USE OF INVALSI DATA IN SCHOOL

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

edited by
Patrizia Falzetti

FrancoAngeli
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Introduction

by Patrizia Falzetti

Since its establishment, INVALSI had the task of preparing and carrying out periodic and systematic checks on the learning outcomes of Italian students (the INVALSI national tests), and of periodically managing Italian participation in international surveys.

The amount of data collected is processed in order to trace a history of students' skills and knowledge and acts as a valid tool for improving the evaluation activities of individual schools and the whole school system.

This volume is the result of a collection of the research works presented during the days of the "V Seminar INVALSI data: a tool for teaching and scientific research – Rome, 25th - 28th February 2021" and provides an example of the use of the data disclosed by the Institute.

The topics covered are different: in the first chapter a study on added-value is conducted (provided by INVALSI since 2016): it's the contribution of the school effect on the test results, net of factors that do not depend on it.

The work aims to analyze the probability for a school to reach a certain value-added category in the last year of lower secondary school, based on the score obtained by its students at the end of primary education in the Italian and Mathematics INVALSI tests.

In the second chapter the author studies the regional reality of Friuli-Venezia Giulia. The study of the RAV (Self-Assessment Report) of the schools concerned implicitly suggests the indispensable elements for any training projects for school managers and teachers, also through the opportunities of schools' networks. This contribution is an example of how data are not mere numbers but working tools.

In the third chapter, however, the author proposes a method to isolate as much as possible the effects of the different educational innovations present in the Italian territory on the learning outcomes measured by the INVALSI National Surveys, to contribute to the debate on the effectiveness of such al-

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ternative approaches, such as “Avanguardie educative”, Montessori, “Senza Zaino”, “We Debate”, “Book in Progress”, etc.

In the following chapters the focus are two issues that the pandemic situation related to Covid-19 highlighted.

In the fourth chapter the topic is the seriousness of the digital divide, already present in our country, but which emerged dramatically when the school moved “home”.

In the fifth chapter, the authors analyze the role that new technologies can play in improving students’ motivation and sense of effectiveness.

In the sixth and final chapter of the volume, the authors attempt a critical reading of the spelling questions present in the reflection section on the language of the INVALSI Italian tests, from the first years of administration until 2019.

As a Statistical Service we hope that the works collected in the volume are the basis for new reflections and a solid example of how the data released by INVALSI allow for quality research within the school context, whose goal has always been to improve students’ skills.

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1. Do schools have the same probability of adding value to competencies of their students at the entrance?

by Chiara Sacco, Angela Martini

Since 2016 INVALSI returns to the schools their achievement tests results not only as observed scores but also as value-added scores. Value-added is a fundamental judgment parameter for school accountability and evaluation in order to avoid an unfair comparison between schools with very different intakes. The school value-added represents the contribution of the school to its students' progress net of other variables affecting learning such as their socio-demographic features and their competencies at the entrance. In other words, value-added is the part of variance between schools that cannot be explained by student variables and consequently may be due to processes implemented by the school. Our paper aims at analysing the probability for a school to reach a certain value-added category in the last year of lower secondary education given the score obtained by its students in Italian language and Math INVALSI tests at the end of primary education. The results of this work confirm the well-known territorial differences in the functioning of the school system between Northern and Southern Italy, highlighting the importance of the interaction effect between student prior attainment and geographical area.

Dal 2016, l'INVALSI restituisce alle singole scuole, oltre al loro risultato osservato, anche il loro valore aggiunto. Il valore aggiunto costituisce un parametro di giudizio fondamentale per una valutazione equa delle scuole, in quanto rappresenta il contributo che essa dà al progresso dei suoi studenti al netto dell'effetto esercitato dalle caratteristiche socio-demografiche e dal livello di competenza in ingresso degli alunni che esse reclutano. In altre parole, il valore aggiunto corrisponde a quella parte della varianza tra scuole che non è spiegata dalle caratteristiche degli alunni e che dunque si può ipotizzare sia dovuta all'azione della scuola stessa. Il lavoro che propo-

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niamo mira ad analizzare la probabilità che le scuole hanno di raggiungere un certo livello di valore aggiunto nell'ultimo anno della scuola secondaria inferiore in funzione del punteggio ottenuto dai loro alunni al termine della scuola primaria nelle prove INVALSI di Italiano e Matematica. I risultati di questo lavoro confermano le ben note differenze territoriali nel funzionamento del sistema scolastico fra Nord e Sud Italia, evidenziando l'importanza dell'effetto di interazione tra apprendimento pregresso degli studenti e area geografica.

1. Introduction: the school effect

One of the main questions in educational research is to what extent the schools account for the learning outcomes of their students. This question is at the heart of school effectiveness research (Teddlie and Reynolds, 2000) that since the late 70s has tried to answer it and to demonstrate that schools "can make a difference" to students' performance (Brookover *et al.*, 1979; Rutter, 1979; Mortimore *et al.*, 1988; Scheerens and Bosker, 1997).

The results of a school are largely influenced by its students' background and prior attainment. As Stephen Raudenbush says: «Evidence accumulated over nearly 40 years of educational research indicates that the average level of student outcomes in a given school at a given time is more strongly affected by family background, prior educational experiences out of school, and effects of prior schools than it is affected by the school a student currently attends» (Raudenbush, 2004, p. 6).

Economic-social-cultural status and prior attainment of students are "exogenous" variables because they are beyond the school's control. To ensure a fair comparison between schools, it is important when evaluating the quality of education provided by them to separate the contribution a school gives to its students learning from exogenous variables affecting achievement in order to estimate its value-added. Value-added is the contribution of a school to its students learning "net" of other factors affecting outcomes. If we do not distinguish between exogenous variables and schooling effect, quality of instruction and quality of school intake remain confused with each other (Hanushek and Raymond, 2003).

Putting under control exogenous variables requires value-added modelling. According to OECD definition, «Value-added modelling is a class of statistical models that estimate the contribution of schools to student progress in stated or prescribed education objectives (e.g. cognitive achievement) measured at least two points in time» (OECD, 2008, p. 17). In prac-

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tice, a school's value-added is the difference between the observed outcomes of its students and the expected outcomes conditionally to their characteristics and prior attainment.

A significant advance in the estimation of value-added was made with the introduction of multilevel regression models (Bressoux, 2007), that consider not only the effect on achievement of student individual variables but also the effect due to the aggregation of such variables at school level (contextual effect). From a statistical point of view, the models for the estimation of value-added are developed in the framework of linear mixed models, that allow to account for the hierarchical structure of the data in the field of education, where usually students are nested within classes, classes within schools, and so on (Bryk and Raudenbush, 1992; Hox, 2002).

2. INVALSI value-added model

Since 2016 the National Institute for the Evaluation of the Educational System (INVALSI) returns to the schools their achievement tests results in Reading and Mathematics not only as observed scores but also as value added scores (Martini, 2018).

The INVALSI estimation of school value-added scores is based on a two-level student-within-schools random intercept model:

$$Y_{ij} = \alpha + X_{ij}^{'}\beta + W_{i}^{'}\gamma + u_i + \varepsilon_{ij}$$

Where Y_{ij} is the academic performance of the student j in the school i, α is the intercept of the model, $X_{ij}^{'}$ represents the vector of p predictors for the student j in the school i, β is the corresponding p *x 1* vector of fixed effects parameters, $W_{i}^{'}$ represents the vector of k predictors for the school i, y is the corresponding k *x 1* vector of fixed effects parameters, μ_i is the random effect associated with the school i with mean zero and variance σ_u^2 and $\boldsymbol{\varepsilon}_{ij}$ is the individual normal error with mean zero and variance σ_ε^2.

The term μ_i, estimated by the level two residual component of the multilevel model, allows to model the dependence among students attending the same school and captures the school value-added, a not observable quantity that characterizes the school i and is shared by all its students. From the equation of the model, we can observe that there are two different sets of covariates: X is the set of the student-specific covariates, while W is the set of the school-specific covariates. The choice of the covariates to be included

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in the model is an important issue since the meaning of the value-added indicator (VA) depends on this choice.

The variables included in the INVALSI value-added model are reported in Table 1.

Tab. 1 – Variables included in the INVALSI value-added model

A – Student-level variables
1) Socio-demographic background
Economic-social-cultural status index of student family (Escs)
Gender (Male/Female)
Nationality (Italian/Immigrant)*
Language spoken at home (Italian/Other language)
Regularly dialect speaker (No/Yes)
2) Scholastic profile
Score at previous INVALSI test
Pre-primary school attendance (No/Yes)
Repeating student (No/Yes)
B – School-level variables
Context
Mean score at previous INVALSI test
Mean economic-social-cultural status index
Percentage of immigrant students
Percentage of students that have repeated a grade at least once during their compulsory schooling
Percentage of students absent from the test

Notes: the reference for individual dummy variables is written in Italics

* Immigrant students are non italian citizen students, without distinction between first and second generation.

The variables at the student level (level 1) are grouped in two different sets: the socio-demographic variables (e.g., student background, gender, etc.) and the variables describing the scholastic profile of the students (prior achievement, kindergarten attendance, etc.). The school-level variables (level 2) representing the context are obtained by aggregation from the first level.

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3. Study objective

Starting from this framework, in this work we propose an in-depth analysis of the INVALSI value-added indicator, aiming to answer two research questions:

– Which is the role played by the average prior attainment in the estimation of school value-added?
– Which is the probability for a school to be in a certain value-added class given the previous mean score obtained at the INVALSI Reading or Math test when considering the geographical area where the school is located?

Our hypothesis is that the correlation between the valued added indicator and prior attainment should be minimal since the value-added is intended to measure the school effectiveness independently from that.

4. Data

INVALSI annually carries out standardized tests to assess the performance of all italian students at the end of the second and fifth year of primary school, at the end of lower secondary school, and at the end of the second and fifth year of higher secondary school.

This study exploits the Reading and Math standardized test administered by INVALSI in the school year 2018-2019 focusing on the students in the 3rd grade of the lower secondary school. Moreover, for the estimation of the value-added we used all the variables in INVALSI dataset reported in Table 1.

Before estimating the value-added of schools, we performed a three steps data cleaning procedure: first, we removed the students whose previous score in Reading or Math was missing, then we removed the classes with participation rate lower than 70% of students and in the last step we removed the schools with participation rate lower than 50% of classes. The final sample size of students in the last year of lower secondary school considered for the estimation of value-added is equal to 414,164 students in 4,767 schools for Math and to 416,393 students in 4,790 schools for Reading.

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5. Method

In a first step, we estimated four different value-added models for each subject tested to study the role played by the average prior attainment. The first model (Model 0) is empty, the second model (Model 1) includes only the student-specific covariates, the third model (Model 2) includes all the student level variables and all the school level variables except the school average prior achievement, that is included in the fourth model (Model 3). The last model effectively represents the INVALSI value-added model.

Moreover, we analysed, for each model, the correlation between the estimated value-added indicator and the average prior achievement. To better understand the relation between the school value-added and the previous mean score accounting for the geographical area, we computed the correlation analysis for each Italian geographical area (North, Centre, South).

To answer the second research question, we exploited the value-added indicators categorized in five classes using as threshold the national mean of the school value-added plus or minus 1 or 2 standard deviations. Indeed, the value-added indicator in Reading and in Math is released by INVALSI to each scholastic institution as an ordinal categorical variable with five classes: "Negative", "Slightly negative", "On average", "Slightly positive", "Positive"[1].

Focusing only on the four extreme classes of the value added, we estimated three different logistic multinomial models for each subject to analyse the relation between the probability of a school of being in a certain value-added category given the school previous mean score and the geographical area where the school is located.

The multinomial logistic regression represents the generalization of the logistic regression model to a multiclass problem. In our case the outcome variable is the school value-added in Italian or in Math categorized in five classes and the reference class for the model estimation is the negative class.

In the first model we included only the school previous mean score, in the second model we added the geographical area and in the third model we added the interaction between the two variables.

[1] The five categories are defined on the basis of the distance from the average in standard deviation units: so the "Negative" and "Positive" categories include the schools whose value added indicator is, respectively, two standard deviations above or below average, the "Slightly negative" and "Slightly positive" categories include the schools whose value added indicator is one standard deviation above or below average, and, finally, the "On average" category includes the schools whose value added indicator is in the mean range (between -1sd and +1sd).

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The fit of each model has been evaluated in terms of AIC and Mc Fadden's Pseudo-R2. Based on the third model, we computed the estimated probability for each value-added category, each geographical area and each subject.

All the analyses have been performed using R and the logistic multinomial regressions have been estimated using the net package (Venables and Ripley, 2002).

6. Results

6.1. Step 1

Table 2 shows the results of the estimated multilevel models for Reading in terms of parameters estimates, fit statistics and some marginal statistics. As expected, we observe that the INVALSI model (the one with all the variables included) is the best model in terms of both BIC and AIC.

It is interesting to observe the behaviour of the school variance. The variables included in Model 3 explain about 59% of the school variance with respect to Model 0. Adding the average prior achievement leads to a 12 percentage points increase in the school variance explained with respect to Model 2.

In the same way, analysing the results for Math, reported in Table 3, we can observe that adding the average prior achievement leads to a 5 percentage points increase in the school variance explained.

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Tab. 2 – Multilevel regression coefficients (Reading)

		Model 0	*Model 1*	*Model 2*	*Model 3*
Parameter Estimates	Intercept	200.091***	200.074***	200.056***	200.064***
	Prior achievement (grade 5)		0.558***	0.558***	0.558***
	Female student		0.138***	0.138***	0.138***
	Immigrant student		-0.081***	-0.081***	-0.081***
	Student Escs		0.135***	0.135***	0.135***
	Late-enrolled student		-0.078***	-0.080***	-0.079***
	Kindergarted attendance		0.024***	0.024***	0.024***
	Language spoken at home		-0.100***	-0.100***	-0.100***
	Dialect speaker		-0.092***	-0.092***	-0.092***
	School mean Escs			0.567***	0.423***
	Immigrant students %			0.007***	0.006***
	Late-enrolled students %			-0.003**	0.000
	Mean prior achievement (grade 5)				0.403***
Fit Statistics	AIC	1,131,445.577	877,992.378	874,672.663	873,560.188
	BIC	1,131,478.446	878,112.791	874,825.916	873,724.388
	Log-Likelihood	1,131,439.577	87,7970.378	874,644.663	873,530.188
Marginal Statistics	Student Variance	0.825 (0.002)	0.459 (0.001)	0.459 (0.001)	0.459 (0.001)
	School Variance	0.085 (0.002)	0.095 (0.002)	0.044 (0.001)	0.034 (0.001)
	Variation Student Variance		44.33%	44.31%	44.31%
	Variation School Variance			47.35%	59.72%

* p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001

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Tab. 3 – Multilevel regression coefficients (Math)

		Model 0	*Model 1*	*Model 2*	*Model 3*
Parameter Estimates	Intercept	200.082***	200.062***	200.042***	200.046***
	Prior achievement (grade 5)		0.542***	0.542***	0.542***
	Female student		-0.040***	-0.040***	-0.040***
	Immigrant student		-0.033***	-0.032***	-0.032***
	Student Escs		0.142***	0.142***	0.142***
	Late-enrolled student		-0.161***	-0.162***	-0.162***
	Kindergarted attendance		0.017***	0.016**	0.016**
	Language spoken at home		-0.089***	-0.089***	-0.089***
	Dialect speaker		-0.117***	-0.117***	-0.117***
	School mean Escs			0.620***	0.565***
	Immigrant students %			0.013***	0.013***
	Late-enrolled students %			-0.004***	-0.002*
	Mean prior achievement (grade 5)				0.261***
Fit Statistics	AIC	1,138,003.512	924,296.983	921,434.402	920,979.600
	BIC	1,138,036.369	924,417.383	921,587.638	921,143.782
	Log-Likelihood	1,137,997.512	924,274.983	921,406.402	920,949.600
Marginal Statistics	Student Variance	0.844 (0.002)	0.513 (0.001)	0.513 (0.001)	0.513 (0.001)
	School Variance	0.128 (0.003)	0.138 (0.003)	0.074 (0.002)	0.067 (0.002)
	Variation Student Variance		39.23%	39.22%	39.22%
	Variation School Variance			42.12%	47.55%

* p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001

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As expected, analysing the correlation between the value-added indicator in Reading and in Math and the average prior achievement at the national level (Table 4), we can confirm that it is not linearly dependent on prior attainment. Indeed, we can see that the correlation coefficients are positive for Model 1 and Model 2, but they are close to zero and not statistically significant considering the value-added estimated from Model 3.

Tab. 4 – Pearson's correlation coefficients

		Avarage prior achievement	
		Reading	*Math*
Value added	Model 1	0.631***	0.372***
	Model 2	0.382***	0.270***
	Model 3	0.017	-0.004

* p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001

However, performing the same analysis only on the value-added estimated from Model 3 and accounting for the geographical area (Table 5), we observe a weak but statistically significant correlation between the value-added indicator and the average prior achievement in Northern and Southern Italy.

As we can see from table 5, the correlations are positive for the schools in the North and negative for the schools in the South. This finding suggests that analysing the residuals separately for each geographical area, only in the Centre the model hypothesis is validated since in the North and in the South it is still possible to observe a linear association between the value-added indicator and the previous mean score.

Tab. 5 – Analysis of correlation between value-added indicator estimated from model 3 and the school average prior achievement by geographical area

		Coefficient	*P-value*
Reading	North	0.060	5.00E-03**
	Centre	-0.022	5.24E-01
	Sud	-0.186	1.23E-14***
Maths	North	0.151	9.82E-13***
	Centre	-0.006	8.59E-01
	Sud	-0.194	1.15E-15***

* p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001

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6.2. Step 2

Figure 1 shows the relationship between the school previous score and the school value-added, for each subject and each geographical area, using a boxplot representation.

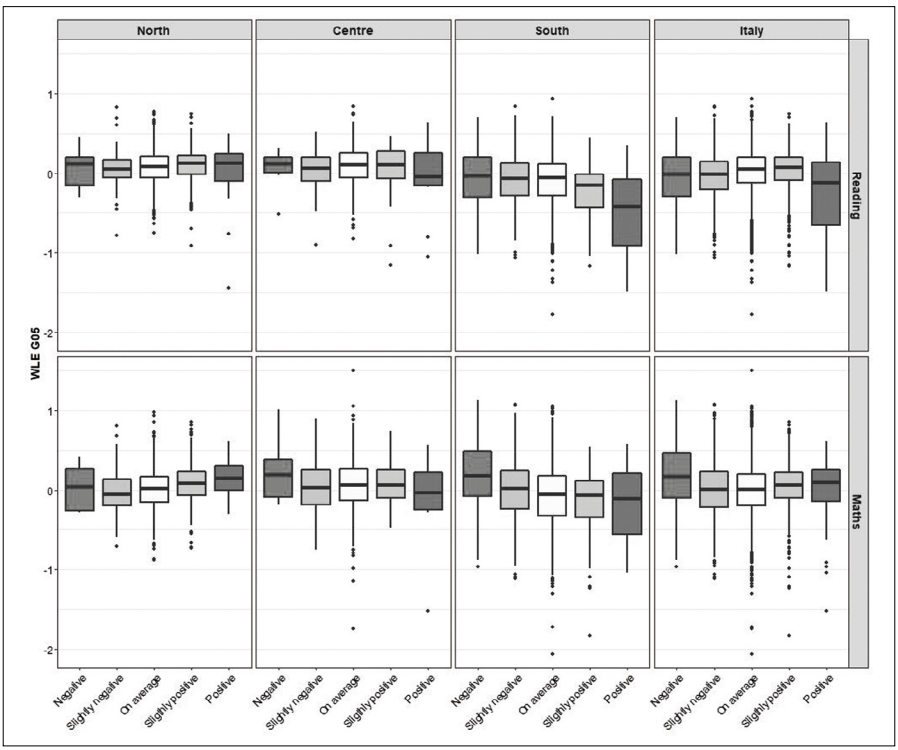

Fig. 1 – Boxplot of school previous mean score at INVALSI Reading and Math test (WLE G05) by value-added classes for each subject (rows) in each geographical area and in Italy (columns)

Focusing on the median values, we observe that in the North and in the Centre of Italy the interquartile range of previous scores of schools with negative value-added, in Math, is wider than the one observed in correspondence of the other schools. Moreover, the median of the previous score of schools with "negative" value-added is always higher than the score of the schools with "slightly negative" value-added. Starting from the "slightly negative" value-added, we observe that increasing the value-added class, the median of the school previous scores grows slightly for Math in Northern Italy. In

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Southern Italy, the schools show the opposite behaviour. As the class of the value-added increases, the school previous score decreases, and this result is true for Math in the Centre. The interquartile range of the previous score of schools with "positive" value-added is wider than the rest of the country. Approximately 75% and 50% of the schools with "positive" value-added in the South have a previous mean score lower than the national one in Reading and Math, respectively.

Table 6 and Table 7 show the parameter estimates and the fit statistics of each model for Reading and Math, respectively. The AIC and the McFadden Pseudo R2 suggest that the best model is the last one. In both tables, the effect of the predictors is reported in terms of the relative risk (RR) ratios for a school of obtaining a certain class of value-added compared to being allocated in the "negative" value-added category (reference class). A RR above one indicates a positive effect, while a coefficient below one indicates a negative effect. The effect of the previous mean score is significant in Model 1 for both subjects. However, we can observe that the geographical variable slightly decreases the effect of the previous score, but in most cases, it remains significant. The addition of the interaction term implicates the loss of the statistical significance of the previous score effect.

Including the geographical area variable in the model, we can see that the schools in the South are more likely to be less effective since the relative risk ratio of the three categories is always statically significant and above one. Analysing the interaction term, we can observe that switching from a school in the North to a school in the South, the relative risk ratio for a one-unit increase in the previous score is 0.05 for being in "positive" vs. "negative" class and 0.075 for being in "slightly positive" vs. "negative", pointing out that the schools in Southern Italy with students having on average high previous competencies are more likely to be less effective.

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Tab. 6 – Multinomial logistic regression coefficients (Reading)

		Model 1 (ref: Negative)			*Model 2 (ref: Negative)*			*Model 3 (ref: Negative)*		
		Slightly negative	*Slightly positive*	*Positive*	*Slightly negative*	*Slightly positive*	*Positive*	*Slightly negative*	*Slightly positive*	*Positive*
Parameter Estimates	Intercept	4.192***	4.259***	0.54***	10.213***	39.369***	3.499***	9.742***	33.191***	3.023**
	Average prior achievement	1.114	2.498**	0.21***	0.705	0.461*	0.074***	1.134***	3.187	0.807
	Geographical Area									
	Centre				1.627	0.334*	0.502	1.66	0.369	0.603
	South				0.287***	0.022***	0.063***	0.306	0.023***	0.059***
	Interaction term									
	Average prior achievement x Centre							0.874	0.458	0.46
	Average prior achievement x South							0.702	0.075	0.05*
Fit Statistics	McFadden R2		0.021			0.152			0.159	
	AIC		2916.583			2539.666			2529.837	

* p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001

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Tab. 7 – Multinomial logistic regression coefficients (Math)

		Model 1 (ref: Negative)			*Model 2 (ref: Negative)*			*Model 3 (ref: Negative)*			
		Slightly negative	*Slightly positive*	*Positive*	*Slightly negative*	*Slightly positive*	*Positive*	*Slightly negative*	*Slightly positive*	*Positive*	
Parameter Estimates	Intercept	5.056***	5.603***	0.68**	11.377***	65.249***	6.75***	10.036***	53.652***	5.007	***
	Average prior achievement	0.218***	0.325***	0.267**	0.3***	0.254***	0.244**	0.268	1.9	4.709	
	Geographical Area										
	Centre				1.133	0.151***	0.104***	1.35	0.188**	0.134	**
	South				0.327**	0.011***	0.031***	0.375**	0.013***	0.039	***
	Interaction term										
	Average prior achievement x Centre							0.768	0.147	0.009	*
	Average prior achievement x South							1.232	0.061	0.027	*
Fit Statistics	McFadden R2		0.009			0.223			0.235		
	AIC		3231.703			2547.942			2521.154		

* p-value < 0,05; ** p-value < 0,01; *** p-value < 0,001

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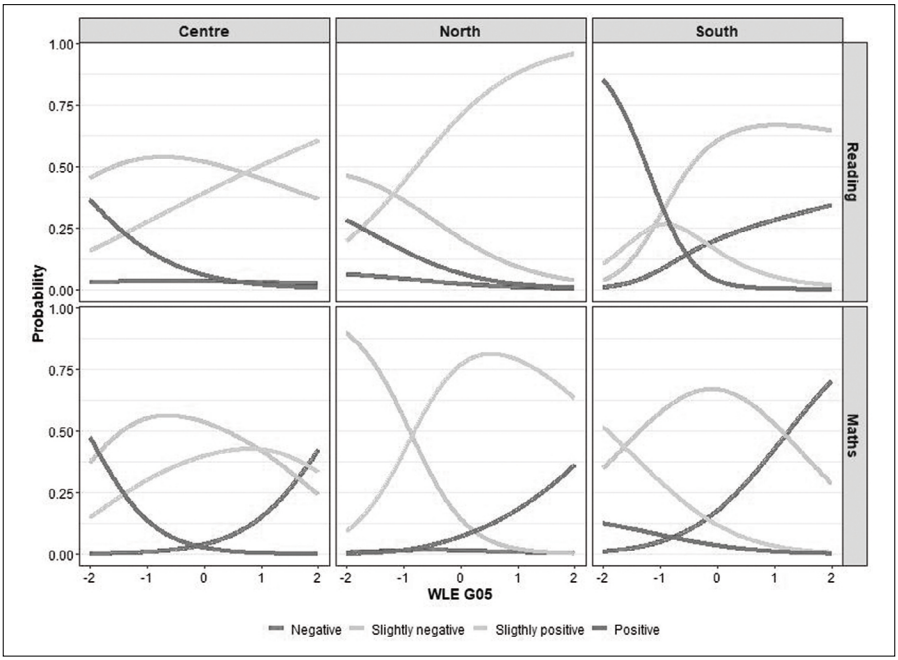

Fig. 2 – Predicted probabilities across school previous mean score (WLE G05) for each level of value-added classes and for each subject

Based on Model 3, we computed the estimated probability for each value-added category, in each geographical area and for each subject. Figure 2 represents how the probability of a school to be in certain value-added class changes in relation to the previous mean score. The relationship between the probability of being in a certain category of value-added and prior achievement in the South is different from the North and partly from the Centre. In the South, the schools with the lowest scores in fifth grade have the highest probability of being in the positive category of value-added at eight grade (that could be explained as a phenomenon of regression towards the mean), while in the North and in the Centre the schools with low scores in fifth grade have a higher probability of being in the slightly negative category.

In summary, the probability of being in the slightly positive category of value-added in eight grade is a growing function of Reading and Math scores in fifth grade in the North, while in the South the function in Reading is first increasing then decreasing, in Math it is always decreasing.

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7. Conclusions

The value-added of italian schools computed by INVALSI in the last year of lower secondary education is not linearly dependent on prior attainment at the national level. However, when we analyse the relationship between value-added score and prior attainment by geographical area, we see a weak but statistically significant correlation, positive in the North and negative in the South.

Moreover, the relationship between the probability for a school of being in a certain category of value-added and prior achievement in the South is different than in the North and partly in the Centre. This finding highlights the importance of the interaction effect between prior attainment and geographical area (Agasisti, Ieva and Paganoni, 2016). In the North schools with low average prior attainment are unlikely to add value to students, while in the South a school is less likely to add value to students as student's prior attainment increases. In other words, schools in the South seem to be less effective for better students.

Although the educational system in Italy has the same organization and is centrally regulated and managed by the Minister of Education, it works differently in the three main geographical areas into which the country is divided. The reasons of this different working should be investigated by targeted researches crossing INVALSI data with other variables about schools and teaching.

