foreseen, once the extraordinary opportunities deriving from the combination of the geographical detail allowed by the data and the power of the multi-level instruments are adequately deployed (Gelman and Hill, 2007). As far as schools are concerned, a greater typological detail would certainly be necessary which would allow, for example, a distinction to be made between the residual category of "other lyceums" and humanistic and artistic or socio-pedagogical ones.

In the coming years, the share of young foreigners who attend high schools in our country is expected to grow significantly. This will take place in a context of generalized reduction in the number of students, following the demographic crisis affecting our country. In general, young foreigners will

[4] It can be observed that North-East areas exhibit (on average) a higher incidence of foreign students. However this is true even for many areas in the North-West or in the Center of Italy. North-East (especially Veneto and Trentino-Alto Adige) is also where average INVALSI scores are higher than the rest of the Country, and this could provide an additional explanation (the higher teaching quality, the lower penalization). However, we are simply suggesting some directions for future research, without any strong affirmative intention.

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become an essential part of the national workforce and production potential, as well as an essential resource for the survival and renewal of prestigious high school curricula (e.g. classical lyceums and traditional scientific lyceums) who are now experiencing a marked reduction in enrollments. These schools are also those where, today, foreign students are less represented and, where present, apparently more penalized in terms of assessment. These aspects, perhaps, are not only empirically related but arise from a common substratum that deserves to be investigated.

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5. Data on learning and teacher decision-making. An "Italian marriage"?

by Serafina Pastore, Cataldo Scarnera, Lucia Pallucca

Nowadays, the references to a teacher professional model that is evidence-based and data-driven have reinforced the need for teachers to avoid take decisions on the base of their perceptions and anecdotes. Furthermore, teachers are called to use data gathered from different sources in order to inform their teaching practice and to develop better levels of assessment and data literacy. Therefore, teacher data-driven decision-making rouses great interest. Different studies, moreover, have pointed out that if teachers (and principals) effectively use data, students' learning achievements will improve.

Data, especially those gathered from large-scale assessment programs, despite recent requests of a radical revision of their rationale and structure, can be used for different aims: school improvement, revision of instructional practice, accountability.

If, on the one hand, it has been proved that contextual factors can influence the use of data, on the other hand, it is true that data characteristics and data systems can influence how data are used. In this vein, the use of data from large-scale assessment programs depends on the users' characteristics. Consequently, crucial elements are the teachers' and principals' assessment competences in analysing and interpreting data, in highlighting criticalities and problems on the school performance, and in designing what actions take (assessment literacy).

Assuming that data, at macro and micro-levels, allow different uses, this paper reports on the first phase of a research project realized in a primary school in the South of Italy and aimed to implement an interim assessment system. Moving from an analysis of INVALSI data at micro-level (school year 2018/19), two different rounds of teacher professional development have been realized to train teachers to analyse INVALSI data, and to design

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new assessment tests on students' learning. Recalling the main aspects of this study, the paper critically reflects on how to facilitate the standardized assessment data use for the teaching practice.

I richiami a un modello professionale evidence-based e data-driven*, negli ultimi anni, hanno costantemente ribadito la necessità di evitare che le decisioni degli insegnanti si basino su aneddoti e intuizioni. Ciò implica che gli insegnanti usino dati provenienti da diverse fonti per informare la propria pratica didattica e che, in termini più generali, sviluppino migliori livelli di* assessment *e* data literacy*. Il* decision-making *basato sui dati desta, oggi, particolare attenzione. Diversi studi, del resto, hanno dimostrato come l'uso efficace dei dati da parte degli insegnanti (e dei dirigenti) possa indurre un miglioramento reale della scuola in termini di apprendimento maturato dagli studenti. I dati, specie quelli ricavati dalle rilevazioni su vasta scala sull'apprendimento degli studenti, al di là delle istanze di revisione profonda di tali programmi di valutazione, possono essere utilizzati per finalità diverse: miglioramento della scuola, azione didattica,* accountability*. Se, da un lato, è stato dimostrato come gli aspetti contestuali possano influire sull'uso dei dati, è anche vero che le caratteristiche dei dati e dei sistemi di dati possono influenzare le modalità di utilizzo dei dati stessi. Pertanto l'uso dei dati ricavati dalle rilevazioni su vasta scala sull'apprendimento degli studenti dipenderebbe dalle caratteristiche degli utilizzatori e, pertanto, dai livelli di competenza di docenti e dirigenti,* in primis*, nell'analizzare e interpretare i dati, nell'individuare criticità e problemi nelle performance della scuola e nel definire le azioni da intraprendere (*assessment literacy*).*

A partire dalla considerazione che i dati, a livello macro e micro, consentano diversi usi, il presente paper riporta la prima fase di un progetto di ricerca realizzato in una scuola primaria del Sud Italia e teso a implementare un sistema di interim assessment. L'analisi micro dei dati INVALSI (anno scolastico 2018/19) ha così portato a definire due diversi percorsi di sviluppo professionale per gli insegnanti in modo che potessero analizzare i dati INVALSI e, comprendere come progettare nuove prove, raccogliere, usare e riportare i dati sull'apprendimento degli studenti. Nel richiamare gli aspetti principali di questo studio, il contributo riflette criticamente sulle modalità con cui veicolare e facilitare un uso estensivo dei dati ricavati dalle valutazioni standardizzate ai fini dell'insegnamento.

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1. Introduction

The changes undergone by national educational systems in replying to the accountability requirements, over the years, have led school personnel (first of all, principals and teachers) to face with different evaluation data, information, and methods. The new evaluation and assessment modalities have been often perceived as a mere control not really responsive to school realities and to instructional needs (DeLuca, 2012; Freddano and Pastore, 2018; Stiggins, 2017). The attempts to reduce these, sometimes, radical positions, have showed how data, especially those gathered through large-scale assessment, may be used to support and improve student learning levels (Wiliam, 2010; 2011).

The data use to inform teaching action is not new in the educational assessment field. Teachers have always used student tasks and test results to judge how, and what, their students have understood or achieved. What is new is the link to accountability systems. For the sake of the truth, if on the one hand educational research in this field has demonstrated how large-scale assessment data may be useful for the design of improvement actions within the school organization, on the other hand, it is clear how teachers and students tend to consider these data not really useful (Castoldi, 2014; Pastore and Freddano, 2017; Rogosa, 2005; Supovitz, 2009). The attempts to mitigate the negative effects related to the accountability requirements (e.g. in the U.S. context or in Australia and New Zealand), trying to combine large-scale and classroom assessments in order to define a more coherent national assessment system, have led to new, mixed, assessment modalities, such as the interim assessment. Defined as a recurrent assessment realized different times over the school year, this assessment measures students' knowledge and skills in order to define their achievement levels and track their progresses through the national curricular standards (Herman, 2016; Crane, 2008). In Italy, this kind of assessment has been suddenly identified, in a more practical perspective, as "parallel tests" (literally, "prove parallele").

The present paper, on the base of the concepts of assessment and data literacy nowadays largely widespread in the educational assessment field, reports on a research project purposed to implement, over two years, an interim assessment system within a primary school in the South of Italy. Moreover, this research project is aimed to support, through different rounds of professional development paths, the teachers involved in the school data-team. More specifically, the paper in the first section offers a brief literature review of the studies focused on the concepts of teacher assessment and data literacy, decision-making, and interim assessment. The second one, instead, re-

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ports on the first phase of this two years research project aimed to implement an interim assessment system with a strong link to the rationale and structure of the INVALSI large-scale assessment and of the INVALSI frames of reference (Quadri di riferimento). The third part, finally, offers a reflection on the main criticalities and implications for educational research and teacher education in the Italian school system.

2. Background and conceptual framework

2.1. Assessment and data literacy

The large spread of the evidence-based and data-driven professional model for teachers (Thorpe, 2014) has gone along with the need teachers avoid, as much as possible, to take decisions using intuitions or anecdotes. In this vein, teachers are called to use data gathered from different sources to inform their teaching practice and develop, in more general terms, better levels of assessment and data literacy (Popham, 2018). While teacher assessment literacy, for a long time, has been limited only within the context of the classroom, nowadays, it is considered more on the school system perspective. This conceptual enlargement is relevant in terms of what teachers are expected to do. Assessment literacy includes the capacity of teachers to read, interpret, and use data for different aims:

– the school self-evaluation process;
– the decision-making;
– the design and implementation of improvement actions (Mandinach and Gummer, 2012; Schildkamp and Portman, 2015).

The relevance recognized to data and to assessment information has led recently to the increasing attempts to define teacher assessment literacy pointing out the need of teachers to use data in a continuous, effective, and ethical way. Therefore, teachers should be able to transform information gathered through different modalities, such as those offered by the large-scale assessment programs, in a knowledge useful for their decision-making (Pastore and Andrade, 2019). The emphasis on data has led, sometimes, to conflate the just overlapping concepts of assessment and data literacy. In this perspective, the concept of data literacy has to be better defined (Mandinach and Gummer, 2012): data literacy represents a set of different knowledge and abilities that allow teachers to transform data in information, and information in knowledge functional to action. Therefore, the decision-making represents a crucial component.

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Decision-making is the process through which administrators and teachers gather and analyse data to guide instructional practice. Furthermore, the widespread of the decision-making is inextricably connected to the accountability requirements. The assumption under the current educational policies is that teachers are called to know how to analyse, interpret, and use data in order to take aware decisions on how to improve student learning (Datnow, Park and Kennedy-Lewis, 2013). Different studies have showed how an effective data use made by principals and teachers should bring on a real school improvement in terms of learning achieved by students. Data, especially those gathered from large-scale assessment programs, beyond their limits, criticalities, and the frequent requests of revision, (Chudowsky and Pellegrino, 2003), can be used for different aims (e.g., school improvement, instructional practice, accountability). Thus, teachers are expected to use data in order to improve teaching and learning. However, after decades of accountability pressures, teachers still continue to struggle in using data to inform their practice. Sometimes, the reason is related to teacher data and assessment illiteracy (DeLuca, 2012). Moreover, teachers have difficulties in interpreting large-scale assessment data and in transferring information to review and improve their teaching action.

There are two possible explanations for this problem:

1) data and results of large-scale assessment programs are reported in a way that does not match the teacher assessment literacy. Thus, teachers have difficulties in interpreting data and in using them in an appropriate way at classroom and school level;
2) data content does not correspond to information needed by teachers. So difficulties start to arise when teachers have to transfer data in actions.

A consistent part of studies focused on the first explanation. These studies have constantly pointed out how the improvement of teacher assessment and data literacy levels is related to the curriculum of teacher education courses and to the quality of professional development paths. Other studies, instead, have focused on data presentation and interpretation: the key aspect, in this perspective, is to present data in a way that match teacher assessment and data literacy levels. For example, K. Schildkamp and C.L. Portman (2015) address many variables that can influence teacher decision-making:

– how data-teams are organized in data use;
– the training of the data-teams on data use;
– the characteristics of the data-teams;
– the levels of data literacy and pedagogical content knowledge of teachers involved in the data-teams.

D. Slavit, T.H. Nelson and A. Deuel (2013) have demonstrated how many times teachers don’t understand what kind of data they need in order to have

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useful information about student understanding or student thinking. At the same time, teachers have not information sufficient to inform their teaching action. Another problem in the data use is related to the incapacity of teachers to ask the right questions to data. As a consequence, teachers have not a "meaningful" dialogue with data; so teachers are not able to transform data in useful and usable information.

