DIFFERENT DATA SOURCES AND THEIR USES

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

edited by
Patrizia Falzetti

FrancoAngeli

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Assistant Editor: Francesca Leggi.

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Introduction

by Patrizia Falzetti

In an increasingly data-driven world, access to a wide range of information sources is essential for understanding complex phenomena and making informed decisions. Integrating different sources not only enriches analyses but also helps to fill gaps and validate results. For this reason, the Seminar on INVALSI data is open not only to papers and research using data produced by the Institute, but also to all data relevant to assessment in education and training, regardless of the source.

This volume brings together a series of contributions which, while addressing different topics, share a common goal: to provide tools for analysis and reflection to improve the quality of the school system, paying particular attention to the Italian context and its territorial divisions, through the combined use of multiple data sources.

These papers were presented at the eighth edition of the "INVALSI Data: A Tool for Teaching and Scientific Research" seminar (Rome, 23-26 November 2023). The five chapters described below represent a research and analysis pathway that moves between empirical data, quantitative indicators, and theoretical reflections. The aim is to support educational policies and promote student success.

The first chapter describes the experience of a network of schools that developed a shared self-assessment system and dashboard of indicators for monitoring the local school system. This collaborative approach has enabled national and local data to be integrated, providing a solid basis for guiding local school policies.

The second chapter addresses the issue of early school leaving. The authors aim to measure this phenomenon using a simple indicator.

The third chapter analyses the educational and training outcomes of a cohort of students five years after their first year of lower secondary school INVALSI tests. By cross-referencing different data sources, it becomes possible to trace students' educational and training pathways, distinguishing between regularity, delays, vocational training and dropout, with a focus on regional differences.

The fourth chapter focuses on the PIRLS 2021 international survey. The authors study significant predictors of student results in verbal content comprehension in relation to the recently introduced survey scales.

The fifth and final chapter analyses Italian data from the ICILS 2018 survey. The authors investigate whether and to what extent digital skills can improve learning in Italian and Mathematics.

Taken together, these contributions offer a comprehensive and up-to-date overview of some of the key challenges currently facing the education system. As a statistical service, we hope that this volume will be of interest to researchers, educators, and anyone concerned with the functioning and improvement of the school system.

1. The Valdera School System Assessment (ValVal project)

by Simonetta Radi, Arianna Cecchini, Cristina Cosci, Simone Mancini

As a result of the introduction of the National Evaluation System, The Valdera School System Assessment project starts as an activity of a network of schools that decide to carry out a self-evaluation process together. The data provided by the National Evaluation System integrated with those of the Provincial School Observatory are the basis to individuate a common critical priority and start planning, implementing and monitoring some improvement actions together. The good results of the experience (which has been going on since 2014/2015) give rise to the idea of extending the quantitative analysis method and the organization, based on comparison and coordination, to the whole educational zone level; the identification of a dashboard of indicators results to be able to represent the school system in its various aspects (school results, internal and external context). Through the INVALSI microdata and the data from the Regional Student Registry, zonal data are constructed in order to detect the positioning of the local school system in comparison with the regional, national and macro-area benchmarks and to represent the situation of each school in Valdera compared to the average zone data. The goal is to provide a useful tool to guide school policies on the basis of objective surveys and to strengthen the school-territory alliance, making comparison and search for coordinated solutions a systematic approach to support the educational and training success of students in Valdera.

Il progetto di valutazione del sistema scolastico della Valdera nasce come attività di una rete di scuole che, con l'avvio del Sistema

nazionale di valutazione, decidono di svolgere insieme il percorso di autovalutazione, integrando i dati forniti a livello centrale con quelli dell'allora Osservatorio scolastico provinciale; poi, individuata una criticità comune, progettano, realizzano e monitorano insieme le azioni di miglioramento. I buoni risultati dell'esperienza (che va avanti dal 2014/2015) fanno nascere l'idea di estendere il metodo di analisi quantitativa e l'organizzazione (basata su confronto e coordinamento) a livello di zona educativa, con l'individuazione di un cruscotto di indicatori capace di rappresentare il sistema scolastico nei suoi vari aspetti (risultati scolastici, contesto interno ed esterno). Attraverso i micro-dati INVALSI e i dati dell'Anagrafe regionale degli studenti è stato costruito un dato zonale capace di rilevare il posizionamento del sistema scolastico locale rispetto ai benchmark regionale, nazionale e di macro-area e di rappresentare la situazione di ogni scuola della Valdera rispetto al dato medio di zona. L'obiettivo è quello di fornire uno strumento utile ad orientare le politiche scolastiche sulla base di rilevazioni oggettive e a rafforzare l'alleanza scuola-territorio, facendo diventare sistematico il confronto e la ricerca di soluzioni coordinate per sostenere il successo scolastico e formativo degli studenti della Valdera.

1. Preface: the territorial context

Valdera is an area of Tuscany which lies between Pisa and Florence.

The School and Educational Conference is a collegial body made up of the mayors of the Valdera municipalities and which responds to the Tuscan regional law.

Today the Valdera Educational Conference is composed of 17 municipalities.

The Conference uses the Valdera Union offices for the administrative and organizational management support and for providing and arranging the educational activities needed to the schools and the childcare centres; The Valdera Union is a second-level body made up of eight Valdera municipalities.

The Educational Conference ensures the educational and pedagogical coordination of childcare centres and all schools (nursery, primary,

and secondary) through the CRED – Educational and Teaching Resource Centre.

In the Valdera area there is also a network of schools called Costell@zioni which is supported by the local municipalities (part of the Valdera Union and the Educational Conference). They all regularly discuss and share projects aimed at schools which are often co-financed by the municipalities.

For those who don't belong to our territory, this type of organization may appear excessively complex, but at the basis of all this architecture is the "Patto educativo di comunità" an educational Community Pact which has been renewed for more than ten years between schools, municipalities and other institutions in the area (local health company, Sant'Anna University, etc.). The Pact represents the beacon to which local institutions look to in proposing activities aimed at students, from the youngest to the oldest, and their families.

The ValVal – Valdera Assessment Project is located here, it is the result of an institutional political choice with precise objectives set by the municipalities through a technical-scientific project carried out by a board composed of mayors, school directors, and experts: to date in Valdera we detect a decrease in the rate of school dropout which is below the national and regional average.

2. ValVal Network: schools synergy to overcome common critical issues

In 2023 the Presidential Decree number 80 introduced a new National Evaluation method for the educational and training system. It represented an opportunity to activate new relationships between schools and between schools and the Valdera Area as association of municipalities, around an evaluation project: on the one hand to begin a constructive comparison between schools on their strengths and weakness and on the other hand to check the health of the territorial school system as a whole.

In the school year 2014/2015 the 15 schools of this area, working as a network began activities like:
– facing together self-assesment in a systematic way: for example:

- reading, analysing and contextualizing the data from multiple sources: at central level from the Ministry platforms and at local level from provincial and regional observatory;
– comparing results and processes;
– identifying together, common goals to be achieved:
  - defining a Network Improvement Plan that includes common priorities and process objectives;
– establishing Vertical Improvement Groups, for each school level, and as a whole:
  - planning the improvement actions, including indicators, targets and monitoring methods;
  - implementing the planned actions in each school, including teacher exchanges;
  - monitoring and evaluating the ongoing work;
  - returning the results to the network annually and proposing, whenever necessary, a reshaping of the activities.

The organization is supported by the schools and the local authorities:
– by the schools formally united in a network (named Costell@zioni and operating since 2005);
– by the local authorities, a local Evaluation Team, representatives of the stakeholders, with tasks of guidance, coordination, technical proposition and evaluation.

These are the signatories of the 2015 Agreement with the purpose of «supporting and monitoring the experimentation of a new mode of self-assessment of educational institutions that integrates different keys, disseminating the results»:
– School Network;
– Unione Valdera as Municipalities Union;
– Tuscany Region;
– Province – School Observatory;
– USR Regional School Office;
– UST Provincial School Office;
– INDIRE National Institute of documentation innovation and educational research (which oversaw initial teacher training on educational avanguards).

3. Territorial ValVal: a school/territory coordination starting from data analysis

The idea of the territorial ValVal was that of creating a working method and organization at the local educational area level, promoting the culture of quantitative analysis, comparing and implementing common strategies specific to the experience of the network ValVal.

As a methodology, it was planned to develop a synthetic tools that, based on a dashboard of indicators, represents the local school system from a perspective of learning outcomes, internal and external context data, so that comparisons can be made both diachronically and synchronically.

All this with the purpose of overcoming weakness, guiding educational policies in a coordinated way and monitoring the outcomes of interventions as individual institutions level as territorial system as a whole.

We have permanent technical boards representatives of schools and local communities working on:
– analysing and contextualizing local area data;
– detecting the most relevant weakness;
– concerting coordinated intervention strategies;
– and eventually analysing and evaluating the initiatives undertaken based on the monitoring data and targets set.

Alongside the technical boards, systematic discussions open to associations, parents, and students on the local evaluation data are planned in order to achieve broad involvement and to acquire input and suggestions.

This is the ambition and challenge, not an easy one, of the project.

4. Data sources and methodology

In the 2018/2019 school year, we initiated the analysis of INVALSI test results from a territorial perspective. Using microdata provided by local schools, we built a model that included all students from the Valdera area who participated in the tests. The analysis focused on the final years of each educational cycle – grade 8 (approximately 1,200

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students across 11 schools) and grade 13 (about 700 students across 4 schools).

The tools developed for this phase included descriptive statistical indicators, cross-sectional and longitudinal analysis techniques, and visual representations such as charts, tables, and interactive dashboards. These resources were designed to describe and explore the educational paths of both attending and resident students, where possible.

Following the Ministry's recommendations, indicators were classified as Context Indicators and School Outcomes. We also plan to incorporate extra-school indicators related to the territory (e.g., cultural associations, employment demand/supply, sports participation) in the future.
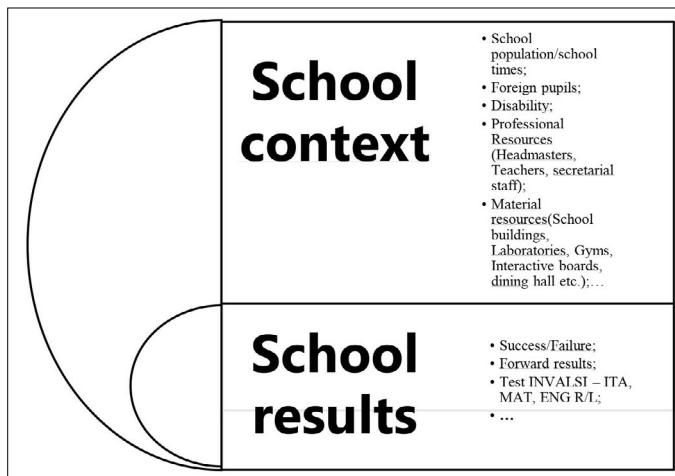
Fig. 1 – Statistics indicators

5. Results and examples

As a first example, a dashboard was created to display the presence of non-Italian students – first and second generation – across institutions and educational levels. The interface allows users to examine historical trends and, for the most recent year, analyze data by school and territory. It also offers comparisons with area, provincial, and regional benchmarks.

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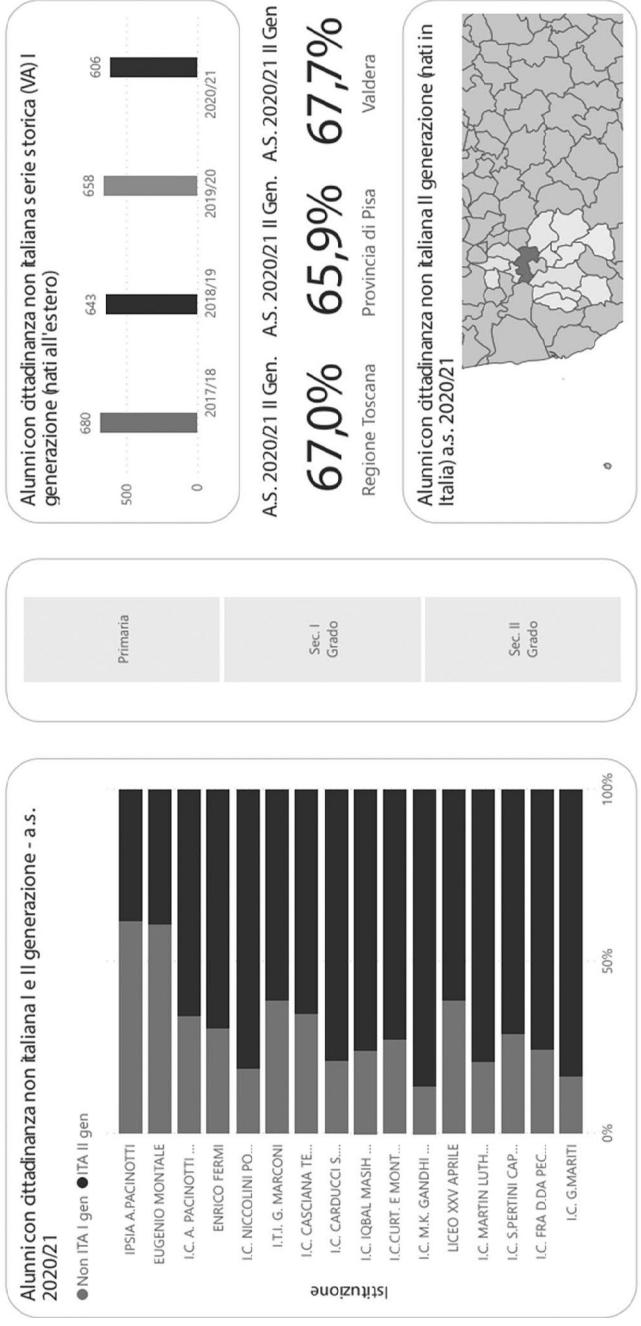
Fig. 2 – Example 1: I and II generations of students with non-Italian citizenship interactive dashboard
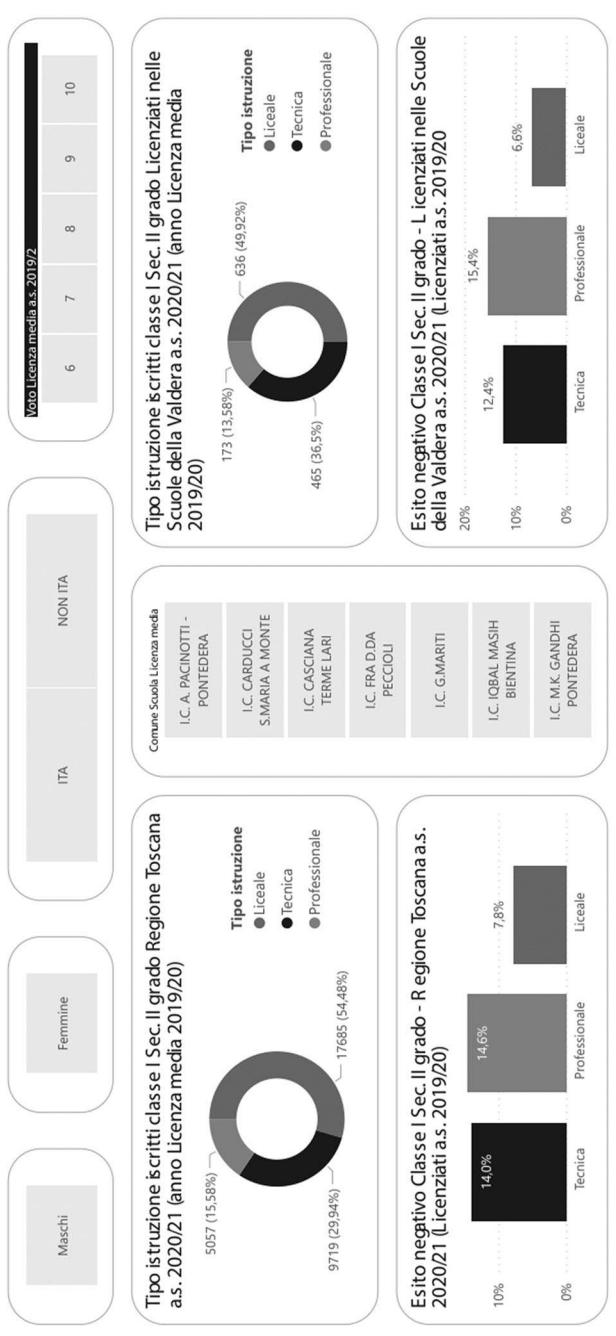
Fig. 3 – Example 2: Transition from I to II cycle of education, orientation (choice) and failure in the first year of secondary school
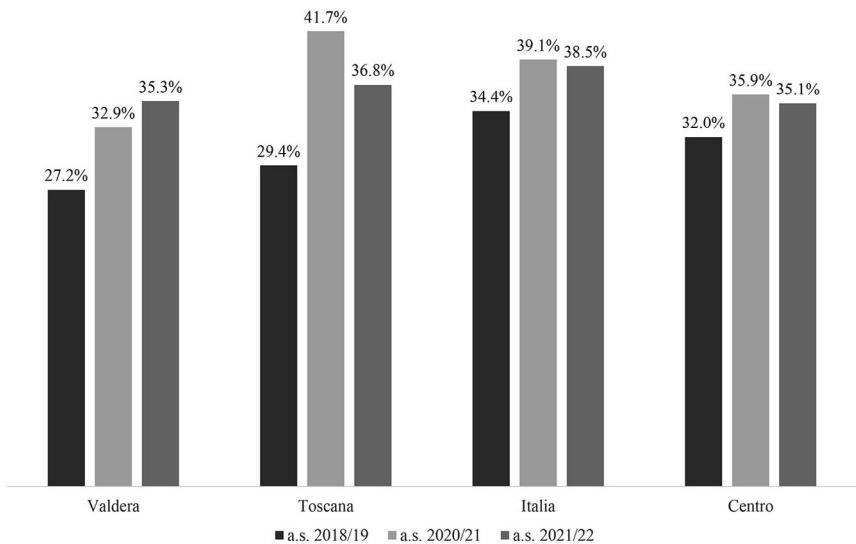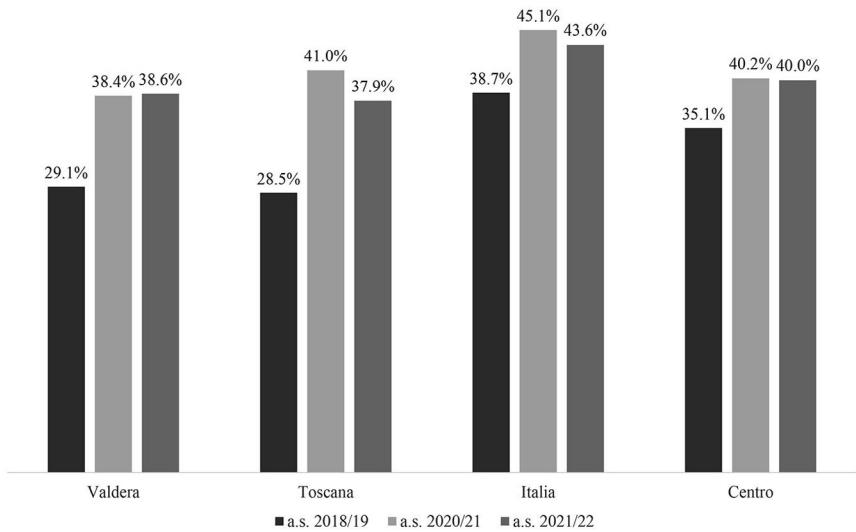
Fig. 4 – Example 3: Test of ITA and MAT Sum of levels I and II (inadequate skills) – Grade 8 – Detail Comprehensive Institutes of the Valdera Zone

Valdera = Valdera zone, Toscana = Tuscany, Italia = Italy, Centro = Central Italy

The second example focuses on a longitudinal analysis of students who completed lower secondary school in 2019/2020 and transitioned to upper secondary in 2020/2021.