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2. Educational and didactical practices in management and organizational practices: a comparative reading of the ravs of Friuli-Venezia Giulia region

by Dina Veronese

The contribution addresses at least two important issues concerning the school world. The first concerns the processing of strategic documentation, in particular the Self-Assessment Report (RAV); the second concerns the training of school staff who, within the National Evaluation System (SNV), can be oriented to the cultural, economic and social growth of the country. The school as a permanent research laboratory can become the promoter of an inter-institutional dialogue for multilevel governance.

Taking the steps towards forms of cooperative accountability, capable of creating consensus on the choices and investment projects of the school, through the participation of the actors of territorial governance according to the principle of co-production of value, is still a road in climb. If both types of practices contribute to improving the quality of the education system, it is implicit that the least investigated practices are those that need more training.

Il contributo affronta almeno due questioni importanti che riguardano il mondo della scuola. La prima riguarda l'elaborazione della documentazione strategica, in particolare il Rapporto di Autovalutazione (RAV); la seconda riguarda la formazione del personale scolastico che all'interno del Sistema Nazionale di Valutazione (SNV) può essere orientata alla crescita culturale, economica e sociale del Paese. La scuola come laboratorio permanente di ricerca può diventare promotrice di un dialogo interistituzionale per una governance di multilivello.

Intraprendere i passi verso forme di responsabilità cooperativa, capaci di creare consenso sulle scelte e sui progetti di investimento della scuola, attraverso la partecipazione degli attori del governo del territorio secondo il principio della coproduzione di valore, è ancora una strada in salita. Se

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entrambi i tipi di pratiche contribuiscono a migliorare la qualità del sistema educativo, è implicito che le pratiche meno indagate siano quelle che necessitano di maggiore formazione.

1. Introduction

The analysis of the Self-Assessment Reports (RAV) published by the schools of the Friuli-Venezia Giulia region (FVG) for the three-year period 2019/2022, deals in an organic way with the study of the "Priorities" and "Goals" identified by the individual School Institutions. With the new edition of the RAVs, elaborated on the occasion of the social reporting that the schools have drawn up for the first time, we enter the new cycle of all the strategic documentation made public with the "Scuola in chiaro" portal.

Among the motivational impulses there is the search for the "virtuous" connection between results, processes and contexts, so that there is greater clarity and is more functional for the teaching staff and in order to favor an evaluation rather than suffered. Furthermore, the territorial (regional) school administrations can be oriented towards the development of professional capital, rather than the supervision of administrative procedures and formal compliance. The survey by the Organization for Economic Cooperation and Development (OECD) reveals that schools that pursue some form of accountability achieve approximately 25% higher quality performance than those that do not. Therefore, giving feedback to those who work on the drafting of these documents can be useful in reformulating improvement paths or plans relevant to the objectives identified.

The objective of a regional reading of the RAV data brings us closer to the idea of the network as a very important communication tool, a fundamental means for creating public value, as well as improving relations between local institutions.

2. Research

The research is based on the study of all internal and external factors that can positively affect students' learning in a direct and indirect way.

A first research hypothesis saw in the careful reading of the priorities, identified by the schools, the possibility of collecting data of strong interest and impact both for the individual school and for the entire school community of the observed region. Later, as the research was expanding and chang-

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ing, it became concrete thanks to the contributions that INVALSI makes available. In particular, the following documents were studied:

– the evaluation rubrics that have allowed schools to attribute a judgment to themselves, having as their objective the examination of the psychometric characteristics of the tools and the study of the use that schools have made on the same rubrics;
– the quantitative analysis of the contents of the open fields, in the compilation of the RAVs, to study the reasons given by the schools to justify the self-attributed judgment.

From a hermeneutic and epistemological point of view, this effort supported a more careful conduct of research, and from a scientific point of view, evidence has been elaborated on the basis of the operational indications contained in the "Methodological note and operational guide" version 1.0 of May 2019. The note clarifies that the priorities and targets must be elaborated in an observable and/or measurable form, articulating their contents because they represent the goals of the school in its improvement action for the three-year period of reference.

As regards the school questionnaire, the FVG region highlights that 82% of the schools of the 1st and 2nd cycle of education declare that they join networks of schools to improve teaching and educational practices with an average of 3-5 agreements for 45% of 1st cycle schools and 47% of 2nd cycle schools against a national average of 48% of 1st cycle schools and 40% of 2nd cycle schools. On the other hand, programming conducted in vertical continuity represents an objective not yet achieved, as it is practiced for about 60% in 1st cycle schools, by 50% of secondary schools, by 53% of technicians and by 48 % of professionals. In the same way it is observed that the hourly flexibility of the first cycle reaches 40% compared to the national average which is 29%, together with the lower secondary school which reaches 36% compared to the average of 28%. In the case of upper secondary school we find high schools for 31% compared to the national average of 23%, technicians at 35% out of 26% and professionals with 24% compared to 38% at the national level.

As far as training is concerned, particular attention is paid to issues relating to safety and prevention in the workplace, and to safety aspects relating to the use of information technology with a percentage of 30% for 1st cycle schools and 37% for 2nd cycle schools. There is a partial interest in training for organizational and didactic autonomy and evaluation and improvement. The expenditure for the aforementioned issues slightly exceeds 20% of the available funds.

Bringing the attention back to the research and taking into consideration the previous observations, it is emphasized that the analysis of the process

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objectives is representative of the activities on which the single school intends to act concretely to achieve its improvement objectives in the short and long term period.

The following figures schematically define the principles (Figure 1) that guide the self-assessment and the characteristics (Figure 2) of a good RAV.

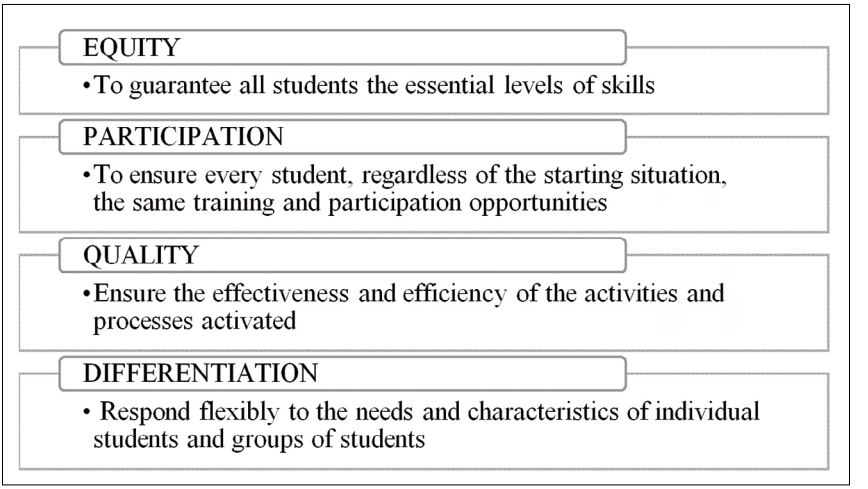

Fig. 1 – The principles that guide the self-assessment

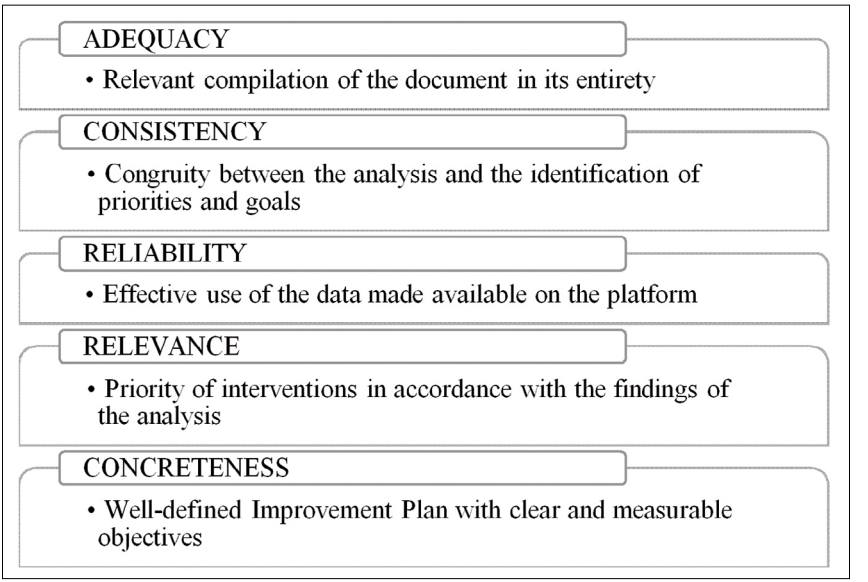

Fig. 2 – Characteristics

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3. The method

The method followed leads back to the same ways in which science reaches an objective, reliable and shareable knowledge of reality. On the one hand, the collection of empirical data under the guidance of the hypotheses to be examined, on the other hand the rigorous, logical-rational and, as far as possible mathematical analysis of the data collected, through the comparison of the contents outlined in the definitions of the priorities and targets described in the RAVs.

Before giving a structured form to this contribution, it was really useful to try to identify, within the single priorities outlined by the schools, elements or words that could bring together the different definitions, looking for the words repeated several times in the .text, such as "skills" or actions such as "improve", "increase" or "promote". An unsuitable attempt as the schools that within the same area had defined their priority, provided very different definitions in the overall meaning and the individual words obviously took on different significance. The effort was rewarded by the rereading of the operational indications suggested by the ministerial note, for which the schools had to review their priorities and make sure that the definitions made reference to the expected outcomes and the actions to achieve them. In this way, the idea was born of comparing the definitions of priorities and goals in the different areas, with the possibility of parameterizing the data collected, thus producing evidence capable of certifying the scientific nature of the contribution.

The note, under study, describes aspects of inconsistency between the results of the self-assessment and the priorities identified. Here are some definitions by way of example:

– the school gave itself a negative rating (between 1 and 3) in a certain area, but did not identify any priority for improvement in that area, but only in relation to other areas with higher levels of judgment;
– the school gave itself a very positive opinion (between 6 and 7) on all areas of the outcomes;
– the school gave a very positive opinion (between 6 and 7) on the "Results in national standardized tests" area, inconsistently with the data linked to the descriptor relating to the differences in the score compared to schools with a socio-economic context and similar cultural (ESCS);
– priorities have been identified only in the "European key competences area, in which there are no national comparative indicators".

The aspects of inconsistency described have become methodological suggestions, as the characteristics suggested for the drafting of a good RAV have

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become guidelines for an evaluation on the comparison between the definitions of priorities and the definitions of the targets indicated by the schools.

Value	*Judgment*	*Definition*
1	Not appropriate	Rationale for the judgment The document is completed, but the content is not relevant to the priorities and goals. (You can find considerations that refer to the mission and vision of the school, very generic texts, ...)
2	Not appropriate	Rationale for the judgment The compilation is relevant to the area, but it is not reliable because it is not based on evidence and therefore there is no congruity between the analysis and the choice. The document is not concrete because the objectives are not clear and measurable (possible to find advances on process objectives) Definitions can be found that express concepts that are sometimes important, but not pertinent, and work plans are often confused. It is not uncommon to read out-of-context process objectives
3	Not always appropriate	Rationale for the judgment The compilation is relevant to the area, it refers to evidence but there is no congruity between the analysis and the choice: the objective remains too generic and/or inadequate The compilation is not relevant to the reference area, but is based on evidence because the objective is clear and measurable: there are some irrelevant or not relevant generalizations (process objectives, considerations regarding the school's vision and mission, ...)
4	Adequate	Rationale for the judgment The compilation is relevant to the area, it refers to evidence, but there is little congruity between the analysis and the choice. The goal is clear and measurable. (E.g. improve in mathematics and Latin) The compilation is relevant to the area, refers to evidence and there is congruity between the analysis and the choice. The clarity of the objective remains weak
5	Very adequate	Rationale for the judgment Comply with all defined criteria

Fig. 3 – Evaluation table – Priorities and goals

The characteristics of adequacy, consistency, reliability, relevance and concreteness, make clear the priorities and goals for improvement by assuming the available evidence as reference parameters. Adequacy and consistency are two characteristics that deserve a clarification: the first anticipates an evaluation of merit and the second merges with the first through the concept of congruity between the analysis and the identification of the contents in both definitions. These possible misunderstandings have been remedied with a reformulation of the definitions associated with the values from 1 to 5.

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1) the document is *completed*;
2) the compilation of the document is *relevant* to the reference area;
3) the document is *reliable* as it is based on evidence available on the platform;
4) the document is *congruous* between the analysis and the choice;
5) the document is *concrete* because the objectives are clear and measurable.

Naturally, the reasons for the judgment expressed were defined for each value attributed, which for the sake of clarity are reported in the table (Figure 3).

4. The results

The results achieved are quantitative in relation to the learning outcomes in the various areas, and qualitative in relation to the contents expressed in the description of the priorities and goals identified.

The following figure shows the percentages of choice, of all schools, in each area of results (Figure 4).

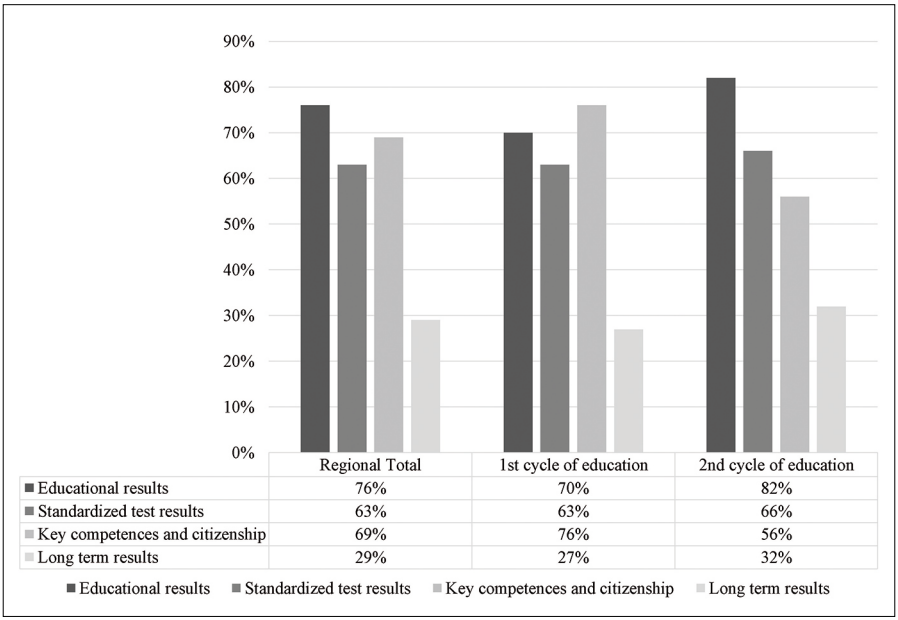

Fig. 4 – The areas chosen by the school

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The "Academic results" area is the area of greatest interest by schools, with percentages close to the "key competences and citizenship" area. This area is mainly followed by Comprehensive Institutes, while the second grade secondary school has greater interest in the area of "Distance Results" because they are connected to the Pathways for Transversal Skills and Orientation (PCTO).

Below we find the numerical data indicative of the quantity of areas chosen. Contrary to the ministerial note, which suggests moving towards one or two work areas, the schools have preferred to indicate a more consistent number (Figure 5).

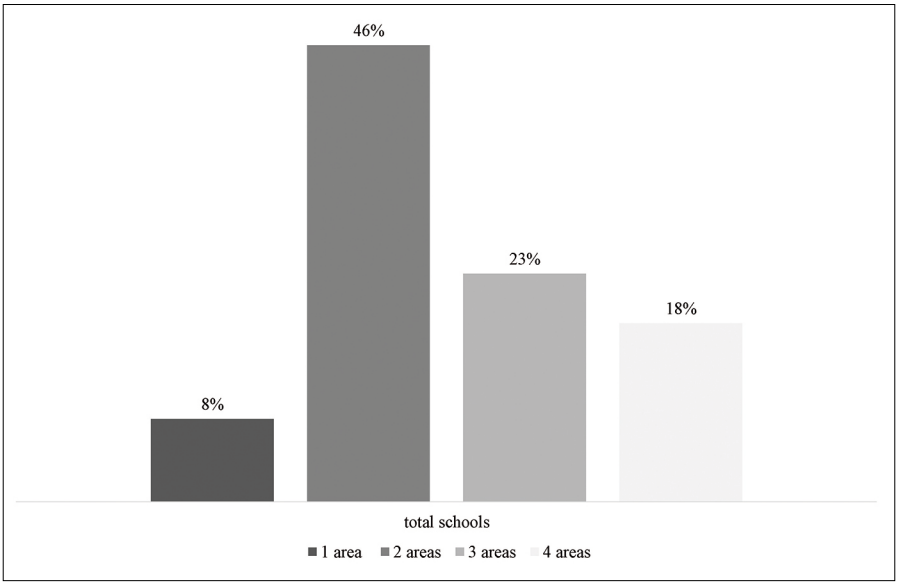

Fig. 5 – Number of areas chosen by the schools

46% of the schools observed chose to work on two areas; the sum of the schools that have worked on three or four areas reaches 41%. Only 8% choose a single area to intervene.

The qualitative data are represented by the graph below which describes the regional trend. The schools, in this second-from edition of the RAV, results consistent results in the section with value 1 (37 institutes out of 159 examined). This data indicates a low level of processing in the area of school results in the reserved area of the Education Information System (SIDI).

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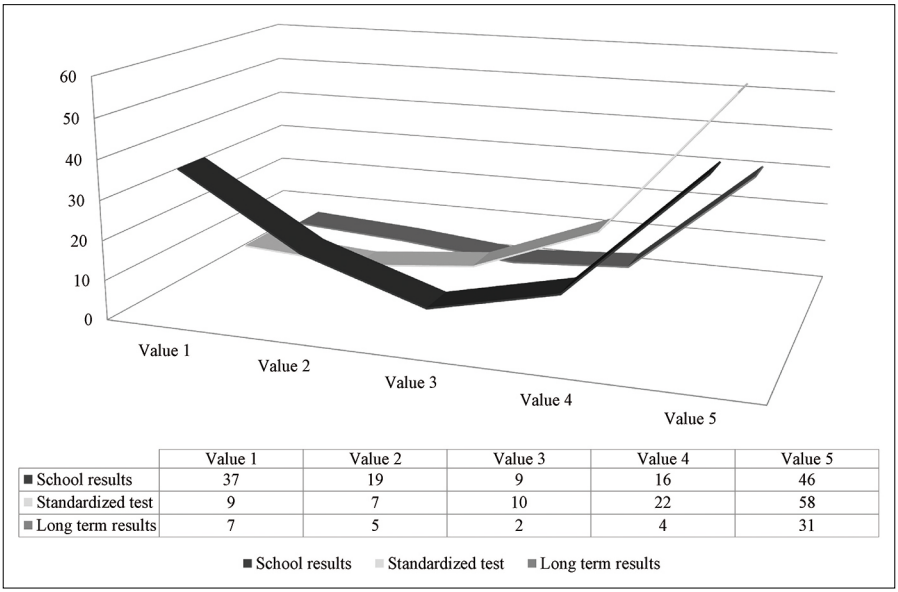
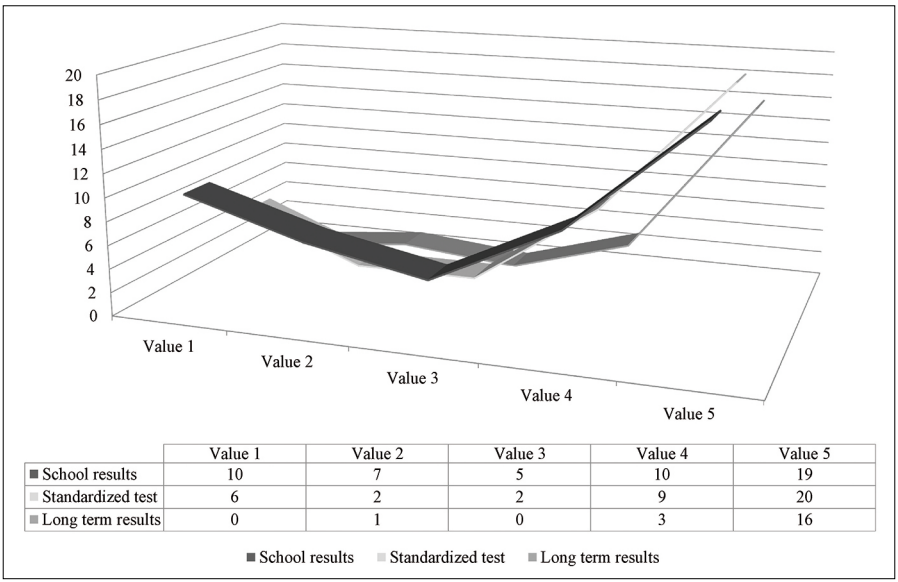


	Value 1	Value 2	Value 3	Value 4	Value 5
School results	37	19	9	16	46
Standardized test	9	7	10	22	58
Long term results	7	5	2	4	31

School results Standardized test Long term results

Fig. 6 – Different view of the data



	Value 1	Value 2	Value 3	Value 4	Value 5
School results	10	7	5	10	19
Standardized test	6	2	2	9	20
Long term results	0	1	0	3	16

School results Standardized test Long term results

Fig. 7 – Priorities and goals identified by the schools of the 1st cycle of education

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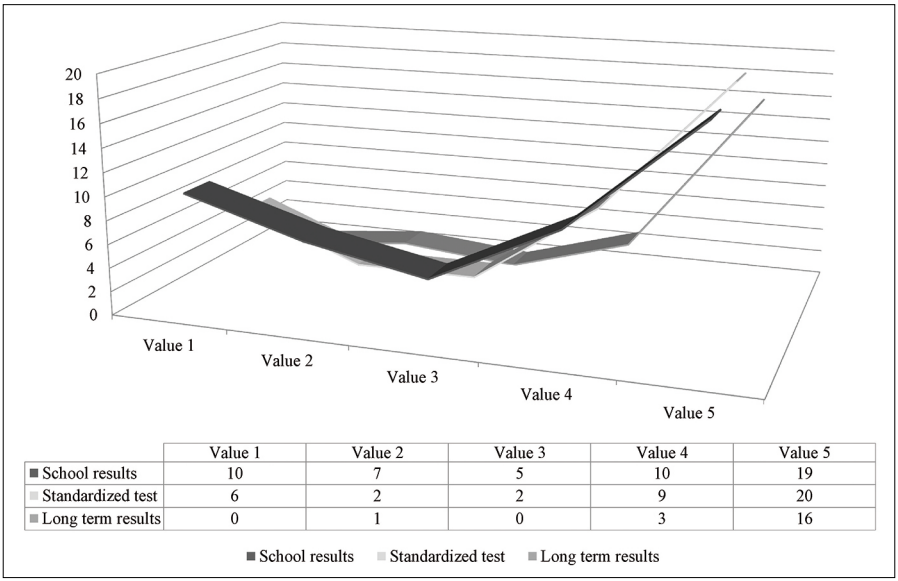

	Value 1	Value 2	Value 3	Value 4	Value 5
School results	10	7	5	10	19
Standardized test	6	2	2	9	20
Long term results	0	1	0	3	16

School results Standardized test Long term results

Fig. 8 – Priorities and goals 2nd cycle of education

The overall results for the first cycle of education (Figure 7) and those of the second cycle of education (Figure 8) are reported.

The graph of the 1st cycle of education is less aligned. The best results are concentrated in the central bar which corresponds to the area dedicated to the "national standardized tests" better known in the first cycle of education.

The results of the 2nd education cycle are more aligned and better. There are uncertainties that need to find better execution.

By carefully observing the graphs shown above, we can see that the central bar is the one that presents the best results in both school levels, in fact, it concerns the area of the results of the national standardized tests.

The first bar has the highest number of value 1 as the priorities and goals described are not adequate or relevant.

The third and last bar refers to the area of remote results that were less pursued, but better processed by schools.

The percentage of priorities and targets that are placed in the lowest band (with values 1 and 2) is very high and is equal to 29.79% compared to a national average estimated at around 20%. Consoling, but not too much, the percentage of 62.77% of schools that work well (values 4 and 5).

As regards the value 3, equivalent to an evaluation defined as "not always adequate", it corresponds to 7.44%. This percentage can be added to the positive values indicated above, so as to reach 70.21% of the schools that have

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worked correctly. But if we added 7.44% to 29.79%, we would reach 37.23% of schools that have not worked adequately.

A further study, the subject of the research, concerns the choice of process objectives that are reported in the Three-Year Training Offer Plan (PTOF), fundamental elements of the Improvement Plan.

The process objectives are divided into educational and didactic practices for the first four types, and management and organizational practices in the last three.

The next figure shows the results collected (Figure 9).

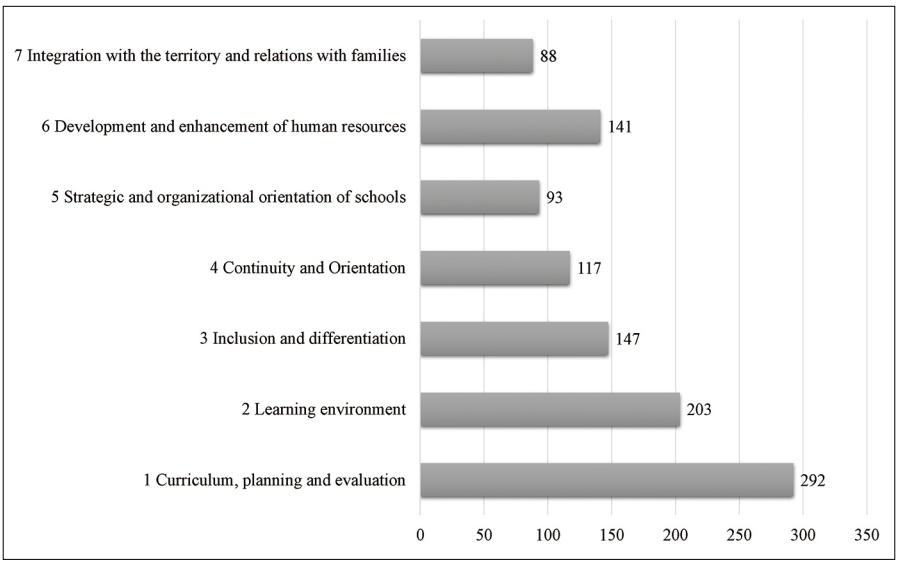

Fig. 9 – Objectives of process chosen by schools

Schools develop process objectives relating to educational and teaching practices, with a percentage incidence of 70.21%, while the process objectives relating to management and organizational practices, record a percentage of 29.79%.

The area of "key competences and citizenship" sees a greater development of process objectives, inherent to the strategic and organizational orientation of schools, integration with the territory and relationships with families. The recorded fluctuations are closely related to the reference areas (e.g. the area of remote results sees greater attention in orientation).

The quantitative results collected in each area of school outcomes are reported (Figures 10-13).