L. Kallemeyn (2013) has showed how two routines facilitate teachers' data use: teacher collaboration and teacher inquiry. When these two processes are combined they allow teachers to experience the "data-cycle" (Ackoff, 1989): teachers can gather, analyse, and create knowledge that can be transformed in teaching action. However, teachers, sometimes, are not able to query the data; sometimes, they use data in very simplistic way, disaligned with their teaching action. Following E. Farley-Ripple and J. Buttram (2015) teachers manifest a literacy gap in establishing which results have to be used to effectively and responsively reply to problems highlighted by data. The teacher knowledge and the understanding of different modalities for data use are really limited. J.A. Marsh, M. Bertrand and A. Huguet (2015) define, therefore, this process as "data-practice divide", the gap teachers demonstrate in having, interpreting, and giving data a meaning in order take instructional decisions. It is also true, however, that, if on the one hand, contextual variables may influence data use, on the other hand, data characteristics and data systems may influence how data are used. A. Datnow, V. Park and B. Kennedy-Lewis (2013) suggested to look more carefully at modalities teachers use to interact with data and reply to data on student learning. In this way, teachers' professional learning needs can be identified, and more responsive professional development paths can be, therefore, implemented.

Given this premise, the present paper reports on a possible model of integration between the INVALSI data and a system of interim assessment coherently balanced and aligned with the national curriculum standards. The next paragraph is devoted to illustrate the main aspects of the interim assessment.

2.2. The interim assessment

Widely spread in the US context, as a consequence of the *No Child Left Behind* policy instances, the interim assessment, despite its clear accountability rationale, is aimed to support school improvement processes focusing on the improvement of student learning performances. Moreover, this assessment is also related to the improvement of actions teachers implement

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to pursue a continuous and coherent alignment with national curricular standards. Precisely because interim assessment replies both to accountability and improvement requirements, this kind of assessment is generally integrated by professional development paths aimed to train teachers to use, in a systemic and continuous way, evidence-based assessment and to take instructional decisions responsive to student learning needs.

The interim assessment is, in this perspective, a powerful lever for the improvement of student learning: teachers can use data on student performances to diagnose and monitor student learning; at the same time, teachers can modify, adjust, and differentiate their teaching actions.

The rationale below is clear: more the teaching action replies, with data gathered through several assessments, to student learning needs, more chances there are to improve instruction. Paraphrasing P. Goren (2010): if we test student learning and have data, then we will improve the overall quality of the school system.

Generally, the interim assessment consists in a set of standardized tests very similar to national and international large-scale assessment tests. With a strong link to the national curricular standards, the interim assessment, however, has a reduced number of test items, and it can be administered several times over the school year (e.g., from three to five times) (Babo, Tienken and Gencarelli, 2014; Henderson *et al.*, 2007; Pereira and Teiken, 2012; Williams *et al.*, 2014).

M. Perie, S. Marion and B. Gong (2009) underline that interim assessment presents some similar characteristics with formative assessments, namely, that these types of assessment are conducted more frequently and have a narrower content focus than do summative assessments. The researchers point out also that interim assessment can be used to pursue three main kinds of aims:

1) instructional. These aims are related to the data use among teachers to modify and adapt curriculum and instruction to promote students' attainment of learning goals;
2) evaluative. In this case, assessment results may be used at the classroom, school, and regional levels to examine curricular or instructional effectiveness;
3) predictive. These purposes deal with score use to make judgments about how students may perform on an end-of-grade, summative assessment. Interim assessment scores can been used to anticipate student performances in the summative assessments (e.g., at the end of a module) or in the national large-scale assessment program (in this case, however, it is required a good alignment between the interim assessment tests developed by teachers and the national curricular standards).

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In Italy, interim assessment, in the terms and characteristics reported above, currently is not widely used. Very often, here, interim assessment has been associated only with the teachers' attempts to develop standardized tests administrated to students of the same grades within a school. Therefore, the implementation of this assessment has been rhapsodic and no systemic, in the hands of schools' and teachers' initiatives. Moreover, this assessment, when implemented, remains largely focused only on the instructional aims because limited to the identification of weak areas in the students' learning. In this perspective, data on student learning levels allow teachers, in most of the cases, only to define remedial teaching actions. However, it has to be noted that the interest in analyse and document the effects of interim assessment not only on student learning, but also on the improvement of teaching action, as well as on the impact of educational policy decisions at school and classroom levels, is recent. Achieving a meaningful change implies teachers have, as reported above in this chapter, a sufficient level of literacy in the educational assessment domain: if it is true that the interim assessment helps to identify the improvement areas, then it is responsibility of the school personnel to use assessment information in the right way to revise and adjust instructional actions. In this vein, S. Blanc, J.B. Christan, R. Liu, C. Mitchell *et al.* (2010) confirm that the success in the implementation of a good interim assessment system depends by the principal's and teachers' knowledge and abilities to transfer that system in the daily school life. Accountability measures, a strong curricular guide, and periodic assessments do not assure the school improvement, as well as the improvement of student learning performances. Data can make more evident the problems, but then are the actors to be called to solve the problems. For this reason, it is necessary to support teachers in refining their assessment and data literacy through *ad hoc* professional development paths.

3. The research project and the teacher professional development path

3.1. Research aims and questions

In the follow it is reported the first phase of this two years research project focused on promote teachers' assessment and data literacy. More specifically, the focus is on how to read, analyse, and use not only the INVALSI data at micro-level (classroom level) but also data gathered through the design and the implementation of an interim assessment system. In this way, teachers, matching different kind of assessment data, should be able to reply more

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effectively to the school context requirements and needs. In this case, considering the latent teachers assessment illiteracy and their lack of experience in the interim assessment, it has been decided to use the data gathered only for instructional and evaluative aims.

The study moves from the following questions:

- RQ1: Is it possible to analyse the INVALSI data at micro-level?
  - SQ2: What are the practical implications for teachers?
  - SQ2: What are professional needs teachers have related to the assessment and data literacy domains?
- RQ2: How to implement a system that allows teachers to compare and contrast national large-scale assessment program results with school interim assessment results?

INVALSI data (school year 2018/19) have been analysed at micro-level and shared with teachers before the dissemination of the INVALSI yearly report to schools. Data have been analysed at classroom and student level.

The next paragraphs bring back on the first research questions and on the results of the INVALSI data micro-analysis. Moreover, a description of how the interim assessment has been designed (its rationale) is reported.

3.2. The school context

The present project involves the "San Giovanni Bosco" school placed in two different contexts. In the first case, the school is in the city centre and one of the main problems is the population decline; in the second case, instead, the school is in a little suburb. Here, the school has to deal with a culturally deprived context characterized, however, by the active involvement and participation of families in the school life. On the whole, the school has a very heterogenic catchment area with low incoming students and a relevant number of students with a high socio-economic background. Therefore, the school deals with very different problems. For this reason, over the years, the educational activities and the remedial initiatives have been purposed to reduce gaps between student performances.

In this perspective, the collaboration between the school and the families is a key aspect: the voluntary works of parents and the civic engagement have effectively improved the perceptions of internal and external school's stakeholders. At the same time, teachers, if on the one hand, have progressively oriented their instructional design to a more inclusive perspective, on the other hand, they have paid increasing attention to the school efficacy monitoring student achievements and reviewing their instructional practices.

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The present project has been developed, since May 2019, in replying to the school's data-team needs: teachers asked for a conceptual and practical knowledge in order to interpret INVALSI results and share them with colleagues for the self-evaluation process. The difficulties to query INVALSI data led teachers to ask for different kind of analyses. INVALSI report, in fact, while is useful to compare a school with different or similar contexts, has been perceived by teachers as not really helpful in reporting information about single students or groups of students performances within their school. As a consequence, teachers have had several doubts, perplexities, and concerns about the real use of INVALSI data in their daily teaching practice. Moreover, teachers have considered the reporting time of the INVALSI results as not functional to pursue the planned improvement actions. Thus, the school's data-team was in trouble with its workload, perceived as unfeasible and not useful.

Once the raw INVALSI data have been gathered (May 2019) a first training path has been implemented for teachers in order to support them in the analysis and interpretation of results at micro-level.

3.3. The data

Gathered micro-data of second and fifth grades have been imported in PSPP. First of all, descriptive analyses have been performed: the focus on basic statistical analysis has been functional to train teachers to understand how to perform data analysis and how to use results on students' learning. Then, the micro-data have been compared with the official INVALSI results. These micro-data have been also linked to INVALSI micro-data for each student: thus, using student panels, teachers have been able to compare macro and micro-data. More specifically, performing student panels has allowed to record "snapshots" of students' learning. Insofar panels of data are less informative than event-history data, they have had some benefits for teachers. Generally speaking, in fact, student panels:

– are more informative (more variability, less collinearity, more degrees of freedom) and its estimates are more efficient;
– allow study individual dynamics (e.g., separating age and cohort effects);
– give information on the time-ordering of events to control for individual unobserved heterogeneity, and this benefit is relevant in terms of unobserved heterogeneity in non-experimental research.

As a result, teachers have had very detailed and informative data at school, class, and student levels.

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The following table, for example, reports the basic processing of student panels: the normalized dataset (row data) of the fifth-grade students has been linked to the INVALSI dataset of the same students when they were in the second grade (Tab. 1). The scores have been calculated without considering deflective effects related to the threshold value of correct answers in multiple tests.

Tab. 1 – Mean scores (students and ESCS values). Student panels ss.yy. 2015/16 and 2018/19

	Student ESCS S.y. 2015/16				*Student ESCS S.y. 2018/19*			
	High	*Medium-High*	*Medium-Low*	*Low*	*High*	*Medium-High*	*Medium-Low*	*Low*
Italian (2°)	63.07	53.85	61.79	51.55	60.98	63.09	46.10	57.72
Italian (5°)	72.76	62.57	60.36	57.39	70.28	67.16	54.78	64.68
Maths (2°)	50.76	44.92	44.89	47.43	42.43	51.60	49.05	48.00
Maths (5°)	63.37	56.41	58.52	49.70	59.52	63.85	45.33	57.41
English Reatding (2°)	21.70	21.92	20.56	22.61	21.82	22.00	21.75	21.88
English Reading (5°)	77.09	67.52	87.04	70.37	70.55	79.26	70.76	74.34
English Listening (5°)	66.12	54.13	71.30	51.18	58.73	69.75	45.22	59.79

While teachers, following this micro-analysis process have had detailed, usable, and robust information on students' performances, it has to be noted that the process of normalization of the second and fifth grades data was really expansive in terms of time and workload (e.g., elaboration and test of code strings). The result has been a good level of information but not timely for teachers in order to review their instructional practice and to design plans and strategies for the school improvement.

4. Discussion and next steps

Even though the inquiry path has showed how it is possible to analyse the INVALSI large-scale assessment data at micro-level (RQ1), it has been suddenly evident how complex were the practical aspects and the implications for teachers (SQ1). Moreover, this first phase has been useful to show how deep were the teachers' gaps in the assessment and data literacy field (SQ2). Therefore, the second phase of the research project has been devoted to support teachers in the implementation of an interim assessment system. This system should allow teachers to gather data on students' learning in a more

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sustainable and smart way, and then compare these data with the INVALSI results. Thus, a new professional development path has been realized in order to train teachers to design and construct standardized tests.