The dashboard shows school-type choices (*liceale*, *professionale*, *tecnica*) with a regional vs. local comparison (pie chart), along with failure rates in the first year of upper secondary (histogram). Filters allow for detailed analysis by gender, citizenship, and academic background.

Lastly, the third example focuses on INVALSI performance at grade 8, specifically the proportion of students in levels 1 and 2 for Italian and Math. This analysis, repeated in 2020/2021 and 2021/2022, allows comparison with regional and national averages. A radar chart summarizes school-by-school results, highlighting those with the highest and lowest shares in the two lowest levels. Additional variables from the INVALSI dataset – gender, career regularity, family background – were also considered in the interpretation of outcomes.
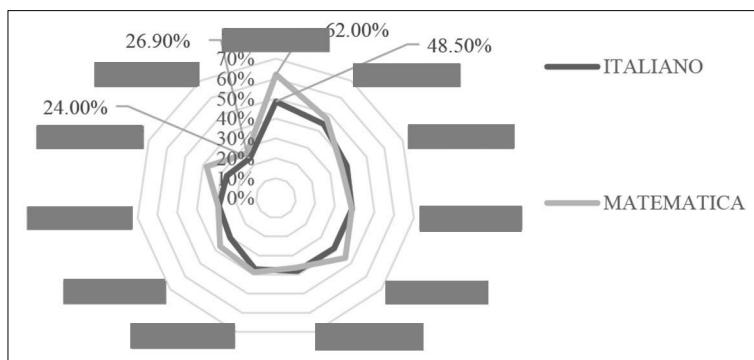
Fig. 5 – Detail of the 11 Comprehensive Institutes of the Valdera Zone

The labels do not show the names of the schools in order to keep them anonymous

5. The first evaluation phase

What are the results of the network work?

In the first evaluation phase 2014-2019 the priority to be achieved was to decrease school failure in the transition from lower secondary to upper secondary.

In December 2019, at the conclusion of the improvement activities, the schools produced a Joint Social Report that showed the positive outcome of the ValVal project: Ministerial sources noted an increase in the% of those admitted in the two-year secondary school and a decrease in the% of those with suspended school judgment.

In Figures 6 and 7 we see two graphs taken from the regional student registry.

The first graph shows the percentage of students not admitted to the upper class by orders and school levels, and as we see the highest values are still the first upper secondary class, but we can also observe a decreasing from school year 2014/2015 to 2017/2018 from 16% to 13%.

If we compare the Valdera's with the Province and Regional values as benchmarks, on the second one, we observe that the Valdera rate is becoming the lowest.

Of course, we cannot claim that there is a cause-and-effect relationship between the project and a decrease in school failure, but we also cannot rule out a significant contribution.
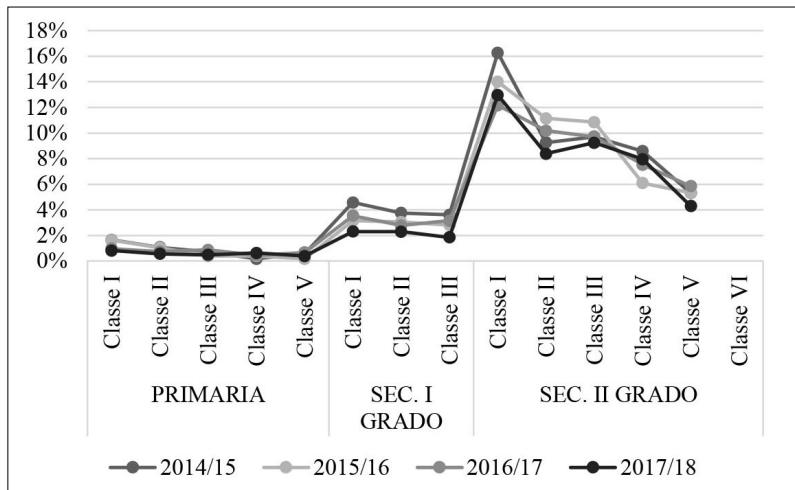
Fig. 6 – School failure by grade year-Valdera schools aa.ss. 2014/2015-2017/2018
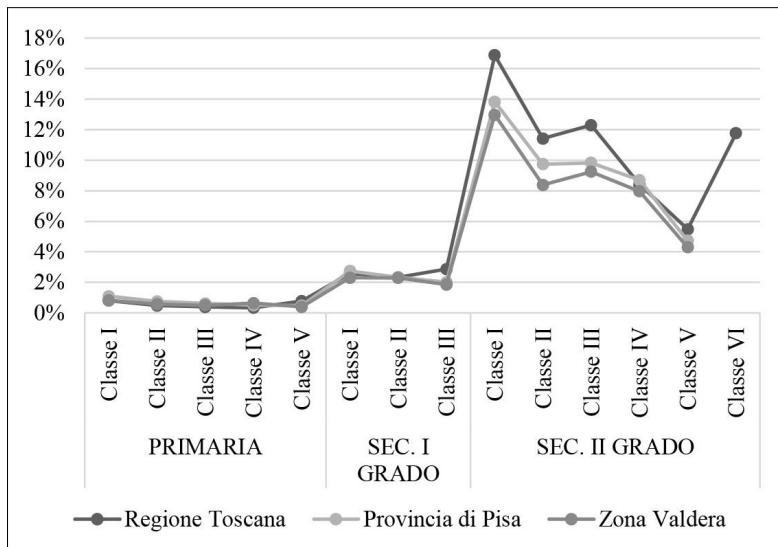
Fig. 7 – School failure by course year a.s. 2017/2018

For the 2022-2025 phase, the weakness identified is the students' basic skills, and the new priority of Network Improvement Plan is to decrease the percentage of students placed in levels 1 and 2 of the INVALSI classification representing the inadequate levels of skills in Italian, Math and English.

The strengths of the project can be summarized:

- first we have realized a coordination of the Valdera's educational institutions and municipalities around the territorial educational system with shared goals;
- second we have contributed to promoting a culture of data, disseminating a working method based on quantitative analysis developed at all stages of the process;
- third we have created synergies around a common weakness: to increase the chances of success of improvement activities, because they are carried out in a coordinated way, as well as the impact on the entire territorial school system is stronger.

6. Final remarks

The ValVal project illustrates how collaboration, data analysis, and shared educational goals can drive systemic improvement within a school territory. By involving schools, municipalities, and other local stakeholders, the initiative has helped create a culture of co-responsibility and continuous development. The emphasis on identifying common challenges and addressing them through coordinated strategies has already shown positive outcomes, especially in reducing school failure and building stronger connections between schools and the wider community. As the network moves into its next phase, the ongoing challenge will be to maintain this synergy while expanding the scope of evaluation and ensuring that every student benefits from the collective effort.

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2. Measuring early school leavers: how to get institutional and INVALSI data to talk to each other

by Massimo Armenise, Barbara Baldazzi

Reducing early school leaving is one of the European Union (EU) priorities. In fact, this phenomenon generates serious repercussions on young people and society in general: greater difficulty in finding a job, limited employment prospects, lower participation in social, political and cultural activities; increased risk of poverty and poor health (ISTAT, 2021; Baldazzi and Cascioli, 2019). The aim of this work is to measure school dropout with an easily constructed indicator, capable of going down to a smaller territorial detail. In addition we will make a descriptive comparison between the indicators produced is the IN-VALSI data.

L'abbandono scolastico rappresenta di fatto un ostacolo per la crescita economica e l'occupazione, frenando la produttività e la competitività e alimentando povertà ed esclusione sociale. Secondo l'ISTAT, la percentuale di giovani fra i 18 e i 24 anni che hanno abbandonato prematuramente gli studi e la formazione (conseguendo solo la licenza della scuola secondaria di primo grado) risulta essere in Italia pari al 11,5% nel 2022. Inoltre, una delle consuete caratteristiche del nostro Paese risulta essere quella di avere ampi divari al proprio interno. Le forti disparità nei tassi di abbandono scolastico che emergono in determinate aree geografiche del Paese, potrebbero indicare problemi strutturali specifici e se tale evidenza la si coniuga con la necessità di attuare politiche volte all'attenuazione delle differenze territoriali, si spiega dunque quanto sia rilevante l'esigenza di raffinare il più possibile il livello di analisi territoriale, così da poter

distinguere e avviare misure specifiche per quei territori e per quelle scuole maggiormente colpiti da tale fenomeno. Obiettivo di questo lavoro è misurare l'abbandono scolastico con un indicatore di facile costruzione, capace di scendere a un dettaglio territoriale più piccolo. In aggiunta procederemo a un confronto descrittivo tra gli indicatori prodotti e i dati INVALSI.

1. Introduction

Leaving education without attaining qualifications has profound ramifications for both young individuals and society at large. This phenomenon is associated with increased difficulty in securing employment, diminished career prospects, reduced engagement in social, political, and cultural activities, and a heightened vulnerability to poverty and adverse health outcomes (ISTAT, 2021; Baldazzi and Cascioli, 2019). Furthermore, a high prevalence of Early Leavers from Education and Training (ELET) means a lower educational level. Substantial empirical evidence demonstrates a correlation between low educational levels and reduced income, limited opportunities for stable employment, elevated rates of unemployment, and increased susceptibility to health complications, including obesity.

Consequently, early school leaving presents a significant impediment to economic growth and employment, thereby constraining productivity and competitiveness while exacerbating poverty and social exclusion. Italy is characterised by a significant demographic decrease (ISTAT, 2023b) and a relatively stagnant labour productivity dynamic (Bugamelli and Lotti, 2018). The dropping out of school by a substantial number of "young people" risks widening economic and social disparities. Moreover, the particular territorial distribution of the phenomenon in some regions, which is highlighted by ISTAT data on early school leaving, risks further undermining territorial cohesion, compromising any possible future convergence (Baldazzi, 2021). According to ISTAT, the percentage of young people aged 18 to 24 who dropped out of education and training prematurely, obtaining only a lower secondary school leaving qualification (ELET) is 11.5% in Italy in 2022 (Fig. 1).
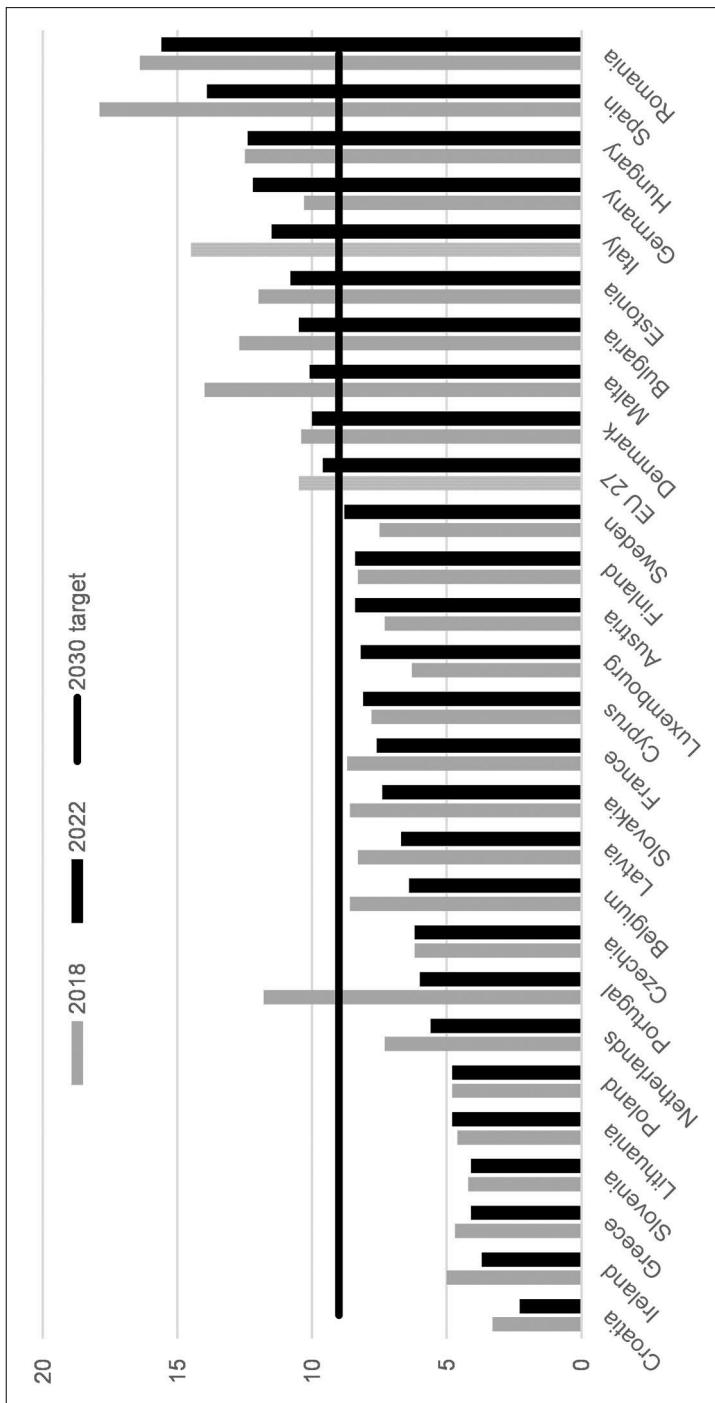
Fig. 1 – Early Leavers from Education and Training (ELET) by country, percentage value

Source: ISTAT, *Labour Force Survey*

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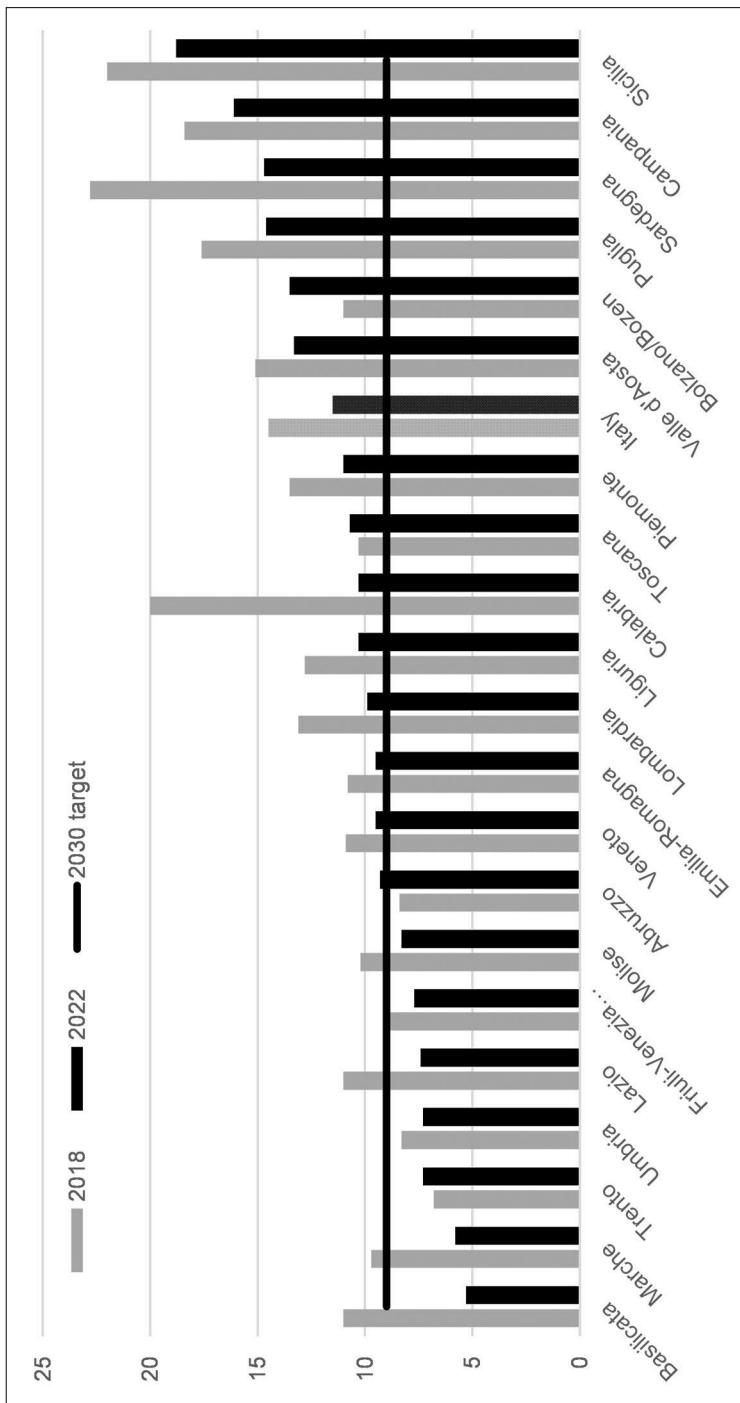
Fig. 2 – Early Leavers from Education and Training (ELET) by regions, percentage value

Source: ISTAT, *Labour Force Survey*

Despite the considerable progress achieved in mitigating school dropout rates, this figure remains among the highest within the European Union, surpassing those of Spain (13.9%), Germany (12.2%), Hungary (12.4%), and Romania (15.6%), and exceeding the EU target of 9%.