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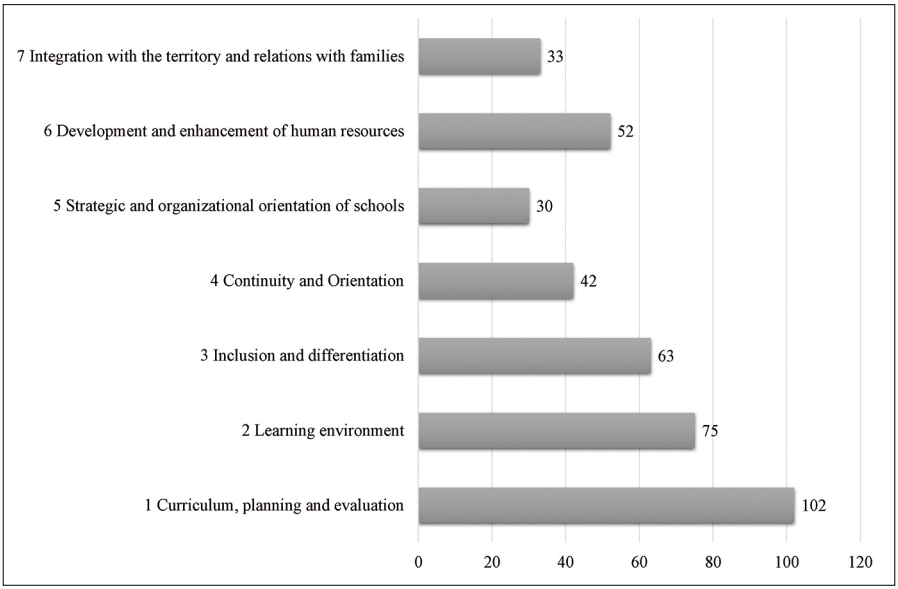

Fig. 10 – Process objectives – School results area

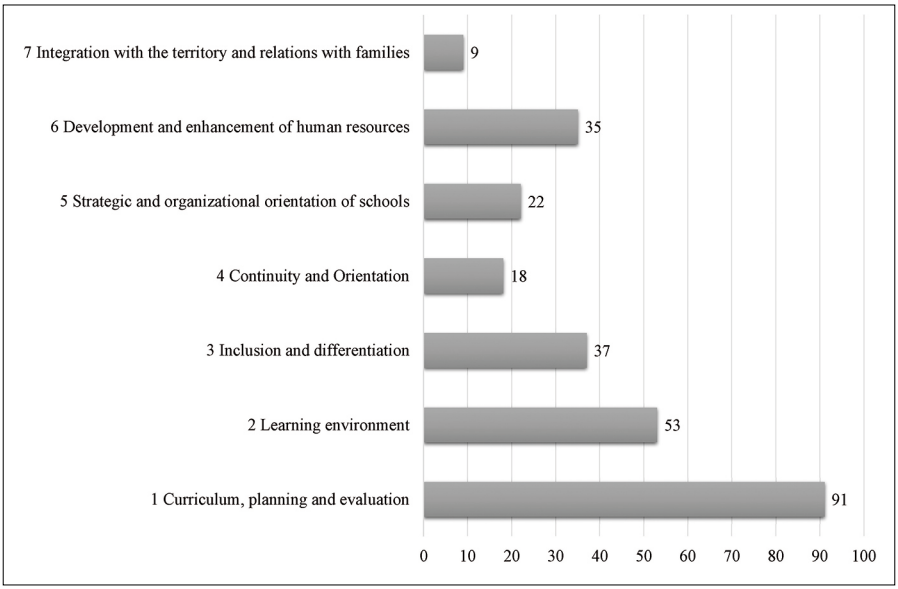

Fig. 11 – Process objectives – National standardized test area

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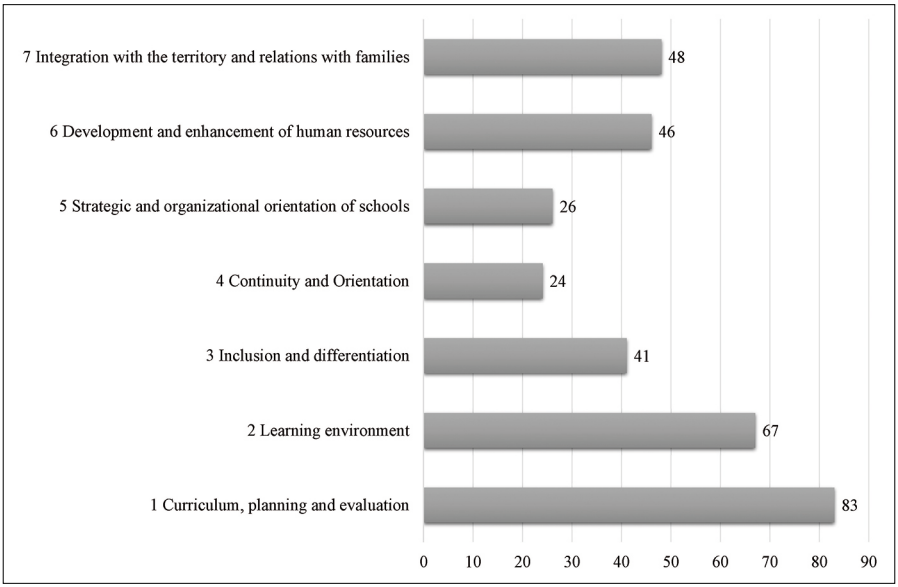

Fig. 12 – Process objectives – Area of key competences and citizenship

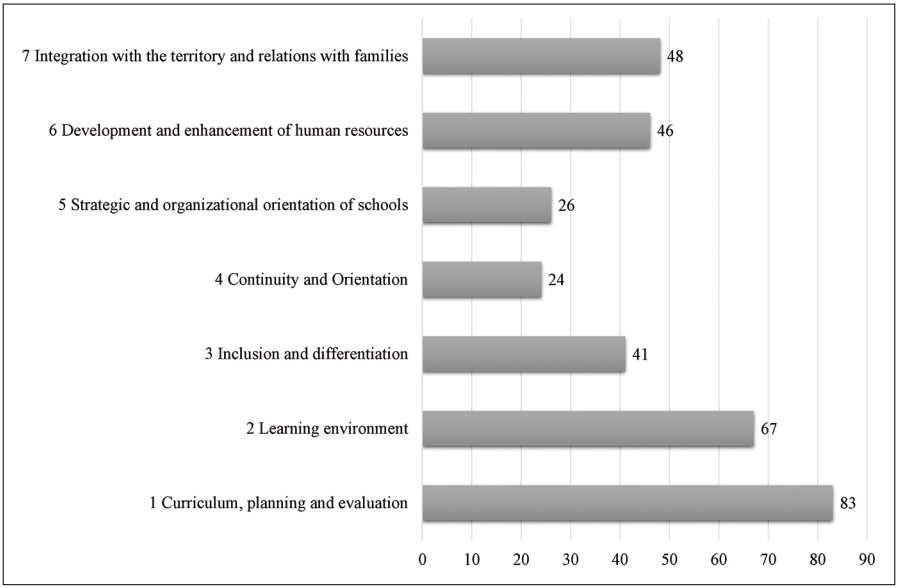

Fig. 13 – Process objectives – Remote results area

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Through an overall reading of the process objectives, managerial and organizational practices are less pursued than educational and didactic practices, especially as regards:

– the strategic and organizational orientation of schools;
– integration with the territory and relations with families.

These actions are strongly connected to the figure of the school manager and to the "system figures" who contribute to the smooth running of all activities. The research therefore becomes significant for a broad reflection on the formation and use that is made of the networks of scope and purpose.

5. Conclusions

The research conducted for the USR FVG on the self-assessment reports of schools has recently been concluded.

In the hypothesis of future prospects, it is necessary to resort to strategic planning that sees within the limits, opportunities that often do not present themselves in an orderly and predictable manner; there is a need for flexibility and the ability to accept the non-regular systematic nature of the procedures.

It will be important to imagine an activity that is not limited to a simple passage of information, but that transforms a set of data into useful evidence for the management of organizational knowledge. To this end, the dissemination of information for the continuous improvement of the school is hoped for.

The 2009 Talis survey confirms that Italy has few evaluation tools and the few that exist have no influence on most schools.

The downward convergence of little autonomy and the absence of accountability provide a plausible explanation of why in an institutional context lacking in accountability mechanisms for results, autonomy can result in the worsening of academic performance.

The regulatory framework (Law n. 122/2010 and Legislative Decree n. 150/2009) directs towards a rationalization of resources according to the logic of essential strategic objectives, which can be monitored, defined in terms of target, just as required in the RAV and in all the strategic documentation of the schools.

If we assume that equity is measured as the difference between 100% and the percentage change in learning, explained by the socio-economic and cultural status of the student, together with the quality, which is directly proportional to the challenge that the school puts in place through the pursuit of values, attitudes and beliefs, we cannot imagine a governance of educational systems unable to see autonomy as an opportunity rather than a threat.

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3. Detecting the achievements in INVALSI National Surveys of students who followed educational innovations: a five step method

by Stefano Scippo

The present chapter proposes a method to isolate as much as possible the effects of the different educational innovations present in the Italian territory on the learning outcomes measured by the INVALSI National Surveys, to contribute to the debate on the effectiveness of such alternative approaches, such as "Avanguardie educative", Montessori, "Senza Zaino", "We Debate", "Book in Progress", etc.

To illustrate the proposal, we take as an example the research that is taking place on Montessori teaching, in the framework of the PhD in Social & Developmental Psychology and Educational Research at Sapienza University of Rome.

According to Cook, Campbell and Peracchio's (1990) classification, the research design is *a design with non-equivalent groups, with only post-tests*, because there is no random assignment to experimental and control groups: the assignment takes place with the simple matching (precision control) method, which guarantees the greatest possible isolation of the effect of the independent variable, which keeps under control a) the effects of all the variables that we know affect dependent variables, and b) the effect of their interaction.

The proposed method consists in five steps. The first step is about reconstructing the list of schools that follow a certain educational innovation. In the case of Montessori pedagogy, the list of 50 fifth primary classes active in Italy in 2013 and 2016 has been defined. The second step consists in reconstructing the school careers of the students attending the schools on the list. In the case of Montessori schools, for about half of the students of both cohorts, the number of years of Montessori school attended was defined through a meticulous collection of data from the secretariats of 12 Montessori schools in Italy. By this way, in addition to the experimental group of all

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those enrolled in the Montessori sections identified, there is an experimental group whose number of years of Montessori school attended is also known. The third step is about requesting, to the Statistical Office of INVALSI, the achievement in National Surveys of the students attending the list of identified classes. In the case of Montessori schools, on 24 November 2020 the list of sections and SIDI codes of students whose career was reconstructed was submitted, and between January and February 2021 the databases of the 2013 and 2016 National Surveys was returned, with the distinction between Montessori and non-Montessori students. The fourth step consists in defining the experimental group, made up in this case by the students who attended a Montessori school, and the control group, whose members are identified with the simple matching method (Bailey, 1982, p. 340). The last step consists in verifying, by ANOVA, any statistically significant differences between the distributions of the scores of the experimental groups and related control groups.

Il presente contributo propone un metodo per isolare il più possibile gli effetti delle diverse sperimentazioni didattiche presenti nel territorio italiano sui risultati di apprendimento misurati dalle prove delle Rilevazioni Nazionali dell'INVALSI, per contribuire al dibattito sull'efficacia di tali approcci alternativi, come per esempio la differenziazione didattica Montessori, le scuole Senza Zaino, Waldorf, libertarie, DADA.

Per illustrare la proposta si prende per esempio la ricerca che si sta svolgendo sulla differenziazione didattica Montessori, nell'ambito del Dottorato in Psicologia sociale, dello sviluppo e della ricerca educativa alla Sapienza, Università di Roma.

Stando alla classificazione di Cook, Campbell e Peracchio (1990), il disegno di ricerca è un disegno con gruppi non equivalenti, con solo post-test, perché non c'è assegnazione casuale ai gruppi sperimentale e di controllo: l'assegnazione avviene con il metodo dell'uniformazione semplice, che garantisce il maggior isolamento possibile dell'effetto della variabile indipendente, che tiene sotto controllo gli effetti di tutte le variabili che sappiamo influenzare le variabili dipendenti, e l'effetto della loro interazione.

Il metodo proposto prevede cinque passi. Il primo passo consiste nel ricostruire la lista di scuole che seguono una certa innovazione didattica o pedagogia. Nel caso della pedagogia Montessori, è stata definita la lista delle 50 classi di quinta primaria attive in Italia nel 2013 e nel 2016. Il secondo passo consiste nel ricostruire le carriere scolastiche degli studenti iscritti nelle scuole della lista. Nel caso delle scuole Montessori, per circa la metà degli studenti di entrambe le coorti, è stato definito il numero di anni

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di scuola Montessori frequentata, attraverso una meticolosa raccolta dei dati delle segreterie di 12 scuole Montessori del territorio italiano. In questo modo, oltre al gruppo sperimentale di tutti gli iscritti alle sezioni Montessori individuate, c'è un gruppo sperimentale di cui è noto anche il numero di anni di scuola Montessori frequentata. Il terzo passo consiste nel richiedere all'Ufficio Statistico dell'INVALSI i risultati degli studenti iscritti nella lista delle classi individuate. Nel caso delle scuole Montessori, il 24 novembre 2020 è stata inoltrata la lista delle sezioni e dei codici SIDI degli studenti di cui è stata ricostruita la carriera, e tra gennaio e febbraio 2021 è stata restituita la matrice dei dati delle Rilevazioni nazionali 2013 e 2016, con la distinzione tra studenti montessoriani e non, al fine di verificare i risultati dei primi. Il quarto passo consiste nella definizione del gruppo sperimentale, costituito in questo caso dagli studenti delle scuole Montessori, e del gruppo di controllo, i cui membri sono individuati con il metodo dell'uniformazione semplice (Bailey, 1982, p. 340). L'ultimo passo consiste nella verifica, tramite ANOVA, di eventuali differenze statisticamente significative tra le distribuzioni dei punteggi dei gruppi sperimentali (il gruppo di tutti gli iscritti alle scuole Montessori, più il gruppo degli studenti di cui è noto il numero di anni durante i quali hanno frequentato le scuole Montessori) e i relativi gruppi di controllo.

1. Evaluating educational innovation: reference framework and literature

The panorama of educational-didactic "experimentations" and "innovations" in Italy, self-proclaimed as such or in some way officially recognized, is vast, articulated and with boundaries difficult to define. In the *mare magnum* of the educational offer, public or private, there are very particular islands of experiences that refer to alternative pedagogies. They are difficult to imagine for those who are not in the profession (for example the "kindergartens in the woods"). There are also archipelagos of more widespread schools now quite well-known, even in name only (such as the "Montessori" schools), peninsulas of realities that have a partial official recognition that try to follow an innovative pedagogy (such as schools Senza Zaino), and continents with more or less aggregated realities that mix with the "traditional" school reality in different and hardly recognizable ways: in these cases they range from quite aggregated and defined realities such as the network of Dada schools to the experiences of individual teachers, perhaps belonging to the Educational Cooperation Movement, which operate in classes of

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"traditional" public schools trying to carry out pedagogical practices and principles that refer to Freinet pedagogy and popular education.

Just as the geography of the Earth's crust is the result of a geological history, which leaves both very evident traces such as the separation between continents, and minute traces such as the fossil of a shell on a stone, so the map of the educational offer is the result of the history of pedagogy and school. This history leaves both very evident traces, such as the affirmation and diffusion of educational philosophies known all over the world, and little or not at all evident traces in the practices of individual teachers, traces sometimes recognizable even to the teachers themselves.

As Guerra and Antonacci (2017, p. 3448) state, there is «an articulated map of schools which have started innovation projects, some with known and more historical references, others with evolving and more recent experiences».

The metaphor of the *mare magnum* tries to convey the idea of a complexity that is very difficult to describe, first of all because, as Cros (1997) argues, the notion of innovation can only be defined by clarifying first of all the socio-cultural matrices in which it is used, and in any case owes its attraction to its ambiguity and its illusory strength. However, according to the French pedagogist, in schools the word innovation takes on its own specificity if it can be clearly understood by the teachers who have to carry it out, because it is accompanied by a fairly precise definition of the practices to be adopted, which must bring something more than those adopted.

Guerra and Antonacci (2017), to contextualize their innovative project, try to give a picture of similar experiences based on a volume published by Terra Nuova, entitled "Mappa della scuola che cambia" (AA.VV., 2017). The volume collects spontaneous reports of those who believe they are involved or author of an innovative experience in the school. The result of this mapping, approximate and unrepresentative precisely because it is based on spontaneous "bottom-up" reports, is reported by Guerra and Antonacci (2017, p. 3349) and, listing the different experiences in descending order of diffusion. The list sees first the network of "Avanguardie Educative", a movement promoted in 2014 by INDIRE, which has 1139 schools (Mughini, 2020, p. 33), followed by diffusion by the network of "Senza Zaino" schools, which has 285 schools[1], then by the network of 177 schools adhering to the "We Debate" project[2], and followed by that of the

[1] See https://www.scuolasenzazaino.org/wp-content/uploads/2021/01/elenco-scuole-sito-new.pdf.

[2] Cfr. https://www.debateitalia.it/pagine/componenti-della-rete.

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84 members of the "Book in Progress" project[3]. A historically more deeply rooted reality is undoubtedly the one of Montessori schools, which currently has about 200 schools on Italian territory, including Children's Houses (kindergartens) and primary schools, plus very few first-degree secondary experimentations. More than half of the Montessori schools in Italy are public schools[4], to teach in which an enabling qualification recognized by the MIUR is required, as well as for the Pizzigoni and Agazzi methods, which each have only one public school on Italian territory. Less widespread, but growing, is the National Network of Public Outdoor Schools, which currently has 36 member institutions[5]. To these must be added other isolated experimentations, such as those authorized by the MIUR and reported by Guerra and Antonacci (2017): the Scuola-Città Pestalozzi in Florence, the Scuola Rinascita-Livi in Milan, the Scuola Sperimentale Don Milani in Genoa, the *Una scuola* project in Varese.

Finally, on the private schools' front, there is certainly to consider the Federation of Steiner-Waldorf Schools in Italy, which has 27 Kindergartens, 19 schools with cycle I-VIII and two with cycle I-XII[6], and the Network for Libertarian Education, which has six schools[7].

This quick overview, certainly approximate and not exhaustive, would deserve an extensive study to become clearer and more defined, but here it serves only to make the idea of how, on Italian territory, there are many and different experiences that pursue, each in its own way and in the terms permitted by law, a certain identity around a more or less coherent pedagogical model, more or less innovative, more or less different from what you imagine for "traditional school".

Surely, it is a need for educational research, and for society, to evaluate the functioning of the school system, including the experimentations and innovations that arise and develop within it, basing these assessments on evidence as much as possible.

It should also be said that there is a difference between experimentation and innovation. The notion of "innovation" actually seems to have prevailed over that of "experimentation", just as Becchi had predicted in 1997, when,

[3] See http://www.bookinprogress.org/index.php?s=62#.YAX3dEHPzIU.

[4] The precise count of Montessori schools is currently uncertain, because to the schools listed on the website of the Montessori National Opera (ONM) must be added the schools affiliated with the Montessori Italia Foundation (FMI), which since 2014 has activated agreements with some schools but does not list them on its website.

[5] See https://scuoleallaperto.com/chisiamo/.

[6] See https://www.scuolasteineriana.org/organismi-steiner-waldorf-in-italia/.

[7] See http://www.educazionelibertaria.org/scuole/in-italia/.

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summarizing the history of experimentation in italian school and school regulations, she wrote:

> The official culture of school experimentation started [...] in a climate of self-referentiality, where it was easy to foresee – as it happened and is actually accessing – that the complex experimentation construct [...] would result in innovation in which the constraints and rules proper to an authentic experimentation were not present or in any case were not highlighted (Becchi, 1997, p. 207).

However, as Calvani and Marzano (2019, p. 90) point out, «Recent research on education, particularly in the last two decades, has acquired significant knowledge about "what works and in what contexts"» and it is clear that we need to continue along this path to improve the education system, because «the choices of improvement actions [...] should be "informed by evidence"» (ivi, p. 94).

Of course, obtaining evidence of the effect that a certain educational method has on learning outcomes is a very difficult operation, perhaps impossible to complete as a pure experimental design would require, because education works as a complex hierarchical system, «a multi-level structure, with the individual learning, the setting of education or the class, school and national education system as the key hierarchical levels» (Scheerens, 2016, p. 24).

However, «the "scientificity" of the ways of approaching human problems of great complexity and relevance, as eminently are the educational ones, can only be, in turn, a sort of complex and multi-dimensional scientificity. It is a matter of sourcing the results of many studies, different in object and methodology», by paradigms and values that have driven the collection and interpretation of data (Visalberghi, 1990, p. 119).

This work aims to contribute to the complex problem of evaluating the effectiveness of educational methods, proposing a method that has been made possible thanks to some innovations introduced in recent years in the Italian education system (such as the existence of a code that follows students throughout their school career). The proposal focuses on the use of simple matching (precision control) method as a technique to obtain an experimental group and a control group as equivalent as possible, since random assignment is impossible. It is based on paradigmatic choices, which we will then explicit, and is based on the choice, as a test of the proposed method, of one of the most well-known educational approaches in the world: Montessori pedagogy.

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2. An example on Montessori schools: objectives and hypothesis of the study

Montessori pedagogy was born in Rome at the beginning of the 20th century and today it is an international reality applied in more than 30 countries, but there is no empirical research in Italy that try to measure the learnings of students who have attended Montessori schools.

The literature of empirical surveys that try to provide data for the evaluation of the effectiveness of Montessori primary education is quite vast and has a history of more than half a century: most of the research has been carried out in the United States, but there is no lack of contributions in Europe (France, Switzerland, Germany) and Asia (Malaysia, India, Taiwan).

Marshall (2017) recently analyzed the strongest investigations and identified, in this body of research, the following recurring limitations:

- Few longitudinal studies.
- Lack of good quality randomized control trials.
- The effects of the specific practices of Montessori education are not isolated.
- Studies rarely include more than one Montessori school, and sometimes not more than one Montessori class.
- Not all Montessori schools have trained Montessori teachers, or are accredited by a professional organization.
- Children's experiences in Montessori education will vary in terms of the length of time they spend in Montessori education, and the age at which they attend.
- The numbers of children participating in studies are usually small and quite narrow in terms of their demographics, making generalization of any results problematic.

The proposed method allows to overcome many of the aforementioned limitations, because it allows to carry out a longitudinal study, it reports on many schools and classes and on the widest possible variability at the socio-economic-cultural level, and it takes into account how many years of education Montessori the students have received. The method consists in verifying, throughout Italy, the achievements of two cohorts of Montessori and non-Montessori students, at the tests of the National INVALSI Surveys at grades 5, 8 and 10: the oldest cohort was in the fifth grade in 2012/13, while the youngest was in the second grade.

The study pursues three objectives.

The first objective concerns the verification of the hypothesis that the experimental group achieves significantly higher scores than the control group,

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on school learnings as measured by the tests of the INVALSI Surveys. Since the score could also be affected by the number of years during which students attended Montessori school, it is intended to verify the hypothesis that the differences in scoring between experimental and control groups are greater and statistically significant for an experimental subgroup that has attended Montessori schools for several years. The tests will be carried out with univariate ANOVA with a single factor between the groups, with post hoc comparisons. If one of the score distributions in the two samples is significantly different from the normal distribution (according to the Shapiro-Wilk test), then *outliers* will be identified and excluded.

The second objective of the survey is descriptive/exploratory. Since it will be possible to isolate the Montessori students among the other students of the two cohorts concerned, then it will be possible to verify whether or not there is a significant difference between the average level and the variability of the socio-economic-cultural conditions of Montessori and non-Montessori students. If it were discovered that part of the Montessori students belongs to more marginalized strata of society, this would pave the way for a possible future research development aimed at verifying how much this pedagogy can promote equity, that is, how much it can compensate for the starting disadvantages, with a teaching that was born exquisitely inclusive, and it still is.

The last objective is to apply for the first time a survey method which can also be extended to students who have attended schools belonging to the networks of other experiments/innovations rather widespread on the national territory. The wealth of information collected during this work (concerning the procedures necessary for accessing INVALSI data, the way to reconstruct lists of schools that adopt a certain teaching and the careers of their students) is forming as a solid basis for applying the same method also to other expanding and growing contexts. The pivot of the proposed method is the use of data from National Survey which, being aimed at the entire school population, allows the application of simple matching (precision control) for the definition of the experimental and control groups so that they are as equivalent as possible, to better compensate for the impossibility of random assignment.

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3. Research method and design

3.1. Paradigm choices: ontological, epistemological and methodological

Picking up Lincoln, Lynham, Guba, (2011) and Creswell's (2007) outline, each research operates choices on three levels: ontological (what is the nature of reality?), epistemological (what is the relationship between researcher and research object?), methodological (what is the research process?). On an ontological level, this research is situated in a post-positivist paradigm, with a realistic assumption, whereby there is «a single reality, but we may not be able to fully understand it as it is» (Guba, Lincoln, 2005, taken from Benvenuto, 2015). In the words of Cook and Campbell (1979, p. IX) we can place ourselves in a perspective of critical or hypothetical realism, which «postulates that causal connections are "real", but are imperfectly perceived».

On the epistemological level, the position is probably not ascribable to either post-positivism or pure constructivism, but lies more within Dewey's theory of inquiry, whereby objects of knowledge are definable within an intersubjective consensus of the scientific community, qualitatively with descriptive systems, quantitatively reinforced by statistics and probabilities. Finally, on a methodological level, this research uses the post-positivist methods, for which «The use of statistics is important to clearly interpret our results» (Guba, Lincoln, 2005, taken from Benvenuto, 2015).

3.2. The simple matching method

The method chosen aims to respond to several needs. Firstly, to have an experimental group as large as possible, which therefore allows to take into account as many schools as possible within the network of Montessori schools in Italy, and to have a wide socio-economic-cultural variability within it.

Secondly, the need to account for how many years of Montessori education the members of the experimental group have received.

Thirdly, there is a need to carry out a longitudinal study, which measures learning outcomes not only at the end of Montessori primary school, but also at subsequent school grades, to verify the possible existence of a medterm "Montessori effect" on learning even when the student is in secondary school, which does not follow a Montessori teaching.

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In order to have an experimental group as large as possible, it is necessary to have a measure of learning about the entire Italian school population, in order to certainly intercept the small percentage of those who have had Montessori primary education. For this reason, the most valid and reliable measurement to be addressed is that carried out by the National Surveys of INVALSI. It currently measure, on the entire school population, learnings in Italian and Mathematics for grade 2 (second primary), 5 (fifth primary), 8 (third secondary grade), 10 (second secondary second degree), 13 (fifth secondary second degree). Starting from 2012/13, INVALSI has identified each student with a code, called Sidi INVALSI code, to be able to follow its progress in the different surveys over the years. For this reason, the oldest cohort that can be followed, to verify the longest possible learning, is the one that was in 2012/13 in the fifth grade in Montessori classes. To have both measurements during primary school years, we decided to follow a younger cohort, which was in 2012/13 in the second primary and in 2015/16 in fifth primary (Table 1).

Tab. 1 – The two cohorts involved in the research

	2012/13	*2013/14*	*2014/15*	*2015/16*	*2016/17*	*2017/18*	*2018/19*
Younger cohort	*Primary*				*Secondary, I grade*		
	II	III	IV	V	I	II	III
Older cohort	*Primary*	*Secondary, I grade*			*Secondary, II grade*		
	V	I	II	III	I	II	

INVALSI can release databases with the score of the tests and the values on a whole series of variables related to socio-economic-cultural conditions, which we will describe better later. What INVALSI does not know is which classes and which students followed a Montessori teaching.

This is possible with the help of the Montessori National Opera (ONM), which publishes on its website a list of schools where are active classes with Montessori teaching[8].

[8] http://www.operanazionalemontessori.it/scuole-montessori/scuole-montessori-in-italia. The list includes all schools that have entered into an agreement with the ONM, thus excluding those schools that have officially activated a section with differentiated teaching Montessori, but have not entered into an agreement with the ONM. The number of these schools is unknown and should be residual. Through contacts with the Montessori Italia Foundation (FMI), that is the other major private entity that deals with the promotion of Montessori pedagogy in Italy, we discovered, by Dr. Sonia Coluccelli (head of the training office), that «all schools open independently of ONM have been active since 2014 or after» (email received on September 9, 2019).

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Once the list of second and fifth grades classes that in 2012/13 followed a Montessori teaching was defined, on November 24, 2020 the list was sent to the Statistical Office of INVALSI[9] which is tracking down, in the National Surveys databases, the students belonging to those classes. This will to be the experimental group.