More specifically, teachers have been train on how:

- to establish the main aims of the tests;
- to examine the clarity and the specificity of aspects and traits measured by the tests;
- to arrange a sufficient number of test items in order to take a valid decision;
- to analyse test items perceived as more difficult by students (or items with more errors or wrong answers);
- to examine a sample of items for having information on a wider competency domain;
- to disaggregate data for different groups of students.

The implementation of the interim assessment system is currently on the going and will continue through the school year 2020/21. The interim tests will be administered, in two different rounds during the school year, not only to the INVALSI target students (second and fifth grades) but also to third and fourth grades students. The last aim, in fact, is to define an interim assessment system that, avoiding inquisitive lectures or obsessive controls, allow teachers to reflect on and to review their instructional practices.

5. Conclusions

Despite the current diffusion and the relevance of data in the school context, there are different problems and open questions related to the teacher data-driven decision-making and to the assessment data use. Educational policies, not only in Italy, sometimes don't support school actors with clear explanations on how to use data for the improvement of the school neither on how to effectively use data.

Having data is not a guarantee of the improvement.

At the school level, data can differently impact decision-making. The sense-making theory, in this perspective, has clearly explained how actors tend to interpret, adapt, or transform the action directions. The decision-making is not focused only on the data use for instructional activities within the classroom. Thus, the most relevant aspect in this process is represented by the change of the school culture.

The professional development path implemented after the micro-analysis of the INVALSI results has trained teachers to pursue more clear and

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tailored learning goals and will support them in interpreting the interim assessment data. If a teacher doesn't know how a test has been designed and realized, if he/she doesn't know how scales (or sub-scales) have been used and how the standards have been defined, he/she will never be able to interpret a percentage or the rate on student proficiency, he/she will never really understand what data mean and imply for students and for teaching practice. If assessment results are disaggregated for learning goals it is possible to have information that teachers will use more easily in their instructional practice.

Hence the implications related to the use of standardized tests are several. Data gathered through large-scale and interim assessment should be useful for teachers to:

– define what are instructional priorities;
– define further teaching actions for students who have difficulties in learning;
– identify, more easily, student learning strengths and design instructional actions that support them in fostering their leaning;
– review teaching methods and strategies;
– establish, at the micro-level of the classroom as well as at macro-level of the school system, if and how adjust the instructional curriculum (in terms of local student learning goals and expected outcomes) to the information gathered about student learning (Stiggins, 2017).

There are relevant and different implications in terms of educational policies and practices because how teachers use data, and more specifically assessment data, to support decision-making and instruction, is not only a "technical" question. Moreover, interpreting, and using data gathered from an interim assessment system constrain teachers to act in a more functional and responsive way to the local context needs but also to the national context requirements (Little, 2012). Beyond the classrooms, teachers have, therefore, the chance to really identify and manage the factors that impact on the alignment between the national evaluation school system and their daily teaching practice. In this perspective, there should be more chances to understand if teachers' assessment practices and their data-driven decision-making are responsive to innovations and to educational, social, and institutional transformations (Levin and Datnow, 2012).

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6. Links between the INVALSI Mathematics test and teaching practices: an exploratory study

by Ferdinando Arzarello, Federica Ferretti

The chapter shows the first results of an interdisciplinary project aimed at investigating the link between the Mathematical INVALSI tests and the teaching and learning processes of Mathematics, in particular with didactic practices. The research project is conducted by the INVALSI Group – Disciplinary Didactics of the SIRD – Italian Didactic Research Society. The group is composed by disciplinary experts (from the Universities of Turin, the Free University of Bolzano, the University of Milan and the University of Bari) and educationalist (from the University of Bologna, the University of Turin and the Sapienza University of Rome) coordinated by Prof. Arzarello and Prof. Vannini. The interdisciplinary study consisted in the construction of a tool for detecting teachers' attitudes towards INVALSI, both towards the INVALSI as an Institute, with its aims and working methods, and towards the INVALSI Mathematical tests and their effects on teaching. The aim is to understand which are the "tools" that the teachers have and, above all, use to read and interpret the INVALSI standardized assessment and which "tools" are available to identify possible effects of INVALSI tests on Mathematics teaching. The aim of the research is to identify professional development teachers' needs at national level within schools and to propose guidelines for improving practices regarding the use of INVALSI surveys. To answer the research hypotheses, a questionnaire was designed and administered to investigate teachers' beliefs regarding the knowledge and skills investigated by the INVALSI tests, their closeness to teaching practices in Mathematics and the role that they assume within the context school. In detail, the questionnaire consists of two areas of variables, one specifically for Mathematics Education and one relating to the aspects of Education. In detail Mathematics Education variables are aimed at investigating how much the Mathematical contents and abilities detected with the INVALSI tests are – more or less close to daily personal teaching

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practices – lived as coherent/inconsistent with the national guidelines and are recognized or not consistent with the intentions of INVALSI – considered useful for influencing/innovating personal teaching practice. Questions about teachers' ability to read INVALSI data were in the questionnaire; these variables represent the focus of the survey and they are the dependent variables. The independent variables are those related to the aspects of Education and Didactics that refer to constructs aimed at detecting the attitudes of teachers and all scholastic subjects. The research that is taking place is a correlation type; the first data collected are being analyzed.

Il capitolo mostra i primi risultati di un progetto interdisciplinare volto ad indagare il legame tra le prove INVALSI di Matematica con i processi di insegnamento e apprendimento della Matematica, in particolare con le pratiche didattiche. Il progetto di ricerca è condotto dal Gruppo INVALSI -Didattiche Disciplinari della SIRD – Società Italiana di Ricerca Didattica, formato da esperti disciplinaristi (appartenenti alle Università di Torino, alla Libera Università di Bolzano, all'Università Statale di Milano e all'Università di Bari) e pedagogisti (appartenenti all'Università di Bologna, all'Università di Torino e alla Sapienza Università di Roma) coordinato dal prof. Arzarello e dalla prof.ssa Vannini. Il lavoro interdisciplinare è consistito nella costruzione di uno strumento di rilevazione degli atteggiamenti degli insegnanti nei confronti dell'INVALSI, sia nell'INVALSI come Istituto, con le sue finalità e modalità di lavoro, sia nei confronti delle prove INVALSI di Matematica e delle loro ricadute sulla didattica. Lo scopo è quello di comprendere quali sono gli "strumenti" che gli insegnanti hanno e, soprattutto, utilizzano per leggere e interpretare le rilevazioni INVALSI e di quali "strumenti" dispongono per individuare possibili ricadute delle prove sulla didattica della Matematica. L'obiettivo della ricerca è quello di identificare i bisogni formativi a livello nazionale all'interno delle scuole e proporre linee guida per il miglioramento delle prassi per quanto riguarda l'uso delle rilevazioni INVALSI. Per rispondere alle ipotesi di ricerca è stato progettato e somministrato un questionario volto a indagare le convinzioni degli insegnanti per quanto riguarda le conoscenze e le competenze indagate dalle prove INVALSI, la loro vicinanza alle pratiche didattiche in Matematica e ruolo che assumono all'interno del contesto scolastico. In dettaglio, il questionario è costituito da due ambiti d variabili, uno specificamente di Didattica della Matematica e uno relativo agli aspetti di Didattica generale. In dettaglio variabili di Didattica della Matematica sono finalizzate a rilevare quanto i contenuti e le abilità matematiche rilevate con le prove INVALSI siano: a) più o meno vicini alle pratiche didattiche personali quo-

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tidiane; b) vissute come coerenti/incoerenti con le Indicazioni nazionali e siano riconosciute o meno in modo coerente con le intenzioni di INVALSI; c) ritenute utili per influenzare/innovare la pratica didattica personale. Sono state inoltre proposte domande sulla capacità di lettura dei dati INVALSI da parte degli insegnanti; queste variabili rappresentano il focus dell'indagine e sono le variabili dipendenti. Le variabili indipendenti sono quelle relative agli aspetti di Didattica generale che fanno riferimento a costrutti volti alla rilevazione degli atteggiamenti di insegnanti e di tutti i soggetti scolastici. L'indagine che si sta svolgendo è di tipo correlazione; i primi dati raccolti sono in fase di analisi.

1. Rationale

This chapter shows the first results of an interdisciplinary research project aimed at investigating the links between INVALSI tests of Mathematics and Mathematics teaching and learning processes, especially with respect to teachers' didactic practices. The research project is conducted by the "Gruppo INVALSI – Didattica e Saperi Disciplinari" of the SIRD (Italian Society of Didactic Research), which includes experts in Mathematics and in Pedagogy. The coordinators of the group are Ferdinando Arzarello (*Mathematics*: University of Turin) and Ira Vannini (*Pedagogy*: University of Bologna)[1]. The aim of the study is to investigate Mathematics teachers' beliefs about INVALSI surveys, in particular about the way they read and interpret INVALSI surveys data, and in what measure INVALSI tests effectively impact on their Mathematics teaching practices.

In line with the goals of the SIRD, a broader objective of our research is to identify training needs at national level within schools, and to propose guidelines for the improvement of practices regarding the use of INVALSI tests. In details, our study is part of a broader line of research aimed at improving a close link between standardized assessments and Mathematics education. Its aim is to find an effective way to merge standardized assessments' results, methods, theoretical frameworks and tools – that are designed in order to impact at a systemic level – into actions of teachers and schools (Doig, 2006;

[1] The researchers of the project are: Barbara Balconi (University of Milan), Giorgio Bolondi (Free University of Bozen-Bolzano), Eleonora Faggiano (University of Bari), Federica Ferretti (University of Ferrara), Violetta Lonati (University of Milan), Daniela Maccario (University of Turin), Annarita Monaco (Teacher, Rome), Ottavio Rizzo (University of Milan), Roberto Trinchero (University of Turin), Valentina Vaccaro (INVALSI, Rome).

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Looney, 2011). In order to fully acknowledge the potentials and educational aims of standardized assessment we need effective theoretical tools to interpret the quantitative data they provide and the macro-phenomena that emerge from the complexity of educational systems. The use of the standardized assessment can truly improve the teaching and learning of Mathematics only if it is able to give refined, culturally wide-ranging and operational information to policy makers, teacher training programs, curriculum developers, principals and teachers (De Lange, 2007). Our research moves exactly within this stream of thought: in particular, its first part investigates teachers' beliefs on standardized assessment and tools and on the way they actually use to read and interpret standardized tests and data.

1.1. The INVALSI test and Mathematics education

As we underlied, our research is part of a study within a broader strand of international research regarding the link between Large Scale Assessment (LSA) results and Mathematics Education Research (De Lange, 2007) and, in particular, the central role that analysis of standardized assessment data may have for teachers' professional development.

Specifically, INVALSI provides annually the data results, based on a statistically significant national sample, for every single item of all INVALSI tests and in our research these data have been used. The framework adopted by INVALSI assessment tests (INVALSI, 2018) is strictly connected to the Italian National Guidelines, includes aspects of mathematical modelling adopted in PISA research, and is developed according to results provided by Mathematics education research. These facts show the link between INVALSI tests and results from research in Mathematics education. The INVALSI publishes the results of the national sample of each item and gives back to the schools the results relative to each grade; the results are issued annually and can provide important information for categorizing students' errors at a macro level. As already shown in various research studies (e.g. Ferretti and Bolondi, 2019), the results of the INVALSI surveys highlight didactic macro-phenomena that can provide very useful information on learning/teaching processes. As we will see in the examples presented below, one of the focuses of our investigation is to study if and how teachers are aware and properly understand the macro-phenomena emerging from INVALSI assessments.