The ELET indicator is the only official one and is available at regional level (Fig. 2). Are there differences within regions? Are there differences between provinces or between other geographical aggregations (e.g. underdeveloped inland areas)? Are there differences between major cities or local labour systems? Are there differences between school typologies?

The development of a new territorial indicator allows us to investigate and answer these questions. Indeed, observing where there is a higher number of school drop-outs means identifying the most at-risk and vulnerable areas.

One of the research objectives is to explore the local variability of early school leaving by developing a measure of early school leaving calculated at a different level of territorial breakdown.

It will be possible, also, to combine this measure of early school leaving with data from the INVALSI tests to monitor the territorial variability of explicit and implicit drop-outs (INVALSI, 2022).

2. Data and methods

In this specific study, the school drop-out rate was calculated at the provincial level. This territorial level allows important territorial differences to emerge.

In practice (Armenise and Baldazzi, 2022, 2025), we follow the schooling of the cohort of 15-year-olds enrolled in all the schools of a given territory, in the 2015-2016 school year, until their 18th birthday (in the 2018/2019 school year) and so on for the following years. By following this cohort of students, it is possible to see how many of these 15-year-olds continued their studies until the age of 18.

The Open Data National Register of Students (source: Ministry of Education and Merit) provides census information (for school years 2015/2016, up to 2021/2022) on:

– number of students enrolled in each Italian school;
– student distribution by age and grade;
– the type of school;
– and the exact geographical location of the school.

Each school is located in a geographical area and provides information on the number of students enrolled in the school for each age group. By tracking the educational path of students in a given area (e.g. province) between the beginning and the end of compulsory education (i.e. between the ages of 15 and 18), it is possible to calculate the number of school drop-outs in that area.

Through these data, it is possible to track fifthteen-year-old students present in Italian schools, up to the age of eighteen, in order to quantify how many of them, in the pre-pandemic (school year 2018/2019) and post-pandemic period (school year 2021/2022), stopped attending schools in a given territory.

More formally, the dropout rate, called OUT from Education (OUT-E) is the percentage change of 18-year-olds enrolled in all schools (ISCR18) in a given territory in 2018-2019 compared to the 15-year-olds who were in schools in 2015-2016 (ISCR15):

$$\text{OUT-E}_{p,\,t} = (\text{ISCR18}_{p,\,t} - \text{ISCR15}_{p,\,t\text{-}3}) / (\text{ISCR15}_{p,\,t\text{-}3})*100$$

where t is the school year and i is the area over which the rate is calculated (e.g. regions, provinces or other level).

The variation of students may result not from actual drop-out but also from other possible factors.

Firstly, the student cohort is not a closed system: new students may enter it from outside or leave it due, for example, to internal or external migration flows. This factor may alter the value of the drop-out rate, overestimating or underestimating it, even if a) internal or external migration processes are more likely in young individuals. Households with children at least 15 years old presumably have older parents; b) from the exclusion of a student in a school due to traumatic events (death); but mortality rates are very low in that age group; c) by a student's decision to change school, choosing one outside the territory under consideration. Secondly, the presence of "anticipatory" students (15-year-olds in their third year of high school), who could gradu-

ate and therefore leave school before the age of 18. This factor can be neutralised by separating the share of 15-year-olds from those attending grade 11. Third: not leaving school at 18 does not necessarily mean graduating. Fourth: data not available for Trento and Bolzano and currently not available for the province of Sardinia. Fifth: students choosing different school paths such as VET (*Vocational Education and Training*).

INVALSI data were also used to analyse data on school drop-outs. In particular, open data was used on the:

– average result obtained in the Mathematics tests in the different grades of all schools in each individual province. In these open data, the relative standard deviations are also available and this allowed us to also calculate a coefficient of variation for each province and grade (Stiglitz, Fitoussi and Durand, 2018);

– share of students in different grades who do not reach an adequate level of proficiency in literacy competence (level 1 and 2 out of 5 levels).
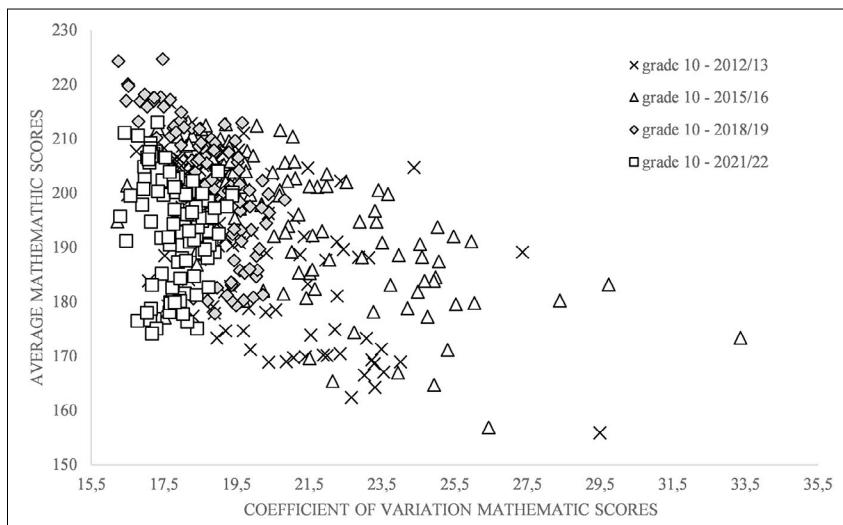
Fig. 3 – Provinces by Average Mathematic scores in grade 10 (y axis) and coefficient of variation Mathematic scores in grade 10 (x axis), year 2012/2013, 2015/2016, 2018/2019, 2021/2022

Source: processing on data from INVALSI
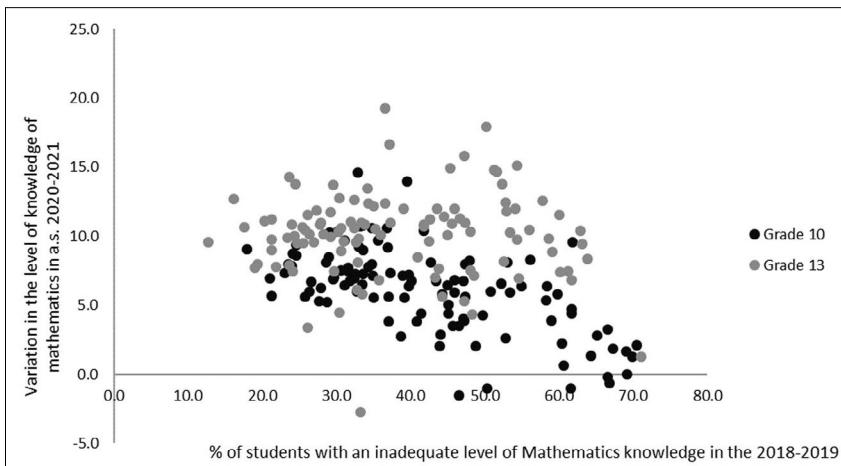
Fig. 4 – Provinces by variation of Average Mathematic scores in grade 10 and grade 13 from year 2018/2019 and year 202/2021 (y axis) and share of students in grade 10 and grade 13 who do not reach an adequate level of proficiency in Mathematic competence (x axis)

Source: processing on data from INVALSI

Looking at the INVALSI test scores of the mathematical skills of 15-year-olds (in class 10) in different school years (pre- and post-pandemic period), it is interesting to note how the variability of results has decreased and, at the same time, the average value of results has decreased (Fig. 3).

Looking at the cohorts of students in grade 10 and grade 13 in the school year 2018/2019 (pre-pandemic) and in the school year 2020/21 (post-pandemic), a worsening in average Mathematic achievement can be observed in all provinces (Fig. 4), which is more pronounced for students in grade 13 (the variation in Mathematics achievement is higher – y axis).

On the other hand, as is well known, the share of students with inadequate competences in grade 13 is slightly lower than the percentages calculated for grade 10 (x axis).

3. Main results

3.1. OUT-E, pre and post-Covid results at a province level

The OUT-E indicator was 16.5% in Italy for the 2018/2019 school year. In the period just after the pandemic, in the school year 2020/2021 OUT-E drops to 14.6% and then rises again slightly in the following school year (2021/2022) to 14.9% (Fig. 5).
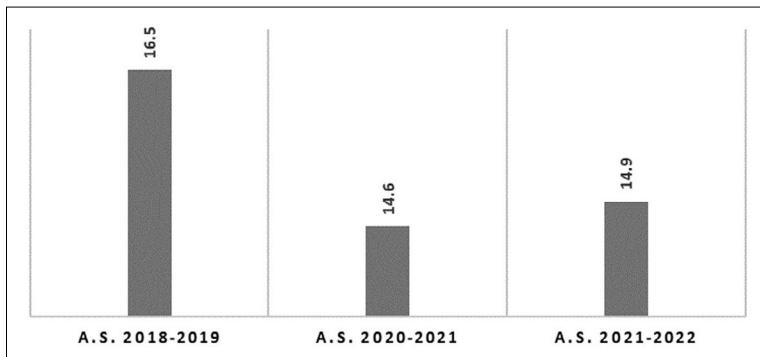
Fig. 5 – OUT-E in year 2018/2019, 2020/2021 and 2021/2022 by Italy

Source: processing on data from Ministry of Education and Merit

From the preliminary results, an overall territorial coherence emerges also at the provincial level. The provinces of Southern Italy are characterized by higher school dropout rates. The general trends are also confirmed by province. Between 2018/2019 and 2020/2021 only 9 provinces worsened in the OUT-E indicator while the others improved. Instead, between 2020/2021 and 2021/2022 there is a general worsening and in 70 provinces the OUT-E indicator worsens (Fig. 6).

2018/2019

ProvCM01012021_g_WGS84
4 - 10
10 - 13
13 - 16,5
16,5 - 21
21 - 30

2020/2021

ProvCM01012021_g_WGS84
4 - 10
10 - 13
13 - 16,5
16,5 - 21
21 - 30

2021/2022

ProvCM01012021_g_WGS84
4 - 10
10 - 13
13 - 16,5
16,5 - 21
21 - 30
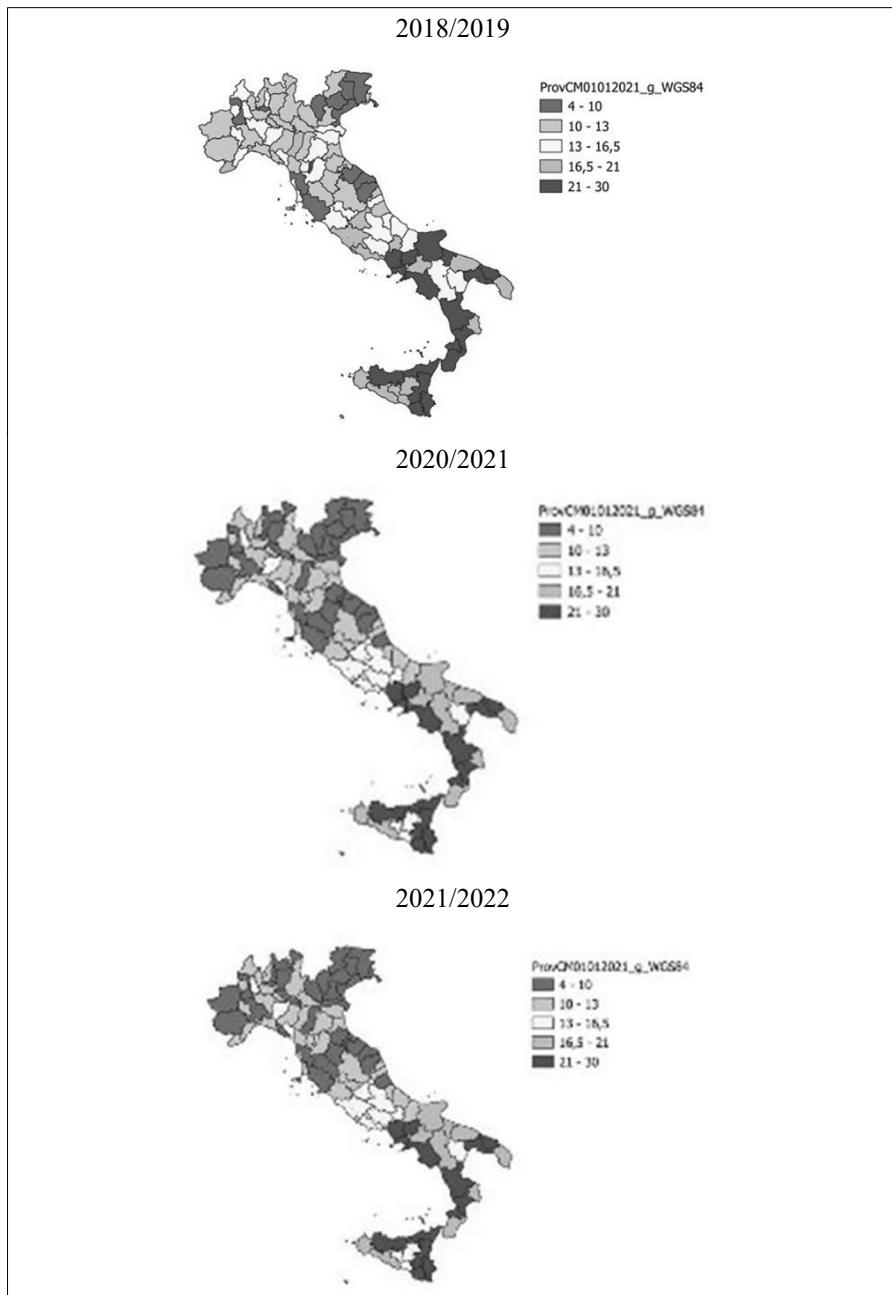
Fig. 6 – OUT-E in year 2018/2019, 2020/2021 and 2021/2022 by province

Source: processing on data from Ministry of Education and Merit

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3.2. OUT-E and the implicit drop-out

By placing on the same graph the share of students in grade 10 who do not reach an adequate level of proficiency in mathematical competence in the year 2018/2019 (y axis) and the OUT-E indicator for the year 2021/2022 (x axis), a greater propensity to drop out of school is observed in the provinces where the percentage of inadequate competence in Mathematics is also higher (similar to implicit dispersion). Furthermore, the increase in the share of students with inadequate skills between the grade 10 cohort in the year 2018/2019 (pre-pandemic) and the grade 13 cohort in the year 2021/2022 (post-pandemic) visualized by the size of the bubbles, is, on average, higher in the provinces with more drop-outs (Fig. 7).
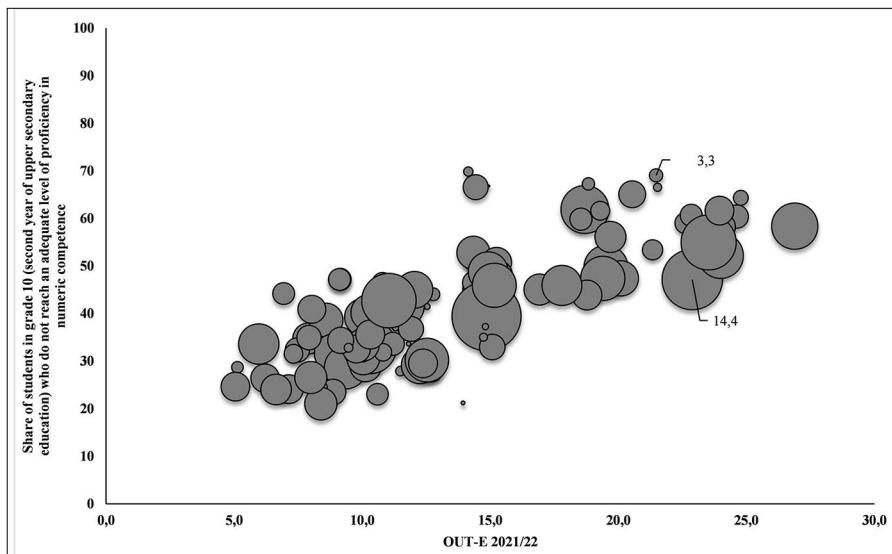
Fig. 7 – Provinces by share of students in grade 10 who do not reach an adequate level of proficiency in mathematical competence in the year 2018/2019 (y axis) and OUT-E indicator for the year 2021/2022 (x axis)

The size of the bubbles indicates the increase in the share of students who do not reach an adequate level of proficiency in mathematical competence from grade 10 (year 2018/2019) to grade 13 (year 2021/2022)

Source: processing on data from INVALSI and Ministry of Education and Merit

3.3. *An econometric evaluation*

In order to assess the effect and possible predictive value of the INVALSI test and the variability of the grades obtained in these tests on school drop-out, it may be interesting to attempt an econometric estimation (OLS). The baseline regression takes the following form:

$$\text{OUT - E}_{p,t} = Less\_developed_{p,t} + CV_{p,t-3} + Score\_Test_{p,t-3} + \varepsilon_{p,t}$$

where OUT - E$_{p,t}$ is our measure of drop out from the school at a provinces level (*p*) and time *t*; *Less_developed*$_{p,t}$ is a dummy variable, it identifies the provinces (p) belong to Regions defined as *Less developed* according to the Cohesion Policy (with a GDP pro capite less than 75% of the European Union); *CV*$_{p,t-3}$ is the coefficient of variation of the scores test in Math for each province at the grade 10 (*t-3*); *t* is the school year 2018/2019 (pre-Covid) or 2021/2022 (with or post-Covid)[1].