But how to define the number of years of Montessori education of students who, in 2012/13, were in the fifth or second grade classes and who participated in the National Surveys?

To do this, you must ask the secretariats of the individual schools for the data necessary to reconstruct the careers of these two cohorts and assign, to each student, a number of years of attendance at school in a Montessori class, both in primary and in preschool (Children's Houses), and add this variable to the list to be sent to INVALSI.

For the definition of the control group, it was decided to use the simple matching (precision control) method as defined by Bailey (1982, p. 340), which consists in finding «matching pairs of identical subjects and place one of the pair in the experimental group and the other in the control group. Obviously, it is not sufficient to match the two subjects on a single characteristic. They must be matched on all relevant characteristics simultaneously».

The characteristics that are considered relevant are all the variables that INVALSI considers for the purpose of calculating value added:

– ESCS INVALSI index (calculated on the basis of: degree and employment status of parents, possession of certain specific material goods);
– gender: male, female;
– citizenship: Italian, immigrant;
– regularity: in advance, late.

For privacy reasons, INVALSI cannot release citizenship and regularity data, because it would make minorities identifiable, so only native and regular students will be included in the database.

To these variables, in the comparison between the score at grades 2 and 5, we also add the school complex variable (otherwise educational institute, otherwise province, otherwise region, otherwise geographical area). In the comparison of the score at grades 8 and 10, the following variables are also added: total score to the tests of grade 5 and class (otherwise school complex, otherwise educational institute, otherwise province, otherwise region, otherwise geographical area).

Since in Italy the numerical ratio between Montessori and non-Montessori student is about 1:500, that is, for each Montessori student reached by the

[9] In particular, the study was followed by Dr. Valeria Tortora and Dr. Patrizia Giannantoni.

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National Surveys there are 500 non-Montessori ones, then it should be easy to find, for each student belonging to the experimental group, a non-Montessori student who has the same values on the variables listed above.

3.3. Research design and data collection

According to the Cook, Campbell and Peracchio's (1990) classification of quasi-experimental designs, the research design is *a design with non-equivalent groups, with only post-tests*, in which the non-equivalence of groups is given by the impossibility of random assignment. However, the establishment of the experimental group and control group by the simple matching method ensures the greatest possible isolation of the effect of the independent variable, because it keeps under control the effects of all variables that can be influenced by dependent variables and the effect of their interaction.

Among the uncontrolled variables there is certainly the propensity of families to enroll their children in a Montessori school, but the cultural level of parents is controlled and, therefore, the pro-Montessori attitude of parents, purged from their cultural level, can be considered part of Montessori education itself, which is the independent variable. The dependent variables are the achievements to the tests of the National Surveys.

For the comparison between the experimental and control groups, the independent variable is dichotomic, i.e., it is assumed that the members of the control group have had no Montessori education and the members of the experimental group have had at least four years of Montessori education.

As noted above, within the experimental group there will be a sub-group of students for whom it will have been possible to reconstruct their school careers and identify how many years of Montessori education they have attended. For the comparison between this experimental sub-group and a control sub-group (identified by the same simple matching method) the independent variable is ordinal and can take on four values: absence of Montessori education, less than three years, between four and five years, between six and eight years.

As regard the data collection, the reconstruction work of the list of Montessori primary school fifth grade classes active in Italy in 2013 and 2016, as mentioned, was mainly based on the list of Montessori schools affiliated with the ONM (since those affiliated with the FMI were activated after 2014). However, this list does not record the history of all the second and fifth grades classes that, in 2012/13, were already following Montessori education. Therefore, the ONM secretariat was contacted, there was a meeting

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with the responsible[10] for updating the list of educational institutes affiliated with the ONM. She cleaned the list from those schools in which Montessori classes were activated certainly later than 2013.

At this point we proceeded by searching, on the portal "Scuola in chiaro" of the MIUR, the approximately 50 school complexes on the list to understand their size and make a quick analysis of the PTOFs (Three-year Plan of the Educational Offer), to understand how long Montessori classes had been activated and, if indicated, how many there were[11].

In some cases, the PTOFs report the number of teachers with Montessori specialization, from which it is possible to deduce an estimate of the number of classes, in other cases they report the year from which the didactic differentiation was activated, in others the number of active sections. On the basis of this information, it has been estimated that in Italy, for each school year, about a thousand students complete a Montessori primary school. Between December 2019 and July 2020, more than 50 schools identified by ONM segretary were contacted one by one, and on 9/04/2019 an email was sent requesting missing information to accurately reconstruct the number of second and fifth grades classes of 2012/13 and the number of students for each of the two cohorts.

Since very few schools answered the e-mails, we proceeded with telephone contacts, with secretaries, principals, and referents of the Montessori classes, asking them the following questions: 1) Were there Montessori fifths grade classes active in 2012/13? 2) And in 2015/16? 3) How many were there? 4) Which letters distinguished the section(s)? 5) Did the students participate in the INVALSI tests[12]?

After this work, it was reconstructed that, in Italy, there were, in 2012/13, 50 fifth grade Montessori classes, for an estimated total of about 920 students and, in 2015/16, 50 classes for about 990 student.

Regarding the reconstruction of careers, after taking contact by mail and by phone with all schools, 13 of them were visited in Rome, Milan, Chiaravalle, Ancona, Gubbio and Perugia. So, for 2012/13 we reconstructed the careers of 401 students, and 91.77% of them attended at least four years of Montessori education; for the 2015/16 cohort, we reconstructed the careers of 446 students, and 90.36% of them attended at least four years of Montessori education. Only after receiving the data from the Statistical Office of

[10] The responsible is Dr. Arianna Romoli.

[11] http://cercalatuascuola.istruzione.it.

[12] This question was asked because in some Montessori schools parents decide, more or less en masse, not to send their children to school on the day of the National Surveys tests.

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INVALSI we will discover how many students took part in the National Surveys[13]. In Table 2 you can see in detail the result of career reconstruction[14].

Tab. 2 – Reconstructing the careers of Montessori students

Years of Montessori education	*Fifth graders in 2012/13*	*Fifth graders in 2012/13 (%)*	*Fifth graders in 2015/16*	*Fifth graders in 2015/16 (%)*
A (6-8 years)	227	56.61	215	48.21
B (4-5 years)	141	35.16	188	42.15
C (1-3 years)	33	8.23	43	9.64
Total	401	100	446	100

We consider four years of Montessori education as the minimum to be considered Montessori student, because in Italy there are more Montessori kindergartens (Children's Houses) than primary schools, therefore it is possible that in the control group there are students who attended a Children's Houses as children, and it is not possible to identify them with this reconstruction that starts from a Montessori primary schools list. However, the percentage of Montessori kindergartens in Italy is so low on the total number of Italian kindergartens that the probability of students attending them being assigned, by the simple matching method, to the control group is derisory.

Regarding the group of 2012/13 whose career has not been reconstructed, we can generalize the sub-group data and we can assume, with more than 90% of the probability, that they have attended at least four years of Montessori education.

For the experimental group of the cohort that was in fifth grade in 2015/16, it is not necessary to make this assumption because INVALSI can track down all those who participated in both the 2013 grade 2 Surveys and the 2016 grade 5 Surveys. Of all of them we will know, with certainty, that they have attended at least four years of Montessori education.

The work of reconstructing careers has been complex and has generally required the following steps: 1) personal contact with some teachers working in the school of interest, and illustration of the research with request to plead

[13] For example, of the 446 students of the 2015/16 cohort, 39 of them did not finish fifth grade in the Montessori school and, of these, most still had more than four years of Montessori education: they are students who should be considered Montessori student and the Invalsi should track them in its database even if they were not in the Montessori classes.

[14] From the calculation were eliminated four classes of the Montessori school in Brixen (which reached a total of 37 students in 2012/13 and 38 in 2015/16) because in the Autonomous Province of Bolzano the tests of the National Surveys take place only for Mathematics, and only for secondary schools.

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the case with the principal, 2) sending to the principal a request for access to students' careers and the release of their SIDI codes, 3) telephone contacts with the secretariats to make sure that the principal had seen the email and to request an appointment, 4) talking with the principal and waiting for approval. In case of approval, 5) access to the secretariats, where an attempt has been made to reconstruct careers through data in paper or electronic format using the software used by the school to communicate with the National Student Registry (ANS).

Once the hurdle of principal approval had been overcome, there were often further difficulties: the software did not contain the SIDI codes of all students because they may not have been imported from any software previously used. Sometimes the codes had never been entered. In these cases it was necessary to find paper lists that related name and surname with the SIDI code. Usually, these lists are found in the files related to the National Surveys, piled up in some cabinet. At other times, a change of software without importing data made it impossible to reconstruct students' careers because information about cohorts that finished primary school before the software change had been lost, and the paper was in some cabinet, unknown to the secretarial employee because it was dealt with by an employee no longer working at that institution[15].

3.4. Data analysis and hypothesis testing

Once the databases have been received from the Statistical Office of INVALSI, it is about carrying out two operations: 1) cleaning and aggregating the different databases for each school grade; 2) identifying the pairs of students to be assigned one to the experimental group, the other to the control group.

The first action consists first of all in unifying, for each cohort, the databases of the three degrees released by the Statistical Office. For the older cohort we had grades 5, 8 and 10, for the younger cohort we had grades 2, 5 and 8. The connection takes place through the SIDI INVALSI code, which identifies each student. Then, it is about eliminating from the database the

[15] Due to these and other similar difficulties, in some schools it was not possible to associate the SIDI code with 28 students of the 2012/13 cohort and one student of 2015/16 one. As a result, they will not be identified by Invalsi as Montessori students and may be assigned to the control group. However, since they are few and predominantly have attended a few years of Montessori education, it is reasonable to consider that they will not have any significant impact on the average of the control group itself.

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cases belonging to regions in which there are no schools adhering to the pedagogical innovation, in this case the Montessori pedagogy. Thirdly, two new variables must be calculated: the number of sections for each school complex and the number of school complexes for each school. Finally, it is about sorting the database several times. In the first phase, it is sorted by region, school, complex, gender, kindergarten attendance, number complexes per school, number of sections per complex, student ESCS, and class ESCS. By this way, in the database there will be, above or below each Montessori student, a non-Montessori one from the same region, from the same school, from the same complex, who has attended or has not attended the kindergarten, who has the same individual ESCS index, and who belongs to a class with a similar ESCS index. The Montessori student is attributed to the experimental group and the closest student to the control group. Once you have found all the possible pairs in the database sorted by this way, you have to sort it in a second way, similar to the first, but removing the school and complex variables. By this way, couples are no longer sought in the same school, but in schools with similar dimensions, that is, with the same number of complex per school and the same number of sections per school complex.

Once the experimental and control groups have been defined, for each cohort, both for Italian and for Mathematics, it is possible to start analyzing the data, in order to verify the hypotheses. First, it is checked that there have been no errors in the pairing, verifying that, for each of the two groups, experimental and control one, there is the same number of students of the same sex, from the same region, who attended or not the kindergarten. Then, you have to check that the distributions of the scores on the ESCS indices of the school, the class and the student respect some parameters of normality: asymmetry lower than 2 and kurtosis lower than 7 (Curran, West and Finch, 1996).

Then, you have to check that the distributions of the ESCS indices are not statistically significantly different between the two groups, experimental and control one.

Having ascertained that the two groups are comparable, it is possible to verify that the distributions of the scores respect the parameters of normality. Then it's possible to carry out the variance analysis to verify the hypothesis that the experimental group and the control group have significantly different distributions. In the case of Montessori pedagogy, not so much a difference in the mean of the scores is expected, but a higher variance in the experimental group. In fact, the purpose of Montessori pedagogy is not to standardize students' learning, but to enhance the characteristics of each one. Consequently, a student may not necessarily privilege the mathematical

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or linguistic dimension. For example, if a student is not inclined for Mathematics but for Drawing, in Montessori schools he should find the space to develop this inclination, so there could be a lower score on the INVALSI tests that measure learning in Italian and Mathematics. Or, a student who is gifted for Mathematics should develop excellence. Therefore, in the case of the study on Montessori pedagogy, the ANOVA is useful to verify the existence of a significance in the difference between the distributions of the scores and not between the averages of the scores. Obviously, for other educational innovations the hypothesis may be different and more related to the average of the scores.

4. Strengths and limitations

4.1. Strengths

The main strength is certainly the definition of a method that can also be applied to other educational programs widespread in Italy. If we want to verify the existence of a possible effect on disciplinary learning, the use of the achievements at the INVALSI National Surveys makes it possible to identify, by the method of simple matching, a control group as comparable as possible to the experimental group. The first step of this method is to define the list of schools that follow a certain pedagogy, the second in reconstructing the career of as many students as possible, to consider how many years they have attended certain schools and participated in certain educational practices. Then, it is a matter of sending this list to INVALSI and agreeing on the release of data relating to the variables that are relevant with respect to the dependent variable. A further research perspective is to check whether such a method is also applicable abroad.

The second strength lies in the fact that this is the first survey conducted in Italy on the learning achievements of the population of two entire cohorts of Montessori students. The research of literature conducted in the first phase of the PhD did not find scientific publications on the subject[16].

The third strength is related to the research design, which allows to overcome most of the recurring limitations of investigations carried out on this subject.

[16] We found only a dissertation work carried out on a single school by Anna Ceccacci, referent teacher of the Montessori school in Via Lemonia in Rome.

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4.2. Limitations on internal and external validity

The first limitation relates to the internal validity of the conclusions. Among the limitations listed by Marshall (2017) is undoubtedly the most difficult to overcome: the lack of random assignment of subjects to the two groups, experimental and control. This makes the research design a non-experimental design *strictu sensu* but a "quasi-experimental" one and, according to the last Cook, Campbell and Peracchio's (1990) classification of research designs, it is a "non-equivalent group design with only post-test", represented by the following diagram.

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X O1
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As Becchi (1997, p. 189) points out: «The weakness of this design is that [...] the final differences may be attributed indifferently to the treatment or to the choice of subjects». This means that, if the average score of the members of the experimental group is significantly higher than the average score of the control group members, the difference may be due not to the different primary education (Montessori or not) but to differences between the subjects in the two groups. Simple matching method allows you to control all the differences that are known to be relevant, but this does not preclude the possibility that additional variables not controlled by this method may affect the values of the dependent variables.

The second limitation concerns the external validity of the conclusions, that is linked to the fact that it is not possible to reconstruct the career of all Montessori students in the two cohorts involved. Thus, there will be a smaller experimental group (which in this case covers about 50% of the population of both cohorts) of which we know how many years they have attended Montessori education, and a larger experimental group, coinciding with the entire population of Montessori student in the cohorts involved, of which we could only assume that they have attended some years of Montessori education. Since the selection is not randomized but determined by the willingness of schools to provide data to reconstruct careers, then the external validity of the conclusions that would be reached by analyzing the results on the members of this experimental subgroup is compromised. What is gained is the internal validity of the same conclusion, because knowing the number of years of Montessori education of the members of the reduced group, keeps under control the variability of treatment.

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4. INVALSI data: a source to improve our knowledge of digital divide among students

by Lorenzo Maraviglia

The Covid-19 epidemic has dramatically drawn attention to the deep inequalities in terms of access to digital resources that still plague our country.

In particular, the seriousness of the digital divide has emerged with special intensity and gravity in connection to the outcomes of distance learning (DDI). Moreover, the condition of young people without access to the internet and/or to the skills and resources to take advantage from DDI is indicative of the difficulties and backwardness in which many families still find themselves.

The INVALSI data, once integrated with other statistical sources (e.g. the micro-data of the Survey on the Aspects of Daily Life of ISTAT) and administrative (e.g. the open data of MIUR), allow to deepen the knowledge of the dimensions of digital divide; above all, thanks to their territorial detail, they allow a reconstruction of the geographical variability of the phenomenon, providing an important tool in support of the action carried out by local and central administrations to reduce the opportunity gap.

This contribution illustrates these cognitive and practical possibilities, with specific attention to the needs of territorial governance systems.

L'epidemia di Covid-19 ha fatto emergere in modo drammatico le profonde disuguaglianze in ordine alla possibilità di accesso alle risorse digitali che ancora affliggono il nostro Paese.

In particolare, la gravità del digital divide si è imposta all'attenzione con particolare intensità in relazione alla didattica a distanza. Peraltro, la condizione dei giovani privi di accesso a internet e/o alle risorse competenze per fruire in modo adeguato degli insegnamenti impartiti in remoto è indicativa delle condizioni di difficoltà e di arretratezza in cui versano ancora molte famiglie.

I dati INVALSI, una volta integrati con altri fonti statistiche (per es. i microdati dell'Indagine sugli Aspetti della Vita Quotidiana dell'ISTAT) e am-

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ministrative (per es. gli open data del MIUR), consentono di approfondire la conoscenza delle dimensioni del digital divide; soprattutto, grazie al loro dettaglio territoriale, essi permettono una ricostruzione del quadro della variabilità geografico del fenomeno, costituendo un'importante strumento a sostegno dell'azione svolta dalle amministrazioni locali e centrali per la riduzione del gap di opportunità.

Il presente contributo illustra tali possibilità conoscitive e pratiche, con una specifica attenzione alle esigenze dei sistemi di governance territoriali.

1. Introduction

In this paper we explore the utility of INVALSI micro-data in order to improve our knowledge of a relevant aspect of the problem of *digital divide* among students, namely the availability of a personal computer that can be used for distance learning[1]. More specifically, we discuss the possibility to derive robust and consistent aggregated indicators of pc unavailability at sub-regional level, thus overcoming the issues of insufficient geographic resolution posed by other sources of information[2].

Our contribution consists of six paragraphs. In the first one we set the general framework of the problem in the context of both recent (the Covid-19 epidemics) and longer term (the digital transition of our society) scenarios. In the second one we analyse available data on various aspects of the digital divide issue, subsequently narrowing our attention to the practical problems faced by those who bear the responsibility to design interventions at local level. In the third paragraph we introduce INVALSI data and show their potential usefulness for the purposes of the local decision-making process. In the fourth paragraph we discuss both strengths and weaknesses of INVALSI data. In the fifth paragraph we propose our interpretation of the emerging territorial differences, taking into account the previous *caveats*. In the sixth paragraph we propose some suggestions to improve the quality of data and to develop a type of research that brings together different skills, knowledge, needs and interests.

[1] Other aspects, such as the lack of an internet connection or the overcrowding of domestic spaces, can be explored using INVALSI micro-data. We limit the analysis to the PC availability aspect for reasons of space. In the conclusions we discuss some lines of development of the present research, also suggesting some methodological improvements.

[2] See *infra*.

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2. Setting the framework

In early march 2020 we were overwhelmed by a sort of hurricane. Millions of people were placed in smart working from day to night (ISTAT, 2020a). At the same time many young people, adolescents, children had to say goodbye (temporarily) to familiar school routine and start treading the largely unknown path of remote learning (INVALSI, 2020a).

As we all know, many adult workers are parents and almost all students are daughters and sons. The sudden need to share the same domestic space to perform activities previously carried out in decentralized places has generated unprecedented problems of relationship, coordination and allocation of means and resources.

This is a huge issue. As noted by many observers, the Covid-19 epidemic has been a cause of dramatic changes in itself, but also the catalyst of processes that had been underway for some time. Problems and delays accumulated by our economy and society have revealed themselves, coming into the spotlight. Among these the digital backwardness of our country definitely stands out (European Commission, 2020).

Digitalization is a many-folded phenomenon. At systemic level, it is a matter of infrastructures, networks, connections. At micro-level, it has to do with people's endowment of digital skills and material resources (hardware, software, connection, etc.). To this regard, the pandemic highlighted not only systemic shortages, or modest average achievements, but also the existence of relevant inequalities among households (Save the Children, 2020). Here we focus on a limited but absolutely fundamental aspect of the digital divide: the availability of devices allowing to connect and carry out daily activities such as *smart*-working or *remote*-learning.

We identify such a condition with the availability of a minimally performing and updated personal computer, leaving aside (for the moment) the issues related to network connection or digital skills[3]. In other words, we focus on what is, by far, the simplest of all problems related to the digital divide issue. After all, a pc with the above mentioned technical specifications costs only a few hundred euros and providing such tool to every family which does not

[3] Alternatives are tablets or smartphones. Whether personal computers or tablets should be favoured – smartphones can be plausibly ruled out – is an open questions, requiring more evidence. In our opinion, if "the mean is the message", care should be posed in providing students with a device – such us the tablet – whose user interface is based mainly on pointing and clicking operations, stimulating no coding/programming skills. On a more prosaic ground, we focus on pc availability because that's the only information provided by the sources (AVQ, INVALSI) at our disposal.

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possess one is certainly within the reach of our transfer system – once the "jungle" of *ad hoc* bonus has been streamlined[4].

As for remote learning, which we will discuss in the following, the most difficult problems are those related to the contents, with respect to which there is no uniformity of views and, rather, prejudices and stereotypes without scientific basis continue to thrive[5]. However, although partial, the hardware issue is foundational: without a proper device, remote learning as well as remote working is impossible.

3. Data and figures on PC-availability

At the beginning of the lockdown period, estimates on the number of students living in families without a pc were released by ISTAT (2020b). Such figures have represented the basis for a first, empirical, estimate of households' hardware requirements in our country.

The primary source of these estimates is ISTAT Daily Life Survey ("Indagine sugli aspetti della vita quotidiana", abbr. AVQ). AVQ is a multipurpose survey carried out every year (ISTAT 2006, 2010). The strengths of such source lie in the fact that it provides valuable information on several aspects of people's lives[6]. The cons have to do, among others, with geographic domain of estimation, which is at most that of NUTS2[7] regions (Regioni).

The point is that, to a large extent, interventions aimed at closing the digital gap between families are administered locally; even measures financed by the State or by Regioni (NUTS2 authorities) are implemented at county or municipal level; the rationale is that only local authorities may properly assess the needs of their communities. But, unfortunately, local authorities lack disaggregated data that can be used to tune their interventions. When the best is not available, one must rely on second best.

[4] For an estimate of the target population, see *infra*.

[5] As for remote learning (didattica a distanza), the problems of teaching methods and of the contents to be conveyed through this channel are much harder. In our opinion there is a misunderstanding – or rather an anachronism – regarding the burden of proof: in a society and an economy now irreversibly launched along the path of digital transformation, such burden should be borne by those who assert the absolute priority of traditional teaching methods. In other words, it's analogic teaching that should prove its ability to match the requirements of digitalization, and not vice versa.

[6] We develop on this point in the discussion paragraph.

[7] NUTS stands for "Nomenclatura delle Unità Territoriali per la Statistica" (https://ec.europa.eu/eurostat/web/nuts/background).

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In this context, the second best are aggregated estimates such as those summarized in table 1, obtained from the AVQ survey carried out by ISTAT in 2018[8].

Tab. 1 – People aged between 10 and 17 years old living in households without a PC

	Absolute values			*Percentage rates*		
	Lower	*Estimate*	*Upper*	*Lower*	*Estimate*	*Upper*
Overall	338,700	389,100	439,600	8.2	9.4	10.6
Italians	255,000	300,700	346,000	6.9	8.2	9.4
Foreigners	21,000	40,000	59,100	9.4	17.8	26.4
North-West	20,000	38,100	56,300	1.8	3.5	5.1
North-East	32,800	52,800	72,900	4.2	6.8	9.4
Center	31,800	50,400	68,900	4.1	6.5	8.9
South	123,300	147,900	171,500	12.1	14.5	16.9
Islands	76,500	99,900	123,700	16.2	21.2	26.2

Source: our estimates based on ISTAT 2018 AVQ micro-data

According to these figures, 9.4% of all people aged between 10 and 17 years old live in households without a pc, which amounts to about 389.000 individuals all over the Country. This is a point estimate; if we take into account uncertainty, we get a confidence interval between 8.2% and 10.6% and an absolute fork between 339,000 and 440,000 units[9]. One hundred thousand is a relevant range, due to small size of the sub-sample used to estimate the quantities of interest[10]. Some more efficient inferential procedures can be applied in order to reduce uncertainty surrounding estimates[11]. However, not much can be achieved in this context, considering that collecting data is expensive and AVQ sample size is optimized to produce aggregated estimates.

[8] For our analysis we use AVQ micro-data released by ISTAT for public use (https://www.istat.it/it/archivio/129956). By the time we write, the 2019 survey micro-data have not been made available yet. Aggregated statistics on pc availability for year 2019 can be found in ISTAT (2020b).

[9] These are approximate confidence intervals based on tables for interpolated standard errors provided by ISTAT (2020c).

[10] The overall AVQ sample (for year 2019) amounts to 44,672 units. However, the sub-sample of people aged between 10 and 17 years is about 3,000 individuals only.

[11] For example, more specific post-stratification procedures targeted to the issue of digital divide among children. The type of post-stratification applied by ISTAT – on which the standard error estimates in table 1 are based – is a multi-purpose one, good for many generic inferential targets. For a description see ISTAT (2020c).

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Problems grow when more disaggregated estimates are taken into consideration. For example, the amount of italian students without a pc is estimated between 6.9% and 9.4%, whereas that of foreign students – a fairly smaller group – is estimated between 9.4% and 26.4%. This is enough to state that the latter are more penalized than the former. But it's the order of magnitude of such penalization that matters when one has to decide resource allocation on specific measures. Fairness is a delicate issue.

Although territorial estimates are technically possible at NUTS2 level (Regioni), in table 1 data are provided at most for NUTS1 regions (Ripartizioni). The reason is that, after sub-setting by age, some NUTS2 estimates would risk to be based on less than 5-10 sample units.

NUTS1 estimates picture a deep divide between North and South of the Country. But once uncertainty is added to the picture confidence intervals appear almost adjacent.

Now let's try to imagine ourselves in the shoes of a local decision maker, or official, who must decide/suggest how many resources to allocate to the purchase of personal computers to be delivered to students who do not have them – to give concreteness, imagine to be the statistician of a provincial authority, asked of an estimate by her boss.

Is the closest data provided by ISTAT AVQ – for example, 6.5% of all students aged between 10 and 17 assuming that the local authority is in the Centre NUTS1 region – a safe reference, considering that the confidence interval ranges from 4% to 9% and resources are limited? And, given a specific choice, how the amount should be divided among the municipalities, which are the entities that will actually have to administer the measure? A flat share for all? These are delicate questions. Eventually, the utility of a (very) aggregated estimate depends on how robust it is but, above all, on how variable the situation is at local level: the more heterogeneous the territories, the riskier it is to rely on an estimate at NUTS1 or NUTS2 level.

4. The garden of forking paths

Working for a local authority means clashing daily with such problems. Those who are responsible for the well-being of a community need clear, high-quality data upon which to base their decisions. Quality stands for updated and granular. Nowadays, data are a relevant part of the legitimation discourse surrounding policies. Providing an estimate that dates back to a few years earlier and, above all, that refers at NUTS2 or at NUTS1 level, is not the best viaticum for our statistician.

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Nonetheless, in some cases it is the only ethical thing to do: little is better than nothing. However, practical problems provide a strong push to search for new sources of information.

At this point, the path taken by a statistician working for a local organization tends to diverge from the one followed, for example, by an academic researcher. On average, academic researchers are very concerned with quality of data and inclined to trade quantity for quality. When you have to deploy sophisticated models aimed at formally testing theoretically grounded hypotheses, noisy measures are a bother: they mess up parameter estimates and weaken the credibility of a study. But when you have to strive to grab what's going on in a specific area, be it a county, a bunch of municipalities or even an obscure block within a city, every source of information, although noisy, deserves your attention. Nowadays, the world is full of promising messy information, and the challenge is how to separate the signal from noise (Silver, 2013).