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2. The research

As hinted above, the general aim of our research is to identify training needs at a national level and to propose guidelines for the improvement of Mathematics practices with the use of INVALSI tests. The general objectives of our study are:

– to investigate teachers' beliefs regarding the knowledge and skills investigated by the INVALSI tests;
– to investigate the relation between INVALSI Mathematics tests and Mathematics teaching and learning processes in the classroom, in particular about the didactic practices adopted by teachers.
– More specifically, the aim is to understand:
– (level 1) which tools teachers actually use to read and interpret INVALSI tests and data;
– (level 2) which means are available to researchers in order to identify the possible effects of INVALSI tests on mathematics education in our schools.

To answer the research questions, a questionnaire was designed and administered. Before the final administration to a large sample of Italian teachers, a try-out was performed; some of the results of the try-out are presented in the following paragraphs. The questionnaire aimed at investigating aspects such as teachers' awareness of the learning objectives detected by the INVALSI tests, their conceptions of errors in Mathematics, their use of tests in daily teaching, their misconceptions about standardized tests, their idea of assessment and, in particular, of formative assessment. It is built basing on variables from two areas: one specifically for Mathematics Education and one relating to aspects of General Education. The questions were prepared considering teachers' ability to read INVALSI Mathematics data as well as using constructs aimed at detecting more general teachers' attitudes and practices. The interdisciplinary work led to the construction of a tool apt to detect the attitudes of teachers towards INVALSI in two main directions: both of INVALSI as an Institute with its aims and methods of work, and of INVALSI Mathematics tests and their impact on teaching practices.

Mathematics Education variables are aimed at detecting to what extent the Mathematical contents and abilities identified within INVALSI tests are:

– more or less "close" to daily personal teaching practices;
– experienced as consistent/inconsistent with the National Guidelines and whether they are recognized as consistent or not with the intentions of INVALSI;
– deemed useful for influencing/innovating personal teaching practices.

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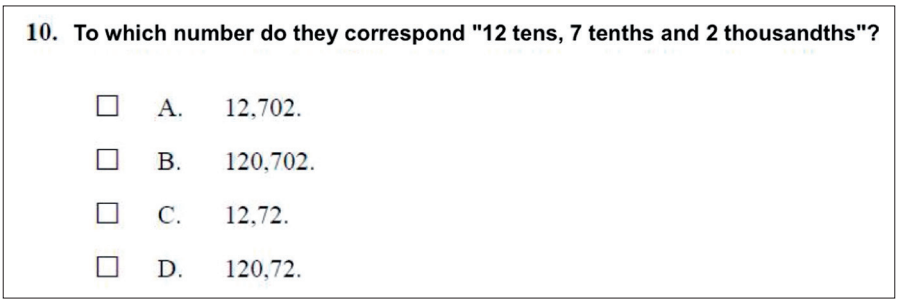
The try-out of the questionnaire consisted in its administration to 85 primary school Mathematics teachers. This first part of the analysis mainly investigates the types of correlation between the involved variables. In the following section we will present some highlights of the try-out of the questionnaire, providing examples from the section of Mathematics education.

3. Examples

This paragraph illustrates three examples of reflections inherent to 3 INVALSI Mathematics items, which emerged after the administration of the questionnaire. In addition to the questions focused on 7 items of the INVALSI tests which highlight didactic macro phenomena, at the end of the Mathematics education section there are some transversal questions. Two of these questions ask how suitable INVALSI items are for assessing students learning and how commonly they are used in assessment practices. The following analyses will also illustrate how the investigated items position with respect to these two questions.

3.1. Decimals

The first of the questions investigated is related to the following item, administered in the Mathematics INVALSI test for grade 5 Italian students in the s.y. 2008/09.


10. To which number do they correspond "12 tens, 7 tenths and 2 thousandths"?

☐ A. 12,702.

☐ B. 120,702.

☐ C. 12,72.

☐ D. 120,72.

Fig. 1 – Item 10, grade 5 Mathematics INVALSI test 2009

Teachers are asked to estimate the degree of difficulty of the question, in terms of "how difficult do they find this question at the end of the fifth grade".

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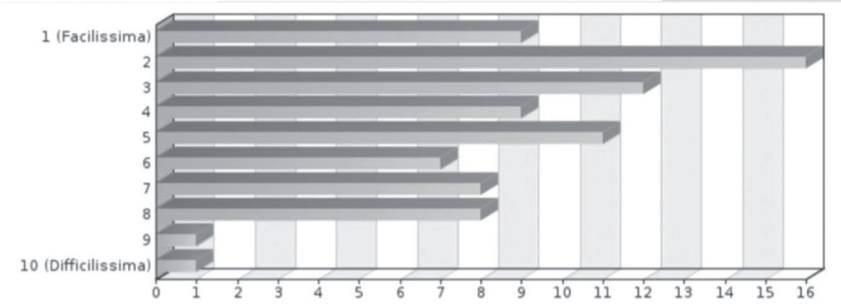
The following figure (Fig. 2) shows the results with reference to 82 collected responses (facilissima = *very easy*, difficilissima = *very difficult*).



Frequency table

Levels	Absolute frequency	Cum. absolute frequency	Relative frequency	Cum. relative frequency	Adjusted relative frequency	Cum. adjusted relative frequency
1 (Facilissima)	9	9	5.03%	5.03%	10.98%	10.98%
2	16	25	8.94%	13.97%	19.51%	30.49%
3	12	37	6.7%	20.67%	14.63%	45.12%
4	9	46	5.03%	25.7%	10.98%	56.1%
5	11	57	6.15%	31.84%	13.41%	69.51%
6	7	64	3.91%	35.75%	8.54%	78.05%
7	8	72	4.47%	40.22%	9.76%	87.8%
8	8	80	4.47%	44.69%	9.76%	97.56%
9	1	81	0.56%	45.25%	1.22%	98.78%
10 (Difficilissima)	1	82	0.56%	45.81%	1.22%	100%
Sum:	82	-	45.81%	-	100%	-
Not answered:	97	-	54.19%	-	-	-

Average:	4.26	Minimum:	1	Variance:	5.58
Median:	4	Maximum:	10	Std. deviation:	2.36

Total answered: 82

Fig. 2 – The results in reference to the "Decimal" question

The question requires a *conversion* transformation between two different semiotic registers (Duval, 2006) and the low percentage of correct answers at national level (33%) highlights that managing this *conversion* is difficult for many Italian students. The perception of the difficulty of the question by teachers is very different from the national trend: looking at the cumulative probability we note that almost 70% answered "5". The data suggest a failure to perceive the degree of difficulty of a question. Reflections inherent in this item suggest that it could be very interesting also to investigate this non-correspondence between a perceived difficulty and a national difficulty also in other questions. In the try-out it is the only item in which we do not inform about the percentages of correct answers. This fake perception of the difficulty level of the item poses also an interesting question to investigate: it

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may be indeed significant to scrutinize whether, and to what extent, this fake perception is connected with the fact that the item is one of those considered "most suitable for assessing learning" and one of the "most commonly used in assessment tests".

3.2. Ribbon bow

Other interesting results emerged from the following INVALSI question, administered to students of the fifth primary class in the s.y. 2008/09.

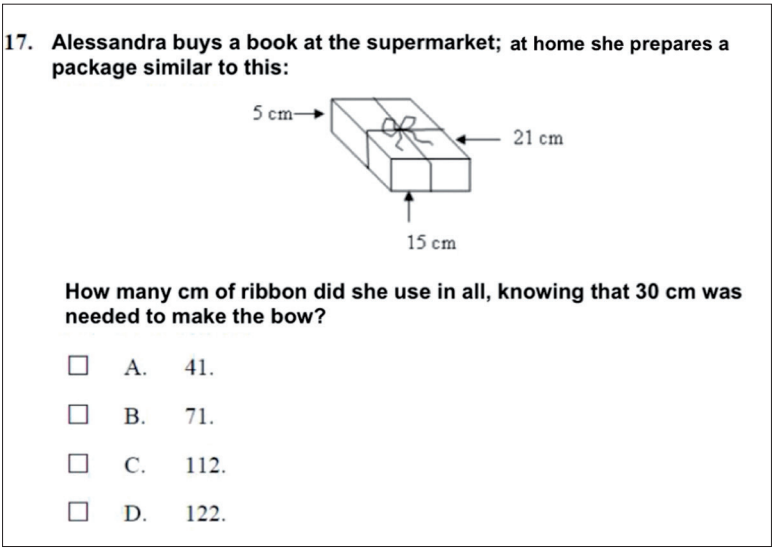

Fig. 3 – Item 17, grade 5 Mathematics INVALSI test 2009

In the questionnaire, the percentage score for correct responses at national level (14.7%) was given.

Various possible causes of students' errors were then reported and teachers were asked to indicate which, by their opinion, was the main cause of students' difficulties.

The sentences were:

– because the students don't have sufficient spatial visualization skills;
– because the students didn't do enough manipulative activities;
– because the students didn't understand the task;
– because the students made wrong calculations;
– because the students didn't read the text carefully;

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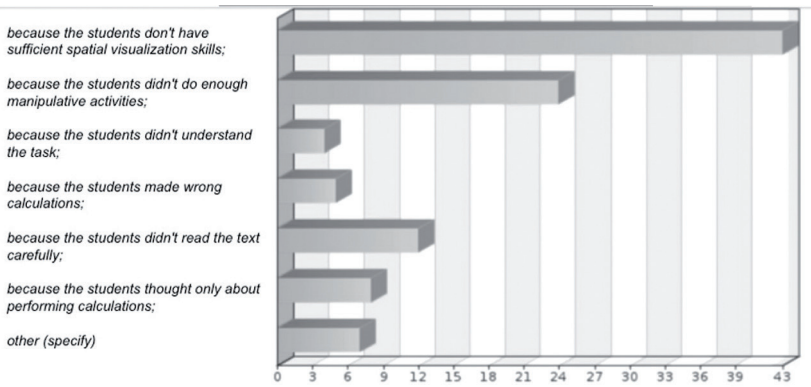
– because the students thought only about performing calculations;
– other (specify).

The graphs in the follow figure (Fig. 4), show the percentage of choice for each sentence.



Frequency table

Choices	Absolute frequency	Cum. absolute frequency	Relative frequency by choice	Relative frequency	Cum. relative frequency	Adjusted relative frequency	Cum. adjusted relative frequency
because the students don't have sufficient spatial visualization skills;	43	43	41.75%	24.02%	24.02%	58.9%	58.9%
because the students didn't do enough manipulative activities;	24	67	23.3%	13.41%	37.43%	32.88%	91.78%
because the students didn't understand the task;	4	71	3.88%	2.23%	39.66%	5.48%	97.26%
because the students made wrong calculations;	5	76	4.85%	2.79%	42.46%	6.85%	104.11%
because the students didn't read the text carefully;	12	88	11.65%	6.7%	49.16%	16.44%	120.55%
because the students thought only about performing calculations;	8	96	7.77%	4.47%	53.63%	10.96%	131.51%
other (specify)	7	103	6.8%	3.91%	57.54%	9.59%	141.1%
Sum:	103	-	100%	-	-	-	-
Not answered:	106	-	-	59.22%	-	-	-

Average:	2.72	Minimum:	1	Variance:	4.17
Median:	2	Maximum:	7	Std. deviation:	2.04

Total answered: 73

Fig. 4 – The results in reference to the "Ribbon Bow" question

Almost 60% of teachers attribute the low percentage of correct answers at national level to the fact that students do not have sufficient spatial visualization capacity and 33% to the fact that students did not do enough manipulative activities.