The results obtained in the two different periods (pre- and post-pandemic) show a discrete goodness of fit of the model in both periods examined. The R-squared is 0.59 in pre-pandemic and 0.69 in post-pandemic.

The dummy variable *Less_developed* is statistically significative in both periods. Being in a Region with lower per capita income increases dropout rate; this effect increases in the with pandemic cohort (0.32 vs. 0.39).

The average score in Mathematics has a strong negative effect on the dropout rate, but this effect declines in the post- pandemic period (-2.7 vs. -2.3).

The covariate coefficient of variation of the score obtained in the Mathematics test (CV) is not statistically significant in the pre-Covid, while it becomes so in the post-Covid and, in particular, takes on a positive coefficient[2]. This could indicate that as the gap between the provinces widens, the drop-out rate increases.

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[1] For more information on this cohesion policy, see ISTAT (2023a).

[2] We verified the absence of multicollinearity between the CV and score_test variables by calculating the Variance Inflation Factor (VIF), which resulted well below the conventional threshold (VIF < 5), confirming that multicollinearity is not a concern in our model.

Source	SS	df	MS		Number of obs	=	99
					F(3, 95)	=	49.08
Model	7.08192604	3	2.36064201		Prob > F	=	0.0000
Residual	4.56911803	95	.048095979		R-squared	=	0.6078
					Adj R-squared	=	0.5955
Total	11.6510441	98	.118888205		Root MSE	=	.21931

ln_outE_2018	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
Regioni_meno_sviluppate	.3266007	.0694035	4.71	0.000	.1888173	.4643841
ln_cv_2015	-.0785449	.2513085	-0.31	0.755	-.5774553	.4203655
ln_voto_grado10_2015	-2.719145	.674836	-4.03	0.000	-4.058864	-1.379426
_cons	17.15452	4.024336	4.26	0.000	9.165206	25.14384

Fig. 8 – Results pre-pandemic cohort (year 2018/2019)

Source	SS	df	MS		Number of obs	=	99
					F(3, 95)	=	76.65
Model	10.6681139	3	3.55603797		Prob > F	=	0.0000
Residual	4.4074114	95	.046393804		R-squared	=	0.7076
					Adj R-squared	=	0.6984
Total	15.0755253	98	.153831891		Root MSE	=	.21539

ln_outE	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
Regioni_meno_sviluppate	.3907201	.0762592	5.12	0.000	.2393264	.5421138
ln_cv_2018	.9810743	.5547912	1.77	0.080	-.1203255	2.082474
ln_voto_grado10_2018	-2.30133	.7485361	-3.07	0.003	-3.787362	-.8152983
_cons	11.75806	5.09449	2.31	0.023	1.644222	21.8719

Fig. 9 – Results with pandemic cohort (year 2021/2022)

4. Conclusion and policy implications

Administrative data offers the potential to quantify early school leaving with a high degree of territorial granularity. INVALSI data are extremely useful for observing and predicting this phenomenon; Use of INVALSI data at a finer (micro) level for calculation of the relationship between implicit and explicit dispersion could be useful in the future to observe this phenomenon at a different territorial level.

Future developments of this preliminary analysis could benefit from observing these results at another territorial level. For instance, the exploration of inland regions or the application of the DEGURBA classification, which delineates municipalities into urban and rural areas, may offer critical perspectives for a more comprehensive under-

standing of the phenomenon and the development of targeted policy interventions.

Also from the point of view of the econometric specification used, it might be useful to consider the inclusion of other control variables in the analysis, such as school size or type, class size, the presence of precarious teachers or non-Italian citizens. However, the results seem to show some interesting differences between the post-pandemic and pre-pandemic periods. For example, in the pre-pandemic period, grade seemed to have a greater influence on dropout rates, whereas in the post-pandemic period it is the structural characteristics of the area that seem to have a greater influence on the decision to drop out. Finally, in the post-pandemic period, the inherent variability within classes seems to play a positive role in increasing the dropout rate. This latter finding suggests that mitigating intra-class knowledge disparities should be prioritized. It also implies that educational institutions with a uniformly high standard of quality across the student body are preferable to those with a few exceptional students, in order to effectively reduce dropout rates.

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3. Where have they gone.
Following the destiny of a cohort of students through the intricacies of italian school and society

by Lorenzo Maraviglia, Andrea Bendinelli

The aim of this study is to reconstruct the pictured of educational outcomes of the cohort of students who took the INVALSI 8th grade tests in the summer of 2018 (2017/2018 school year). The outcomes are detected five years later (June 2023) when, under the hypothesis of a regular course of studies, the students in question should be about to take the secondary school final exam (*esame di maturità*). By cross-referencing different sources, we are able to measure/estimate the percentages of students who, respectively, attend school regularly, attend school having repeated one or more grade (or having interrupted attendance at least once), attend or have attended a vocational training course and, finally, have dropped out of school before obtaining a diploma or a professional qualification (ELET, Early Leavers from Education and Training). The breakdown in question is provided at the regional level (taking the region of residence in 2018 as a reference). This allows us to highlight the notable geographical variability of school and training outcomes, especially between Northern and Southern regions. In the discussion we provide some food for thought on the theoretical and practical implications of the analysis.

L'obiettivo del presente studio è ricostruire il quadro degli esiti scolastici e formativi della coorte di studenti che ha affrontato le prove INVALSI per le classi terze della scuola secondaria di primo grado nell'estate del 2018 (anno scolastico 2017/2018). Gli esiti sono definiti a cinque anni di distanza (giugno 2023), ovvero nel momento in cui, sotto l'ipotesi di regolare prosecuzione degli studi scolastici, gli stu-

denti in questione dovrebbero essere in procinto di sostenere l'esame di compimento del ciclo secondario di istruzione (esame di maturità). Attraverso l'incrocio di fonti differenti siamo in grado di misurare/ stimare le quote di studenti che, rispettivamente, frequentano la scuola in condizione di regolarità, frequentano la scuola avendo ripetuto uno o più anni (o avendo interrotto almeno una volta la frequenza), frequentano o hanno frequentato un corso di formazione professionale e, infine, hanno abbandonato precocemente gli studi prima del conseguimento di un diploma o di una qualifica professionale (ELET, Early Leavers from Education and Training). La scomposizione in oggetto è fornita a livello regionale (prendendo a riferimento la regione di residenza nel 2018). Ciò consente di evidenziare la notevole variabilità geografica degli esiti scolastici e formativi, soprattutto fra regioni del Nord e regioni del Sud del Paese. Nelle conclusioni forniamo alcuni spunti di riflessione sulle implicazioni teoriche e pratiche dell'analisi presentata.

1. Motivation

This contribution focuses on the apparently narrow goal of determining the present condition of the students who took INVALSI eight grade tests in spring/summer 2018[1]. Have they completed upper secondary school, as it would be desirable? Or, alternatively, have they achieved a vocational training qualification? Is it possible to determine, or at least estimate, how many of them have abandoned their studies before obtaining a secondary education title, as required by italian laws[2]?

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[1] As it will be explained below, we refer to the whole cohort of students who took INVALSI eight grade tests in 2018.

[2] According to italian law 144/1999, everybody has the right and duty (*diritto-dovere*) to achieve a secondary school diploma or a vocational training 3-years-course qualification by the age of 18. This ordinamental goal tends to overlap to the statistical definition of ELET. In fact, according to Eurostat, an early leaver from education and training is a person aged 18 to 24 recorded in the Labour force survey: a) whose highest level of education or training attained is at lower secondary education; b) who received no education or training (neither formal nor

As Popper (1976) says, questions are the fundamental drivers of our knowledge. When dealing with a complex phenomenon, questions should be asked from different angles. Under this regard, we think that our approach can help shed light on some relevant, but in a way neglected, aspects of current discussion on school drop-out. Focusing on the outcomes for a whole cohort of students forces to think rigorously about all the conditions in which individuals may find themselves at the end of the observation period. This poses interesting challenges in terms of availability and integration of different data sources. Heterogeneity of data – and inconsistency of definitions – is an issue that tends to remain in the background of the mainstream discussion. For example, expressions like *school drop-out* and *Early leaver form education and training* (ELET) often tend to be used as synonyms while they are not. When it comes to talking about the concrete destiny of a specific group of young people, ambiguities are not allowed; nor statistical tricks: eventually, figures must add up to one hundred.

We do not have the ambition to provide a solution to all these problems; nevertheless, we hope to give a small contribution to the broadening of the study of educational outcomes of young generations in Italy.

2. Antecedent

Our analysis builds upon a pilot study whose results have been exposed in INVALSI 2023 National Report (INVALSI, 2023). The study tried to reconstruct at an aggregate level the present condition of the same group that we will consider here: the cohort of students who had undertaken INVALSI eight grade tests in the 2017/2018 school year[3].

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non-formal) in the four weeks preceding the survey. In the current discussion, it is common to refer to ELETs statistics to evaluate the degree of fulfilment of the ordinamental goal (*diritto-dovere di istruzione*). This is not always appropriate, as will be shown in the following.

[3] Since 2017 taking INVALSI tests is a mandatory precondition for students to be admitted to eight grade final exams. This ensures an almost perfect coverage of the target students' population. From a research perspective, using INVALSI data allows to draw on a large amount of information about students' skills and family conditions that can be exploited to analyse differential outcomes among students.

Here we enhance this approach by developing the reference analytical framework and, above all, by breaking down outcomes by NUTS2 region (Regioni)[4]. As in the original study, we exclude Valle d'Aosta and Trentino Alto Adige students, due to unavailability of complete data for some of the sources that we will draw upon for the reconstruction of students' outcomes[5].

3. Analytical framework

The basic assumption of our work is that five years after taking the INVALSI eight grade tests one must necessarily be in one of the following conditions:
– be about to take the 13th grade exam which concludes secondary school; in the following, we will refer to such people as "regular school students";
– be still in school, but attending a class lower than thirteenth grade due to a previous failure or interruption; in this case, we will speak of "repeating school students";
– be no longer in school, having shifted to a vocational training course aimed at issuing a secondary qualification according to national and international standards; we include in this group both people who have already achieved a qualification and those still attending a VT track and call them "trainees";
– be no longer present in our Country, we will refer to these people as "emigrants";
– be still in our Country and in a true ELET condition, that is having abandoned school or vocational training attendance before achieving any secondary title, be it a diploma or VT qualification. We will call these people "early leavers form education and training[6].

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[4] Explaining geographical, especially between North and South of Italy, is one of the major goals of this study.

[5] Data for Valle d'Aosta and Trentino-Alto Adige students are not supplied by the Anagrafe degli Studenti.

[6] The concepts of *Early leaving form education and training* (ELET) and of school drop-out are often used as if they were interchangeable, which they are not, generating a good deal of confusion.

We are especially interested in territorial (regional) variation in each of these components. In fact, we assume that different causes may be locally at work not only with reference to a specific outcome but also in determining the greater or lesser likelihood of an outcome compared to the others. Furthermore, this calls into question structural conditions that may vary from region to region. To make an example vocational training tracks must be available locally to represent an effective alternative to school attendance. In Italy, the supply of vocational training courses is planned and administered at regional level; this makes room for a large amount of heterogeneity, not only in terms of resources but also of social and cultural arrangements.

In this contribution we will not organically develop this theoretical framework but rather focus on some basic conceptual and empirical issues that can allow a fruitful discussion on the topic.

4. Data

When a phenomenon places itself at the intersection of different systems, finding data is challenging. People are differently classified according to the logic of each system (Douglas, 1986), be it school, vocational training sector, labour market or else. That's why an independent analytical framework is fundamental. As we have said, we assume that people must necessarily find themselves in a limited number of states defined with reference to human capital accumulation. Since more than one institution is involved in the process of human capital accumulation, this requires a cross- or multi-institutional view.

Tab. 1 – Students of the INVALSI 2018 eight grade cohort who are in regular or repeating condition five years later (grade 13th 2023)

NUTS2	Regular (#)	Repeaters (#)	Not-in-school-anymore (#)	Total (#)
Piemonte	25,718	4,723	6,977	37,418
Lombardia	60,252	11,485	21,602	93,339
Veneto	32,168	5,854	8,805	46,827
Friuli-Venezia Giulia	7,072	1,406	1,626	10,104
Liguria	8,922	1,741	1,891	12,554
Emilia-Romagna	27,883	5,475	5,852	39,210
Toscana	23,962	4,669	4,096	32,727
Umbria	6,476	591	697	7,764
Marche	10,834	1,429	1,319	13,582
Lazio	40,592	5,140	6,447	52,179
Abruzzo	9,272	1,241	977	11,490
Molise	2,082	244	236	2,562
Campania	50,249	6,083	8,590	64,922
Puglia	31,767	3,718	4,969	40,454
Basilicata	4,391	512	397	5,300
Calabria	15,139	1,683	1,890	18,712
Sicilia	36,469	5,528	9,165	51,162
Sardegna	9,209	2,530	1,728	13,467
Totale	402,457	64,052	87,264	553,773

NUTS2	Regular (%)	Repeaters (%)	Not-in-school-anymore (%)	Total (%)
Piemonte	68.7	12.6	18.6	100.0
Lombardia	64.6	12.3	23.1	100.0
Veneto	68.7	12.5	18.8	100.0
Friuli-Venezia	70.0	13.9	16.1	100.0
Liguria	71.1	13.9	15.1	100.0
Emilia-Romagna	71.1	14.0	14.9	100.0
Toscana	73.2	14.3	12.5	100.0
Umbria	83.4	7.6	9.0	100.0
Marche	79.8	10.5	9.7	100.0
Lazio	77.8	9.9	12.4	100.0
Abruzzo	80.7	10.8	8.5	100.0
Molise	81.3	9.5	9.2	100.0
Campania	77.4	9.4	13.2	100.0
Puglia	78.5	9.2	12.3	100.0
Basilicata	82.8	9.7	7.5	100.0
Calabria	80.9	9.0	10.1	100.0
Sicilia	71.3	10.8	17.9	100.0
Sardegna	68.4	18.8	12.8	100.0
Totale	72.7	11.6	15.8	100.0

In Table 1 we reported aggregated data about students of the IN-VALSI 2018 eight grade cohort who are in *regular* or *repeating* condition five years later (2023).

We identified both "regular" and "repeating" students checking the records of the *Anagrafe degli studenti*. These figures are therefore counts (not estimates)[7]. Following a self-referential attitude (Luhmann, 1996), the school system keeps track of people as long as they stay within its boundaries. When someone exits school, she goes out of sight. Whether she is enrolled in a vocational training course[8] or has abandoned her studies makes (almost) no difference from the system's point of view. This is at stark contrast with the goal of providing everyone with a certain threshold of human capital accumulation, which is a holistic target.

Since there is no effective inter-institutional communication flow between school, vocational training sector, labour market and public administration, one must query the records of each system – if any – to retrieve the necessary information about individuals.

5. Vocational training

Unfortunately, much of the information on vocational training courses is spread across a variety of regional databases with different levels of accuracy and updating. Aggregated figures on VT attendance can be extracted from *ISTAT Annuario di Statistica*.

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[7] Net of recording or measurement errors; in any case, figures do not include random error due to inferential procedures.

[8] In Italy, vocational training tracks are administered both by schools and by private organizations. Here we refer to the latter (which account for many vocational training tracks, especially in the North and in the Centre of Italy).
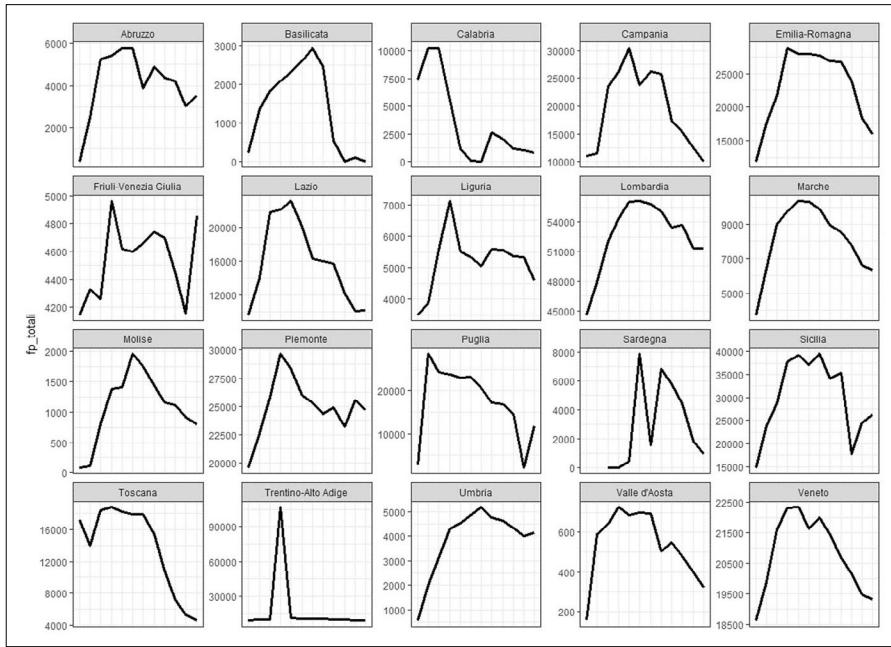
Fig. 1 – Time series 2010-2022 – Number of trainees for italian NUTS2 regions

Overall number of trainees 2010-2022 time series for all italian NUTS2 regions are reported in Figure 1. It can be noticed that in recent years vocational training attendance shows a significant decline in all areas. As far as we know, this is a point that has not been raised in the current discussion on human capital accumulation targets – or, at least, that has not attracted much attention. Caution should be need when interpreting these figures as actual counts of young people enrolled in vocational training courses. Spikes and drops in regional time series suggest the possibility of episodic anomalies in data communicated by regional authorities to statistical bodies. More generally, the extreme fragmentation of the italian VT system – that is administered at regional level and includes schools as well private agencies and local authorities – makes any quantification attempt a challenging one.