This is a sound reason to look at INVALSI data, which provide an extraordinary opportunity to study the heterogeneity of digital resources at local level. The price to pay is the willingness to trade the safety of a surveilled sample for the potential "mess" of large population data. But there is no way out: only INVALSI population data allow the kind of geographical granularity that is required by local planners and decision makers[12]. On the other hand this is a great chance to improve local policies while at the same time build renewed legitimation around the whole assessment (INVALSI) system.

For the purposes of our analysis, we use INVALSI population micro data from 8th grade survey and 10th grade survey conducted in year 2017/2018 and from 10th grade survey conducted in year 2018/2019. The reason is that the questionnaire administered to students belonging to such waves includes a few questions related to the digital endowment issue. More specifically, we focus on answers to the question "at home do you have a pc that you can use for studying?". This sentence is close to that included in ISTAT AVQ questionnaire ("do you have a pc at home?"). However, the latter is addressed to an adult – the person identified as "head of the family" – and does not focus specifically on learning tasks. In other words, a pc might be present but not available to the student and this could justify differences in results; or, more simply, one or both measurements could be affected by error[13]. Such issues

[12] Restricting the focus to the INVALSI sample does not solve the problem of territorial resolution of data.

[13] A further issue is not perfectly overlapping age intervals across sources (assuming that age is related to availability of digital divices). However, a strict match of age groups is not possible due to AVQ comparatively smaller sample size.

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cannot be solved on an a priori basis; the most reasonable thing to do is to compare results from the two sources of information.

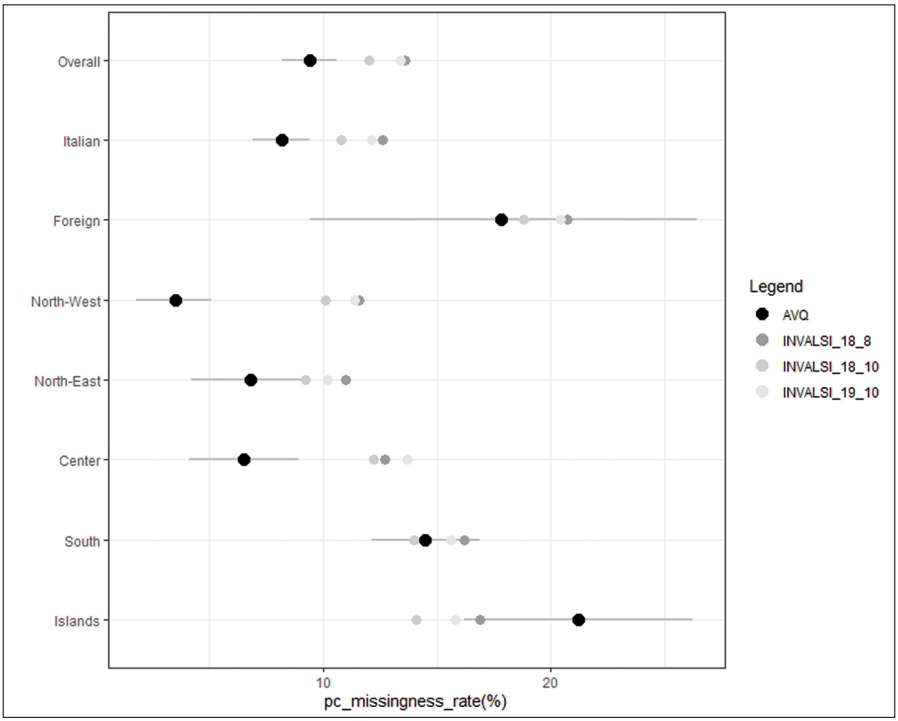

Fig. 1 – AVQ estimates (point estimates in black and confidence intervals in grey) and results derived from INVALSI data (dark gray: 8th grade, 2017/2018, medium gray: 10th level, 2017/2018, light gray: 10th grade 2018/2019)

Source: our elaboration on ISTAT micro-data

In Figure 1, AVQ estimates are confronted to measurements derived form INVALSI micro-data.

Highly aggregated quantifications of the share of students without a pc, both overall and by citizenship, are fairly close. This is a first relevant result, not obvious at all. If we place ourselves at a sufficient distance, the two pictures tend to overlap. However, we need to look closer: that's the reason why we searched for higher resolution data. On this regard, looking at geographic (NUTS1) differences we may notice that, though preserving traces of the North/South cleavage, INVALSI data are compressed within a smaller range. As we said, the two sources are not measuring exactly the same thing with the same resolution – rather one must be taken as a proxy of the other and

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vice versa. But this is a relevant point, that must be brought to the attention of the readers.

5. Internal coherence issues

Results of a first, quick, comparison between digital divide measures derived from INVALSI and AVQ data are quite mixed, suggesting the need of further analysis. We now turn to internal coherence issues, confronting percentages of students without a PC across INVALSI waves.

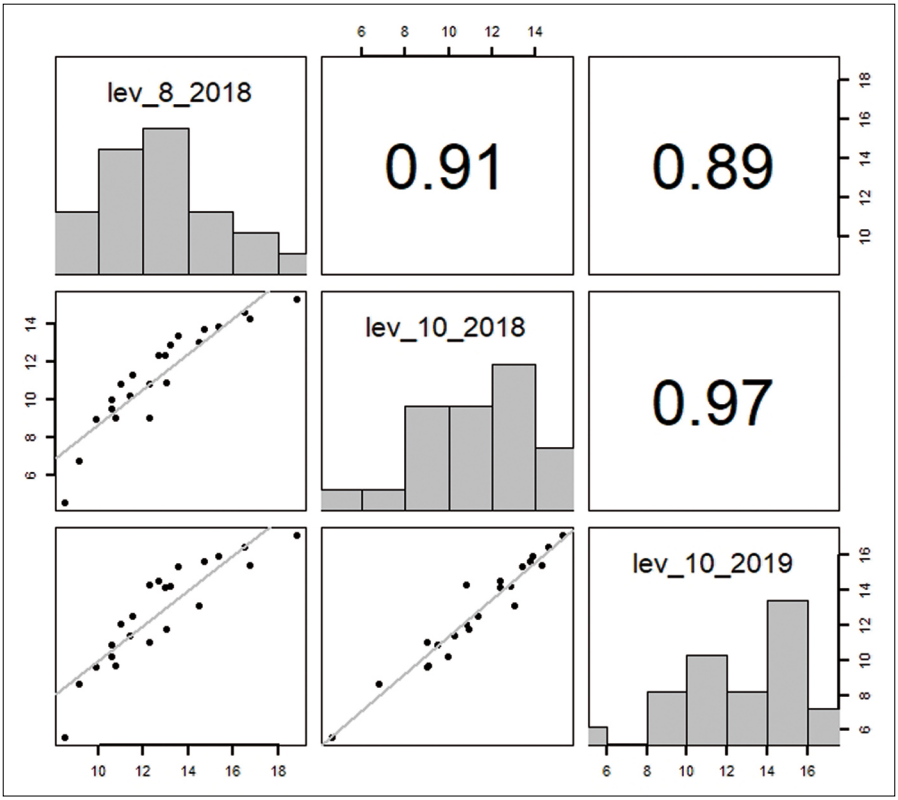

Fig. 2 – Correlation between NUTS2 percentages of students without a PC across different INVALSI waves

Source: our elaboration on INVALSI micro-data

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Figure 2 shows correlations between percentages calculated al NUTS2 level (each point represents a region). Coherence is high (r = 0.97), especially between 10th grade results of the two subsequent years (2018 and 2019). Moving one step lower in the ladder of geographical hierarchy, univariate and bivariate distributions of percentages calculated at NUTS3 level are displayed in Figure 3. Correlation are still relevant, with a peak of 0.92 for 10th grade results across years[14].

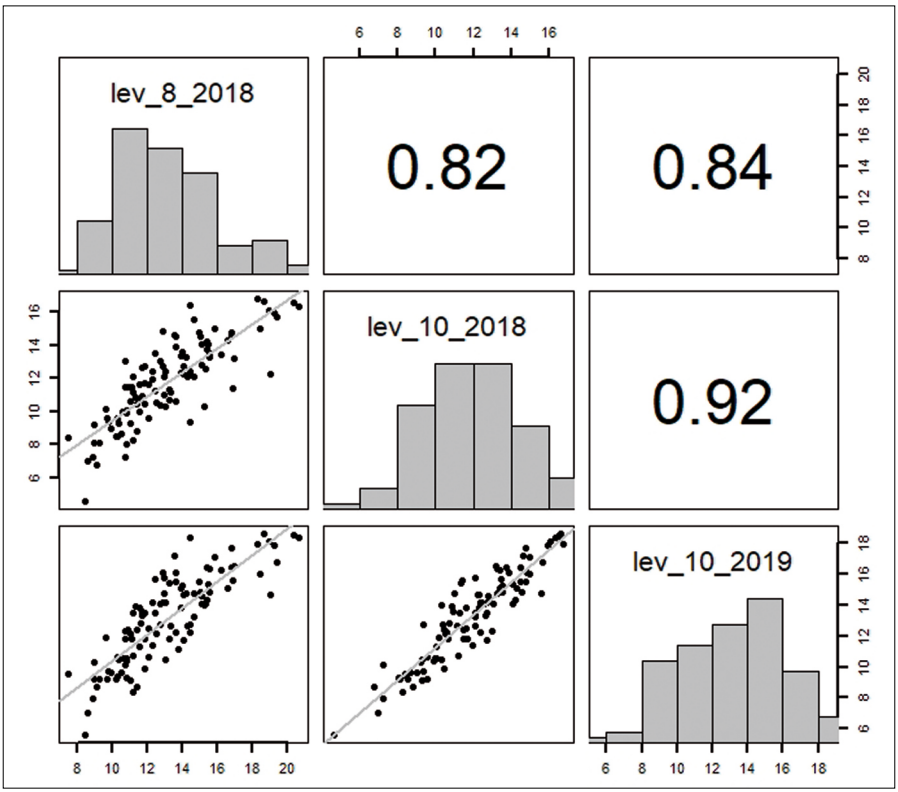

Fig. 3 – Correlation between NUTS3 percentages of students without a pc across different INVALSI waves

Source: our elaboration on INVALSI micro-data

[14] We removed one outlier value (Fermo) for 2018 8th grade measures and one (Sud Sardegna) for 2019 10th grade. Outliers may be true one or result from coding errors by the author. We did not delve deeper into the matter here, given the demonstrative nature of this study.

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Problems arise when moving to finer territorial level, such as commuting areas (local labour markets) defined by ISTAT (Figure 4). Here, values tend to swing rather widely across waves and years, with a lot of visible outlier points. Since local labour markets are a sensitive level for the implementation of policies aimed at reducing educational poverty and digital divide, this point needs to be further explored – which we will not do in the present context, taking into account the limits and illustrative nature of our contribution.

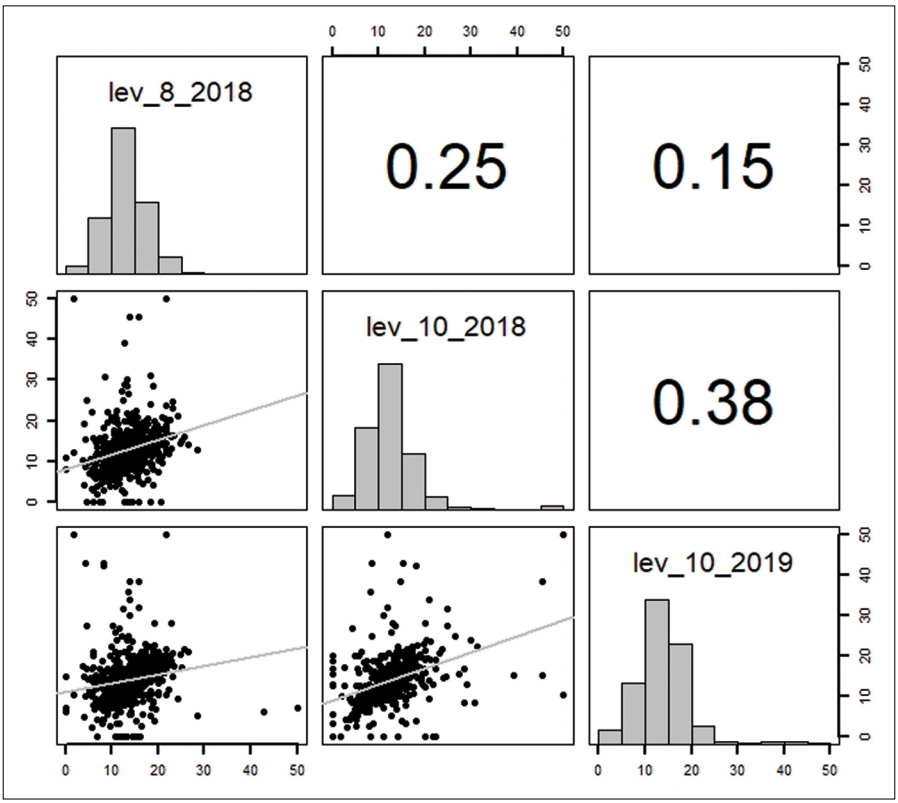

Fig. 4 – Correlation between local labour markets percentages of students without a PC across different INVALSI waves

Source: our elaboration on INVALSI micro-data

As a last step, the geographic distribution of percentages calculated at local labour market level for the 10th grade of year 2019 are plotted on Figure 5.

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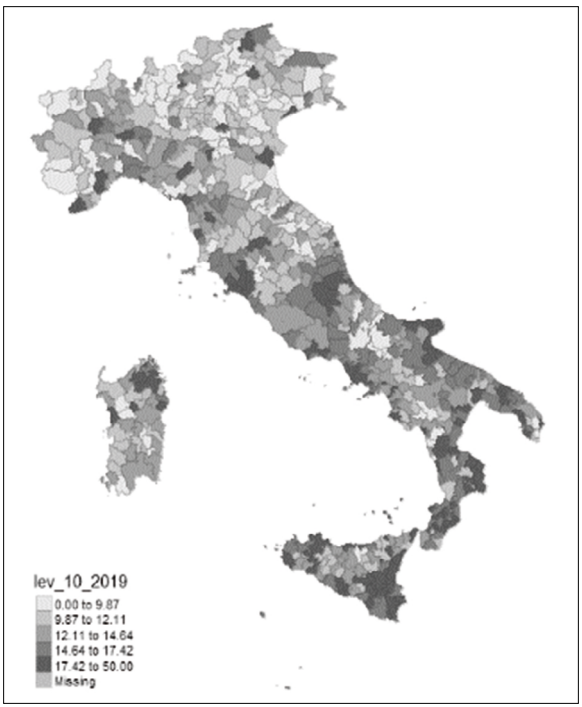

Fig. 5 – Percentages of 10th grade students without a pc calculated at local labour market (commuting area) level for year 2019

Source: our elaboration on INVALSI micro-data

Both the North/South cleavage and local heterogeneities – within NUTS1 and NUTS2 regions – are clearly visible on the map[15].

6. Territorial heterogeneity reviewed

So far we have found a lot of data *and* a lot of noise. Depending on the point of view, one may think of being confronted with a chaos from which it is better to keep away or with clues of a treasure that is worth continuing to search for. We bet on the second[16].

[15] Spatial correlation at local level, consisting of groups of adjacent commuting areas with both high or low percentages of students without a PC, is particularly striking and should be carefully analysed.

[16] As we said, it's just a bet motivated by practical and theoretical considerations.

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As we observed earlier, some outliers tend to emerge when we move towards finer territorial aggregation. This suggests using multilevel models to get shrinked estimates that are skeptical of too extreme values (McElreath, 2020)[17]. In this context, for demonstrative purposes only, we limit ourselves to estimating simple non-nested models with territorial random intercepts for NUTS3 regions (province), for local labour markets and for municipalities.

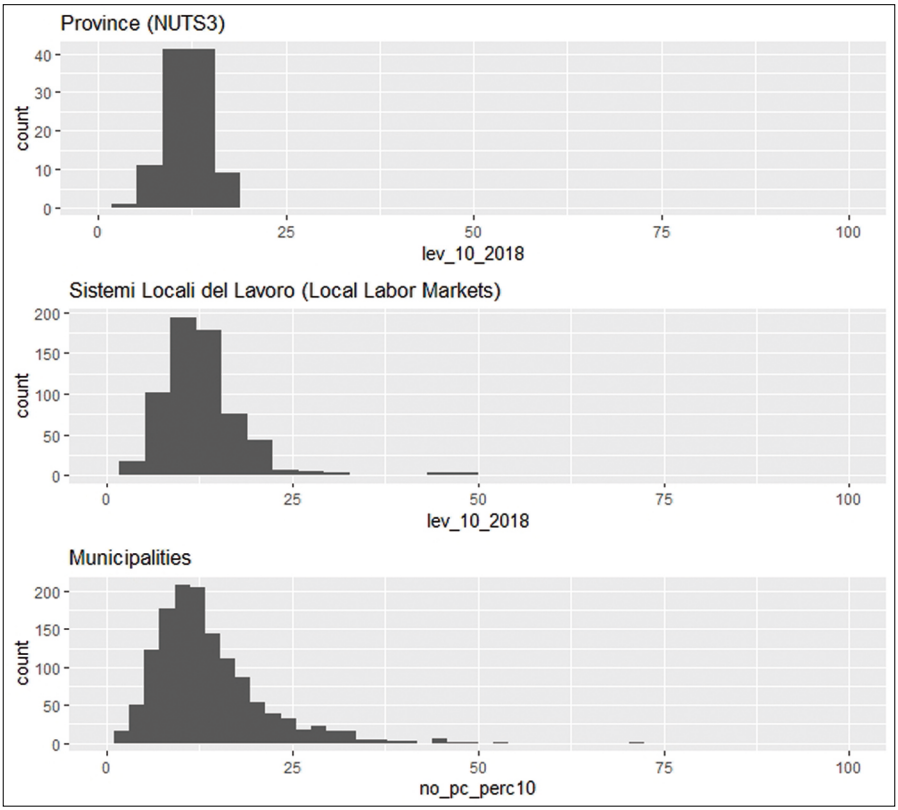

Fig. 6 – Univariate distributions of percentages of 10th grade students without a PC, estimated as varying intercepts in separate multilevel models, for year 2018

Source: our elaboration on INVALSI data

[17] In a case like this, where even local sub-samples have on average large sizes, bayes inference with strongly informative priors is necessary in order to get appreciable shrinkage towards the mean of more extreme cases. Models applied for the purposes of the present analysis are estimated via maximum likelihood approximation (non-bayesian procedure) and therefore are of limited interest. However, we are pointing to a direction which, in our opinion, deserves to be pursued in further studies.

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Figure 6 displays the resulting distributions of our target quantity – the percentage of students who do not have a personal computer at home – estimated as varying (random) intercepts in three, separate, multilevel models[18].

These results, that must be taken with caution, suggest a substantial amount of variance at finer territorial level (local labour markets, municipalities).

Eventually we can close the circle and go back to our statistician facing the problem of supporting the decision-making process at local level with sensitive data.

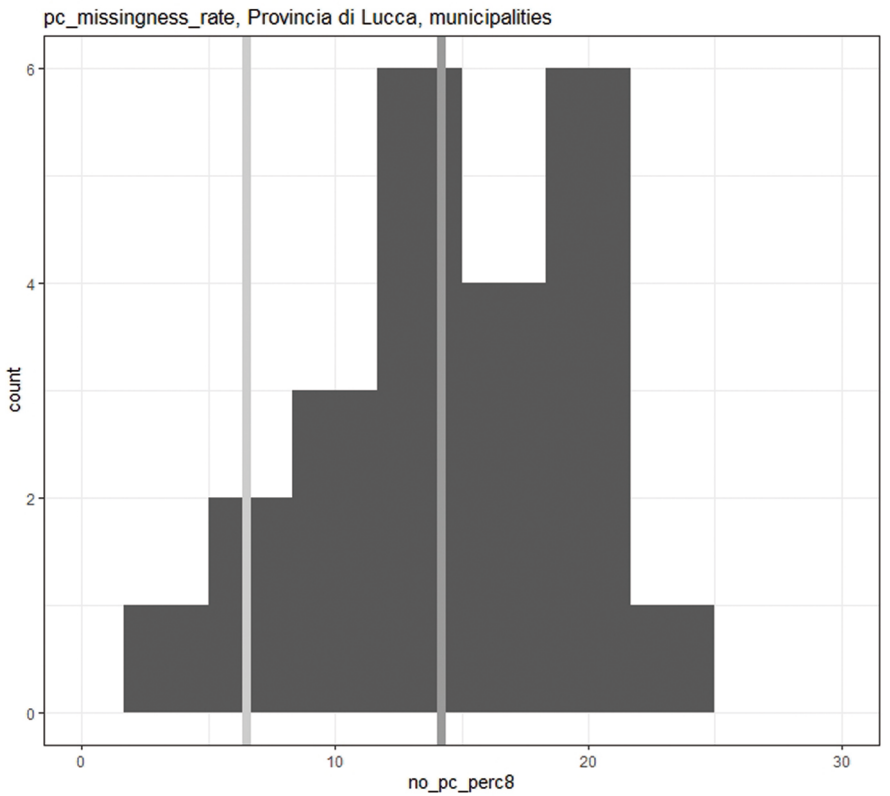

Fig. 7 – Univariate distributions of percentages of 10th grade students without a PC calculated (estimated) at municipal level, provincia di Lucca, year 2018

Source: our elaboration on INVALSI data

[18] We use separate multilevel models, instead of a single nested one, because we are interested in improving estimates at finer territorial level rather than in splitting variance according to geographic hierarchy. From a strictly technical point of view, variance decomposition it's hard in binomial logistic models ( ) and we are not going to undertake such a task in the present context.

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Figure 7 depicts the distribution of our target quantity for the municipalities of the Lucca NUTS3 region (provincia). The percentages are estimated from INVALSI micro-data, thorough the above described procedure.

The resulting territorial heterogeneity suggests that a differential distribution of resources among municipalities would allow the problem to be tackled in a more equitable – and efficient – way.

Together with the complete distribution, the plot shows two alternative allocative choices that correspond, respectively, to the decision to give to every area a flat amount of resources taking as reference the county average (darker line at the center of the distribution) and the ISTAT estimate obtained from the results of the survey on aspects of daily life (the lighter line on the left side of the distribution).

Implications of these alternatives are potentially very different, which makes the issue of data availability more crucial than ever.

7. Discussion

We are conscious that we have raised several deep questions, scraping only the surface of most of them. From a certain point of view, this may sound disappointing. On the other side there are lots of things still to be done, and this is exciting. We limit to sketch a few points that can lead to further discussion and research.

First of all we firmly believe that INVALSI data are a huge potential source of territorial information. By "territorial information", we refer to a type of insight that can improve our knowledge of local dynamics in many relevant fields. INVALSI data carry with them a lot of information, plenty of "signal", mixed with plenty of noise. In our opinion, the issue of quality of data cannot be hindered and must be address for the entire population participating in the survey. In other words, it cannot be solved extracting from the latter a restricted, high-quality, sample to be sent to researchers for their analytical purposes: today an increasing number of cognitive challenges call into question the territorial dimension of data, which requires population (not sample) data.

The second point concerns the attitude with which available data should be approached. Academic research interests are affected by econometric, psychological and sociological attitudes that have developed in a very different context from the current one, in an environment in which data were scarce but both statistical methods and theoretical hypothesis had already reached a relevant degree of refinement. Under these circumstances, it is

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quite natural for the latter to prevail on the former. Nowadays things have changed dramatically. There are plenty of data out in the wild. Not only relatively structured data, such as those provided by the surveys conducted by INVALSI; but also more fluid and sparse data – or ubiquitous, like those produced by the use of electronic devices. It is certainly worth going to see what all this can offer in terms of a better understanding of what's going on in the world, adopting a less dogmatic and more open attitude towards data analysis – which, in our opinion, implies the need to hybridize more traditional statistical knowledge with new, complex, data science skills.

The third point is about the risk to mistake data for knowledge. Knowledge can help to extract information from otherwise noisy data. After all, the digital divide issue is just an updated expression of the eternal problem of inequality. We can draw this awareness from an in-depth analysis of the data provided by the ISTAT Daily Life Survey (AVQ), which reveal the deep connection between lack of digital resources and various other aspects of economic and social deprivation. This is, among other things, an example of how the crossing and joint use of distinct data sources can enrich our cognitive framework. We can take advantage of that; for example, we can improve our estimates of digital deprivation rates in some areas by drawing on available data on income distribution, on the educational level of the population, on the presence of specific national groups (immigrants).

The fourth and last point concerns the need for a new alliance between the academic world, institutions such as INVALSI and ISTAT, and the scattered galaxy of instances expressed by local institutions and networks – an alliance aimed at the production of knowledge that allows us to orient ourselves in this scenario of growing complexity.

We all have something to learn from each other. Above all, we can contribute to the construction of new legitimacy around knowledge production tools, such as the surveys conducted by INVALSI. I am deeply convinced that a true leap forward in the perception of the value of these tools will be achieved when local communities become aware of their practical value for daily efforts to promote development and combat inequalities.

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5. Perceived self-efficacy and use of new technologies: the personalization of learning for the improvement of the didactical strategies[*]

by Sara Mori, Alessia Rosa, Daniela Bagattini, Jessica Niewint

The period of emergency in which schools were obliged to implement distance learning highlighted even more the need to rethink learning environments and to analyse the role that new technologies can play in fostering teaching processes capable of improving students' motivation and self-efficacy. The aim of this contribution is to describe the design of a training research path with a high-tech middle school. I will analyse and bring together the school reports of the previous year of the pandemic and a questionnaire specifically created to detect students' perceptions about the use of new technologies and the experience of distance learning. Although the school has on one hand an above-average learning outcome, one the other hand it has also a below or average of school's impact. Starting from this context, the research is focused on the enhancement of technologies for the personalizationlearning. Teachers will be supported in to design didactic interventions aimed to improve students' motivation, their sense of self- efficacy and the impact that the school can have in improving their results.

Il periodo di emergenza sanitaria in cui le scuole sono state costrette a svolgere attività di didattica a distanza ha messo ulteriormente in evidenza la necessità di ripensare gli ambienti di apprendimento e di analizzare il ruolo che le nuove tecnologie possono assumere nel migliorare la motivazione e il senso di efficacia degli studenti. Il presente contributo ha l'obiettivo di descrivere la progettazione di un percorso di ricerca-formazione svolto insieme ai docenti di una scuola secondaria di primo grado ad alto livello

[*] The paragraphs 3, 4.1, 4.2, 5.1, 6 are to be attributed to Sara Mori; the paragraphs 2, 2.1, 2.2 to Alessia Rosa; 4.4, 5.2, 5.3, 5.4 to Daniela Bagattini; 1, 2.3, 4.3 Jessica Niewint. Conclusion was written by all the authors.

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tecnologico. Lo studio si basa sull'analisi dei documenti prodotti dalla scuola (RAV, PTOF) e da un questionario appositamente creato per rilevare, su scala nazionale, le percezioni degli studenti in merito all'utilizzo delle nuove tecnologie e all'esperienza di Didattica a Distanza (DAD). Da questi emerge che l'istituto presenta risultati degli apprendimenti sopra la media, ma ha un "effetto scuola" sotto o nella media in Italiano, Matematica ed Inglese. Per ciò che concerne il questionario le risposte degli studenti confermano un alto uso delle nuove tecnologie in aula e, rispetto ai coetanei di altre scuole, l'abitudine di interfacciarsi con i docenti più che con i genitori per ottenere supporto didattico. Considerando questi presupposti, in un contesto dove "migliorare non è scontato" il processo di ricerca-formazione intende concentrarsi sulla valorizzazione delle tecnologie per la personalizzazione dei percorsi di apprendimento. I docenti saranno supportati nel progettare interventi didattici finalizzati a migliorare la motivazione degli studenti, il proprio senso di autoefficacia e l'impatto che la scuola può avere nel miglioramento dei loro risultati.