At national level, the correct answer (D) was selected by 14.7% (one of the worst performances in closed-ended answers since 2008) while option A was chosen by 28.9% and option B by 41.5%.

Option A shows the number 41 which corresponds exactly to the sum of the numbers shown in the figure (5+15+21) while option B (71) corresponds to the sum of the numbers in the figure and the only number expressed in

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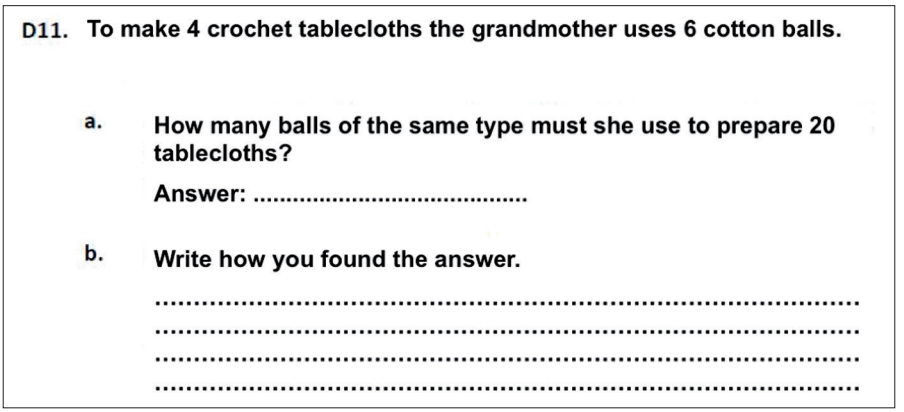
figures in the text (41+30). The causes of the difficulties, framed by the *didactic contract* construct in the sense of Brousseau (1988), are quite evident and they do not correspond or correspond only partially to those recognized by teachers. We are therefore faced with a lack of awareness of the causes of the error. It will certainly be interesting to consider this issue in depth, to try to investigate whether the causes of these interpretative difficulties are linked to difficulties in interpreting students' difficulties or to difficulties in understanding the goal of the question.

Regarding the transversal questions, this item is considered by teachers as one of the least "suitable" for assessing learning and one of the questions "least used in assessment tests".

3.3. Cotton balls

Relevant results are those inherent to the question concerning the following item, given in the INVALSI grade 5 test in the s.y. 2012/13.



D11. **To make 4 crochet tablecloths the grandmother uses 6 cotton balls.**

a. **How many balls of the same type must she use to prepare 20 tablecloths?**

Answer: .....

b. **Write how you found the answer.**

.....
.....
.....
.....

Fig. 5 – Item 11, grade 5 Mathematics INVALSI test 2013

The following table shows some answers from grade 5 students (Primary School). Some possible answers plausibly provided by the students (some taken from Arzarello, 2018) and others designed by the group of researchers were then proposed. The teachers were asked to indicate how they would rate them. The following table shows the answers in reference to each proposed sentence (Completamente corretta = *Completely correct*, Parzialmente corretta = *Partially correct*, Prevalentemente scorretta = *Mainly incorrect*, Completamente scorretta = *Completely incorrect*).

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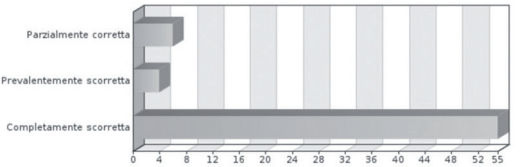
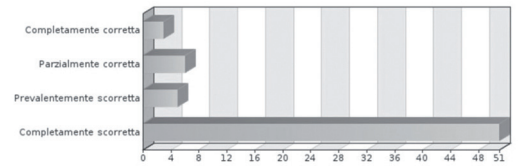
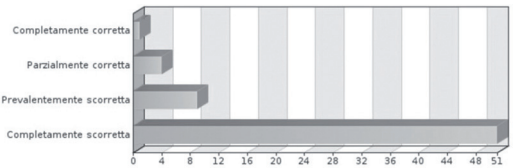
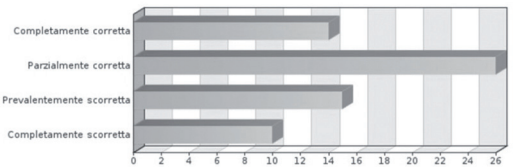
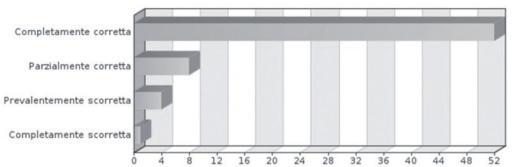
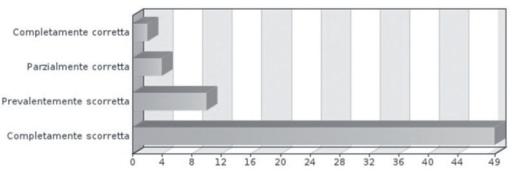
Tab. 1 – Results of each sentence – Cotton balls item

a. “First, I calculated 6-4 = 2; after the 20, I added 2 and I got 22”	
b. “I multiplied 6 balls for 4 placemats and I got 24”	
c. “I have multiplied 6 balls by 20, for 20 placemats”	
d. “Since, for 4 placemats, we need 6 balls of yarn (so 2 more), for 20 place mats I just add 10”	
e. “The grandmother uses a ball and a half to prepare a placemat so I did this = 20 x 1.5 = 30 (in one corner of the sheet is the multiplication in a column)”	
f. “Because I calculated 20+6+4”	

One of the most interesting data is certainly the “noise” in the answers inherent to our solution *d*, in which the strategy inherent to the correct an-

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swer uses the mixed addition-multiplication model and does not explain all the steps.

In fact, while the teachers evaluate incorrect the first three answers (as they in fact are), there is a lot of confusion as far as the fourth is concerned. Why do almost 40% of teachers not accept *d* as correct? Because not all the steps are made explicit or because they do not recognize it as a possible correct strategy?

Finally, the last option is the only one for which there is low coherence in answers to the two final questions that we have always asked in each item. A consequent suggestion for changes in the text is to modify it, maintaining the combination right answer-wrong strategy. In fact, together with item 2 (ribbon bow), this item is considered by teachers to be the least "suitable for assessing learning" and one of the questions "least used in assessment tests".

4. Discussion

In the paper we have presented the first findings from the try-out of a questionnaire aimed at investigating the way primary school Mathematics teachers read and interpret INVALSI surveys data.

To discuss what we have found until now, we make an analogy between the small context of an usual mathematics classroom and the general national school context, which our research is considering. In the analysis of classroom interactions it is common to see what Anna Sfard calls an "incommensurable discourse" (Sfard, 2008) between the teacher and the students: they use the same words but with a different meaning and moreover are not aware of the difference; a conflict is generated, which, if not overcome, can have serious consequences for successful teaching/learning processes in the classroom.

Something similar happened to us when we analyzed the answers to our questionnaire: also here we found incommensurable languages. They are the sign of what we call a *three-fold meta-didactical conflict*: it has been possible to realize its existence thanks to the questionnaire. As its name suggests, this conflict has three components and is meta-didactic since it concerns discourses about didactic processes like assessment, students' competencies and mistakes, etc., and not about the thought mathematics concepts themselves, as it is in the case of usual epistemic or didactic conflicts reported in the literature (e.g. by Brousseau, 2002 or Sfard, 2008). We will now sketchily describe it.

A first component of the conflict concerns the fact that many teachers perceive the difficulty of a question from the INVALSI survey very differently

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from the national trend (see example 3.1). A second component concerns the fact that many teachers interpret the difficulties of students (see example 3.2) or evaluate their answers (see example 3.3) to the INVALSI tests in a way that is completely different from what unquestionably appears from the data of the survey. A third component is a consequence of the previous two and concerns the contradictory way according to which teachers interpret the rationale of the INVALSI tests (for example, see how they couple the dyads suitable/not suitable Vs most used/not used in the examples with respect to what appears in the survey data).

Of course, it is possible that the three components may be only the epiphenomenon of a deeper conflict, whose nature at the moment we have not yet understood, but until now we can speak only of a three-fold conflict, since its three components in any case appear deeply intertwined.

We think that our current hypothesis about this conflict will be confirmed or refuted through the administration of the questionnaire to a wider court of subjects and a deep analysis of the related data. In case of confirmation, it will be possible to refine the same analysis of the conflict, deciding about its three-fold or different nature, and also clarifying its deep structure and nature, e.g. with respect the knowledge and beliefs of teachers. Basing on the analogy from the conflicts in the classroom, for which a successful strategy for overcoming them is generated by a clear understanding of their nature, it will be precisely from a clean picture of the structure and dynamics of our conflict that it will be possible to design suitable guidelines for getting rid of it and obtaining a real improvement of practices regarding the use of INVALSI tests in the school. But this will be possible only with a further step of our research, after the completion of the current one with the analysis of a suitable number of subjects.

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7. The INVALSI data for the 2030 Agenda

by Barbara Baldazzi

The 2030 Agenda for sustainable development adopted from the UN-Assembly General (UN Resolution A7RES/70/1, New York) is built on 17 Sustainable Development Goals (SDGs) with the aim to end poverty, protect the planet and ensure prosperity for all by 2030. The 17 goals are articulated in 169 targets and 244 indicators (232 of which are different) for monitoring of the Goals.

Goal 4 monitoring "Quality education for all" for our country focuses on the training path of people from access to learning activities at five years, continuing with inclusion in secondary and tertiary education levels, monitoring skills and learned knowledge. Quality education and lifelong learning opportunities for all are central to ensuring a full and productive life to all individuals and to the realization of sustainable development. Targets to be monitored concern different dimensions: access for all to education of all levels (primary, secondary and tertiary), the quality of education, the possession of knowledge and skills for employment and sustainable development; the elimination of gender disparities in education and equal access for the most vulnerable; monitoring of school facilities, so that they are suitable for everyone's needs.

The present work shows how the integration of data from various sources (INVALSI data, data from ISTAT survey and data from MIUR) can give a global picture of the situation in Italy; and how from the aggregation of data, from the analysis of each single indicator and from the involvement of other targets and objectives of the 2030 Agenda, substantial information on inequalities can arise.

Every child and young person has the right to learn, train, develop his skills, competences and aspirations in the most profitable possible way and with the best opportunities; when this right is not guaranteed, the child finds

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himself in a condition of educational poverty, suffers from a lack of opportunity, which strongly and negatively affects his growth.

Moreover, educational poverty is a multi-dimensional phenomenon, which also involve other targets and objectives of the 2030 Agenda. The disadvantage of children and young people is often influenced by the socio-economic family situation, by material factors that penalize good growth (for example the region of residence), from inequality of opportunity that is perpetuated from generation to generation, in some places and some families.

The empirical measurement of educational poverty will therefore be studied through the levels of literacy and numerical competence, knowledge of the English language, early school leaving and educational qualifications, trying to disaggregate information in a widespread manner to bring out inequalities.