However, although partially noisy, VT statistics provide valuable information, especially in terms of territorial heterogeneity. To allow territorial comparisons, we have calculated for all NUTS2 regions an

indicator obtained by dividing the number of young people attending VT courses by the amount of population aged between 14 and 18 years old. Results are plotted in Figure 2.
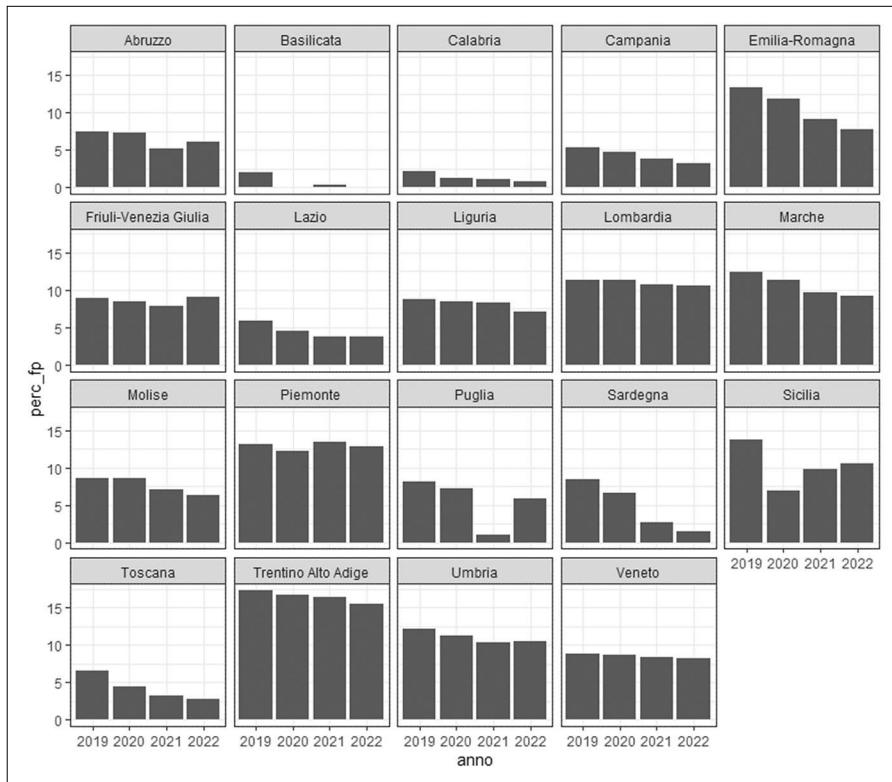
Fig. 2 – Time series 2019-2022 – Number of young people attending VT courses divided by the amount of population aged between 14 and 18 years old

A fact appears evident beyond reasonable doubt: the prevalence of vocational training (VT) courses among young people is significantly higher in Northern Italy than in the South. This territorial heterogeneity closely mirrors the distribution of regular and repeating students across regions. In areas where the school system is more selective – characterized by a lower percentage of regular students and a higher proportion of repeaters – vocational training tends to emerge as a more viable alternative. Conversely, in regions with higher rates of regular school attendance, the demand for vocational training is comparatively lower.

6. Early Leavers from Education and Training (true ones)

According to Eurostat guidelines, the percentage of young people who are Early Leavers from Education and Training – the "true" drop-outs from any form of human capital accumulation – is estimated from sample data. For this purpose, ISTAT uses the Labour Force Survey sample (ISTAT, 2006)[9]. Official statistics on ELETs are provided for the age class from 18 to 24 years old[10]. For the aim of our analysis, this is not an optimal solution. In fact, we are interested in estimating the percentage of true ELETs among the cohort of students who attended IN-VALSI eight grade tests in 2018. Today, these people should be approximately 18 years old, and it is reasonable to think that ELET rates vary with age. To overcome this problem, we estimated custom 18-years-old ELET rates using ISTAT Labour Force Survey micro-data[11].

As a robustness check, we estimated 18-years-old ELET rates using population weights supplied by ISTAT (grey) as well as raw sample percentages (black) and multilevel random intercepts (light grey). Even accounting for inferential uncertainty (vertical segments intersecting point estimates), a certain degree of territorial heterogeneity seems apparent. The (true) ELET phenomenon tends to be higher in the South rather than in the Centre and, especially, in the North of Italy. However, excluding Sicily, differences are compressed in a 5-7 points range – less than it is the case with regular and repeating percentages and, presumably, rates of enrolment in vocational training tracks.

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[9] The Labour Force Survey provides a large sample that in this case allows relatively robust estimates even at NUTS2 level.

[10] See Eurostat, Statistics explained, definition of Early Leavers from Education and Training (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Early_leavers_from_ education_and_training).

[11] We used the 2022 ISTAT micro-data that we accessed micro-data through the SISTAN protocol.
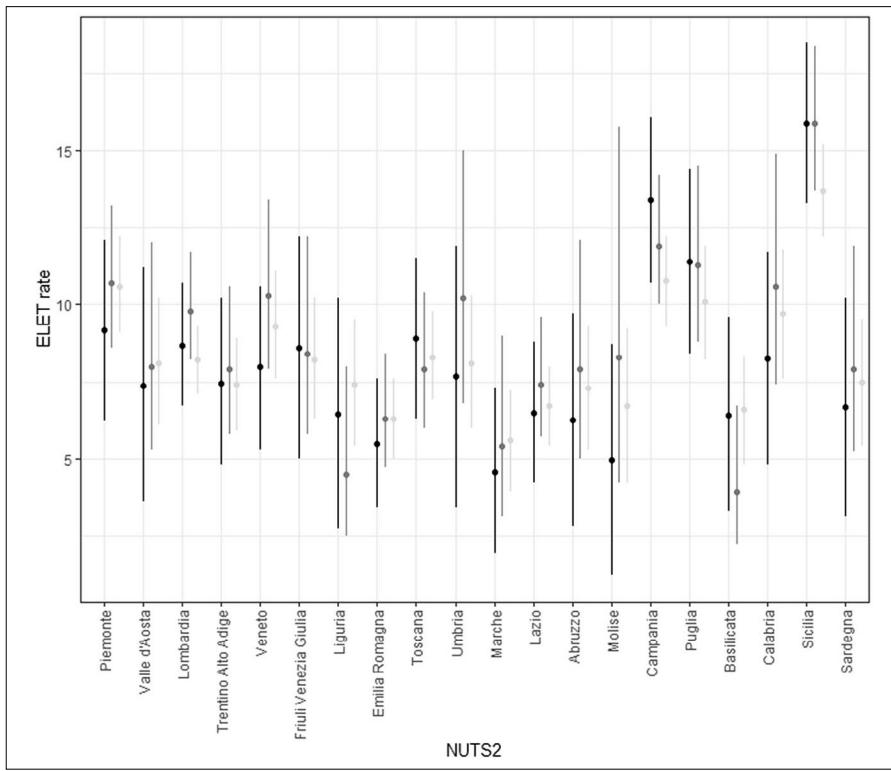
Fig. 3 – 18-years-old ELET rates (three types of estimation)

7. Emigration

Aggregated data on emigration are regularly (yearly) published by ISTAT[12]. Figures are based on cancellations in the population registry held by municipalities[13]. Here too, for our goals we need more detailed information on emigration rates of people in school age (14-18 years old people). We calculate/estimates such quantities from ISTAT Change of Residence micro-data – that we obtained thorough the SISTAN protocol[14].

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[12] See https://demo.istat.it/.

[13] Quality of these data depend on the accuracy with which registries are kept and on people compliance with the cancelling obligation.

[14] Emigration rates were estimated using data for the years spanning from 2017 to 2021.

Tab. 2 – Emigration rates of people in school age (14-18 years old people)

NUTS2	Abroad	Total	Abroad	Total
Piemonte	443	37,418	1.2	100.0
Lombardia	1,330	93,339	1.4	100.0
Veneto	636	46,827	1.4	100.0
Friuli-Venezia	130	10,104	1.3	100.0
Liguria	97	12,554	0.8	100.0
Emilia-Romagna	520	39,210	1.3	100.0
Toscana	305	32,727	0.9	100.0
Umbria	85	7,764	1.1	100.0
Marche	220	13,582	1.6	100.0
Lazio	358	52,179	0.7	100.0
Abruzzo	115	11,490	1.0	100.0
Molise	33	2,562	1.3	100.0
Campania	280	64,922	0.4	100.0
Puglia	214	40,454	0.5	100.0
Basilicata	18	5,300	0.3	100.0
Calabria	157	18,712	0.8	100.0
Sicilia	419	51,162	0.8	100.0
Sardegna	70	13,467	0.5	100.0
Totale	5,430	553,773	1.0	100.0

Results for all regions are reported in Table 2. On average, emigration should absorb around 1% of the initial cohort of students, without relevant variation among territories. Here, the lesson to take home is that emigration does not play a major role in determining the overall outcome picture of students who took INVALSI tests in 2018.

In Table 3 we put together in a single picture:
– figures about regular and repeating students; these data are counts that we derived from the *Anagrafe degli studenti* records and are in bold – like the totals – since they are relatively certain;
– figures about people living abroad; these quantities are obtained through an analytical procedure that relies on registry of population records and are in plain black characters (not bold), since they encapsulate a certain amount of uncertainty;
– figures about true ELET; these are simply, and arguably, point estimates obtained from ISTAT micro-data – in grey, because they

are surrounded by a relevant amount of uncertainty (they could be slightly or even moderately different);

– figures about people attending, or who have attended, a vocational training course; in this table, data and rates about trainees are obtained purely by subtraction since they are, in our opinion, the less determinable and more uncertain component of the picture.

As we said in the beginning, the outcome must add up to one hundred, which we managed in a way or in another. Our discussion must start from here.

Tab. 3 – Amount of people in 13ᵗʰ grade by type (estimation in grey)

NUTS2	Regular (#)	Repeaters (#)	ELET (#)	Emigrated (#)	VT (out of school) (#)	Total (#)
Piemonte	25,718	4,723	3,431	443	3,103	37,418
Lombardia	60,252	11,485	8,081	1,330	12,191	93,339
Veneto	32,168	5,854	3,730	636	4,439	46,827
Friuli-Venezia Giulia	7,072	1,406	869	130	627	10,104
Liguria	8,922	1,741	807	97	987	12,554
Emilia-Romagna	27,883	5,475	2,144	520	3,188	39,210
Toscana	23,962	4,669	2,912	305	879	32,727
Umbria	6,476	591	593	85	19	7,764
Marche	10,834	1,429	620	220	479	13,582
Lazio	40,592	5,140	3,365	358	2,724	52,179
Abruzzo	9,272	1,241	715	115	147	11,490
Molise	2,082	244	127	33	76	2,562
Campania	50,249	6,083	8,647	280	-337	64,922
Puglia	31,767	3,718	4,599	214	156	40,454
Basilicata	4,391	512	339	18	40	5,300
Calabria	15,139	1,683	1,533	157	200	18,712
Sicilia	36,469	5,528	8,107	419	639	51,162
Sardegna	9,209	2,530	896	70	762	13,467
Total	**402,457**	**64,052**	51,517	**5,430**	30,317	**553,773**

(to be continued)

NUTS2	Regular (%)	Repeaters (%)	ELET (%)	Emigrated (%)	VT (out of school) (%)	Total (%)
Piemonte	68.7	12.6	9.2	1.2	8.3	100.0
Lombardia	64.6	12.3	8.7	1.4	13.1	100.0
Veneto	68.7	12.5	8.0	1.4	9.5	100.0
Friuli-Venezia Giulia	70.0	13.9	8.6	1.3	6.2	100.0
Liguria	71.1	13.9	6.4	0.8	7.9	100.0
Emilia-Romagna	71.1	14.0	5.5	1.3	8.1	100.0
Toscana	73.2	14.3	8.9	0.9	2.7	100.0
Umbria	83.4	7.6	7.6	1.1	0.2	100.0
Marche	79.8	10.5	4.6	1.6	3.5	100.0
Lazio	77.8	9.9	6.4	0.7	5.2	100.0
Abruzzo	80.7	10.8	6.2	1.0	1.3	100.0
Molise	81.3	9.5	4.9	1.3	3.0	100.0
Campania	77.4	9.4	13.3	0.4	-0.5	100.0
Puglia	78.5	9.2	11.4	0.5	0.4	100.0
Basilicata	82.8	9.7	6.4	0.3	0.7	100.0
Calabria	80.9	9.0	8.2	0.8	1.1	100.0
Sicilia	71.3	10.8	15.8	0.8	1.2	100.0
Sardegna	68.4	18.8	6.7	0.5	5.7	100.0
Total	72.7	11.6	9.3	1.0	5.5	100.0

8. Discussion

When addressing a multifaceted phenomenon, it is sometimes necessary to confront the limits of what can be measured. We argue that the inability to precisely quantify all the components of the overall picture – such as regular and repeating students, trainees, emigrants, and ELETs – is not a shortcoming, but rather an insightful outcome.

This limitation highlights the complexity arising from the coexistence of multiple systems, each operating according to its own logic. Such complexity generates both conceptual and empirical challenges. For instance, relying on official statistics regarding the ELET rate as a proxy for evaluating the school system's effectiveness is problematic. The proportion of young people who leave school without a diploma

may be high, while the ELET rate remains relatively low – as is the case in Northern Italy. What ultimately matters is the availability of alternatives to school, which varies significantly across regions.

To describe and understand the interweaving of systems through which the concrete educational experience of young people unfolds, we need more than a single indicator or theory or point of view. This requires a review of concepts and cooperation between researchers from different fields.

From a more substantive standpoint, we wish to highlight the territorial disparities revealed by our analysis, despite its inherent limitations. In particular, we observe a polarization between a more selective school system in the North, where vocational training provides additional pathways, and a more inclusive school system in the South, which is often surrounded – at least in certain areas – by a "desert" of post-school alternatives.

In a sense, these dynamics are well known. Yet, in our view, they are often examined in isolation, as if the pieces could never form a coherent mosaic.

Against this backdrop, focusing on a specific group of individuals serves as a methodological device that compels us to consider the organic nature of the phenomenon under study and to remain attentive to what is truly at stake.

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4. How motivational constructs interact to predict primary students' reading performance

by Beti Lameva, Zaneta Chonteva

PIRLS (*The Progress in International Reading Literacy Study*) was first conducted in 2001 as a follow up of the IEA's 1991 (International Association for the Evaluation of Educational Achievement) Reading Literacy Study and is one of the core studies of IEA that provides internationally comparative data on how well children read; and offers policy-relevant information for improving learning and teaching. Conducted once in every five years, PIRLS evaluates the reading comprehension development of fourth graders (Mullis and Martin, 2019). Given that the results have helped shape education reform around the world, in this work we explore what are the significant predictors of student's achievement in understanding verbal content relative to the newly introduced scales in the PIRLS 2021 survey, namely motivation for reading. We first tested the construct validity of the scales with confirmatory factor analysis (CFA) on a representative Macedonian sample of 2929 students which participated in the survey and then ran regression analyses to explore how the variance of student's verbal content understanding is explained by the first-order dimensions which define this construct. We report the obtained results from the CFA which confirmed the validity of each of the proposed scales. Next, we report and discuss the findings on the significant predictors of students' achievement in understanding verbal content. The regression model showed significant contribution for all first-order factors which comprise motivation for reading construct, with students' competence contributing the most in explaining the variance in students' achievement. We contextualize the theoreti-

cally unexpected direction of influence indicated by some of the beta coefficients from the regression equation which defined the criterion variable and give suggestions for future research.

PIRLS (The Progress in International Reading Literacy Study) è stato condotto per la prima volta nel 2001 come follow-up del Reading Literacy Study della IEA (International Association for the Evaluation of Educational Achievement) del 1991 ed è uno degli studi principali della IEA che fornisce dati comparativi a livello internazionale su quanto bene leggono i bambini; e offre informazioni rilevanti per le politiche per migliorare l'apprendimento e l'insegnamento. Condotto una volta ogni cinque anni, il PIRLS valuta lo sviluppo della comprensione della lettura degli studenti del quarto anno della scuola primaria (Mullis e Martin, 2019). Dato che i risultati hanno contribuito a modellare la riforma dell'istruzione in tutto il mondo, in questo lavoro esploriamo quali sono i predittori significativi dei risultati degli studenti nella comprensione del contenuto verbale rispetto alle scale recentemente introdotte nell'indagine PIRLS 2021, vale a dire la motivazione per la lettura. Abbiamo innanzitutto testato la validità del costrutto delle scale mediante un'analisi fattoriale confermativa (CFA) su un campione rappresentativo di 2929 studenti macedoni che hanno partecipato all'indagine. Successivamente, abbiamo eseguito analisi di regressione per esplorare come la varianza della comprensione del contenuto verbale degli studenti sia spiegata dalle dimensioni di primo ordine che definiscono questo costrutto. Riportiamo i risultati ottenuti dalla CFA, che hanno confermato la validità di ciascuna delle scale proposte. Successivamente, presentiamo e discutiamo i risultati relativi ai predittori significativi del rendimento degli studenti nella comprensione del contenuto verbale. Il modello di regressione ha mostrato un contributo significativo di tutti i fattori di primo ordine che comprendono il costrutto della motivazione alla lettura, con la competenza degli studenti che contribuisce maggiormente a spiegare la varianza nei risultati. Contestualizziamo la direzione di influenza, teoricamente inaspettata, indicata da alcuni dei coefficienti beta dell'equazione di regressione che definisce la variabile criterio e forniamo suggerimenti per ricerche future.

1. Introduction

Numerous research studies confirm the role of students' motivation as a significant predictor for their achievement on tasks, which require of them to read and perform comprehensive analysis, that is, to discover, select, interpret, integrate and evaluate different information (Good and Lavigne, 2017). One such study is the international research study PIRLS (*Progress in International Reading Literacy Study*) an ongoing international assessment program of students' reading achievement in their fourth year of schooling (grade 4), which is an important transition point in their development as readers. By this time in their education, students typically have learned how to read and are now reading to learn (Mullis *et al.*, 2023). The PIRLS 2021 testing includes questions related to the *motivation for reading* construct. To gain an in-depth understanding of this motivation, integrative motivation theory is essential. In this respect, several motivation theories have been adopted in reading research, such as the self-efficacy theory (Bandura, 2006), expectancy-value theory (Wigfield and Eccles, 2000), achievement goal theory (Ames, 1992), and self-determination theory (Ryan and Deci, 2000). In the present research, we implement the theoretical framework of self-determination theory.