1. Introduction

The emergency linked to Covid-19 has forced schools to rethink the space for learning, taking full advantage of the opportunity of technologies in reorganizing the time and space of teaching. The innovation of teaching and the change of the traditional model of learning processes are a debated topic since before the pandemic (Indellicato, 2019). In many cases the school found itself unprepared to face the needs related to the rethinking of a completely remote teaching; in others, however, some contexts have managed to maximize their resources thanks to the didactic practices already tested before the pandemic. The inhomogeneity between territories and between schools, which was even more evident in this period as also reported by the Censis report (2020), highlights the need for rethinking and transforming the school that starts from listening of all the actors involved (Puccetti and Luperini, 2020). The research on which is based this contribution aims to support teachers at exploring the data of the students (results both INVALSI test and of a specific questionnaire on the use of technology before and during the first lockdown) to maximise the value of technologies in the personalization processes. The concept of personalization (Mincu *et al.*, 2012) contemplates the set of didactic strategies aimed at guaranteeing each student their own form of cognitive excellence, through the elective possibilities of cultivating their own intellectual potential (marked capacity compared to others).

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In this sense, these paths can be configured as transferable good practices, to facilitate overcoming the gaps that exist today.

2. Personalized learning and digital learning environments

Personalization is an ever-expanding umbrella term that includes different expressions and prospective like "student-centered instruction" or "instruction tailored to individual student needs" that traditionally describe a good teaching (Bransford, Brown and Cocking, 2000; Sebba *et al.*, 2007). Digital learning environments and the use of technology can offer a great opportunity to achieve the goal to personalize learning and to give a concrete help to the teachers to differentiate their teaching.

2.1. Personalized learning to improve motivation and self-efficacy

In the analysis realized in 2020 by the Teaching and Learning Review Group[1] "personalizing" learning means focusing in a more structured way on each child's or student's learning in order to improve progress, achievement and participation. The review also underlines that all students have the right to receive support, tailored to their needs, interests and abilities. In short, we can say that personalized learning is an approach finalized to encourage students to learn in a way that suits their abilities and competences for break down and building upon the information they receive in the classroom. From a broader school system perspective, we consider it useful to recall and shortly analyze the five aspects of personalized learning identified by the UK government's DfES (Department for Education and Skills) (FitzGerald *et al.*, 2018):

– assessment for learning and use of evidence aimed to identify the learning needs of each pupil;
– teaching and learning strategies that actively engage students to develop their competence and confidence;
– curriculum entitlement that presents a breadth of study, according to personal relevance and flexible learning pathways through the system. This may also have an important impact on the organization. Paludan, for example, suggests that personalization could help in solving problems relating to the time of year and age at which children start school, whe-

[1] https://dera.ioe.ac.uk/6347/.

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re some children may be disadvantaged by being the youngest in their year (Crawford, Dearden and Meghir, 2007; Paludan, 2006). However, the cost of this may be prohibitive, with educational institutions having to provide additional staffing throughout the year, or other resources in order to supply this level of service;
– a student-centered approach to school organization, with school leaders and teachers thinking creatively about how to support high-quality teaching and learning;
– strong partnership with the context around the school to drive forward progress in the classroom and to support pupil well-being. (Pollard and James, 2004, p. 5).

That description of personalized learning encompasses such a broad range of possibilities – from customized interfaces to adaptive tutors, from student-centered classrooms to learning management systems – that expectations run high for their potential to revolutionize learning. It is less clear from these descriptions what personalized learning systems offer and whether they improve the learning experiences and students' outcomes. Exploring the boundaries of personalized learning involves a long and complex analysis. First, it is important to differentiate the concept of individualization and personalization. Both methods monitor student progress, and especially for the personalized learning, the strengths and weaknesses of students are a combination of learning style preferences and performance. An additional aspect of differentiation concerns the role assumed by teachers and students in the considered approaches. In individualized instruction, the teacher uses data that provide a description of individual students' proficiencies in order to select best practice strategies that help each student to master competencies defined by established standards. The student's role is to pay attention to the teacher, follow instructions, remember and perform. In personalized learning, the teacher crafts and maintains a learning environment where students are free to safely and effectively pursue a personal interest in a given topic. In addition, the teacher assists students in developing and refining personal learning literacies and habits. Students for their part pay attention to the surrounding reality, consult with reference adults, identify and pursue emerging areas of interest, resourcefully earn and identify diversified learning strategies. These last elements highlight the centrality of the socio-relational aspect in the personalization of the learning experience. In this connection, the experience describes how personalized learning does not happen in a contest of isolation but in a more complex dynamic learning experience (Bulger, 2016). Järvelä (2006) highlights the chance for personalized learning to contribute towards sharing and developing expertise, through collaboration and

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networking. Different studies have also suggested that personalization can increase motivation (Jones *et al.*, 2013; Pintrich, 2003; Järvelä, 2006), students' empowerment (or the perception thereof), and attitudes to learning (Higgins *et al.*, 2008), especially when students are given the opportunities to stimulate their creativity and curiosity. Leadbeater (2004, 2005) highlights that personalized learning «encourage children, from an early age and across all backgrounds, to become more involved in making decisions about what they would like to learn and how. The more aware people are of what makes them want to learn, the more effective their learning is likely to be, since… personalized learning allows individual interpretations of the goals and value of education» (Leadbeater, 2003, pp 68-69). Within the personalized learning experiences, there are two important aspects: the motivations and the self-regulation (establish and maintain a work planning toward goals); the self-determination (support intrinsic tendencies toward healthy and effective behaviour) (Ames and Archer, 1988). A personalized learning approach permits to enable students to progress more quickly through understand and pinpoint areas where more instruction is needed (Anand and Schimke, 2015) and areas where student self-efficacy shows new opportunities. Although personalized learning is not an innovative educational field, today there is a broad optimism that technology can and does support personalized learning. Technology enables teachers to adjust their activities in response to students' interpersonal cues, not only the personal learning styles but also the knowledge base they are starting from. (Brophy, 1985; Fredricks, Blumenfeld and Paris, 2004; Wineburg, 2008) This approach will allow explaining the same concept through a multitude of strategies and paths (Beetham, 2015).

2.2. Technologies and personalization: how to promote learning?

The four key areas to improve the use of technology in classroom identified by *FutureLab Learner's Charter* are: feedback (assessment and recognition); choices (i.e., learner voice and choice); skills and knowledge (curriculum) and learning environment (pedagogies and institutions) (Green *et al.*, 2005). As far as feedback is, concerned technologies allow access to a diverse range of assessment mechanisms and media more appropriate to the students' activity. To use diverse assessment tools in a course is functional to support the process of reflection. A differentiated evaluation system allows achieving recognition for learning independently of the context of learning (in private experiences, in school, in the community). Moreover, technology systems can provide support and guidance adapted to their current knowl-

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edge to empower learners with the data and information needed to take the next steps in their learning journeys (Kingsbury, Freeman and Nesterak, 2014). Finally, thanks to technology some feedback can be automated so that teachers can focus on more high-level commentary (Broadfoot *et al.*, 2013; Drover, 2015). Regarding the "opportunity to choose", personalized learning technologies and adaptive, interactive learning environments can lead to learning 'on the go' where students can use mobile devices to provide seamless or continuous contexts for learning. In this case, the line between formal and informal learning can become out of focus, according to the learner's preferences and goals (Sharples, 2013). The easy use of the technology frees up time for higher-order learning opportunities (Brown, 1994), and consequently promotes more meaningful learning (Hernandez-Serrano, 2000) as well as the development of learner autonomy (Schnackenberg and Sullivan, 2000). Technology is considered as functional to promote more active learning (Reiser and Butzin, 2000), enabling new skills rather than just established skills at greater levels of competence. These aspects become functional and essential within learning paths focused on personalization. Finally, according to Hargreaves (2004), pupils' opportunity to participate actively in their own individual learning leads to a deeper engagement, improves meta-cognitive skills, better relationships between students and staff, and greater responsibility among learners. Respecting the "skills and knowledge" area, technology-enhanced personal learning environments allow a functional adaptation of content to match instructional objectives that support the development of a learners learning ability (Martinez, 2002, p. 25). Most of this research also explicit the underpinning idea of personalizing learning, that emphasized the value of technology empowering students to practice greater control over their learning (Higgins and Moseley, 2001). In this perspective, we can see a change in the teacher's role, towards a facilitator and coach approach. About the best manner to integrate technology into the curriculum-based culture of schooling and to develop student autonomy represents a still open debate (Loveless and Ellis, 2001). Technologies allow access to different teaching and learning approaches and resources that meet in parallel various students' needs. Moreover, technologies allow students to experience their knowledge in contexts authentic, appropriate and continually updated. Different researches underline the functionality of technology to increase students' self-regulated learning when it's combined appropriately with other educational innovations (Steffens, 2006). In fact, the insertion of only technological instruments is not sufficient without an overall rethinking of the didactic, curricular and organizational practice (Schnackenberg and Sullivan, 2000). In general, while there is no evidence that learners per-

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formed less well than control or comparison groups using digital technologies, there is also no clear evidence that performance was superior in terms of children's learning measured by traditional tests, or that these kinds of interventions have anything other than average effects (Higgins, 2003). It can, be argued that, if such environments tend to be as successful as more traditional teaching approaches, and that the students are developing both social and technical skills as well as covering the traditional curriculum, then they offer broader educational benefit and greater well-being for students.

2.3. Assessment for learning in personalized approaches

Teachers are in the need of more transformative technology environments in which the use of technology is needed to create learning approaches that are not possible in traditional analogue learning spaces (McLeod and Graber, 2019). Assessment through technology in this digital learning environment needs to be a tool to support students' learning and to provide constructive feedback for improvement. It also needs to be a tool to make the learner aware of his strengths and weaknesses and to give support in the case of disability to ensure equity in the educational process. Personalized learning tools need to adapt in a unique way to students, to respect the individual goals, interests and competences. Technology that is able to personalize learning can be divided in two main types: responsive and adaptive systems (Bulger, 2016). Responsive systems like custom interfaces, learning management platforms or data drive management systems have the limitation that the content itself is not adaptive, but only the way how the content is made available and arranged for the student. Adaptive learning systems are based on the process of machine learning rather than a predetermined decision tree. The goal of the most innovative algorithm driven adaptive learning systems is to automatically adapt to reach a previously defined goal using capacities like facial recognition to respond to emotions to become an intelligent tutor that offers guidance, interaction and inspiring questions instead of providing answers.

The system can also predict student performance and identify their strengths and weaknesses and suggests ways to improve with tests or practices (Anand *et al.*, 2018; Alam *et al.*, 2018).

It is therefore necessary to develop personalization paths that start from data at the class and school level, to guide teachers' choices in teaching/learning paths. Some features that can be analysed to evaluate customization in teaching within a specific context are:

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– learning times and how they differ between students (fast vs. slow);
– the sensitivity and the ability to analyse situations, for example the preference for complex problems or not;
– temperamental aspects, such as introversion, extroversion and sociability;
– the ability in fine motor skills, that is to make small movements with fingers, hands, feet;
– the motivational aspects;
– locus of control, i.e., the attribution of one's successes or failures to oneself or to others;
– the emotional aspects;
– the socio-economic aspects, i.e., the socio-cultural background;
– results in learning, with the need for an interdisciplinary comparison.

INVALSI data can be an excellent diagnostic tool: they can indicate in which direction to direct customization both in terms of content and in terms of process. Furthermore, it's also an excellent tool to identify the strengths or criticalities of the school and its area of affiliation.

The development of educational technologies and emerging methodologies together with extending available digital resources are a boost for the formative processes. ICTs have created possibilities to carry out formative actions and to provide students with access to the contents and teaching materials and to adapt the educational system to the conditions, needs, and demands of students in a digital age (Bognar *et al.*, 2019). This has also resulted in the creation of new moments and places, formal and informal, to deploy teaching practices that create a connection between educational activities and the intrinsic characteristics of the information and knowledge society.

3. The research questions

This research aims to investigate the role of new technologies in the process of personalization of learning, based on the data gathered from schools. Learners of all ages have increased opportunities to access learning personalized materials because technologies offer new and diversified opportunities. The study was conducted in the context of a high level of use of new technologies in teaching, even before the Covid-19 emergency. This research includes INVALSI data and the students' perception of different orders and grades emphasizing the perception of the change in the student's ability to use new technologies for learning and in their spare time. This study also aims to investigate a high-tech middle school and the given potential for

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teachers to personalize the courses to improve inclusion and overcoming gaps, starting from the use of data available to the school as an opportunity to reflect. Hypothesis is that starting in a high-tech context; students will perceive themselves as more autonomous and have a wider sense of self-efficacy. At the same time, teachers might to be able to maximize personalization paths thanks to the facilitating context of technological support. This research will also investigate the change in students' perceptions of the support of technologies in the process of learning during the pandemic Covid-19. This contribution illustrates the data from which the research group started to accompany the school's personalization process.

4. Methodology

4.1. Participants

The activity of the training research path will start from the analysis of the data acquired through an online survey, administered in June 2020, compiled in three different contexts: a charter middle school in the Milanese hinterland, which we will call ES (Experimental School; 376 respondents), the students involved in the experimentation of robotics of the Pon Coding and Robotics project[2] (197 respondents) and a voluntary compilation, through Indire's online channels (349), for a total of 922 students. For the group of students who chose to voluntarily participate in the survey, we will limit the analysis to 107 middle school students, for homogeneity with the other two groups. The total number of questionnaires considered in this work is therefore 680. The analysis will be carried out by comparing two groups: the group consisting of students from the school subject to the experiment (ES) and the group of other students (OS) composed of students of the previous experiment and students with voluntary compilation. For these two sets, in fact, there are no significant differences on the items proposed. Overall, 320 females (47.1%) and 360 males (52.9%) answered the survey (Table 1), divided as follows: 28.5% 6th grade, 36% 7th grade and 35.4% 8th grade (Table 2).

[2] Project "CODING e ROBOTICA has been drafted under the European Structural and Investment Funds 2014-2020. National Operational Programme for schools. Competences and learning environments 2014-2020.

FSE/FESR-2014IT05M2OP001 – Axis 1 – Education. OS/RA 10.2. Project code 10.2.7.A2-FSE PON-INDIRE-2017-1, CUP B59B17000000006.

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Tab. 1 – Participating students divided by gender and reference group. Absolute and percentual values. X^2 (1, n= 680) = 2,360, p > 0.05

		OS	*ES*	*Total*
Female	AV	153.0	167.0	320.0
	%	50.3	44.4	47.1
Male	AV	151.0	209.0	360.0
	%	49.7	55.6	52.9
Total	AV	304.0	376.0	680.0
	%	100.0	100.0	100.0

Tab. 2 – Participating students divided by class and reference group. Absolute and percentual values

		OS	*ES*	*Total*
6th grade	AV	56.0	138.0	194.0
	%	18.4	36.7	28.5
7th grade	AV	116.0	129.0	245.0
	%	38.2	34.3	36.0
8th grade	AV	132.0	109.0	241.0
	%	43.4	29.0	35.4
Total	AV	304.0	376.0	680.0
	%	100.0	100.0	100.0

The teacher training and research activity will be carried out with the teachers of the experimental school, which has a long tradition in the use of technologies. The research is aimed at supporting teachers in maximizing the use of technologies to improve practices of personalization and inclusion. In 2019, the school obtained the Apple Distinguished School qualification for the digital training of its teachers. The school is located in a single building, which has 18 classrooms, 1 lecture hall and 1 theatre. High attention is given to physical activities, for which two gyms and a large outdoor courtyard are available. The Headmaster has been in the school for 5 years now; the teaching staff is very young, with an average age of 35: the turnover of teachers is mainly due to the transition of teachers to public schools. The school has a total of 540 pupils, of which 376 (69.6%) responded to the survey. The headmaster has a 6-year stay in the school; the teaching staff is very young, with an average age of 35: the turnover of teachers is mainly due to the transition to state schools by teachers.The classes are six 6th, six 7th and six 8th grades. The lessons hours are scheduled the morning in five days a week and on the fifth day there is also an afternoon return consisting

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of two one-hour modules. The lessons are 50 minutes long and meet the learning needs of students. The discipline of English is strengthened with 5 hours per week. As regards digital competence, there is a weekly lesson of Digital Education for the 6th grade and of Coding for the 7th grade. As for the presence of devices, the learning spaces are equipped with multiple types: video projectors, Apple TVs, multimedia trolleys, in addition to science and music laboratories.

4.2. Tools

This work used assessment tools for the pre- and post-assessment and for monitoring during the research activity. As regarding the pre-assessment, an online survey, based on the annual reports and policies provided by the school, was used.

The survey was created with the goal to include typical aspects of digital competence, linked to the perception of personal identity efficacy. Therefore, the students' perception was taken into consideration, not only before and during the pandemic, but also investigating on the self-perception for the future. It is believed that the period of the lockdown can be considered as an opportunity for self-reflection, by becoming part of their own baggage of experiences, emotions and experiences.

The survey investigates on the students' perception of the following dimensions:

- the activities proposed by the school during the period of distance learning: how much and in which way the online lessons and the activities were proposed by the teachers and the ease of access;
- the use of devices and software: the time spent for study and free time and which devices are used for which purposes. This dimension was analysed from a longitudinal point of view, asking how much the hard- and software were used before and during the period of distance learning what was the interest in continuing to use them afterwards;
- the students' perception of self-efficacy for the use of new technologies: the perceived personal competence for the use of hard- and software before and after the period of distance learning;
- the support: who the student asked for help and support during the period of distance learning;
- a personal overall evaluation of the period of distance learning: students were asked for a feedback of how much they liked or disliked the experience of distance learning during the first lockdown.

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The indicators for the outcomes were defined based on school reports and policies:

– the result of the tests of National Institute for the Schools' System Evaluation (INVALSI);
– index of abandonment and dispersion;
– the critical and strength points described by the school in self-evaluation rubrics;
– the description of the mission and vision.

The description of the presence of foreign students or those diagnosed with specific learning disorders of disabilities (SLD).

4.3. Research sequence

The project is based on research-training models (Magnoler, 2012; Asquini, 2018), which have the advantage of actively involving the stakeholders reflecting on the implemented practices.

The online survey for the pre-assessment was administered at the end of the first distance learning period in spring 2020. The post-assessment online survey was administered in September 2020 at the beginning of the new school year 2020/21.The researchers analyzed the reports provided by the school in order to have a picture of the relevant data of the school in terms of outcomes and processes, with particular attention to the processes of personalization and inclusion through new technologies.

The data from the surveys and the reading of the contextual elements (reports) were reported back in a meeting with the Manager's Staff before the Christmas holidays 2020: this meeting provided a useful insight of the schools' staff self-perception and common classroom activities. In a later meeting, the data were also returned to all the teaching staff and will be followed by a combined process of research and teacher training that will then be carried out with a group of 20 teachers promoting:

– knowledge of methodologies or personalized learning activities with the use of new technologies;
– knowledge of evidence-based and brain-based practices for personalized learning with new technologies;
– co-creation of feasible approaches for personalized lesson units with a focus on students with special educational needs and for overcoming the gap;
– administration of post evaluation tools.

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4.4. Data analysis

As specified, the data gathered from online survey of the middle school students will be used, analysing the 5 dimensions previously illustrated (section 2.2), excluding the first, *The activities proposed by the school during the period of distance learning*, for which, compared to all responses, no significant differences were found.

The case study of the experimental school will be enriched by the analysis of context data like the school reports, average rating in the INVALSI tests and the index of dispersion.

5. Results

5.1. INVALSI data of the Experimental School

The ES presents results both in Italian and in Mathematics above the reference averages for its geographical location, and for schools with the same socio-economic background (Tables 3 and 4).

Tab. 3 – Data comparison of the National Test of Mathematics

Year	*Score ES*	*Score Lombardy*	*Score North-West Italy*	*Score Italy*
2018	218.9	209.0	206.8	200.0
2019	215.4	203.9	203.3	199.1

Tab. 4 – Data comparison of the National Test of Italian

Year	*Score ES*	*Score Lombardy*	*Score North-West Italy*	*Score Italy*
2018	221.6	209.7	207.4	200.0
2019	221.2	208.4	206.6	200.1

Even the results compared to schools with the same ESCS are higher (Table 5).

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Tab. 5 – Score in INVALSI tests and differences compared to schools with similar ESCS (Economic, Social and Cultural Status (ES school)

	Average score 8th grade ES (a.s. 2019)	*Lombardy*	*North-West Italy*	*Italy*	*Diff. ESCS*
Italian	215.4	203.9	203.3	199.1	1.5
Mathematics	221.2	208.4	206.6	200.1	7.0
English listening	217.2	211.5	209.4	201.6	nd
English reading	219.6	210.9	209.6	203.3	nd

The dispersion and abandonment index is zero, as is the percentage of failures.

The school effect is however overall "slightly negative" as for Italian and "in the average of other schools" in Mathematics (INVALSI, 2018)[3].

In addition, the index variance within classes is high and between classes while that between classes is low (Tab. 6).

Tab. 6 – Variance between and within classes ES

	Variance between classes	*(VB) North-West Italy*	*Variance whitin classes*	*(VW) North West Italy*
Italian	0.4	5.4	99.6	94.6
Mathematics	1.4	8.2	98.6	91.9
English listening	4.6	14.4	95.4	85.6
English reading	2.2	12.3	97.8	87.7

5.2. The use of ICT before the lockdown

The data show a strong unevenness in familiarity with ICT between the ES. The use of tablet in the reference school was a common practice: 67.3% of students used it for lessons, 90.4% for individual study, which is consistent to the context concerning the students' availability of a personal tablet.

Students from other schools used different devices, especially for individual study: as a matter of fact, only about a third of them did not use any digital device. Though the proportion of mobile phone use is higher, probably due to the lack of other tools (Table 7).

[3] Retrieved to https://www.invalsiopen.it/come-leggere-effetto-scuola-valore-aggiunto/.

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Tab. 7 – Students who used devices to follow the online lessons and for individual study before the lockdown. Percentual values by groups

	Online lessons				*Individual study activities*			
	OS	*ES*	X^2 *(Gdf)*	*p*	*OS*	*ES*	X^2 *(Gdf)*	*p*
Smartphone	5.3	1.9	5.951231 (1)	0.015	15.8	2.7	37.142809 (1)	0.000
Tablet	6.6	67.3	257.815627 (1)	0.000	18.8	90.4	355.414587 (1)	0.000
PC/notebook	15.5	7.2	11.882 (1)	0.001	50.0	15.4	94.138 (1)	0.000

5.3. The school during the lockdown

Since the very first lockdown moments the ES teachers and students seem ready to the distance learning: in fact, they have both availability of tools and habits in using presentation and writing programs. The students that did not use either PC, tablet or phone to follow the lessons were a very little percentage, as the use of devices becomes common to the students at all schools. The lower value of using more than one instrument in the ES school might be due to the availability of tools: indeed, the mobile phone use has the higher rate, that probably means it is the only free device.

Tab. 8 – Students who used devices to follow the online lesson and for individual study during the lockdown. Percentual values by groups

	Online lessons				*Individual study activities*			
	OS	*ES*	X^2 *(Gdf)*	*p*	*OS*	*ES*	X^2 *(Gdf)*	*p*
Smartphone	51.3	3.7	203.061 (1)	0.000	41.4	5.6	127.585 (1)	0.000
Tablet	27.3	87.8	257.687 (1)	0.000	24.0	89.9	305.133 (1)	0.000
PC/notebook	71.1	18.6	189.653 (1)	0.000	62.2	25.5	189.653 (1)	0.000

The time devoted to simultaneous lessons in distance teaching marks an important difference between the ES students and other school: more than half of the first, in fact, states that on average more than 15 hours of lessons per week have been scheduled. Instead, the ES students spent between 1 to 3 hours a day in front of one or more devices to study or do homework.

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Tab. 9 – How many hours of video lessons per week on average have been scheduled in this period? X^2 (3, n = 680) = 152, p 0,000

Hours of in presence online lessons	*From 1 to 5*	*From 6 to 10*	*From 11 to 15*	*More than 15*
OS	19.1	28.3	32.9	19.7
ES	12.3	1.1	31.6	55.1

Tab. 10 – How many hours on average do you stay in front of one or more devices (mobile phone, tablet, PC) per day to study or do your homework in this period (excluding video lessons). Percentual values by groups. X^2 (4, n = 680) = 30,538 p = 0,000

Hours of homework and study	*None*	*From 1 to 3*	*From 6 to 10*	*From 7 to 10*	*More than 10*
OS	3,0%	58,2%	31,3%	5,6%	2,0%
ES	0,5%	76,1%	20,7%	2,4%	0,3%

More than 40% of ES students during the lockdown did not need any support for the use of tools to follow distance learning. Even when ES students needed support, they searched for it between classmates or teachers, instead the students belonging to other schools turned to family members. The difference between two groups are statistically significant.

Tab. 11 – In this period, when did you find the most support for using the tools to follow distance learning? Percentual values by groups. X^2 (6, n = 680) = 45,991, p = 0.000

	OS	*ES*
No need of support	26.0%	43.9%
In my teachers	23.0%	25.0%
In my class mates	14.1%	12.8%
In my father	8.6%	8.0%
In my mother	17.1%	6.1%
In my brothers/sisters	9.2%	4.0%
In other people	2.0%	0.3%

5.4. Thoughts on lockdown: students' perception

Students were asked to report about their self-perception about their efficacy in using digital devices, software or apps. Regarding the use of the device itself, the students perceive an improvement: the ES students feel to have improved in the use of the tablet, while OS feel they have improved in

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the use of PC/notebook and smartphone, since they used these devices for learning activities (see Table 13)[4].

Tab. 12 – Numbers of students who perceive an improvement in the use of devices. Values in percentage

	OS	*ES*	X^2 *(Gdf)*	*p*
Smartphone	67.4	43.4	39.264 (1)	0.000
Tablet	38.2	75.5	96.937530 (1)	0.000
PC/notebook	80.3	36.4	131.056155 (1)	0.000

Students were also asked to indicate, for each software or app, they claimed to be using, if they perceived an improvement. The number for the OS group is increasing (Figure 1).

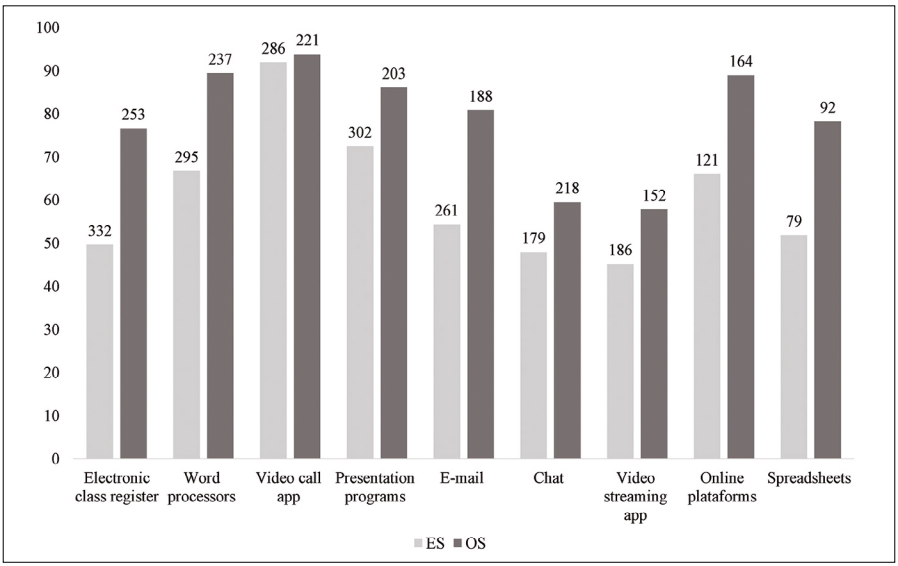

Fig. 1 – Students who have perceived an improvement in the use of software/apps. Percentage values and number of respondents (students who used software/apps during the lockdown)

[4] The data was also checked through the creation of a variable sum "Use of devices in teaching practice", which added the use of the individual device in formal education/lesson and in individual study activities, that confirmed the relationship between perceived improvement and device usage.