L'Agenda per lo sviluppo sostenibile del 2030 adottata dall'Assemblea generale dell'ONU (risoluzione A7RES/70/1, New York) si basa su 17 Obiettivi di sviluppo sostenibile (Sustanaible Development Goals) con l'obiettivo di porre fine alla povertà, proteggere il pianeta e garantire la prosperità per tutti entro il 2030. I 17 Goal sono articolati in 169 target e 244 indicatori. Il Goal 4 "Istruzione di qualità per tutti" dell'Agenda 2030 si occupa del tema della istruzione di qualità, fattore rilevante per migliorare la vita delle persone e rendere attuabile uno sviluppo sostenibile. I target da monitorare riguardano diverse dimensioni: l'accesso per tutti all'istruzione di ogni ordine e grado (scuola dell'infanzia, primaria, secondaria e terziaria), la qualità dell'istruzione impartita, il possesso delle conoscenze e delle competenze per l'occupazione e per lo sviluppo sostenibile; l'eliminazione delle disparità di genere nell'istruzione e la parità di accesso per i più vulnerabili; il monitoraggio delle strutture scolastiche, in modo che siano adatte alle esigenze di tutti.

Il monitoraggio del Goal 4 per il nostro Paese si concentra sul percorso formativo delle persone dall'accesso alle attività di apprendimento a cinque anni, proseguendo con l'inclusione nei livelli di istruzione secondaria e terziaria, monitorando le competenze e conoscenze apprese.

Il presente lavoro mostra come l'integrazione di dati da varie fonti (dati INVALSI sulle competenze, dati da indagine da fonte ISTAT e dati da MIUR) possa dare un quadro globale della situazione del paese Italia; e come dall'aggregazione dei dati, dall'analisi di ogni singolo indicatore e dal coinvolgimento di altri target e obiettivi dell'Agenda 2030, possano scaturire informazioni sostanziali sulle disuguaglianze.

Ogni bambino e ragazzo ha diritto ad apprendere, formarsi, sviluppare le sue capacità, le sue competenze e le sue aspirazioni nel modo più proficuo

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possibile e con le migliori opportunità; quando questo diritto non è garantito, il minore si trova in una condizione di povertà educativa e sconta una mancanza di opportunità, che incide fortemente e negativamente sulla sua crescita. La povertà educativa è un fenomeno che attiene a più dimensioni. Lo svantaggio dei bambini e dei ragazzi è spesso influenzato dalla situazione socio-economica familiare, da fattori materiali che penalizzano la buona crescita (ad esempio la regione di residenza), da disuguaglianza di opportunità che si perpetua di generazione in generazione, in particolari luoghi e in particolari famiglie.

La misurazione empirica della povertà educativa sarà, quindi, studiata attraverso i livelli di competenza linguistica e matematica, la conoscenza della lingua inglese, l'abbandono scolastico e le qualificazioni formative acquisite, cercando di disaggregare l'informazione in maniera capillare per far emergere le disuguaglianze.

1. Introduction

The 2030 Agenda for sustainable development adopted from the UN-Assembly General (UN Resolution A7RES/70/1, New York) is built on 17 Sustainable Development Goals (SDGs) with the aim to end poverty, protect the planet and ensure prosperity for all by 2030. The 17 goals are articulated in 169 targets and 244 indicators (232 of which are different) for monitoring of the Goals. The Goals of the 2030 Agenda refer to social, economic and environmental development, which need to be considered with an integrated approach that safeguards the planet and guarantees the well-being of people and an equitable distribution of development over time.

The present work shows how the integration of data from various sources (INVALSI data, data from ISTAT survey and data from MIUR) can give a global picture of the situation in Italy; and how from the aggregation of data, from the analysis of each single indicator and from the involvement of other targets and objectives of the 2030 Agenda, substantial information on inequalities in education and on educational poverty can arise.

2. Purpose of Goal 4: the word-cloud

The Goal 4 of Agenda 2030 is the goal of "Quality of education". Quality education and lifelong learning opportunities for all are central to ensuring a full and productive life to all individuals and to the realization of sustaina-

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ble development. The Targets to be monitored in this goal concern different dimensions: access for all to education of all levels (primary, secondary and tertiary), a good quality of education; the elimination of gender disparities in education and equal access for the most vulnerable; monitoring of school facilities, so that they are suitable for everyone's needs.

Without going into target detail, the word cloud shows that education (words that appear larger are most cited in the 2030 Agenda):

– must be inclusive (no left leave behind) and be available for boys, girls, disabled people, youths, children, vulnerable people;
– has to be of quality, accessible to all, to enhance skills and to promote culture;
– must increase equality, promote inclusion and sustainability.

Fig. 1 – Goal 4 word-cloud of Agenda 2030

3. Dissemination of data in Italy

To meet the global and national information demand different components of the Italian National Institute of Statistics (ISTAT) worked together: an integrated effort to enhance statistical information framework, thematic and methodological investments, interinstitutional synergies.

In Italy, ISTAT proposes, every 6 months, the updating of the indicators together with the analysis of their trends, and interconnections, giving a statistic framework for monitoring progress towards Sustainable Development.

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In the Second report of ISTAT, published in 2019, 273 statistical measures are available for 123 SDGs indicators (ISTAT, 2019). For the Goal 4 on "Quality of education", ISTAT releases 36 statistical measures related to eight Targets.

Goal 4 monitoring "Quality education for all" for Italy focuses on the training path of people from access to learning activities at five years[1], continuing with inclusion in secondary and tertiary education levels[2], monitoring skills and learned knowledge[3].

4. Educational poverty and SDGs

What is meant when we talk about educational poverty? How can the objectives of Agenda 2030 help us to learn about this phenomenon? The universal principle is that every child and every young person has the right to learn, to train, to develop his or her own skills and competences and aspirations in the most profitable way possible and with the best opportunities; when this right is not guaranteed, the child is in a state of educational poverty.

Usually educational poverty is accompanied by a lack of opportunities, which strongly and negatively affects the growth of the child. One can also speak of "ex ante inequality" which looks at how different the circumstances unintentionally inherited or faced by individuals are and which influence their economic performance (Stiglitz *et al.*, 2018).

The educational disadvantage of children and young people is often influenced by the family socio-economic situation, by material factors that penalize good growth (e.g. the region of residence), by the inequality of opportunity that is perpetuated from generation to generation, in some places and in some families.

[1] Target 4.2 "By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education".

[2] Target 4.3 "By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university", Target 4.5 "By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations" and Target 4.6 "By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy".

[3] Target 4.1 "By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes" and Target 4.4 "By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship".

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In addition, educational poverty is a multidimensional phenomenon, which also involves other objectives and targets of Agenda 2030.

The reading of the interconnections and interactions between themes, areas and objectives is useful to trace the paths of analysis to investigate complex phenomena such as educational poverty[4].

Goal 4 "Quality of education" is very connected with Goal 3 "Good health and well-being", Goal 5 "Gender inequality", Goal 8 "Decent work and economic growth" and Goal 1 on poverty (Fig. 2).

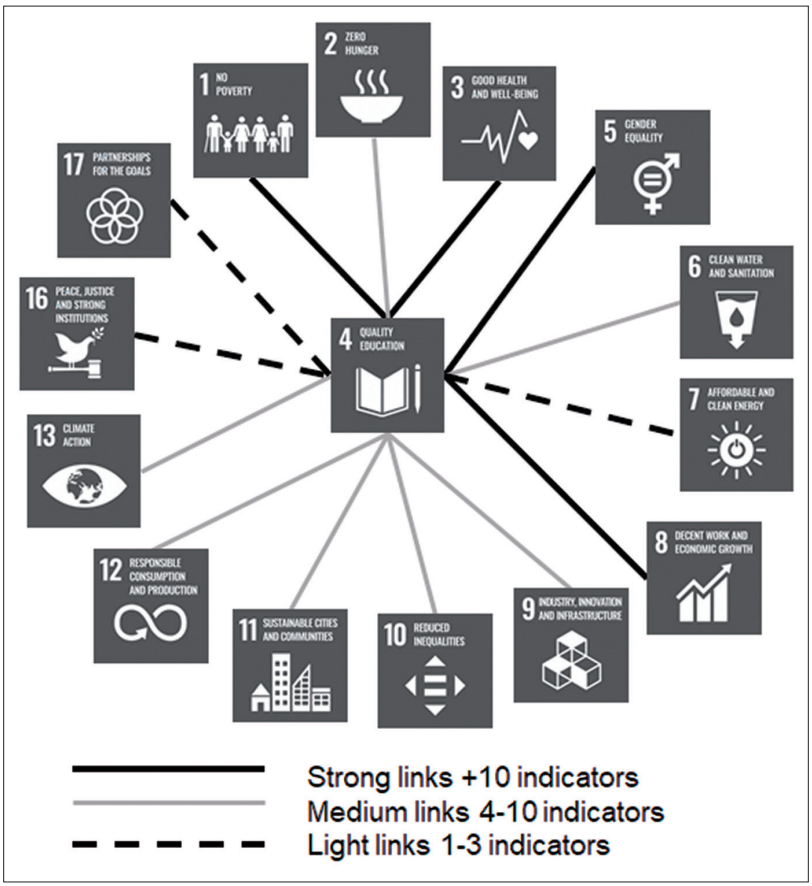

Fig. 2 – The wheel of Goal 4

[4] The network is built by looking at the UN metadata (https://unstats.un.org/sdgs/): for each indicator the interrelationships with another indicator are indicated. These links have been represented in matrices and visualized by charts.

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5. Educational poverty through data: the situation in Italy

Educational poverty involves several indicators of the 2030 Agenda: SDG 4.1.1 – "Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex" and SDG 4.3.1 "Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex".

SDG 4.1.1 will be studied through the levels of literacy and numerical competence; SDG 4.3.1 with the indicator "Early leavers from education and training – ELET (aged 18-24)"[5].

5.1. The INVALSI data

In Italy, in 2019, the share of children enrolled in the third year of lower secondary education who are low performers in literacy skills is 34.4%, in mathematics 38.7%, slightly better than 2018.

There are many territorial, gender and citizenship differences that often fuel inequalities, with regard to access to educational opportunities. The lowest percentages of students (corresponding to the best performance in the territory) with low levels of literacy are recorded in Marche (25.6%), in Veneto (26.8%), in Valle d'Aosta (27.7%) and in Friuli-Venezia Giulia (27.8%).

For numerical skills, the percentage of inadequacy is lower in the province of Trento (23.7%), in Friuli-Venezia Giulia (25.4%), Veneto (26.4%) and Toscana (28.5%). Calabria, with 49.5% of lows performers in literacy, Sicilia (46.8%) and Campania (44.8%) are the regions where the levels of students with low literacy skills are the highest; also for numerical levels skills of third year pupils in lower secondary schools degree, these regions maintain the highest levels of insufficiency, Calabria and Sicilia with 59.5% and Sicilia with 56.5%.

Compared to females, a higher percentage of boys is below the required level in literacy skills (39.1%, against 29.4% of females), while for numerical skills the situation is reversed: 39.9% of the girls does not reach the sufficiency, against 37.5% of the boys.

[5] Percentage of people aged 18-24 years who have achieved only lower secondary education (ISCED level 2) and are not included in education or training program on total people aged 18-24 years.