1.2. Literature review

Self-determination theory (SDT) posits that self-determined motivation is dependent on the satisfaction of three psychological needs (relatedness, competence, and autonomy), which are in turn facilitated through need-supportive behaviors from third parties. In SDT, these needs are conceived as universal rather than as individual subjective differences. Thus, SDT will postulate that: a) the degree to which individuals are healthy and effective is understood in terms of the degree to which these needs have been satisfied; b) deprivation of psychological needs leads to ill-being and psychopathology and c) these needs are fundamental across age, gender, culture, and socioeconomic status (Deci and Ryan, 2008, 2013). As a result of that, psychological needs are not learned, but are universal sources of satisfaction that promote

students' optimal functioning in the schooling environment. Thwarting these needs, on the other hand, will eventually lead to controlled goals and reasons for action. To this end, the social context surrounding students (parents, teachers, peers) is quite important to the end of fulfilling the aforementioned needs.

The theory of self-determination explains the notions of intrinsic and extrinsic motivation (Deci *et al.*, 1999). Intrinsically motivated behavior, mathematically, represents a function of meeting psychological needs related to developmental trends, all the while taking into consideration the function of realizing the potentials that are in a constant process of change and development, as well as serving a more successful environmental adaptation. Intrinsic motivation implies «activity due to internal satisfaction, incentive from the inside to look for challenges and new things, to expand activity and achievement capacities, to explore, to learn and to create» (Spasovski, 2013, p. 124). It occurs spontaneously when an activity causes interest because it is of worth to the person. Intrinsic motivation implies the behavior of people based on their interests and values. It occurs in conditions where there is freedom of choice in behavior, freedom of feeling and leads to deeper understanding, richer experiences, more creative results and better problem solving. Intrinsic motivation increases when the challenge is optimal for the student. It develops into an environment that provides security and support, and jeopardizes pressures, threats, strict supervision and deadlines, disparaging evaluations, imposed goals (Spasovski, 2013).

1.3. Competence

The need for competence is understood as the desire to interact effectively with one's environment (Guay *et al.*, 2010). This need leads students to seek challenges that are slightly beyond their current capacities and to practice activities to eventually enhance their aptitudes. It is not, however, the level of aptitude per se that a student acquires that is important, but rather the phenomenological experience of perceiving oneself to be competent. Because its satisfaction is directly related to performance (Guay *et al.*, 2003), it clearly has

adaptive consequences for students. Without this need, students would be less inclined to act in ways that surmount barriers. For example, Guay *et al.* (2003) have shown that elementary school children who perceive themselves competent at school attain a higher educational degree 10 years later. Satisfaction of the need for competence is thus an essential prerequisite for full functioning at school.

1.4. Relatedness

Students' sense of belonging at school, also referred to as school connectedness, has been found to contribute to their general well-being. Students with a strong sense of school belonging feel safe at school, enjoy school, and have a good relationship with teachers. The need for relatedness refers to the necessity for close and secure emotional bonds with significant others and to feeling as a part of collectives (Ryan and Deci, 2017). Without this need, it would be hard to explain why people would so readily internalize ways of interacting effectively and harmoniously with others in their groups. Satisfaction of the need for relatedness also helps students develop their potential. For example, a talent for Mathematics is likely to emerge in an environment where children feel supported by their parents, whereas conditional regard or cold parents are more likely to stifle this potential (Ryan *et al.*, 2006).

1.5. Autonomy

The need for autonomy is defined as the necessity of experiencing a sense of choice, willingness, and volition as one behaves. Students will feel like the initiators of their actions and will act in ways that are consistent with their interests and values (Deci and Ryan, 2013). The need for autonomy is thus intertwined with the "self" which is the active center of integration, initiation, and spontaneous engagement within the social context. Within SDT, the integrative process is at the heart of self, which integrates new functions, values, experiences, and propensities (Ryan and Deci, 2017). When they are able

to experience support for their autonomy, students behave with more autonomy (Guay and Vallerand, 1996) and thoroughly internalize aspects of the education context that allow them to volitionally adopt school rules and expectancies. In SDT, autonomy does not equate with independence. People can be autonomously independent, but they can also be autonomously dependent on others. Moreover, it is not a stage of development, instead it is considered important from the beginning of life until its end. Finally, autonomy is not synonymous to being detached or separated from significant others. In fact, many studies have shown that feeling accepted and related to significant others is associated with a greater feeling of autonomy (e.g., Guay *et al.*, 2010).

According to SDI, the three psychological needs do not operate in isolation but rather interdependently and they should, as a result, be considered in combination rather than separately. This theory advances the notion that students do not only vary in the quantity but also in the quality of their motivation (i.e., the kind of motives underlying one's behavior) (Ryan and Deci, 2000). Based on this assumption, SDT describes a full continuum of motivation and differentiates between qualitatively different types of motivation: a) amotivation (e.g., lack of motivation to read); b) external regulation (e.g., reading because of experiences of external pressure, such as obtaining a reward); c) introjected regulation (e.g., reading because of experiences of internal pressure, such as shame; d) identified regulation (e.g., reading because of personally valuing the activities), and e) intrinsic regulation (e.g., reading because of an inherent enjoyment found in the activities). Within SDT-research in general and in the field of language learning in particular (Ryan and Deci, 2000), the last four types coincide two by two in controlled and autonomous motivation, respectively. Autonomous motivation is the most optimal type of motivation and refers to engaging in an activity with an inner sense of satisfaction or because one values the activity (i.e., intrinsic and identified regulation; Ryan and Deci, 2000).

1.6. Value of reading

A predominant component in students' motivation is played by the component of value. The various values component in students' motivation refers to the goals of the task and their beliefs about the importance and interest in practicing and completing the task. This motivational component essentially refers to the reasons which students have to perform the task. In other words, it refers to students' answers to the question: Why am I doing the task? And do I want to complete the task? Even when someone is confident that they can solve a particular task, they may be reluctant to engage in the task and thus lack strong motivation to approach it (Wigfield and Eccles, 2000). Research shows that students who have a motivational orientation that includes goals of improvement to perfection, learning, and challenge, as well as beliefs that the task is interesting and important, use metacognitive strategies, use multiple cognitive strategies, and manage effort effectively (Pintrich, 2002).

Intrinsic value is the satisfaction that the individual receives from the performance of the task, that is, the subjective interest that the individual has for the subject (Wigfield and Eccles, 2000). Students' motivation to read is influenced by whether they find reading interesting and how much they want to read (Frenzel *et al.*, 2010). Interest can decrease (weaken) if a person changes in their assessment of their own competence for a certain activity or behavior. It happens when the student feels competent and effective enough to perform a certain activity or behavior. Such an experience of one's own competence leads to a weakening of one's internal interest in the specific activity or behavior.

Students are not passive objects of environmental influences on them, but have their own power to act, create new values (Hughson, 2022), make their own choices and create their own developmental environments and future life paths. Many psychological factors such as motivation (Salmela-Aro, 2009), goal orientation (Pintrich, 2003), mindset (Dweck, 1986), self-efficacy (Bandura, 1993), decision making, and related commitments are responsible for this mechanism (Dietrich *et al.*, 2012). Students try to achieve their goals and regulate their behavior in a social context based on mutual action. Goal achievement is not based on self-regulation alone, but on reciprocal

action and co-regulation in a social context. The key social contexts for student interaction in the context of education are peers, teachers and parents. During this socialization process, students build responsibility (Dietrich *et al.*, 2012). Students are active creators of their own lives and have the potential to direct their own lives. Through the ways in which they make choices, they create new values and choose different directions for their future life (Nurmi, 2001).

Teachers are the primary adults who interact with children at school and exert a significant influence on children's autonomous motivation. Like parents, autonomy-supportive teachers foster autonomous motivation in their students (Reeve, 2012). Again, like parents, and irrespective of education levels or children's problems, teachers adopting an autonomy-supportive teaching style contribute to more autonomous motivation in their students. A recent study indicates that teachers' autonomy support could reduce students' tendency to compare themselves with their classmates (Gilbert *et al.*, 2022). Promoting an autonomy supportive context encourages students to focus on their own success to form their self-concept rather than on the performance of their classmates.

Research shows that students' path to self-determination in reading depends on the support they receive from significant others. Not surprisingly, a favorable and stimulating context ensures the development of reading competence and expands autonomy in directing one's reading activities. Additionally, when family and school ensure that the student builds self-efficacy and independence in reading, the individual grows toward internally motivated and self-determined reading. According to findings, students who focus on intrinsic goals for engaging in a specific activity show greater motivation, persistence and higher achievement compared to students who focus on extrinsic goals (Vallerand, 1997).

The teacher is the "significant" actor for the development of language literacy (Reeve, 2012). Various studies show that teachers who foster a sense of ownership and competence aid students in becoming active, high-achieving readers. Conversely, teachers who neglect these instructional practices undermine students' efforts to become autonomous, resulting in students who are disengaged from reading and underachieving.

Research results indicate that experiences and relationships at school have a significant impact on how students experience the quality of life. Some student behaviors, such as teamwork and self-regulation, attitudes toward school and life, including a sense of belonging at school, hope, and love, protect students from experiencing negative emotions. That is why schools have a role not only to nurture academic success, but also to promote the health and well-being of students (Weber *et al.*, 2020).

2. Method

2.1. *Object and research hypothesis*

The present paper follows the research aims to define the model and the role of motivation to read in the international assessment program of students' reading achievement (PIRLS, 2021) in their fourth year of schooling.

In the research framework for conducting the PIRLS 2021 testing, four scales were introduced to measure the construct titled Motivation for reading, which is why the research and subsequent paper are divided into two parts. The first part focuses on testing the hypothesized validity of the four constructs related to motivation for reading, while the second part of the research aims to determine whether these constructs predict the achievement of tasks in verbal content comprehension tests among 4th grade students in the Republic of North Macedonia, covered by the testing within the international research study PIRLS 2021. The average score for the North Macedonian students in reading is 442 and it is below the international average, so the findings and recommendations of this research would help educational policy makers to design programs aimed at emphasizing the importance of students' motivation in order to achieve higher academic results.

2.2. Sample

The sample for this research consists of 2,929 primary students from 150 primary schools in North Macedonia.

2.3. Method(s) employed

2.3.1. Instrument and variables

In order to measure the previously mentioned variables, the research uses scales that refer to the constructs related to motivation for reading. They are an integral part of the questionnaire intended for students, as part of the research procedure prescribed by the protocol of the international research study PIRLS 2021 (Mullis and Martin, 2019). Four different measuring scales from the student's questionnaire applied in PIRLS 2021 were used to assess students' motivation to read. The scales assess the following dimensions: Competence (Students Confident in Reading scale), Autonomy (Students Engaged in Reading Lessons scale), Relatedness (Students' Sense of School Belonging scale) and Value of reading (Students Like Reading scale).

2.3.2. Competence (Students Confident in Reading scale)

The PIRLS 2021 Students Confident in Reading scale asked students how much they agreed with six statements about how well they can read (Mullis *et al.*, 2023):
– C1 – I usually do well in reading;
– C2 – Reading is easy for me;
– C3 – I have trouble reading stories with difficult words (reverse scored);
– C4 – Reading is harder for me than for many of my classmates (reverse scored);
– C5 – Reading is harder for me than any other subject (reverse scored);
– C6 – I am just not good at reading (reverse scored).

By rating, students indicate how much they agree with the 6 statements using a 4-point Likert-type scale with the following values: 1-agree a lot, 2-agree a little, 3-disagree a little and 4-disagree a lot. Higher score on a scale means lower students competence in reading.

2.3.3. Autonomy (Students Engaged in Reading Lessons scale)

PIRLS developed the Students Engaged in Reading Lessons scale in 2011, which includes items about whether the teacher is easy to understand, has clear expectations, gives students interesting things to read, supports students' autonomy, and does a variety of things to help them learn and enhance their reading skills (Mullis *et al.*, 2023).

Students indicate how much they agree with the 9 statements using a 4-point Likert-type scale with the following values: 1-agree a lot, 2-agree a little, 3-disagree a little and 4-disagree a lot. Higher score on a scale means lower students autonomy in reading:
– A1 – I like what I read about in school;
– A2 – My teacher gives me interesting things to read;
– A3 – I know what my teacher expects me to do;
– A4 – My teacher is easy to understand;
– A5 – I am interested in what my teacher says;
– A6 – My teacher encourages me to say what I think about what I have read;
– A7 – My teacher lets me show what I have learned;
– A8 – My teacher does a variety of things to help us learn;
– A9 – My teacher tells me how to do better when I make a mistake.

2.3.4. Relatedness (Students' Sense of School Belonging scale)

The Students' Sense of School Belonging scale was developed in PIRLS 2016, asking students to indicate the extent to which they like being in school, how much they feel they belong at the school, and whether teachers are fair to them. The 2016 results showed a positive association between school belonging and academic achievement, corroborating other research on the subject. PIRLS 2021 improves

the scale by including whether students have friends at this school to reflect the importance of positive student relationships within the school community for students' sense of school belonging (Mullis *et al.*, 2023):
– R1 – I like being in school;
– R2 – I feel safe when I am at school;
– R3 – I feel like I belong at this school;
– R4 – Teachers at my school are fair to me;
– R5 – I am proud to go to this school;
– R6 – I have friends at this school.

Students indicate how much they agree with the 6 statements using a 4-point Likert-type scale with the following values: 1-agree a lot, 2-agree a little, 3-disagree a little and 4-disagree a lot. As above, a higher score on a scale means lower students relatedness.

2.3.5. Value of reading (Students Like Reading scale)

To create the Students Like Reading scale, PIRLS 2021 asked students how much they agreed with a series of eight statements about their attitudes toward reading (the scale from PIRLS 2016) and two items (added in PIRLS 2021) about how often they read outside of school (Mullis *et al.*, 2023):
– V1 – I like talking about what I read with other people;
– V2 – I would be happy if someone gave me a book as a present;
– V3 – I think reading is boring;
– V4 – I would like to have more time for reading;
– V5 – I enjoy reading;
– V6 – I learn a lot from reading;
– V7 – I like to read things that make me think;
– V8 – I like it when a book helps me imagine other worlds;
– V9 – I read for fun;
– V10 – I read to find out about things I want to learn.

Students indicate how much they agree with the 10 statements using a 4-point Likert-type scale with the following values: 1-agree a lot, 2-agree a little, 3-disagree a little and 4-disagree a lot. Higher score on a scale will indicate lower positive attitudes in students about reading.

2.4. Comprehension of verbal test content

This variable is determined through the total score achieved on the reading comprehension test tasks. The international study PIRLS 2021 framework focuses on the two overarching purposes for reading that account for most of the reading done by young students both in and out of school concerning literary experience, and the aim to acquire and use information.

In addition, the PIRLS 2021 assessment integrates four broad-based comprehension processes within each of the two purposes for reading: focus on and retrieve explicitly stated information, make straightforward inferences, interpret and integrate ideas and information, and evaluate and critique content and textual elements (Mullis *et al.*, 2023).

2.5. Statistical data analysis

In order to determine the hypothetical (construct) validity of the proposed factor model (of the first order and the hierarchical model), confirmatory factor analysis was used for the motivational factors in the statistical package SPSS-Amos (Statistical Package for Social Sciences-Analysis of a Moment Structures).

The motivation for reading is a higher order factor that unites the four sub-factors: Competence, Autonomy, Relatedness and Value of reading.

When conducting the confirmatory factor analysis of the data, the following criteria for model fit were used (McDonald and Ho, 2002): Chi-square test (CMIN/DF)[1], Root Mean Square Error of Approxima-

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[1] In its nature, the Chi-square test is sensitive to sample size, therefore it is necessary to divide the CMIN value by the number of degrees of freedom (DF) and thus, the resulting value of CMIN/DF if less than or equal to 3 then it indicates an acceptable model suitability level (Kline, 2015), and if the value is less than or equal to 5, then it is a reasonable model suitability level. Given that the research sample is relatively large, a significant value of the Chi square test was expected (Steiger, 2007).

tion (RMSEA)[2], Root Mean Square Residual (SRMR)[3], Tucker Lewis Index (TLI) and the Comparative Fit Index (CFI)[4].

2.6. Descriptive statistics

Evidently from Table 1, the arithmetic means for the four motivational constructs: competence, autonomy, relatedness and value of reading exceed the mean value of each scale. The minimum and maximum score achieved on each of the four scales is 1 and 4 respectively. Cronbach alpha coefficients as a measure of the internal homogeneity of the scales range from .68 to .83, which indicates acceptable internal homogeneity (Taber, 2018). The average achievement of the students on the tasks in the tests for understanding verbal content is 442 points and it is below the international intermediate benchmark (475) in PIRLS 2021 assessment (Mullis *et al.*, 2023).

Tab. 1 – Descriptive statistics

	M	SD	Min	Max	α
Competence	1.69	0.63	1	4	0.77
Autonomy	1.17	0.32	1	4	0.83
Relatedness	1.15	0.31	1	4	0.68
Value of reading	1.46	0.48	1	4	0.81
Students' reading achievement PIRLS 2021	442.15	90.47	138.23	671.93	

N = 2,929

[2] The limit value of the Root Mean Square Error of Approximation (RMSEA) is .06, that is, the value should be less than .06 to be able to say that the model is adequate (Awang, 2012).
[3] The Root Mean Square Residual (SRMR) values less than.09 indicate a good model fit (Shi and Maydeu-Olivares, 2020).
[4] The values for the incremental indices Tucker Lewis Index (TLI) and Comparative Fit Index (CFI) can range from 0 (fit no better than the null model) to 1 (perfect fit). The cut-off value should be greater than .90 to indicate an acceptable level of model fit. This would mean that the hypothesized model represents more than a 90% improvement over the independence model (Savalei, 2014). Hu and Bentler (1999) proposed a more rigorous cut-off value, that is, they consider that the value should be greater than.95 to indicate an acceptable level of model fit.

2.7. *Confirmatory factor analysis findings for the motivation for reading construct*

As it was previously states, the total sample of the research consists of 2929 students at the age of 10. In order to ensure adequate testing of the factor model and adequate inference from the regression analysis, the sample is divided into two parts (Kline, 2015). The results for one third, i.e. approximately 33% of the total sample (by random selection) were used to conduct the confirmatory factor analysis (a total of 946 students), and the rest, i.e. the results of 1983 students, were subject to hierarchical regression analysis.