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Despite the perception of improvement of self-efficacy, there are only few software and apps that students would like to use in the future in the educational field: only presentation programs and word processors convince more than half of the total respondents. The differences between the two groups are smaller than in other questions (Figure 2).

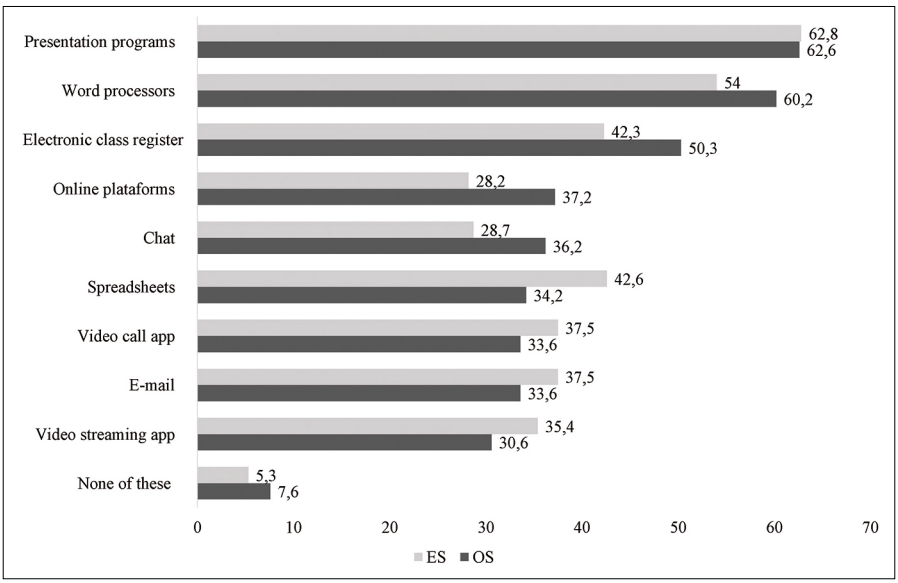

Fig. 2 – What software/app would you like to use at school in the future? Percentual values by group

At the end of the survey, the students were subjected to two different sets of questions, one on the positive elements, the other on the negative elements related to the period of the lockdown, showing a series of indicators chosen by the research team on the basis of a pretest administered to a group of students.

Tables 13 and 14 show the percentage of the students' answers of the two groups who have chosen the different items.

Another element on which there are discrepancies between the two groups is that relating to both the technical problems (recorded to a greater extent by the students of the generic sample) and the difficulties in using the technology, in fact almost absent as a criticality for the ES students.

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Tab. 13 – What did you like about distance learning?Percentual values by group

	OS	*ES*	X^2 *(Gdf)*	*p*
Staying at home and not going to school	38.10	35.10	.625	0.43
My parents participate more in my school life	9.70	9.20	.049	0.82
Lessons are more interesting	18.70	18.60	.001	0.98
I have less homework to do	14.40	19.50	2.996	0.08
I didn't like anything	9.00	7.60	.465	0.50
Being online with my classmates	20.40	10.50	12.592	0.00
I think I was good in using technology	45.20	32.70	10.706	0.00
I have a more relaxed timetable	49.20	63.50	13.661	0.00
I feel better not having the teachers in front of me	35.10	29.70	2.171	0.14
I am feeling less shy	27.10	20.00	4.632	0,03

Tab. 14 – What didn't you like about distance learning?Percentual values by group

	OS	*ES*	X^2 *(Gdf)*	*p*
I feel more anxious about speaking	17.2	12	3.627	0.057
I can't be together with my classmates in person	78.8	84.8	4.453	0.035
There are too many homework compared to when we went to school in person	29.1	20.5	6.560	0.010
My parents participate too much in my school life	7.3	5.1	1.415	0.234
Lessons are more boring	38.7	39.5	.054	0.816
I like everything more than before and nothing less	4.3	3.2	.559	0.455
There are many technical problems that do not allow you to follow and communicate well	61.9	41.9	26.251	0.000
I can't go to school	51.7	53.1	.175	0.676
I have had a hard time using technology	9.9	1.3	25.103	0.000

6. Discussion

The Experimental schools has high test scoring compared to national averages and to schools with similar ESCS (it's a high ESCS schools). However, the school effect is "slightly negative" for Italian and "in the average of other schools" in Mathematics.We could assume a "ceiling effect", considering the difficulty of improving already very good scores of students. In the Experimental School there are a consistent use of new technologies both before and during the lockdown, especially for the tablet, which is distributed for each student.ES pupils also spend more time online than others during lockdown. With a greater use of new technologies in the daily teaching of students at the ES, there is a smaller increase of self-efficacy using digital

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technologies compared to the rest of the students: we assume that this is also due to an already great sense of self-effectiveness on the use of tools. Another interesting aspect is that despite intensive use or not before or after the lockdown, there is no differences between two groups of expectations in the future on the use of technology. So, although there is a different use of instruments in the classroom and although the sense of self-efficiency changes in those who made a lesser use, there are no differences compared to the motivation of a use of digital in the future.

Another important difference between the two groups is the request for help during the first lockdown: the students of the ES had less need of support and if they asked, they did it to the professors.

The students at ES school also appreciated the more relaxed times of *distance learning*; the others show more an interest in the new virtual dimension, the dimension of the online group and a lesser sense of shame. The rest of the students are therefore more satisfied with the new experience of the virtual environment.

The digital skills of the students at the ES school are confirmed by the fact that for other students the major limits of *distance learning* are precisely related to the new technologies, their use and the inconveniences that have been created.

7. Conclusion and future developments

The study has had the objective to analyse the data to disposition of a school to high level of technologies in order to support the teachers in paths of personalization of the didactics.

INVALSI data inform shows that compared to a low school effect; the school achieved excellent results both in Italian and in Mathematics. The results of the students' survey picture a school with a high use of the new technologies in the classroom, and a high-perceived digital competence.

In this context the personalization of the paths can perhaps overcome the "ceiling effect" giving useful guidelines to development students' competence, according to their personal needs.

The present research is a case study and the results are therefore not generalizable: however, the methodology used for the design of the interventions can be replicated in more or less similar contexts.

Future research will investigate how technology enables the personalization in learning for students, involving a co-construction of personalized learning paths together with teachers.The classroom activities will be evaluat-

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ed by the change perceived by teachers and students on self-efficacy in learning and employing devices and application based on their personal needs.

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6. La competenza ortografica nelle prove INVALSI: proposte sulla primaria

by Maria G. Lo Duca, Zuzana Toth*

Il presente contributo si compone di due parti. La prima parte si configura come una ripresa di temi già affrontati in un precedente lavoro (Lo Duca e Toth, 2021), al quale faremo spesso riferimento. In tale saggio abbiamo tentato una lettura critica dei quesiti di ortografia presenti all'interno della sezione di riflessione sulla lingua delle prove INVALSI di Italiano, a partire dai primi anni di somministrazione e fino al 2019. Tali quesiti sono stati analizzati alla luce delle diverse strategie ortografiche che il parlante mette in atto nel momento della scrittura, strategie che la ricerca linguistica e psicolinguistica ha già da tempo individuato, e che noi abbiamo in parte assunto e rimodulato, chiamandole strategia fonologica, lessicale e morfosintattica. Da tale analisi è risultato che i quesiti INVALSI sono costruiti in modo da focalizzare l'attenzione degli studenti sui punti critici dell'ortografia dell'italiano, attivando, in tutti i gradi scolastici, o una strategia lessicale o una strategia morfosintattica, mentre sono quasi del tutto assenti quesiti che attivino una strategia fonologica. Proveremo dunque nella seconda parte a spiegare le ragioni di questa assenza, argomentando a favore della introduzione di quesiti a strategia fonologica almeno nella II classe della primaria. Proveremo anche a proporre dei quesiti possibili, dei formati praticabili sia su carta che su computer, secondo un piano di difficoltà crescente. La ricerca si ferma a questo punto, essendo stato impossibile, nell'attuale situazione, verificare direttamente nelle scuole la plausibilità della proposta.

* Il saggio è frutto del lavoro congiunto delle due autrici, che tuttavia si sono suddivise il compito di redigere i diversi paragrafi nel modo che segue: Maria G. Lo Duca, paragrafi 1, 2, 3, 4, 5; Zuzana Toth, paragrafi 6, 7.

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The present study is composed of two parts. The first part reviews some issues already addressed in a previous article (Lo Duca e Toth, 2021), where we presented a critical review of the orthographic questions administered in the INVALSI tests of Italian, starting from the first years of administration up to 2019. These questions were analysed in terms of the different strategies they activate. The strategies we refer to have been identified by linguistic and psycholinguistic research and can be divided into three categories: phonological, lexical and morphosyntactic. The analysis of the questions showed that they focus on problematic aspects of Italian orthography and activate lexical and morphosyntactic strategies. There are no questions that activate phonological strategies. In the second part of the present study, we will try to explain the reasons behind this pattern and argue in favour of the introduction of questions that activate a phonological strategy, at least into the tests administered in the second class of the primary school. We will also attempt to formulate some sample questions, which could be administered both in paper-and-pencil and computer-based format, and hypothesise their level of difficulty. The research stops at this point, since it was not possible to carry out empirical research at schools due to the current epidemiological situation.

1. L'ortografia dell'italiano

La scelta di inserire almeno un quesito ortografico nelle prove di Italiano risale al *Quadro di riferimento della prova di Italiano* (QdR) del 2013, confermata poi nell'edizione successiva del 2018. Nell'elenco dei sei ambiti grammaticali fatti oggetto di rilevazione, l'ortografia occupa il primo posto, seguita dalla dicitura: «Uso di accenti e apostrofi, maiuscole e minuscole, segmentazione delle parole (*gliel'ho detto*), uso delle doppie, casi di non corrispondenza tra fonemi e grafemi (uso dell'*h*, della *c/q*, dei digrammi ecc.)». Questa lista di fenomeni ortografici è interessante, e rivela l'intenzione, da parte dell'Istituto, di monitorare solo quelli che vengono considerati i punti critici dell'ortografia dell'italiano. Punti critici in che senso?

Cominciamo col definire l'ortografia con le parole di Luca Serianni (2000, p. 5): «l'insieme delle regole che vigono, in una data epoca e per una determinata lingua, per l'uso corretto dei grafemi e dei segni paragrafematici». I grafemi a loro volta «sono le unità grafiche elementari, non suddivisibili ulteriormente, che servono a riprodurre nello scritto i suoni di una lingua» (Demartini, 2010, p. 595). Rientrano invece fra i segni paragrafematici «i tratti e gli accorgimenti grafici che si combinano con una o più lettere dell'al-

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fabeto, oppure ne marcano la forma, per esprimere un valore distintivo o funzionale» (Cignetti, 2011, p. 1033), quindi, tra gli altri, accenti e apostrofi.

Nelle lingue alfabetiche come l'italiano, l'insieme dei grafemi costituisce ciò che comunemente chiamiamo alfabeto, che l'italiano ha ereditato dal latino, ma che è stato, nel corso dei secoli, adattato ai mutamenti nel frattempo intervenuti. Il fenomeno più importante ai nostri fini è stato il nascere e il consolidarsi di nuovi suoni, assenti in latino, e di cui si è dovuto trovare una qualche resa grafica. Per esempio in latino i grafemi *c* e *g* rendevano sempre dei suoni velari, precisamente [k] e [g], che ritroviamo in italiano in *cane* o *gatto*. Il suono palatale dei suddetti grafemi, e cioè [tʃ] e [dʒ], che ritroviamo in *cena* e *genio*, non esistevano in latino. Dunque l'italiano, anziché assumere nuovi grafemi, ha elaborato un sistema per rendere graficamente i due suoni con le diverse vocali dell'italiano. Il risultato è esemplificato dalle seguenti coppie di parole: *cane*/*gatto*, *cheto*/*ghetto*, *chiesa*/*ghiro*, *cosa*/*gomma*, *cura*/*gusto*, con l'inserimento dell'*h* tra *c*/*g* e le vocali *i*/*e* per rendere il suono velare; *cianuro*/*giallo*, *cervo*/*gelo*, *cibo*/*giro*, *ciotola*/*gioco*, *ciuco*/*giunco*, con l'inserimento della *i* fra *c*/*g* e le vocali *a*/*o*/*u* per rendere il suono palatale. Anche altri suoni non esistevano in latino, e in alcuni casi si è dovuto ricorrere a digrammi e trigrammi per rappresentarli (per esempio i suoni *sc* e *gl* che ritroviamo in *scena* e *figlio*).

Il percorso dal latino alle convenzioni ortografiche che oggi noi tutti seguiamo è stato lento e accidentato, con molti tentativi caduti nel corso dei secoli (Maraschio, 1994). Oggi tuttavia il sistema ortografico dell'italiano è ben stabilizzato, incorporato nei programmi di scrittura elettronica che sorvegliano continuamente la nostra scrittura (si veda in proposito, tra gli altri, Marazzini, 2013). È un sistema che ha fama di essere molto trasparente e regolare, nel senso che ai diversi fonemi corrispondono, quasi sempre, dei grafemi che li rappresentano nella scrittura: effettivamente parole come *sole* o *nastro* o *pavimento* esibiscono una perfetta corrispondenza fra fonemi e grafemi, visto che a ogni fonema corrisponde un grafema diverso.

2. Apprendere l'ortografia dell'italiano

Questa buona corrispondenza fonema/grafema che l'italiano registra facilita di molto il lavoro dei bambini alle prese con il compito di imparare a leggere e scrivere l'italiano. Per esempio studi comparativi hanno attestato che alla fine della prima classe della primaria i bambini italiani (e i bambini di altre lingue ugualmente trasparenti, come il finlandese e il tedesco) leggono correttamente il 95% delle parole, a fronte per esempio dei bambini inglesi,

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che si fermano al 34% (Viterbori, 2020, p. 223). Similmente molti studi di stampo sia linguistico (Ferreri, 1971; Lavinio, 1975; Solarino, 2009; Corno e Janner, 2009; Colombo, 2011; Cignetti, 2016; Fornara, 2016; Cignetti e Demartini, 2016) sia psicolinguistico (Notarnicola *et al.*, 2012; Stella, 2013; Tressoldi e Cornoldi, 2013; Viterbori, 2020) attestano che al termine della scuola primaria i bambini italiani scrivono in modo sostanzialmente corretto sul piano ortografico. Ma attenzione: ci sono alcuni punti critici, alcuni fenomeni ortografici anche molto frequenti, che continuano a creare difficoltà non solo nei piccoli, ma anche nei gradi scolastici superiori, e fino alle soglie dell'università (Solarino, 2006; De Judicibus e Maggio, 2008; Serianni e Benedetti, 2015).

Infatti, pur essendo, come abbiamo già detto, l'ortografia dell'italiano molto trasparente, presenta tuttavia una serie di mancate corrispondenze fonema/grafema (alcuni li abbiamo già visti), che sono esattamente i punti di maggiori e persistenti difficoltà. Basterà rileggere alcune pagine della già citata grammatica di Serianni (2000, pp. 27-36) per ritrovare elencate, e talvolta spiegate nella loro genesi storica, le particolarità e le idiosincrasie ortografiche dell'italiano. Che sono poi le stesse che si ritrovano a) nei libri destinati alle prime classi della scuola primaria (e negli eserciziari per i bambini disortografici), con un grado di insistenza proporzionato alla loro comprovata difficoltà; b) negli elaborati scritti di piccoli e grandi, sotto forma di errori; c) nelle molte domande che scriventi competenti (spesso sono insegnanti) rivolgono in materia all'Accademia della Crusca[1]; d) nei quesiti ortografici delle prove INVALSI.

Uno dei meriti della letteratura citata è stato quello di interrogarsi sulla genesi di questi errori, i quali sono stati posti in relazione con il processo di scrittura e con la particolare strategia attivata di volta in volta dallo scrivente sulla base delle caratteristiche della singola parola o della sequenza da scrivere. Così facendo si è giunti a individuare tre diversi percorsi mentali, cui corrispondono tre diversi tipi di errori ortografici. A questo punto ci siamo chieste se ritroviamo questi diversi tipi anche nei nostri dati; se ai diversi tipi corrisponda un diverso livello di difficoltà; infine, e più in generale, se si intravvedano le ragioni che rendono facile o difficile una domanda ortografica, rispetto al grado scolare in cui è stata somministrata.

[1] Alcuni esempi di domande rivolte all'Accademia sono i seguenti: bisogna scrivere *ce ne* o *ce n'è*, *buondì* o *buon dì*, *ognuno* o *ogniuno*, *all'oscuro* o *allo scuro*, *ciliege* o *ciliegie*, *bagnamo* o *bagniamo*, *familiare* o *famigliare*, *obiettivo* o *obbiettivo*, *obiezione* o *obbiezione*? A ciascuno di questi dubbi un linguista esperto risponde proponendo le soluzioni oggi ritenute accettabili, non senza aver mostrato come spesso le idiosincrasie trovino una giustificazione nella storia delle parole, nella loro origine e nella loro successiva evoluzione.

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3. Tre diverse strategie: fonologica, lessicale, morfo-sintattica

La strategia fonologica si attiva naturalmente nelle scritture alfabetiche, nel momento in cui impariamo a tradurre un certo suono in un particolare grafema. E poiché, come abbiamo detto, l'italiano presenta una buona corrispondenza tra fonemi e grafemi, i bambini italiani imparano abbastanza presto a rendere in scrittura una parola regolare – poniamo che sia *lupo* o *armadio* – anche se mai letta o scritta prima, perché non devono far altro che "appoggiarsi" alla versione orale della stessa per tradurla in versione scritta. Lo stesso accade con le parole tronche dell'italiano, che richiedono obbligatoriamente la segnalazione dell'accento sull'ultima sillaba: dobbiamo scrivere *papà*, *però*, *capitò*, mentre non vige obbligo di resa grafica dell'accento con tutte le altre parole dell'italiano che hanno l'accento sulla penultima (*luna*, *divano*), terzultima (*tavolo*, *camera*) o quartultima sillaba (*interrogano*, *moltiplicano*).

Dunque la scrittura delle grafie regolari, che traduce in grafemi dei suoni chiaramente percepiti[2], grazie al buon grado di trasparenza dell'italiano, e grazie all'addestramento ripetuto che le prime classi della primaria sempre prevedono, si impara presto e bene, tranne che nelle disortografie conclamate (Cornoldi, 2016). Questo almeno è quanto dice la bibliografia di settore, e che però non siamo in grado né di smentire né di confermare, visto che non abbiamo trovato nelle prove INVALSI di italiano quesiti ortografici sulle parole regolari dell'italiano, che chiameremo "grafie tipiche". Non li abbiamo trovati neppure nelle prove somministrate in II primaria (tantomeno in V primaria), dove, a nostro parere, sarebbe stato utile verificare l'avvenuto apprendimento di questa fondamentale abilità. Eppure anche tra le parole che esibiscono una chiara e trasparente resa grafica, sarebbe possibile individuare casi di minore o di maggiore difficoltà, che sarebbe stato utile indagare. Ma torneremo presto su questo punto, su cui verterà l'intera seconda parte del nostro contributo.

Una seconda strategia, che chiameremo lessicale, si attiva quando "appoggiarsi" all'oralità non basta più. Bisogna dunque che l'apprendista scrittore impari da una parte a segmentare il flusso del parlato e a trasporre nello scritto le diverse parole staccandole le une dalle altre con l'interposizione di uno spazio bianco; dall'altra a rendere certi suoni non già con un singolo grafema, ma con

[2] Naturalmente sono facilitati nell'opera di traduzione oralità/scrittura quei bambini che sono stati abituati, già nella scuola dell'infanzia, a prestare attenzione alla forma fonica delle parole, a controllare la velocità di dizione, a discriminare e pronunciare chiaramente i diversi suoni (De Santis, 2018), e dunque a notare la differenza, per esempio, tra *pera* e *sera*, o tra *barca* e *banca,* o tra *papà* e *papa*.

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soluzioni più complesse (abbiamo già visto i casi dei suoni velari e palatali di *c* e *g*, o della resa grafica della *sc* e della *gl*). Sia nel primo sia nel secondo caso le convenzioni che normano la scrittura, soprattutto di certe parole particolarmente insidiose, vanno apprese una a una, attraverso un lungo apprendistato.

Per quanto riguarda la segmentazione delle parole, la letteratura di settore (per esempio Pontecorvo, 1996; Solarino, 2006, 2009) registra molti errori di iposegmentazione, del tipo *cera* per *c'era*, *senzaltro* per *senz'altro*, o di ipersegmentazione come *d'avanti* per *davanti* o *in vece* per *invece*. Come si evince dagli esempi, sono coinvolte in questo tipo di errori soprattutto le preposizioni (ma nei più piccoli anche gli articoli), vale a dire elementi funzionali, la cui autonomia lessicale è meno chiaramente percepita[3], e comunque la norma ortografica è spesso arbitraria: perché dobbiamo scrivere *soprattutto* e non *sopra tutto* o *in seguito* e non *inseguito*? È solo l'abitudine alla lingua scritta, la memorizzazione della forma corretta che ingenera, alla lunga, il necessario automatismo che sconfigge questa tipologia di errori.

Lo stesso dicasi degli errori che nascono da grafie atipiche, dove la traduzione oralità/scrittura non è scontata, e la stabilizzazione grafica è spesso il risultato di un lungo percorso che ha impegnato per secoli grammatici, editori e intellettuali. Abbiamo già accennato alla resa grafica dei suoni velari e palatali della *c* e della *g*, che assumono o non assumono l'*h*, e dunque alla presenza di digrammi (*ch*, *gh*, *ci*, *gi*, *sc*, *gl*, *gn*) e trigrammi (*sci*, *gli*). Altre insidie si nascondono nella resa della lunghezza consonantica, diversamente "sentita" nelle diverse aree del Paese, attraverso le doppie (*tubi* o *tubbi*, *dubi* o *dubbi*, *cugino* o *cuggino*?). Un caso classico di mancata corrispondenza fonema/grafema si ha con la *z* intervocalica, che in molte aree del Paese si pronuncia *zz*, ma la norma ortografica prevede diversamente in *razziale*, *azzerare* da una parte, e in *nazione*, *azoto* dall'altra. Ma qui ci fermiamo: per ritrovare la lista di queste idiosincrasie basterà sfogliare una qualsiasi grammatica dell'italiano, per esempio Serianni 2000 (soprattutto alle pp. 27-36) o la più recente De Santis-Prandi 2020 (alle pp. 215-225); oppure un libro di testo per la scuola primaria, dove sono presentati per ultimi proprio i suoni dell'italiano che hanno rese grafiche complesse o irregolari[4].

[3] Sul piano fonologico le parole funzionali non hanno autonomia accentuale: noi pronunciamo *lospècchio, avedère* ma scriviamo *lo specchio, a vedere*. Sul piano semantico, le parole funzionali non hanno significato lessicale ma grammaticale.

[4] Per esempio il corso della Giunti che ha titolo *Amici di classe*, diretto da M.C. Peccianti e L. Valdiserra, propone già per la I classe della primaria un apposito libretto di esercitazioni ortografiche dal titolo *Scrivere bene*, in cui i bambini sono chiamati a esercitarsi prima sui grafemi facili, quelli che riproducono chiaramente un ben definito suono della lingua, poi sulle molte particolarità ortografiche dell'italiano.

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Infine, la strategia morfosintattica viene attivata quando lo scrivente deve scegliere tra grafie concorrenti, le quali segnalano particolari funzioni sintattiche: per esempio *la* è articolo in *la sedia* e pronome in *la vedo*, e in questo caso la grafia non dà problemi perché è identica; *là* con l'accento è avverbio (*la palla è là*); *l'ha* è un nesso in cui il pronome *la* ha subito elisione, segnalata dall'apostrofo (*l'ha detto Maria*). In casi come questi la difficoltà è data dal fatto che nell'orale questi diversi segmenti si pronunciano più o meno allo stesso modo, quindi la strategia fonologica non può essere di alcun aiuto. Serve invece la considerazione del particolare contesto linguistico in cui la forma problematica è inserita. Generano lo stesso tipo di difficoltà molti monosillabi (*e/è*, *a/ha*, *da/dà*, *si/sì*, *la/là*, *di/dì/di*' ecc.) e alcuni nessi come *un altro/un'altra*, *glielo (dico)/gliel'ho (detto)*, *ve lo (spedisco)/ve l'ho (spedito)*, *(non) ce ne (importa)/(non) ce n'è (bisogno)* ecc. Il fatto poi che l'accento serva a distinguere monosillabi aventi la stessa resa fonica ma diversa funzione trascina nell'errore molti monosillabi non omofoni, come *su* o *qua*, *sto* o *sta*, che hanno il torto di avere l'accento tonico (ma in questo caso non grafico) sull'unica sillaba disponibile.

4. Quali strategie nelle prove INVALSI?

Abbiamo raccolto e analizzato tutti i quesiti ortografici somministrati dal 2008 al 2019: da questo corpus di dati abbiamo escluso 6 domande che, per il modo in cui sono state trattate a livello statistico, non sono confrontabili con le altre. Sono rimaste 32 domande di cui la tab. 1 è una rappresentazione sintetica per grado scolastico e per strategia attivata.

Tab. 1 – Quesiti di ortografia somministrati nel periodo tra 2008-2019

Strategia	*Grado 5*	*Grado 6**	*Grado 8*	*Grado 10*	*Totale*
Strategia fonologica	2		1		3
Strategia lessicale	3	1	5	4	13
Strategia morfosintattica	3	2	6	5	16
Totale	8	3	12	9	32

* Le tre domande somministrate nel grado 6 (I classe della secondaria di I grado) risalgono agli anni 2012 e 2013. In questo grado scolare le prove INVALSI sono state effettuate solo nel periodo 2010-2013.

Come si vede, da una parte manca nella tavola il grado 2 della primaria, in cui non vengono solitamente somministrate domande di tipo ortografico; dall'altra, le domande che attivano una strategia fonologica sono soltanto 3,

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e di queste 2 hanno riguardato la V classe della primaria. Una distribuzione più uniforme si registra per le altre due tipologie di domande, che appaiono anche più equamente distribuite nei diversi gradi scolastici.

5. Dal più facile al più difficile?

Potremmo chiederci a questo punto se, sulla base dei risultati delle prove, si rilevi una sorta di scala di difficoltà che, a seconda della strategia attivata dalla domanda, vada dal più facile al più difficile. Le domande più facili sarebbero quelle che attivano una strategia fonologica, che prevede, lo abbiamo visto, una traduzione dei fonemi in grafemi, posto che tale traduzione sia trasparente e regolare. Seguirebbero nella scala di difficoltà le domande che attivano una strategia lessicale, quindi la segmentazione del flusso del parlato in parole autonome e la scrittura di grafie atipiche, dove la relazione tra fonema e grafema presenti ambiguità o irregolarità. In questo caso è lecito attendersi che il processo di scolarizzazione, aumentando col passare degli anni la familiarità con la scrittura, migliori di conseguenza la resa grafica delle parole graficamente irregolari, che sarebbero via via memorizzate e rese in modo automatico nella scrittura. Infine, al livello più alto di difficoltà si porrebbero le domande che attivano una strategia morfosintattica, che richiedono una riflessione esplicita sull'elemento o sugli elementi implicati, vale a dire il riconoscimento di categorie lessicali e di funzioni sintattiche, sulla base del contesto linguistico in cui l'elemento o gli elementi stessi sono inseriti. Possiamo dire che i risultati delle prove confermano questa ipotesi di partenza?