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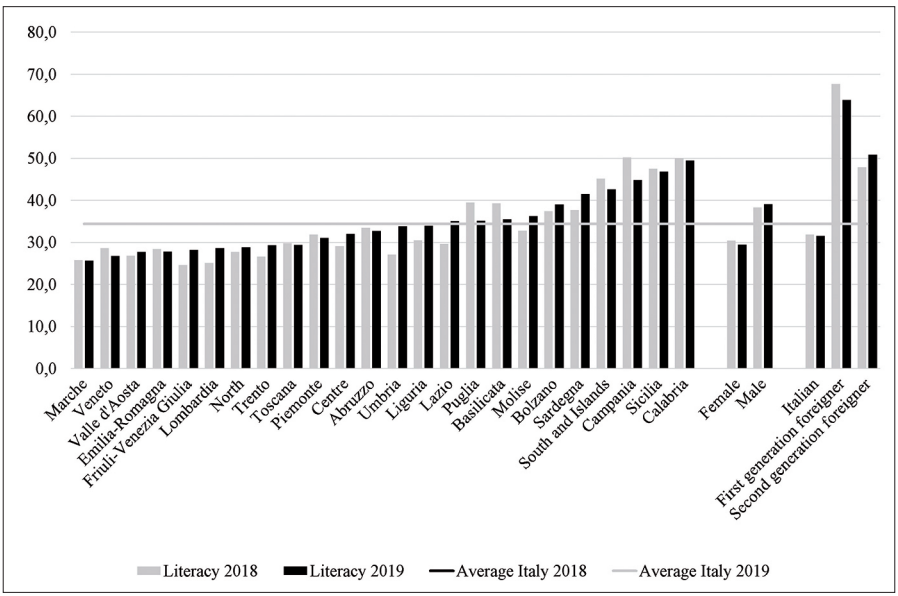

Fig. 3 – Share of students in grade 8 performing below the baseline level of proficiency in literacy competence by region, gender and nationality – Years 2018 and 2019

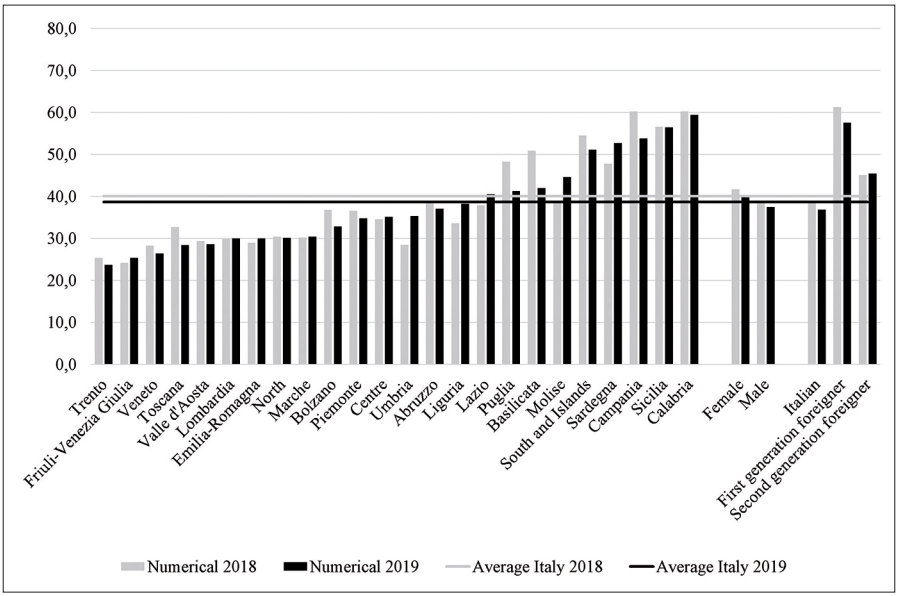

Fig. 4 – Share of students in grade 8 performing below the baseline level of proficiency in numeracy competence by region, gender and nationality – Years 2018 and 2019

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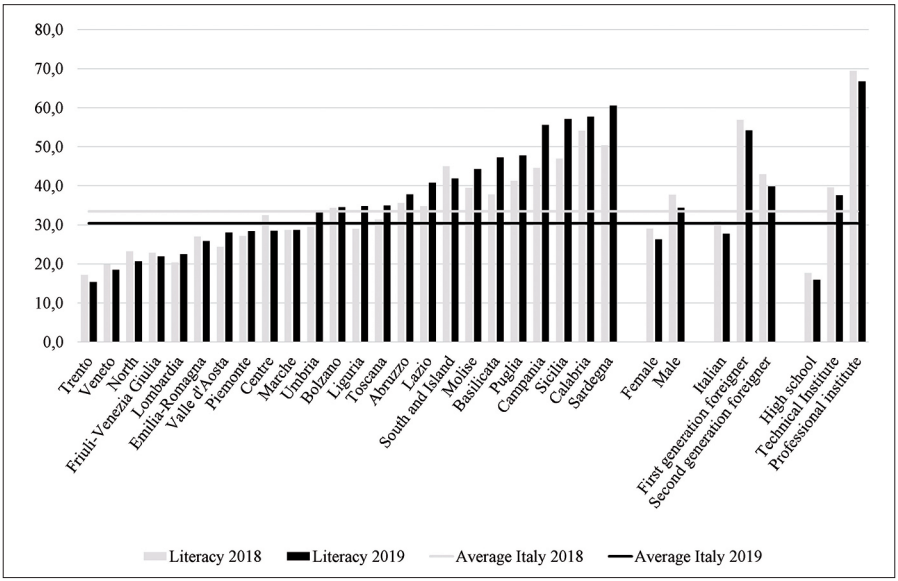

Fig. 5 – Share of students in grade 10 performing below the baseline level of proficiency in literacy competence by region, gender and nationality – Years 2018 and 2019

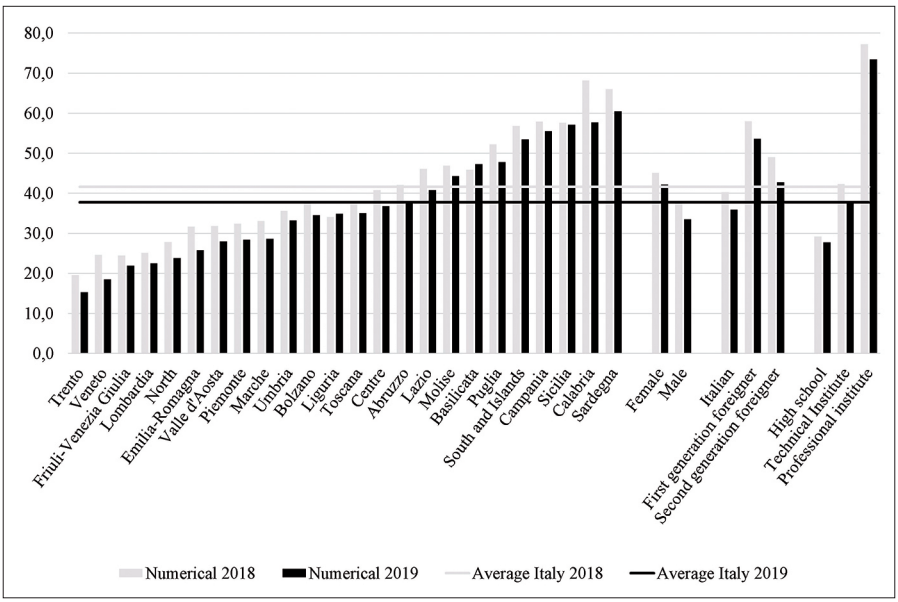

Fig. 6 – Share of students in grade 10 performing below the baseline level of proficiency in numeracy competence by region, gender and nationality – Years 2018 and 2019

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An evidence of the inequalities which exist due to different access opportunities is the strong difference in the competences of the children born in Italy from Italian people (native), compared to the first and second generation foreigners (respectively children born abroad from immigrant parents and children born in Italy to immigrant parents). 63.9% of children who were not born in our country do not reach the literacy sufficiency and 57.6% the numerical one. A measure of the integration capacity of foreign students in the school system is the difference in results between the first and second generation of immigrants and the natives. Youngsters born in Italy from foreign parents behave slightly better, both in terms of literacy (50.9% not sufficient) and in mathematic skills (45.5%). The percentage of Italian students who do not reach sufficiency is 31.5% for literacy skills and 36.9% for numerical skills.

Among the second year students in upper secondary school, 30.4% do not reach a sufficient level in terms of literacy and 37.8% in terms of mathematics. Regional differences are wide. Students in the North are less lacking in both language and mathematical skills, the Centre's students are placed in the national average levels and the students in the South and Islands have particular shortcomings especially in mathematics (more than half of the students from Campania, 55.5%, Sicilia, 57.1%, Calabria, 57.7% and Sardegna, 60.5% are insufficient). The difference between girls and boys is wide for language skills (34.3% of male students do not reach the required level compared to 26.3% of female students), and less strong for mathematical skills in favor of boys (33.5% of males against 42.2% of females).

Upper secondary school is divided into three main channels: high schools, technical colleges and vocational colleges. The result at national level by type of school is very different, with 16% of high school students not achieving a sufficient level in Literacy and 27.8% in Mathematics; among those attending technical schools, 37.6% and 37.9% are insufficient in Literacy and Mathematics respectively; among students in vocational schools, the results are very discouraging, with 66.7% not achieving a sufficient level of literacy and 73.4% of numerical skills.

5.2. The ELET indicator

In Italy, the drop from 20% in 2008 to 13.8% in 2016 of the indicator on early school leaving represents a significant progress but, in 2017 and 2018, the rate of early leavers has risen to 14.5% with clear territorial differences.

In 2018, the rate of early leaving, stable for the South and the Centre, but on the rise for the North-West area and the Islands, remained, however, very

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high in the Islands and in the South 18.8%, against 10.6% in the North-East, 10.7% in the Centre and 13.3% of the North-West.

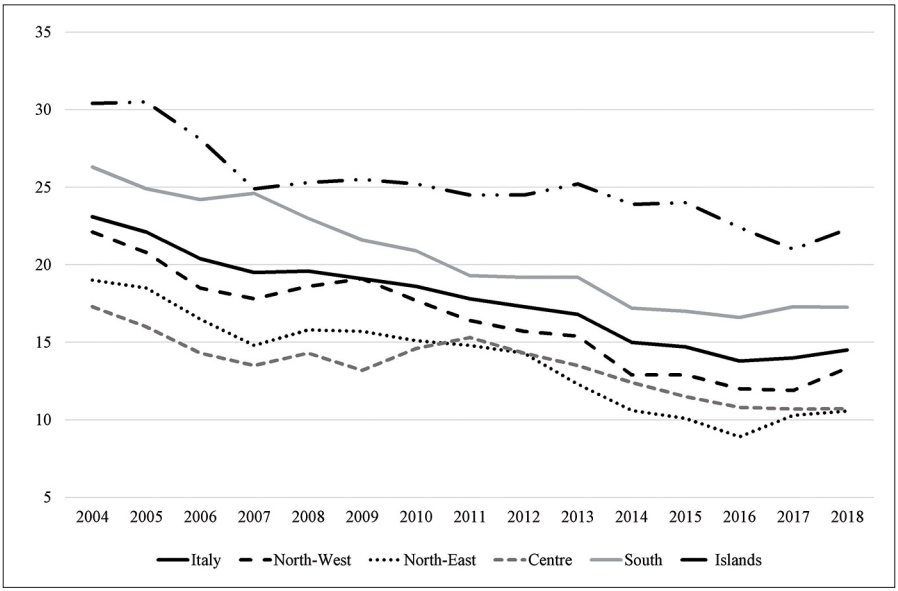

Fig. 7 – Share of ELET (Early leavers from education and training) by geographic region – Years 2004-2018

The difference between the girls, more involved in the education system, and the boys is significant: in 2018, 16.5% of boys dropped out of school and were not part of a training course against 12.3% of girls (Baldazzi and Cascioli, 2019).