In order to check the hypothesis that the original structure of the model of four motivational factors of the first order: *competence*, *autonomy*, *relatedness* and *value of reading* proposed according to the SDT theory will be confirmed based on the results from the research, standardized regression scores were calculated. According to the results of the initial check of the factor structure of the motivational factors (Table 2), it can be noted that the proposed items have factor loadings ranging from .42 to .79.

From the analysis of covariance (shown in Table 3), it can be observed that the six relationships between the factors show a statistically significant positive association ($p < .01$).

According to the results of the initial check of the factor structure of the motivation factors for reading in the final model, the errors of the items V9 and V10, and R3 and R5 were connected and the items: R6, C1, C2, A3, V3 were deleted because their factor loadings are below.40 (Ximénez, 2006). The deletion of these items, as well as the connection of the errors contributed to the improvement of the model and as the most suitable solution according to the theoretical framework of the research (Tab. 4).

Tab. 2 – Factor loadings for the indicators of the latent variables of the motivation for reading construct

Items	Factor	Standardized regression scores	Standardized regression scores (after correction)
R1	Relatedness	0.47	0.50
R2	Relatedness	0.49	0.49
R3	Relatedness	0.49	0.49
R4	Relatedness	0.49	0.48
R5	Relatedness	0.45	0.47
R6	Relatedness	0.34	–
C1	Competence	0.29	–
C2	Competence	0.24	–
C3	Competence	0.57	0.59
C4	Competence	0.78	0.79
C5	Competence	0.75	0.76
C6	Competence	0.66	0.66
A1	Autonomy	0.53	0.53
A2	Autonomy	0.59	0.59
A3	Autonomy	0.39	–
A4	Autonomy	0.56	0.56
A5	Autonomy	0.65	0.65
A6	Autonomy	0.69	0.69
A7	Autonomy	0.67	0.67
A8	Autonomy	0.62	0.63
A9	Autonomy	0.62	0.62
V1	Value of reading	0.47	0.48
V2	Value of reading	0.68	0.68
V3	Value of reading	0.33	–
V4	Value of reading	0.64	0.64
V5	Value of reading	0.79	0.79
V6	Value of reading	0.64	0.65
V7	Value of reading	0.72	0.73
V8	Value of reading	0.62	0.62
V9	Value of reading	0.55	0.50
V10	Value of reading	0.51	0.54

Tab. 3 – Analysis of covariance for the factors of the motivation for reading construct

	Estimate	SE	CR	p
Relatedness-Competence	.009	.002	4.186	***
Value of reading-Relatness	.040	.006	7.275	***
Relatedness-Autonomy	.043	.005	9.156	***
Value of reading-Competence	.016	.003	4.887	***
Value of reading-Autonomy	.046	.005	8.464	***
Competence-Autonomy	.007	.002	3.754	***

Note: SE: standard error, CR: critical value

*** $p < 0.001$

Tab. 4 – Fit indices of proposed models for measuring motivation for reading

		df	CMIN/DF	TLI	CFI	SRMR	RMSEA (90% CI)
Model 1 (first-order factors)	889.33**	292	3.56	0.91	0.92	0.04	0.04 (0.04, 0.05)
Model 2 (hierarchical model)	866.55**	293	2.96	0.91	0.92	0.04	0.04 (0.04, 0.05)

Note: CMIN/DF = Chi square test divided by the number of degrees of freedom; RMSEA = Root Mean Square Error of Approximation; SRMR = Root Mean Square Residual; TLI = Tucker Lewis Index; CFI = Comparative Fit Index

** $p < .01$

Based on the results shown in Table 4, it can be concluded that the proposed four-factor model for measuring reading motivation among 10-year-old students adequately corresponds to the data obtained on a sample of 10-year-old students in the Republic of North Macedonia.

The results presented in Table 4 confirm that the four motivational factors (competence, autonomy, relatedness and value of reading) are connected in a hierarchical model, that is, they are connected in a factor of a higher order – motivation for reading. The correlation between each of the factors with the higher order factor is statistically significant ($p < .01$).

Results from the linear regression analysis showed that all four motivational factors are significant predictors of student achievement of

the tasks in the tests of understanding verbal content. The overall percentage of explained variance is 18% (F (4,1978) = 106.530, p < .01). In addition, Table 5 provides the statistics of the predictor variables that enter the regression equation, as well as the values of the Beta weights that show the individual contribution of each predictor in the prediction of the criterion variable. It can be noted that of the motivational factors, the competence factor has the highest value in predicting the result of the tasks in the tests for understanding verbal content. This means that students with a greater sense of competence achieve higher scores on tasks in verbal content comprehension tests. Oddly enough, the Beta coefficient for the value of reading factor shows that students who value reading more have achieved lower results in tests of verbal content comprehension.

Tab. 5 – Results of regression analysis of predictors of task achievement in tests of verbal content comprehension

Variable	B	95% CI for B		β	T	p
		LL	UL			
(Constant)	544.45	528.86	560.04		68.50	0.000
Competence	-37.64	-41.68	-33.59	-0.38	-18.26	0.000
Value of reading	23.46	15.37	31.55	0.13	5.69	0.000
Relatedness	-11.34	-22.67	-0.02	-0.05	-1.96	0.050
Autonomy	-42.09	-54.99	-29.18	-0.16	-6.40	0.000

Note: CI = confidence interval; LL = lower limit; UL = upper limit

3. Discussion

The results of the PIRLS study, and of other international research in which the Republic of North Macedonia participates, demonstrate a low achievement of Macedonian students. It implies that students are able to locate some of the information they need to make a conclusion, are able to recognize a main idea in the text, understand the relationships in a certain part of the text (low-level inference), make a comparison or to relate the text to their informal knowledge, using personal experience and attitudes – which are the lower levels of task

demands. However, most are unable to understand longer, extensive and abstract texts, compare and integrate information, and draw causal inferences.

PIRLS 2021 introduces new scales to measure constructs of motivation for reading. Therefore, the first part of the research focused and answered the question of the hypothetical (construct) validity of the scales. The results from the confirmatory factor analysis confirmed that these scales are mutually connected in a higher order structure, it has been thus confirmed that the motivation for reading is determined by four factors: competence, autonomy, relatedness, value of reading.

The results from the second part of the research show that all four factors related to motivation to read are significant predictors of students' achievements in reading tests with understanding. In addition, students' competence is the factor that contributes most to explaining the variance in student achievement, and factors that follow: autonomy, value of reading and relatedness. The value of the Beta coefficient for the value of reading factor is positive, indicating that students who value reading more have a lower achievement of tasks in reading tests with understanding.

Let's consider the results from the perspective of the comprehensive school approach, which takes into account the mutual connection of the school, community and family, as well as from the perspective of the developmental theory of Bronfenbrenner (1977) and his bioecological approach to personality development. Teachers and schools lack adequate training and tools for more comprehensive assessment of learning while students receive a small amount of quality feedback that does not help them improve their learning (OECD, 2019). This creates a situation in which teachers do not sufficiently use assessment results to help students understand the extent to which they have mastered the material and determine the next steps in learning. As a result of this, many students move from one grade to another, without meeting the expectations for their level and without having a real insight into their own competencies. In addition, the focus on assessment as the main outcome of learning for students creates a situation in which learning is something that is alienated, does not make sense to them, that is, it is not in line with their current needs,

desires, aspirations, abilities and invested effort, but something that is expected of them to fulfill as an imposed obligation in a social environment in which, paradoxically not everyone is expected to achieve. Considering these conditions in which students grow and develop, including: low expectations for their achievements, stereotypical beliefs that ethnicity and/or gender determine achievement (Santos *et al.*, 2021), low goals in curricula, the absence of feedback to improve learning outcomes, unfounded correction of grades, and an unjustified large number of excellent students, who continue their education in higher education institutions – we can expect students to develop an unrealistic image of their competencies. That is, the picture we get from the PIRLS 2021 test results is that students in North Macedonia have a pronounced sense of competence, autonomy, relatedness and they value reading highly – which do not correspond to the results achieved on reading performance. On international level, the results from PIRLS 2021 show that higher average reading achievement and more positive attitudes tend to exist in mutually reinforcing relationships. PIRLS 2021 data show a positive relationship between students' confidence in their reading skills and higher average reading achievement. Their self-assessments coincide very well with the PIRLS assessment results, i.e., 43% reported they were "very confident" and had average achievement close to the high international benchmark (541), while the 22% who reported they were "not confident" had average achievement just reaching the intermediate benchmark (475). Students' reading enjoyment was associated with higher average achievement, however, the majority only "somewhat" or "do not like" to read (Mullis *et al.*, 2023).

These results of students from North Macedonia can be easily explained by the reduced criticality in students' (self) assessment, unrealistic self-image and low self-expectations, and partly by the tendency to give socially desirable answers. However, it is more likely that the differences between the objective assessment of students' school achievements and their (self) assessment are also due to unrealistic and non-standardized assessments of students' knowledge by teachers and the educational system, as a whole. This contributes to both students and teachers setting too different or low expectations regarding achievement, often far below the level of other countries.

Valuation of reading can also be included as a social dimension, which indicates how much reading is valued in other social fields, as a value in the wider system, especially in conjunction with what is considered a success in society. If in the social system there is no adequate valuation of reading as a significant dimension for individual success and contribution to the community, it can also affect schools – as small social communities – in which the investment of effort is not valued and there is no adequate support and orientation for valuing effort. That is, power relations in our societies defined by systems of dominance and socio-economic status have the greatest influence on the achievement of success, rather than effort, so it is understandable that this model of relations will be reflected in schools. What can be observed in the school environment is that there is no open discussion, no critical argumentation regarding these issues. There is no discussion regarding what goals schools set for improving student learning outcomes in reading, no discussion of how well school learning environments support the development of students' knowledge and reading skills.

These results certainly indicate that curriculum reforms are necessary, setting higher expectations from students in order to raise the degree of relevance and attractiveness, improved compliance with the stages of child development and greater focus on learning outcomes. At the same time, during the implementation of these reforms, the potentials, or in other words, the protective factors that the students stated that they possess, that is, that they have developed to a high degree, should be used. Here, above all, the feeling of competence, autonomy, relatedness and valuation of reading should play a pivotal role.

More successful teachers manage to promote student achievement by enhancing the development of intrinsic motivation. This is achieved by: creating tasks that stimulating interest, challenging students and matching their abilities; giving students the opportunity to have choice and control over classroom activities; setting a focus on individual improvement, learning, advancement; personal, not public valuation/ evaluation; recognition and respect of students' work; helping students see mistakes as learning opportunities; applying group work for student interaction and adjusting time for students who have a problem completing the task (Motevalli *et al.*, 2020). In order to stimulate stu-

dents' interest and maintain motivation to learn, teachers are recommended to take care of the following aspects that are important for maintaining interest and motivation to learn: obtaining information about students' interest in the subject, contents, methods of learning; establishing learning goals/results so that each student can assess their own level of achievement and plan further learning; monitoring and checking focus during the lesson; encouraging autonomy and self-directed learning, to allow students to choose the method and tool with which they will create part of the tasks; taking care of socio-emotional aspects of learning.

From the perspective of the theory of self-determination, teachers encourage or hinder motivation by creating an environment that affects the realization of the three basic psychological needs, autonomy, competence and relatedness (Deci and Ryan, 2008). Teachers can encourage a sense of autonomy by providing choice in assignments and by teaching that is directed by students' interests. In interacting with students, teachers can create classroom conditions that encourage students to feel free to engage in behavior that includes, for example, asking questions and expressing their own thoughts. Teachers can also praise effort and provide feedback that supports internal versus external locus of control rather than controlling and manipulative feedback. Teachers can influence students' perceived competence by communicating in a way that recognizes students' effort when answering questions, providing feedback, and encouraging students' spirit of inquiry. Teachers can support the connection by making emotional contacts with the students during the lessons. Given the amount of time 10-year-olds spend in school, schools are the primary places, outside of the family, where 10-year-olds can develop supportive relationships. The school should be nurtured as a social resource for children's developmental needs for contact, companionship and belonging, but with greater student participation. For example, if we want students to be more present and independent, they need to be involved in deciding on all issues that affect them in the school, including school curricula and regulations, but also the school atmosphere and children's rights.

Along the same lines, the OECD document on the Future of Education and Skills 2030 (OECD, 2018), highlights the importance of

students' motivation and well-being so that they can use their potential and create their own compass, or roadmap of learning and tools used in learning and navigation that will help them find their way in a world that is continuously changing, becoming more complex and unstable.

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5. *Digital skills and learning in Italian and Mathematics: a crossroads of inclusion, education and innovation*

by Valeria F. Tortora, Patrizia Falzetti

Computational thinking has become increasingly relevant in recent years as a key competence for comprehensive education and for playing an active role today. To prepare students for life in the digital age, it has become increasingly necessary to acquire skills in this field (Eickelmann *et al.*, 2019; Gerick *et al.*, 2017). Therefore, useful as a guide, always in a view of the importance of research to support school policies, it is the availability of data from a large-scale study comparing students' digital and information skills and their contextual conditions and characteristics, such as the International Computer and Information Literacy Study 2018 (ICILS, 2018) allows for. The ICILS survey defines Computer and Information Literacy (CIL) as an individual's ability to use computers to investigate, create, and communicate to participate effectively at home, at school, in the workplace, and in society, (Fraillon *et al.*, 2019a). The ICILS 2018 survey, conducted on eighth grade students, involved 14 countries in 4 continents revealing a generally critical situation, among European countries Italy shows greater difficulties (Fraillon *et al.*, 2020). Looking at the international data shows that young people do not develop sophisticated digital skills simply by growing up with digital devices; therefore, equipping students and teachers with ICTT equipment is not enough to improve their digital skills, it would be useful to combine thus combining computer literacy, critical thinking, technical skills and communication skills applied to a range of contexts and purposes (Fraillon *et al.*, 2020). The school questionnaire found that most students attend schools with access to word processing, presentation, video/photo and

graphics/drawing software. However, despite this level of resources, on average, there was a higher percentage of students scoring below level 2 on the CIL scale than above (Fraillon *et al.*, 2020). This paper aims to analyze the italian ICILS 2018 data, collected by INVALSI in collaboration with the IEA, whether and how much digital skills are useful for improving Mathematics and Italian learning. To this end, the results in Italian and Mathematics of the National Survey of students participating in the international survey will be analyzed, also to assess whether the results obtained can be controlled by factors related to the student, the students' engagement with ICT and their socio-economic background.

Il pensiero computazionale è diventato sempre più rilevante negli ultimi anni come competenza chiave per un'istruzione completa e per svolgere un ruolo attivo nella società odierna. Per preparare gli studenti alla vita nell'era digitale, è diventato sempre più necessario acquisire competenze in questo campo (Eickelmann et al.*, 2019; Gerick* et al.*, 2017). Pertanto, utile come guida, sempre nell'ottica dell'importanza della ricerca a supporto delle politiche scolastiche, è la disponibilità di dati provenienti da uno studio su larga scala che metta a confronto le competenze digitali e informatiche degli studenti e le loro condizioni e caratteristiche contestuali, come l'International Computer and Information Literacy Study 2018 (ICILS, 2018) consente di fare. L'indagine ICILS definisce la Computer and information literacy (CIL) come la capacità di un individuo di usare il computer per indagare, creare e comunicare per partecipare efficacemente a casa, a scuola, sul posto di lavoro e nella società (Fraillon* et al.*, 2019a).*
L'indagine ICILS 2018, condotta su studenti di terza media, ha coinvolto 14 Paesi in 4 continenti rivelando una situazione generalmente critica, tra i Paesi europei l'Italia mostra maggiori difficoltà (Fraillon et al.*, 2020). Osservando i dati internazionali si evince che i giovani non sviluppano competenze digitali sofisticate semplicemente crescendo con dispositivi digitali; pertanto, dotare studenti e insegnanti di apparecchiature TIC non è sufficiente per migliorare le loro competenze digitali, sarebbe utile combinare quindi alfabetizzazione informatica, pensiero critico, competenze tecniche e abilità comunicative applicate a una serie di contesti e scopi (Fraillon* et al.*,*

2020). Dal questionario scolastico è emerso che la maggior parte degli studenti frequenta scuole con accesso a software di elaborazione testi, presentazione, video/foto e grafica/disegno. Tuttavia, nonostante questo livello di risorse, in media c'era una percentuale maggiore di studenti che ottenevano un punteggio inferiore al livello 2 della scala CIL rispetto a quelli superiori (Fraillon et al.*, 2020). Il presente lavoro si propone di analizzare i dati italiani ICILS 2018, raccolti dall'INVALSI in collaborazione con l'IEA, se e quanto le competenze digitali siano utili per migliorare l'apprendimento della Matematica e dell'Italiano. A tal fine, verranno analizzati i risultati in Italiano e Matematica dell'indagine nazionale sugli studenti partecipanti all'indagine internazionale, anche per valutare se i risultati ottenuti possono essere controllati da fattori legati allo studente, all'impegno degli studenti con le TIC e al loro background socio-economico.*

1. Background

The new, rapidly changing digital landscape of today's world requires students to be increasingly digitally literate. Digital technologies provide students with increasingly rich information and resources and offer new and innovative ways of learning and engaging with course material (Timotheou *et al.*, 2023).

Digital technologies have transformed the nature and scope of education. Flexible technological innovations, such as smart devices, offer new opportunities to enrich teaching and learning (OECD, 2021).

The critical moment created by Covid-19 suddenly and drastically changed the way we think, live, learn and work.

The closure of schools in March 2020 was the only way to counter the spread of Covid-19, but it brought with it the need to redefine teaching by suddenly transforming it through the PC monitor alone, suddenly highlighting the importance of adequate technological equipment and connectivity of families and teachers, as well as an IT skills base as users.

As a result, there has been a national and international interest in exploring how best to measure the extent and fairness of attainment, in this area.

Although Information and Communication Technologies (ICT) had in recent years become the necessary tools of everyday life, socio-economic relations and work for all of us, the results of the IEA (International Association for the Evaluation of Educational Achievement) ICILS (International Computer and Information Literacy Study) survey had shown that in some school systems the integration of technologies in the teaching and learning of students in school life was still far from being achieved.