In Lo Duca e Toth (2021) abbiamo risposto in modo dettagliato a questa domanda, con analisi di tipo quantitativo (percentuali di risposte corrette) e qualitativo (contenuto e formato dei singoli quesiti). Qui ci limiteremo a sintetizzare i risultati dell'analisi, a partire dalla tab. 2, in cui le domande sono suddivise in 5 diversi livelli, sulla base della loro comprovata facilità/difficoltà. Tra parentesi sono riportate le percentuali di risposte corrette e le sigle delle tre strategie, F(onologica), L(lessicale, M(orfo)-S(intattica).

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Tab. 2 – Distribuzione dei quesiti di ortografia in base alla loro difficoltà e la strategia attivata

Grado	*Facili (84%-71%)*	*Medio-facili (70%-67%)*	*Medie (60%-46%)*	*Medio-difficili (37%-35%)*	*Difficili (34% in giù)*
	----------	----------	2 (F)	---------	----------
05	1 (L)	----------	1 (L)	1 (L)	----------
	2 (M-S)	---------	1(M-S)	---------	---------
	--------	----------	----------	----------	----------
06	1 (L)	----------	----------	----------	----------
	1 (M-S)	---------	---------	---------	1 (M-S)
	----------	--------	1 (F)	---------	---------
08	---------	1 (L)	---------	1 (L)	3 (L)
	1 (M-S)	2 (M-S)	---------	2 (M-S)	1 (M-S)
	--------	--------	--------	----------	--------
10	--------	--------	1 (L)	----------	3 (L)
	1 (M-S)	1 (M-S)	2 (M-S)	---------	1 (M-S)

Questa tabella dimostra, se ce ne fosse bisogno, l'esiguità dei dati sui quali abbiamo lavorato, visto che le caselle che presentano vuoti sopravanzano ampiamente le caselle riempite da numeri, comunque esigui. Ciò detto, proveremo ad avanzare qualche considerazione che a noi pare meritevole di attenzione, anche in vista di possibili futuri sviluppi.

Intanto, esce subito sconfitta l'ipotesi che le tre strategie rivelino un grado crescente di difficoltà. In realtà le uniche 3 domande che attivano una strategia fonologica sono risultate di difficoltà media, indipendentemente dal grado scolastico in cui sono state somministrate. Tuttavia il compito proposto dai quesiti riguardava non già la scrittura di parole regolari, ma la suddivisione in sillabe, in presenza di nessi consonantici e vocalici complessi. Ciò detto, ci si potrebbe chiedere a ragione se in questi casi sia stato giusto ascrivere queste domande alla strategia fonologica, dal momento che "si tratta di compiti che non possono essere risolti in modo intuitivo, facendo affidamento sulla naturale sensibilità fonologica per segmentare le parole in sillabe prototipiche. Al contrario, i quesiti richiedono la conoscenza di una serie di regole, che danno adito a relazioni complesse tra unità grafiche e unità percepite fonologicamente" (Lo Duca e Toth, 2021, p. 23).

Per quanto riguarda le domande a strategia lessicale, colpisce il fatto che due di esse siano risultate facili già nei gradi 5 e 6, mentre ben sei domande (su un totale di 13) hanno registrato il massimo livello di difficoltà pur essendo state somministrate nei gradi 8 e 10. Com'è possibile che grafie (irregolari) risultate facili in V primaria siano poi risultate difficili in II superiore? La spiegazione di questa apparente anomalia sta nelle parole su cui vertono i

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quesiti: mentre in V primaria si propongono (giustamente) ai bambini parole del vocabolario di base, molto frequenti e usuali nella loro esperienza anche scritta (*scienza, esercizio*), nei gradi scolastici superiori le domande si focalizzano su parole meno usuali o del lessico colto (*accelerare, beneficenza*, *efficienza*), su cui evidentemente i dubbi persistono a lungo. Questi risultati, insomma, ci ricordano che la corretta grafia delle parole che non esibiscono una chiara e univoca corrispondenza fonema/grafema si acquisisce via via che l'apprendente incontra queste parole in forma scritta, più e più volte, in modo da memorizzarne la forma e riprodurla. Ma ci potrà sempre essere una parola, mai o poco incontrata in forma scritta, che porrà problemi anche allo scrivente adulto ed esperto.

Le domande a strategia morfo-sintattica hanno una distribuzione ancora diversa, risultando abbastanza equamente distribuite fra tutti i livelli di difficoltà: così ci sono domande che sono risultate facili o difficili in tutti i gradi scolastici. Per esempio è risultata facile, la più facile dell'intero *corpus* (84% di risposte corrette), una domanda in cui si chiede ai bambini di V primaria di inserire in una serie di frasi date uno dei seguenti elementi: *la*, *l'ha*, *là*, *l'hanno*, *l'anno*. Dunque i bambini sanno discriminare e scegliere i diversi elementi sulla base della funzione svolta nella frase (per esempio *non fare come... scorso* vs. *i tuoi genitori te.... detto molte volte*). Viceversa nella seconda classe delle superiori gli studenti rivelano gravissime incertezze (16% di risposte corrette) nell'inserimento in frasi date di monosillabi accentati o meno (del tipo *là/la*, *se/sé*, *da/dà*). La nostra ipotesi, che le domande che sollecitano una riflessione metalinguistica diventino più facili via via che aumentano l'età e la scolarizzazione, riceve una sonora smentita.

La spiegazione che ci siamo date a questi risultati inattesi è duplice. Da una parte il persistere di questo genere di errori può essere spiegato con un allentamento dell'attenzione sulle particolarità ortografiche, ritenute elementari, e dunque date ormai per acquisite dagli stessi studenti. Come scriviamo in Lo Duca e Toth (2021, p. 17) «nelle scritture più mature l'attenzione dello scrivente si focalizza per forza di cose su aspetti cognitivamente molto impegnativi (le idee da reperire, mettere in ordine, tradurre in parole adeguate e in frasi ben costruite e ben collegate ecc.), e di conseguenza si allenta su fatti giudicati elementari, e dunque dati, a torto, come ormai assodati, tanto da essere tradotti in scrittura avendo la testa altrove». Dall'altra, non va sottovalutato quello che chiameremo "l'effetto formato" delle prove INVALSI: spesso nei gradi superiori le domande hanno un formato complesso (per esempio prevedono una tabella da riempire con molti item da analizzare, oppure richiedono il completamento di più parole con lettere mancanti, o di più frasi con parole mancanti). La numerosità degli item aumenta, a prescindere dal

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contenuto, la difficoltà del compito, perché può diventare difficile rispondere correttamente a 8 item su 8: in questo caso anche la ripetitività del compito e la stanchezza possono giocare un ruolo negativo.

E qui ci fermiamo, rimandando chi volesse saperne di più allo studio principale (Lo Duca e Toth, 2021), già più volte citato, in cui i lettori interessati troveranno tutte le delucidazioni del caso.

6. Proposte sulla primaria

Come abbiamo già accennato nel paragrafo 3, l'analisi dei quesiti ortografici presenti nelle prove INVALSI ha messo in evidenza la mancanza di quesiti a strategia fonologica, che vertano cioè sulla scrittura di parole con una grafia trasparente. Questa scelta è probabilmente collegata all'idea che tale strategia venga acquisita facilmente da tutti gli alunni dopo pochi mesi di scolarizzazione (come discusso nei paragrafi 2 e 3), e dunque al termine della seconda primaria, nel momento in cui gli alunni per la prima volta affrontano le prove INVALSI, il suo padroneggiamento si possa dare per scontato. Tuttavia, un'attenta lettura di alcuni studi sull'apprendimento della letto-scrittura, che mettono in evidenza la complessità di tale processo, può mettere in dubbio questa convinzione.

6.1. Un passo indietro: cosa dicono gli studi di settore?

Negli ultimi decenni la ricerca ha proposto diversi modelli per l'interpretazione dei processi di letto-scrittura[5], mostrando che l'efficacia dei diversi processi coinvolti dipende almeno in parte dalla consistenza ortografica della lingua in cui si impara a leggere e scrivere (Zanzurino e Stella, 2009, p. 154). Molte ricerche condotte in ambiti disciplinari diversi, dalla psicolinguistica alle neuroscienze (per esempio Ziegler e Goswami, 2005; Calvani e Ventriglia, 2020; Dehaene, 2009; Goswami e Bryant, 2016 ecc.), suggeriscono che in un sistema ortografico trasparente, come quello dell'italiano, sia utile

[5] I diversi modelli di interpretazione della letto-scrittura danno adito a metodi di insegnamento contrapposti, presi in esame per esempio da Annunziata (2019-2020). I cosiddetti metodi analitici si basano sull'idea che il percorso di apprendimento debba partire dal riconoscimento visivo di elementi dotati di significato, come le parole, mentre l'estrapolazione di lettere e fonemi possa essere affidata all'intuizione del bambino. I metodi sintetico-analitici invece si basano sul principio opposto, nel senso che si procede dalla conversione di fonemi in grafemi, per arrivare alla loro unione in sillabe e parole.

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partire dalla segmentazione di parole in fonemi e dalla loro conversione in grafemi, che poi possono essere uniti per formare sillabe e parole. Ci sono quindi due prerequisiti essenziali per imparare a leggere e scrivere. Il primo è la consapevolezza fonologica, cioè la «capacità di analizzare separatamente i suoni all'interno di una parola consentendo di giungere al valore sonoro convenzionale di essa» (Zanzurino e Stella, 2009, p. 158). Il secondo invece è la competenza metafonologica, cioè la capacità di «individuare, distinguere, analizzare e confrontare i suoni che compongono le parole primariamente nella loro veste "orale" e successivamente in quella "scritta"» (Zappaterra e De Luca, 2018, p. 38).

Le consapevolezze fonologica e metafonologica non si sviluppano naturalmente, ma richiedono un insegnamento esplicito e graduale (Stella, 2013), che tenga conto della struttura sillabica delle parole. Le parole più facili da segmentare in suoni e dunque da rendere graficamente sono infatti quelle in cui ciascun fonema è chiaramente percepibile ed è rappresentato da un solo grafema. Si tratta di parole che non contengono gruppi vocalici o consonantici, ma solo sillabe piane, composte da una consonante (C) seguita da una vocale (V). Dunque, solo dopo aver imparato a segmentare parole bisillabiche piane come *luna* e *mela*, i bambini sono pronti ad affrontare parole che contengono sillabe più complesse, come *barca* e *tenda*. Come infatti osserva Stella (2013, p. 46), «la segmentazione fonologica […] richiede attenzione e memoria in misura proporzionale al numero dei fonemi che compongono la parola e della complessità delle sillabe».

L'importanza della struttura sillabica delle parole era già emersa negli studi antecedenti a quelli sulla relazione tra lo sviluppo della letto-scrittura e la trasparenza ortografica della lingua, in particolare negli studi condotti da Frith (1985), in cui erano stati individuati 4 fasi nello sviluppo della letto-scrittura. Nella prima fase, chiamata logografica, il bambino riconosce la forma grafica di alcune parole, senza però riuscire a segmentarle in suoni e lettere. Quest'ultima capacità si sviluppa nella fase successiva, detta alfabetica, quando gli alunni acquisiscono l'abilità di segmentare le parole in fonemi e si rendono conto della relazione tra la forma scritta delle lettere e loro la realizzazione fonica. In questa fase, la lettura avviene attraverso la decifrazione di singole lettere, come se ci fosse sempre una corrispondenza uno a uno tra fonemi e grafemi. Dunque, gli alunni riescono a leggere e scrivere parole che presentano una corrispondenza biunivoca tra fonemi e grafemi (*mare*), ma non sono ancora pronti a misurarsi con parole che contengono digrammi (*bagno*), trigrammi (*sciarpa*) o grafemi che rappresentano fonemi diversi in base al contesto (*panca vs*. *pancia*). Queste parole possono essere affrontare in un momento successivo, chiamato fase ortografica, quando gli

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alunni sviluppano la capacità di analizzare il contesto fonico, considerando le sillabe e non più le singole lettere come unità di transcodifica. Infine, nella cosiddetta fase lessicale è possibile affrontare parole omofone ma non omografe (*hanno* vs. *anno*) ed espressioni problematiche dal punto di vista della segmentazione (*letto* vs. *l'etto*).

Per riassumere, gli studi che indagano la relazione tra la letto-scrittura e il sistema ortografico della lingua (per es. Ziegler e Goswami, 2005; Goswami e Bryant, 2016 ecc.), le ricerche di Frith (1985) e anche gli studi del neuroscienziato Dehaene (2009) suggeriscono che, almeno nelle lingue dall'ortografia trasparente come l'italiano, l'insegnamento della letto-scrittura debba partire dalla segmentazione di parole in suoni, per proseguire con la resa grafica dei suoni e la loro unione in sillabe e parole. Tale percorso dovrebbe essere graduato in base alla complessità della struttura sillabica delle parole.

I materiali didattici che accolgono questa impostazione (per esempio Stella, Siliprandi e Gorrieri, 2016) propongono infatti percorsi che partono da parole contenenti sillabe piane (CV), per introdurre progressivamente parole contenenti gruppi vocalici e consonantici, e infine parole in cui non c'è una corrispondenza biunivoca tra fonemi e grafemi. Questa progressione è osservabile nella tab. 3 (ripresa da Stella *et al.*, 2016; 19), in cui i gruppi da 1 a 4 contengono parole dalla struttura sillabica via via più complessa.

Tab. 3 – Progressione di difficoltà in base alla struttura sillabica delle parole

Gruppo 1	Parole bisillabe, trisillabe e plurisillabe composte da sillabe piane (CV-CV, CV-CV-CV, etc.) (esempi? Io li metterei, anche sotto)
Gruppo 2	Dittongo/iato N + consonante R/L/M + consonante
Gruppo 3	Parole con i seguenti gruppi consonantici: P + R consonante + R S + P/T/C S + consonante S + T + R S + consonante + R
Gruppo 4	Parole con digrammi e trigrammi: cia/cio/ciu, gia/gio/giu, chi/che, ghi/ghe, gn, gli, sci/sce, cu/qu/cqu

Questa scansione dà un'idea del lungo percorso di apprendimento che gli alunni devono compiere prima di poter concentrare la loro attenzione su parole che contengono nessi problematici, presenti nel gruppo 4. Per scrivere correttamente le parole presenti nei primi tre gruppi, è necessario imparare

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ad applicare con sicurezza quella che abbiamo chiamato strategia fonologica, che traduce in grafemi i diversi i suoni dell'oralità. Data l'importanza di questo traguardo, ci siamo chieste se il suo raggiungimento potesse essere dato per scontato, o se fosse invece opportuno verificarlo nelle prove di II primaria.

6.2. Proposte di quesiti ortografici per la II primaria

Sulla base delle suggestioni della letteratura appena presentata (molto più vasta e importante di quanto non appaia dalle nostre scarne indicazioni), proveremo adesso a sondare la possibilità di costruire prove sulle grafie regolari dell'italiano. La costruzione di domande adatte a questo scopo presenta però una serie di sfide.

I quesiti presenti nelle prove somministrate in passato, che vertono su aspetti problematici dell'ortografia, richiedono il completamento di parole attraverso la scelta fra due o più grafie possibili, già date nella consegna, la quale indirizza l'attenzione dello studente su determinate sillabe o sequenze di lettere ritenute problematiche. Per facilitare la correzione delle prove, sono del tutto assenti quesiti che richiedano agli studenti di scrivere parole intere.

Questa modalità di formulazione sembra meno adatta a sollecitare la strategia fonologica, dato che nei compiti pertinenti non dovrebbero essere presenti sillabe specifiche su cui indirizzare l'attenzione degli studenti. I quesiti da noi ipotizzati richiedono infatti la scrittura di parole, e le prove dovrebbero essere somministrate su cartaceo o al computer, con conseguente correzione manuale o automatica. Dobbiamo però chiederci se i bambini di II primaria siano abituati a scrivere al computer. Se non lo sono, come ci informano alcune maestre che collaborano alla costruzione delle prove INVALSI, la modalità di svolgimento potrebbe incidere sui risultati in senso negativo.

Inoltre, come vedremo, i quesiti proposti richiedono l'identificazione di parole da scrivere, in base a un'immagine o per associazioni evocate dal contesto frasale. Questo tipo di formulazione comporta però il rischio di fornire risultati fallaci, nei casi in cui lo studente recuperi una parola plausibile ma non esattamente quella prevista dal quesito, scelta in base a determinati parametri (che presto vedremo). Per questo motivo, la corretta identificazione delle parole dovrebbe essere verificata con tutta la classe prima che i bambini inizino a lavorare al compito. La somministrazione al computer potrebbe risolvere questo problema, consentendo ai bambini di ascoltare la formulazione orale delle parole cliccando su un'icona. Si tratta di questioni aperte, cui solo una ricerca preliminare potrebbe fornire delle risposte.

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Nell'ideare alcune proposte di domande, e nell'ipotizzare il relativo livello di difficoltà, abbiamo tenuto conto della progressione proposta da Stella *et al.* (2016, p. 19) riportata nella tab. 3, alla quale è stata apportata qualche piccola modifica, determinata dalla necessità di adattare la materia ai 5 livelli di difficoltà presenti nelle prove INVALSI. La suddivisione in cinque livelli di difficoltà è riportata nella tab. 4. Come si vede, i livelli da 1 a 4 contengono quesiti a strategia fonologica, con parole dalla struttura sillabica via via più complessa, mentre il livello 5 rappresenta il passaggio alla strategia lessicale.

Tab. 4 – Livelli di difficoltà

Livello	*Tipi di parole su cui verte il quesito*
Livello 1	Parole bisillabe, trisillabe o plurisillabe composte da sillabe piane (CV-CV, CV-CV-CV ecc.)
Livello 2	Parole di varia lunghezza composte da sillabe piane Parole contenenti dittongo, iato oppure N/R + consonante
Livello 3	Dittongo Iato N/R/L/M + consonante
Livello 4	Parole con i seguenti gruppi consonantici: P + R Consonante + R S + P/T/C S + consonante S + T + R S + consonante + R
Livello 5	Parole con digrammi, trigrammi: cia/cio/ciu, gia/gio/giu, chi/che, ghi/ghe, gn, gli, sci/sce

Faremo adesso degli esempi di prove per ciascuno dei livelli ipotizzati.

Livello 1. Prevede la scrittura di parole bisillabe o trisillabe semplici, composte da sillabe piane. Come già accennato sopra, proponiamo di testare l'abilità di scrivere queste parole in due modi. Nel caso di parole facilmente rappresentabili con una immagine, il compito richiede di scrivere il nome dell'oggetto presentato (esempio 1). Nel caso di parole facilmente inferibili in base a delle associazioni evocate dal contesto frasale, si chiede di completare delle frasi con le parole mancanti (esempio 2).

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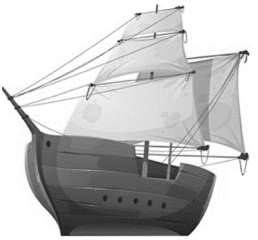
Esempio 1

Scrivi il nome dell'oggetto nell'immagine[6]



n……

r……

(Quesito con 5 parole: *nave*, *mela*, *luna*, *radice*, *regalo*)

Esempio 2

Completa le frasi con le parole mancanti:

– Luca ha vinto la g….. di corsa
– Devi scrivere il tuo n….. sul quaderno

(Quesito con 5 parole: *gara*, *nome*, *minuti*, *numero*, *musica*)

Livello 2. Nei quesiti di livello 2 proponiamo di inserire, accanto a tipi di parole che compaiono nel gruppo 1 della tab. 3 (ca. 40% del quesito), anche parole appartenenti al gruppo 2 (circa 60% del quesito). Come si vede nell'esempio 3, in un quesito che verte su cinque parole, 2 dovrebbero essere del gruppo 1 (come *foca*, *nuvola*) e 3 del gruppo 2 (come *leone*, *baule*, *guanto*). All'interno di uno stesso quesito non si dovrebbero mescolare parole contenenti nessi vocalici (dittongo o iato) con quelle contenenti nessi consonantici (N/R + consonante). Per questo motivo, accanto alle parole contenenti solo sillabe semplici, nell'esempio 3 sono presenti solo parole che contengono

[6] Le immagini utilizzate per il quesito sono state scaricate da: https://www.freepik.com/vectors/vintage, Vintage vector created by upklyak; https://www.freepik.com/vectors/icons, Icons vector created by rawpixel.com.

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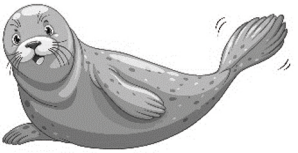
iato o dittongo, mentre nell'esempio 4 solo parole che contengono i nessi consonantici N/R + consonante.

Esempio 3

Scrivi il nome dell'oggetto nella foto[7]



f……

l……

(Quesito con 5 parole: *foca*, *nuvola*, *leone*, *baule*, *zaino*)

Esempio 4

Completa le frasi con le parole mancanti:

– La Sicilia è un'i…… italiana
– Qualcuno ha bussato alla p……

(Quesito con 5 parole: *isola*, *telefono*, *fontana*, *candela*, *porta*)

Livello 3. A partire dal livello 3, i quesiti proposti vertono solo su parole contenenti gruppi vocalici o consonantici complessi, dunque iato, dittongo o nessi consonantici del gruppo 2, cioè N/R/L/M + consonante. Nella loro formulazione si tiene conto anche della lunghezza delle parole. Alcuni quesiti (come l'esempio 3) riguardano solo parole bisillabe e trisillabe (*fiore*, *guanto*, *banco*, *tenda*, *barca*), in altri (esempio 4) sono presenti anche parole più lunghe (*poesia*, *vulcano*, *cortile*, *monumento*, *temporale*). Questo modo di formulare i compiti consentirebbe di tenere sotto controllo la variabile della

[7] Le immagini utilizzate per questo esercizio sono state scaricate da: https://www.freepik.com/vectors/water, Water vector created by brgfx; https://www.freepik.com/vectors/background, Background vector created by brgfx.

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lunghezza, il cui effetto sulla velocità di lettura, soprattutto nei soggetti meno esperti, è ben documentato dalla ricerca (si veda per esempio Marcolini *et al.*, 2006).

Esempio 5

Scrivi il nome dell'oggetto nella foto[8]

f……

g……

(Quesito con 5 parole: *fiore*, *guanto/i*, *banco*, *tenda*, *barca*)

Esempio 6

Completa le frasi con le parole mancanti:

– Per domani dobbiamo imparare una p.... a memoria.
– Il Vesuvio è un v……. attivo.

(Quesito con 5 parole: *poesia*, *vulcano*, *cortile*, *monumento*, *temporale*)

Livello 4. I quesiti proposti per il livello 4 riguardano parole che contengono nessi consonantici presenti nel gruppo 4 della tab. 3. Anche in questo caso proponiamo di tenere sotto controllo la lunghezza delle parole, formulando quesiti che vertono su parole bisillabe (esempio 7) e quesiti che vertono su parole di varia lunghezza (esempio 8). Andrebbe inoltre verificato in quale misura la difficoltà del compito è influenzata dalla variabilità nella tipologia di parole presenti. A tale scopo proponiamo quesiti che vertono su 1) parole contenenti lo stesso gruppo consonantico di livello quattro (per es. *sposa*, *spada*, *spiedino*, *vespa*, *spumante*); 2) parole contenenti diversi gruppi

[8] Le immagini utilizzate per questo esercizio sono state scaricate da: https://www.freepik.com/vectors/flower, Flower vector created by freepik; https://www.freepik.com/free-vector/hand-drawn-winter-clothes-essentials_3479771.htm.

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consonantici di livello quattro (per es. *preda*, *treno*, *vestito*, *vasca*, *prato*); 3) parole contenenti diversi gruppi consonantici e vocalici, da livello due a livello quattro (per es. *piede*, *soldato*, *anatra*, *mosca*, *slitta*).

Esempio 7

Scrivi il nome dell'oggetto nella foto[9]

d……

l……

(Quesito con 5 parole: *drago*, *lepre*, *vespa*, *spada*, *stella*)

Esempio 8

Completa le frasi con le parole mancanti:

– Voglio s…… una lettera alla mia amica.
– La mamma ha cucinato una m…… di lenticchie.

(Quesito con 5 parole: *scrivere*, *minestra*, *Africa*, *spremuta*, *palestra*)

Livello 5. Infine, a livello 5 si collocano i quesiti che vertono su parole che rappresentano il passaggio dalla strategia fonologica alla strategia lessicale, dato che contengono fonemi rappresentati con digrammi e trigrammi (esempio 9) oppure fonemi diversi rappresentati da uno stesso grafema ma con vari accorgimenti grafici (per esempio la presenza dell'h in *gelato* vs. *ghepardo*, *giglio* vs. *ghiro*), come nell'esempio 10. Tuttavia, a differenza dei quesiti già presenti nell'archivio delle prove INVALSI, ci limitiamo a pro-

[9] Le immagini utilizzate per questo esercizio sono state scaricate da: https://www.freepik.com/vectors/cartoon, Cartoon vector created by brgfx.

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porre parole dall'ortografia regolare, in cui c'è una buona corrispondenza tra la pronuncia e la realizzazione grafica delle sillabe. Come già evidenziato al paragrafo 1, i compiti non prevedono la presenza di parole in cui sillabe pronunciate allo stesso modo hanno una realizzazione grafica diversa (*effi**cien**za* vs. *benefi**cen**za*).

Esempio 9

Scrivi il nome dell'oggetto nella foto[10]

s……

m……

(Quesito con 5 parole: *scivolo, montagna, medaglia, sciarpa, scimmia*)

Esempio 10

Completa le frasi con le parole mancanti:

– Per colazione bevo spesso una spremuta d'a…….
– Al parco ci siamo seduti su una p……

(Quesito con 5 parole: *arancia*, *panchina*, *circo*, *chiave*, *lucertola*)

7. Conclusioni

La progressione di difficoltà dei contenuti ortografici ipotizzata nel presente lavoro si basa sull'idea che la consapevolezza fonologica e la competenza metafonologica siano prerequisiti essenziali per attivare la strategia fonologica, necessaria per rendere graficamente le parole dall'ortografia trasparente. La scrittura di queste parole presenta diversi gradi di difficoltà, a

[10] Le immagini utilizzate per questo esercizio sono state scaricate da: https://www.freepik.com/vectors/summer, Summer vector created by upklyak; https://www.freepik.com/vectors/snow, Snow vector created by pch.vector.

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seconda della complessità della loro struttura sillabica. Sarebbe stata nostra intenzione testare sia la scala di difficoltà ipotizzata, sia il formato dei quesiti in prove sperimentali. Avevamo già ottenuto la collaborazione di docenti operanti nella scuola primaria, da tempo impegnati come autori delle prove INVALSI[11], le quali si erano dette pronte a somministrare i quesiti nelle classi seconde degli istituti in cui operano. Purtroppo la difficile situazione sanitaria del Paese, con le conseguenti chiusure delle scuole, ha suggerito di rimandare questa parte della ricerca a tempi migliori.

In futuro sarà necessario verificare la tenuta della scala di difficoltà ipotizzata e, in base a questi dati, riflettere sull'opportunità di inserire quesiti a strategia fonologica nelle prove INVALSI e sulle eventuali modalità di somministrazione.

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Since its establishment, INVALSI had the task of preparing and carrying out periodic and systematic checks on the learning outcomes of Italian students (the INVALSI national tests), and of periodically managing Italian participation in international surveys.

The amount of data collected is processed in order to trace a history of students' skills and knowledge and acts as a valid tool for improving the evaluation activities of individual schools and the whole school system.

This volume is the result of a collection of the research works presented during the days of the "V Seminar INVALSI data: a tool for teaching and scientific research - Rome, 25th - 28th February 2021" and provides an example of the use of the data disclosed by the Institute.

As a Statistical Service we hope that the works collected in the volume are the basis for new reflections and a solid example of how the data released by INVALSI allow for quality research within the school context, whose goal has always been to improve students' skills.

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.

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