The proportion of 18-24 year olds Italian and foreign citizenship who are not included in an education and training is relevant: among the natives, 12.3% left school and education, among foreigners 37.6%.

Among the regions, the Trento Province, Umbria, Abruzzo and Friuli-Venezia Giulia showed values below 10%, while in Calabria, Sicilia and Sardegna the values exceeded 20%.

6. An example of interconnections and the interactions between themes in Goal 4

Within each Goal it is possible to make a first analysis of the interconnections and interaction between the indicators. Principal component anal-

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ysis (PCA) is a statistical method that uses an orthogonal transformation to convert a set of observations of variables into a set of values of linearly uncorrelated variables called principal components, with the first principal component has the largest possible variance and each succeeding component in turn has the highest variance. Components are orthogonal.

The variables of Goal 4 are 11, calculated on 21 regions representing the analysis units.

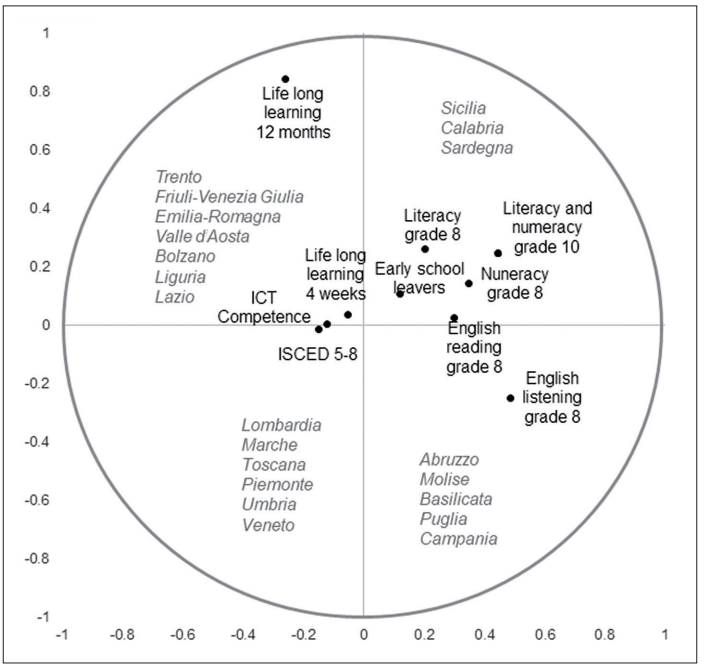

Fig. 8 – PCA for variables of Goal 4 – Year 2019

The first component (represented by the horizontal axis) represents "integration and success in the school system". In the negative part of the axis there are the digital competence variable and the percentage of people with a tertiary level of ISCED, while on the positive semi-axis there are the low competence variables in literacy and numeracy, and the ELET variable.

The second component (represented by the vertical axis) represents the "advancement in skills (also extracurricular)". In the negative part of the axis there are the variables of the low competence in Listening English and Reading English, while on the positive semi-axis there are the percentage of people doing lifelong learning.

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The regions with the best profiles in Goal 4 are the province of Trento, Friuli-Venezia Giulia, Emilia-Romagna, Valle d'Aosta, the province of Bolzano, Liguria and Lazio, which are in the fourth quadrant. Lifelong learning is highly developed in these regions.

Other regions with positive values in many of examined variables are Lombardia, Marche, Toscana, Piemonte, Umbria and Veneto which are positioned in the third quadrant.

More difficult the position of the regions positioned in the second quadrant: Abruzzo, Molise, Basilicata, Puglia and Campania. Sicilia, Calabria and Sardegna, which are positioned in the first quadrant, are the regions most affected by some of the goal 4 indicators. It is precisely in these 8 regions that the highest percentages of children at risk of educational poverty, often associated with forms of economic poverty and severe deprivation, are concentrated (Openpolis, 2019; Save the children, 2019).

7. Conclusion

The wide database of SDGs and the continuous updating of the data allows to analyze in depth the situation of each Goal of the 2030 Agenda. In the case of Goal 4, integration of data from various sources (INVALSI data, OECD-PISA data, data from ISTAT survey and data from MIUR) gave a global picture of the situation of "Quality of education" in Italy.

The wideness and granularity of the indicators disseminated by Agenda 2030, its sharing at global level, allows the study of complex and multidimensional phenomena such as educational poverty.

There are many territorial, gender and citizenship differences that often fuel inequalities, with regard to access to educational opportunities.

Regional differences are wide. Students in the North are less lacking both in Linguistic and in Mathematics skills, the students of the Center are positioned in the national average levels and the students of the South have particular deficiencies especially in Mathematics.

An evidence of the inequalities which exist due to different access opportunities is the strong difference in the competences of the children born in Italy from Italian (native) parents, compared to the first and second generation foreigners (respectively children born abroad from immigrant parents and children born in Italy to immigrant parents).

A first analysis of the interconnections and interaction of indicators of Goal 4 shows two principal components. The first component represents "integration and success in the school system"; the second component rep-

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resents the "advancement in skills (also extracurricular)". The regions with the best profiles in Goal 4 are the province of Trento, Friuli-Venezia Giulia, Emilia-Romagna, Valle d'Aosta, the province of Bolzano, Liguria and Lazio. Sicilia, Calabria and Sardegna are the regions most affected by some of the goal 4 indicators. It is precisely in these 3 regions that the highest percentages of children at risk of educational poverty, often associated with forms of economic poverty and severe deprivation, are concentrated.

The extension of the network of connections with the other Goals and the involvement of other targets and objectives of the 2030 Agenda will give an even more complete picture of the situation in Italy regarding educational poverty and quality education.

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The authors

Ferdinando Arzarello, professor emeritus in Mathematics at Turin University, President of ICMI (2013-2016), President of ERME (2009-2013); Member of PME IC (2004-2009), President of CIIM (1998-2006). Main area of research: Mathematics Education, particularly the learning of pre-algebra and algebra, geometry, and calculus in technological environments; embodiment and gestures in Mathematics; curricular design and theoretical frameworks for learning and teaching. In the last two decades he has authored more than 150 publications, mainly in international Journals or Volumes.

Cecilia Bagnarol, graduated in Statistics, Economics and Business at the Alma Mater Studiorum of Bologna. She currently works at Statistical Service of INVALSI where she performs support activities for statistical analysis on large data bases of national surveys on learning.

Barbara Baldazzi, researcher in Socio-Demographic Statistics at ISTAT since 1997. Researcher in SDGs project: "Sustainable Development Goals" with the responsibility of Goal 1 (poverty), Goal 3 (health and well-being), Goal 4 (education). Researcher in the BES project "Measurement of equitable and sustainable well-being in Italy" with coordination of Economic Well-being, Policies and Institutions and Education and Training sectors. Project Manager of "Adult Education Survey" (2017 and 2012).

Luciano Covi, since 2013 is director of "IPRASE", a provincial Institute for the educational research. The main personal field of interest, with published articles in specialized journal, are Vocational Education and Training and Educations and its social and economic impacts.

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Silvia Donno, graduated in Demographic Sciences for Social and Health Policies at the University of Rome "La Sapienza". Currently she works in Statistical Service of INVALSI, she carries out activities to support the elaboration and statistical analysis of the data of the national surveys on learning.

Federica Ferretti, PhD in Matematics. She is Researcher in Mathematics Education at the University of Ferrara, Department of Mathematics and Computer Science. Her main research interests concern the Didactic Contract at all school levels, formative assessment in Mathematics and the formative use of standardized assessement. For years she has been involved in Mathematics teachers professional development.

Paola Giangiacomo is a researcher at the National Institute for Educational and Educational Education Assessment (INVALSI), where she holds the position of National Data Manager for the surveys promoted by the OECD. Her main activities concern the revision and adaptation of survey instruments, the definition of sampling plans, the statistical analysis of quantitative and qualitative data, the drafting of technical and scientific reports, training activities for data analysis.

Patrizia Giannantoni, PhD in Statistics/Demography. She has worked on psychometric evaluation of developmental tests with CNR and on research projects on migration as research fellow at University of Naples. Since 2017 she has joined the statistical office of INVALSI, keeping her research interests on migrant integration support and educational inequalities.

Jana Kopecna, PhD in Demography. She has been involved in research projects on international migration and educational integration of migrants, at the University Sapienza of Rome. She is currently employed at the Statistical Service of INVALSI.

Lorenzo Maraviglia, PhD in Sociology of Development at the University of Pisa. Manager of the Statistical Office of the Provincia di Lucca and member of National Census Committee (ISTAT) and National Committee for Territorial and Environmental Information (CNITA). Teacher of Data Science at the University of Pisa. His research interests include education, immigration, labor market and volunteering.

Michele Marsili, graduated in Statistics at Sapienza University of Rome. He worked in Business Intelligence consulting, providing software devel-

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opment solutions for analysis and support for company's decision making in insurance and pharmaceutical industries. Since January 2018 he has been working in the Statistical Service of INVALSI.

Mattia Oliviero, PhD in Sociology and Social Research at the University of Trento. His main research areas include social demography, social and educational inequalities, and quantitative methods for the social sciences. Since November 2017 collaborates with IPRASE as research assistant.

Lucia Pallucca is the Principal of the "San Giovanni Bosco-Benedetto XIII-Poggiorsini" school in Gravina di Puglia (BA).

Serafina Pastore, PhD in Instructional Design and Educational Assessment, Fulbright Research Fellow, is currently Associate Professor at the University of Bari. Her research interests centre on educational assessment, formative assessment, quality assurance in the higher education field, and teacher assessment literacy.

Cataldo Scarnera is Research Manager at ISTAT. His main research interests focus on labor market statistical survey (e.g., workforce, professions), information systems design, data analysis with web scraping techniques, and data analysis at the micro-level for schools in the Apulian district.

Chiara Tamanini is responsible for the IPRASE's evaluation area. She follows the INVALSI surveys for the Province of Trento since 2012. She is an INVALSI expert for the external school evaluation (NEV) and for the production of Italian tests for secondary school. She is author of various papers.

Valeria F. Tortora is a researcher at the National Institute for Educational and Educational Education Assessment (INVALSI), where she is National Manager for the International Association for the Evaluation of Educational Achievement (IEA). She is PhD in Comparative Education with a thesis on the use of OECD-PISA results by teachers to improve their teaching strategies. The most recent research concerns the study of social inequalities, the variables connected to educational performance of students.

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Data are precious resources and as such an asset of the community. Collected, ordered, studied data become a tool that allows us to open debates and make most useful decisions. The INVALSI Statistical Service followed up, on this premise, with the organization of the IV Seminar "INVALSI data: a tool for teaching and scientific research". The Institute's databases, in fact, allow researchers and teachers to investigate in depth the theme of education in schools from different points of view and the event allows them to participate in a lively confrontation on the subject. The authors of the contributions collected in this volume investigate in depth the characteristics of students, schools and society. As a Statistical Service we hope that the reading of the volume confirms what has been written on the importance of data and their use, which will allow an ever-growing audience to enrich their knowledge on the subject of education and be a means of giving life to always new ideas for further reflection.

Patrizia Falzetti is Head of the INVALSI Statistical Service, which manages the acquisition, analysis and return of data concerning national and international surveys on learning to individual schools, stakeholders and the scientific community.

FrancoAngeli
La passione per le conoscenze