In addition, several studies have analyzed the impact of the use of digital tools on student outcomes.

Mayer argues that learning with digital tools is effective because of the intervention of 3 assumptions underlying cognitive theory (Mayer, 2014). The first assumption is that learners can structure information using 2 cognitive structures, namely the visual and auditory channels. The second assumption is that the ability to process information in only one channel is limited, so it is advantageous if the learning context allows both the visual and auditory channel to be activated, so that there is no excessive cognitive load on only one channel. The third assumption is motivation, where students need to actively engage and intervene with the learning content in order to acquire skills (Mayer, 2014).

Specifically, the research shows that Mathematics and Science learning experience the positive effects of using digital tools compared to teaching methods without the use of digital tools; at the same time different aspects of the learning context; the combination of contextual learning factors with digital tools can influence the use of digital tools on student achievement (Higgins *et al.*, 2019). Sung *et al.* show a significant effect on Mathematics achievement by incorporating digital tools during Mathematics lessons (Sung *et al.*, 2017).

Another interesting line of research was presented in 2017 by Jacinto and Carreira, who argue for techno-mathematical fluency. The relevant construct is «the ability to combine two kinds of basic knowledge and ability to combine two types of knowledge and skills-mathematical and technological-that are constantly intertwined to develop techno-mathematical thinking» also highlighting «the need to be fluent in a "language" that encompasses both mathematical and technological knowledge» (Jacinto and Carreira, 2017, p. 5).

2. The survey of ICILS 2018

Since 2013 the IEA has been promoting ICILS, a computer-based assessment of eighth-grade students that focuses on Computer and Information Literacy and is repeated every five years. As an international survey, ICILS allows comparisons to be made between different education systems, as well as examining the level of digital and information literacy within countries. The basic aim of ICILS is to provide information and to enable understanding of the ICT domain in order to promote the development of school programmes suitable for the digital age. The definition of CIL is as follows: «an individual's ability to use computers to investigate, create and communicate to aiming to participate effectively at home, school, workplace and society» (Fraillon *et al.*, 2019a, p. xvii).

In ICILS 2018, 12 countries[1] and 2 benchmarking countries[2] participated, with a total of 46,651 students and 26,530 teachers from 2,226 schools. The assessment also included the Computational Thinking (CT) competency, an optional component assessed in 9 of the 13 participating education systems. In 2018, Italy only participated in the main component (CIL).

Students'scores on the Computer and Information Literacy (CIL) scale were divided into five levels (Fig. 1).

The instruments used for data collection were:
– student computer-based test of digital and information literacy;
– Student Questionnaire, which includes questions on economic characteristics, use of information technology and attitudes towards ICT;
– School Principal Questionnaire, which describes the general characteristics of the school, the policies regarding the use of ICT and their perceived value;
– Teachers Questionnaire, which explores their experiences, the difficulties and the propensity to use computers in teaching;
– Digital Animator Questionnaire, which assesses the ICT infrastructure and support available to teachers.

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[1] Chile, Denmark, France, Finland, Germany, Italy, Kazakhstan, Luxembourg, Portugal, Republic of Korea,United States of America, Uruguay.
[2] Benchmark: Moscow and North Rhine-Westphalia.
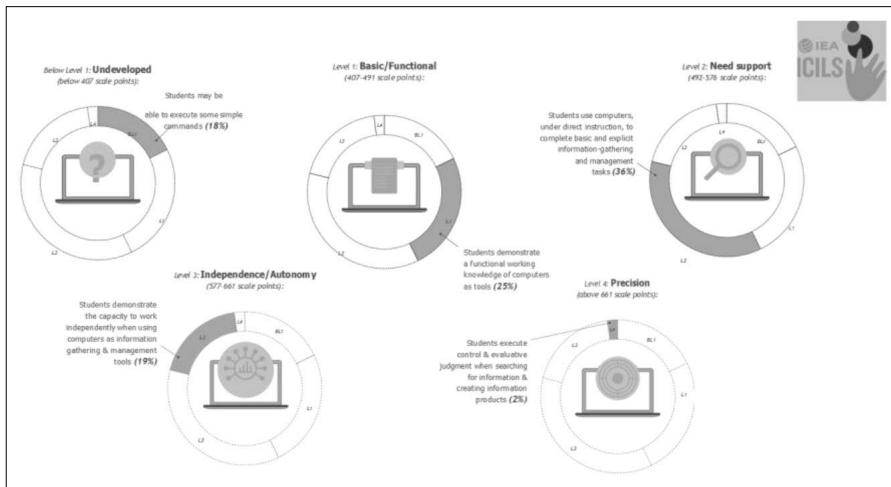
Fig. 1 – The levels on the digital literacy scale

Source: IEA (2019)

3. Objective of the research

The aim of the study was to analyze the Italian ICILS 2018 data, collected by INVALSI in collaboration with the IEA, in order to understand if and to what extent digital skills are useful for improving Italian and Mathematics learning, collected by INVALSI for the national survey.

Thus, the aim of this work is to investigate the significance and strength of the impact of italian students' digital and information skills (CIL index) on their performance in INVALSI Mathematics and Italian, controlling for the effect of other factors usually related to performance in Italian and Mathematics, such as student's gender, Geographical Area and socio-economic cultural background (SES index).

In order to assess the impact of the socio-economic aspects of the students' families, we used the index constructed by INVALSI, specifically the constructed bands (Low, Medium Low, Medium High, High).

Based on these premises, the research questions developed in this article are as follows:

– What are the digital and information literacy competences in the italian context?
– When comparing the results in Italian and Mathematics collected by the INVALSI national survey and the digital competences collected by the IEA survey, what connection does the student's gender or geographical origin have?
– What is the relationship between the results in Italian language and Mathematics collected by the national INVALSI survey and the digital literacy results collected by the IEA survey?
– What characteristics of students' background, familiarity and skill in using computers are related to students' performance in Italian and Mathematics?
– Is there a correlation between the national assessment score and the index of ICT use at school?

4. Sample

In the 2018 edition of ICILS, Italy participated for the first time.

The italian students sample includes 2810 students and 146 schools, about 20 students were randomly selected from 150 schools sampled using the Probability Proportional to Size method. The sample is 53.3% males and 46.7% females, 10.3% of the students have a migrant background, 3.1% first generation and 7.2% second generation.

Starting from the sample in ICILS, we carried out a first match retrospectively with the INVALSI Italian and Mathematics test in grade 8 (2017/2018), using as key variable a longitudinal code for students ("SIDI INVALSI").

Students who took part in all the tests were the reference population. Only 42 students could not be found in the INVALSI dataset, so the sample is 2,768.

The territorial area can only be represented for the 3 macro-geographical areas, as the complex sample design makes this representation possible: North with 64 schools, Centre with 28 schools and South with 54 schools.

5. Data and methods

Statistical analyses were conducted using[3] the IEA's International Database (IDB) Analyzer (IEA, 2020) with SPSS (IBM Corporation, 2016) and following the IEA recommendations for analyzing ICILS data (Fraillon *et al.*, 2020; Mikheeva and Meyer, 2020).

The international surveys promoted by the IEA report student performance using plausible values. Rasch object response theory was used to derive a cognitive scale from the data collected, and the psychometric properties of the scale were consistent across countries.

Not all questions were asked of all students, so to control for bias, a set of five plausible values was calculated for each student with an associated estimated probability. The mean of the five plausible values is used to estimate the meaning of the population of students. The two scale scores were standardized with a mean of 496 and a standard deviation of 100. Furthermore, the psychometric scale was described in terms of four levels of competence. Each level referred to the characteristics of students' use of computers to access and use information and to communicate with others (Fraillon *et al.*, 2020).

The first analyses carried out were descriptive analyses of students' performance in digital, Italian and Mathematical Literacy in order to highlight the extent of the gap between geographical area and gender. In addition, the descriptive analyses explore further questions about the use of technology in school.

It was decided to use linear regression models to understand whether and to what extent digital Literacy can improve national skills and the influence of socioeconomic status, gender and macro area, and to estimate the extent to which the interaction of these variables has a cumulative effect. The linear regression used allowed testing the effect of a given predictor (bn) net of the proportion of variability in the dependent variable explained by the other explanatory variables. Thus, the partial regression coefficient associated with each independent variable represents the average change that can be expected to be

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[3] The IEA IDB (International Database Analyzer) is a free software tool which can be used to combine and analyze data from all IEA's large-scale assessments (www.iea.nl/data-tools/tools).

observed for a unit increase in one predictor, holding all other predictors constant.

Tab. 1 – Scheme of variables included in the analysis

Dependent variable:
– Student's INVALSI score
Explanatory variables:
– Student's cultural and socio-economic background index (ESCS)
– Student's digital skills index (CIL)
– Student's gender
– Student's macro-area of origin

The variable Student's INVALSI score in Italian and Mathematics is the Rasch score obtained by the student at the end of grade 8 in 2018 (which is directly related to the level of proficiency achieved).

6. Some important results

Figure 2 shows the international CIL average and the scores of the participating countries. The best performing students are those from Denmark, the Republic of Korea, Finland, Germany and Portugal with scores of 553, 542, 531, 518 and 516 respectively.

Italian students obtain a score of 461, well below the international average. It should be noted that the italian students participating in the survey took the test at the beginning of grade 8, while the students from the other countries took the test towards the end of grade 8.

The national averages lead one to reflect on the level of skills acquired by the students. The results reflect a problematic overall situation (Fraillon *et al.*, 2019b), as can be seen in the percentages of students who achieved the different levels of skills:
– level 1: only 25% of students had only functional knowledge of using a computer as a tool; 18% of students were below the minimum level, who were unable to create digital information products and without functional knowledge of using a computer as a tool;
– level 2: 36% of students were able, after instruction, to use the computer for simple information gathering and to use basic management tools;

- level 3: 19% of students were able to work independently in finding information and using computer management tools;
- level 4: 2% of students were able to carry out checks and make judgments when searching for information and while creating information products.

Country	Average Age	CIL Achievement Distribution	Average CIL score		ICT Development Index Score (and Country Rank)
Denmark††¹	14,9		553 (2,0)	▲	8.71 (4)
Korea, Republic of	14,2		542 (3,1)	▲	8.85 (2)
Finland	14,8		531 (3,0)	▲	7.88 (22)
Germany	14,5		518 (2,9)	▲	8.39 (12)
Portugal††¹	14,1		516 (2,6)	▲	7.13 (44)
France	13,8		499 (2,3)		8.24 (15)
Luxembourg	14,5		482 (0,8)	▼	8.47 (9)
Chile	14,1		476 (3,7)	▼	6.57 (56)
Uruguay	14,3		450 (4,3)	▼	7.16 (42)
Kazakhstan¹	14,3		395 (5,4)	▼	6.79 (52)
ICILS 2018 Average	14,4		496 (1,0)		
Testing at the beginning of the school year					
Italy	13,3		461 (2,8)	▼	7.04 (47)
Not meeting sample participation requirements					
United States	14,2		519 (1,9)		8.18 (16)
Benchmarking participants meeting sample participation requirements					
Moscow (Russian Federation)	14,8		549 (2,2)	▲	7.07 (45)2
North Rhine-Westphalia (Germany)	14,4		515 (2,6)	▲	8.39 (12)3

▲ Achievement significantly higher than ICILS 2018 average
▼ Achievement significantly lower than ICILS 2018 average

Fig. 2 – Country averages for CIL, average age, CIL score and percentile graph

Notes: ICT Development Index score and country rank data relate to 2017 and were collected form the International Telecommunication Union. Source: http://www.itu.int/net4/ITU-D/idi/2017/index.html (13/5/19)
() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent
Met guidelines for sampling participation rates after replacement schools were included
National Defined Population covers 90% to 95% of National Target Population
Data relate to all Russian Federation
Data relate to all of Germany

Source: IEA (2019)

Country	Below Level 1 (fewer than 407 scale points)	Level 1 (from 407 to 491 scale points)	Level 2 (from 492 to 576 score points)	Level 3 (from 577 to 661 scale points)	Level 4 (above 661 scale points)
Chile	20 (1.7)	34 (1.3)	36 (1.6)	10 (1.0)	0 (0.1)
Denmark†¹	3 (0.4)	14 (0.9)	45 (1.3)	36 (1.5)	3 (0.5)
Finland	8 (0.9)	20 (1.1)	43 (1.3)	27 (1.4)	3 (0.4)
France	13 (1.0)	30 (1.2)	40 (1.2)	15 (1.0)	1 (0.2)
Germany	10 (1.1)	23 (1.3)	43 (1.2)	22 (1.1)	2 (0.5)
Kazakhstan¹	54 (2.1)	27 (1.4)	15 (1.1)	4 (0.8)	0 (0.3)
Korea, Republic of	9 (0.7)	19 (1.2)	32 (1.4)	32 (1.6)	9 (0.8)
Luxembourg	19 (0.5)	32 (0.7)	38 (0.7)	11 (0.4)	0 (0.2)
Portugal††¹	7 (0.9)	27 (1.2)	46 (1.1)	19 (1.2)	1 (0.4)
Uruguay	33 (1.6)	29 (1.3)	27 (1.5)	9 (1.0)	1 (0.2)
Average ICILS 2018	18 (0.4)	25 (0.4)	36 (0.4)	19 (0.4)	2 (0.1)
Testing at the beginning of the school year					
Italy	24 (1.3)	39 (1.2)	30 (1.2)	7 (0.7)	0 (0.1)
Not meeting sample participation requirements					
United States	10 (0.6)	24 (0.8)	41 (0.7)	23 (0.8)	2 (0.3)
Benchmarking participants meeting sample participation requirements					
Moscow (Russian Federation)	3 (0.6)	15 (1.2)	44 (1.4)	34 (1.3)	3 (0.4)
North Rhine-Westphalia (Germany)	8 (1.2)	28 (1.4)	44 (1.5)	19 (1.1)	2 (0.4)

Fig. 3 – Percentage of students at each level of the digital literacy scale in ICILS 2018

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent

Met guidelines for sampling participation rates after replacement schools were included

Nearly met guidelines for sampling participation rates after replacement schools were included

National Defined Population covers 90% to 95% of National Target Population

In Figure 3, the 0 value of Italian students at level 4 is alarming, no students reach the highest level, and only a small percentage reach level 3, 7% compared to 19% of the ICILS average.

Looking at the results obtained by the students of the 3 areas in the different levels of competence of the CIL, most of the students fall below level 2, while only a negligible percentage of the students reach high levels.

Almost 73.4% of students in the South do not reach the average level (35.1% at level 1 and 38.3% at level 2); in the same geographical area only 0.1% have advanced levels of competence.
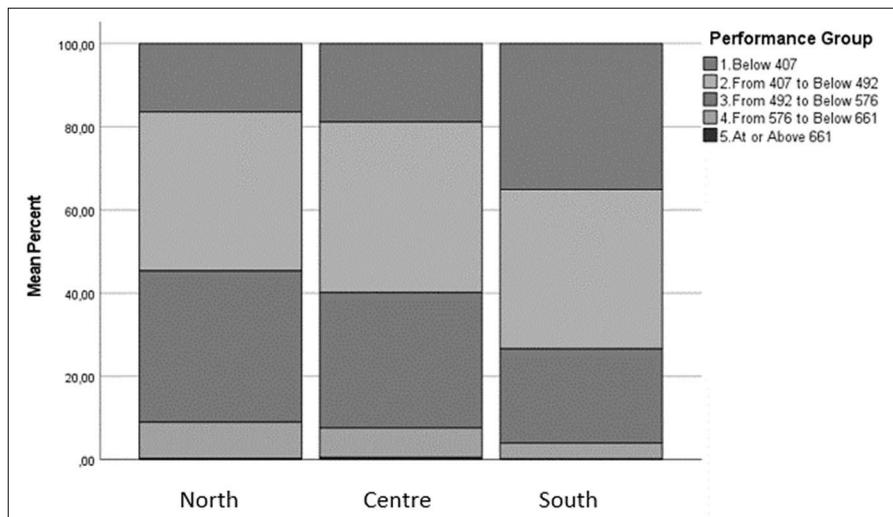
Fig. 4 – Percentage of students at each level of the digital literacy scale in ICILS 2018 by geographical area

When analyzing the results obtained by italian students, we immediately notice that the territorial gap is always predominant: the North obtained 479 points, Centre 471 points and South 436 points (see Fig. 5).

The score obtained by students residing in Northern Italy is significantly higher than the national score, while students in the South score significantly lower than the national average.
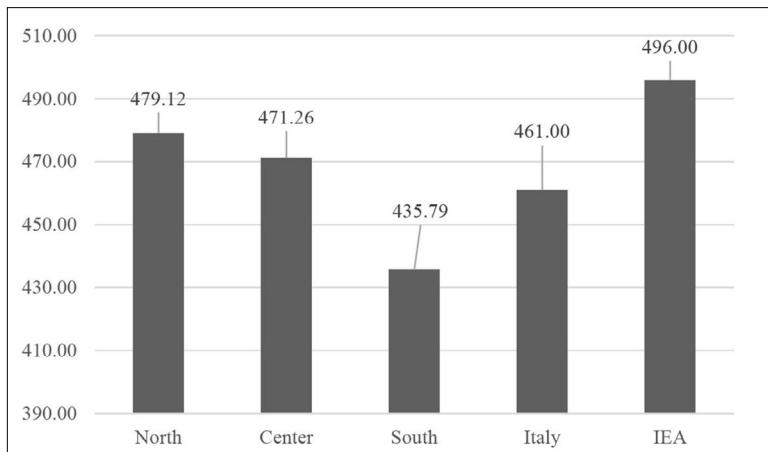
Fig. 5 – Averages for CIL by geographical area in Italy

The following graph, Figure 6, is interesting because it shows that girls score higher on average than boys, regardless of the macro-area they belong to; this is an interesting aspect because normally and traditionally, girls score lower on average than boys in Mathematics.

Girls performed better in digital Literacy, as ICILS measures students' ability to use computers to collect and manage information and to produce and share information; girls are on average more proficient in these skills than boys (Figure 6).
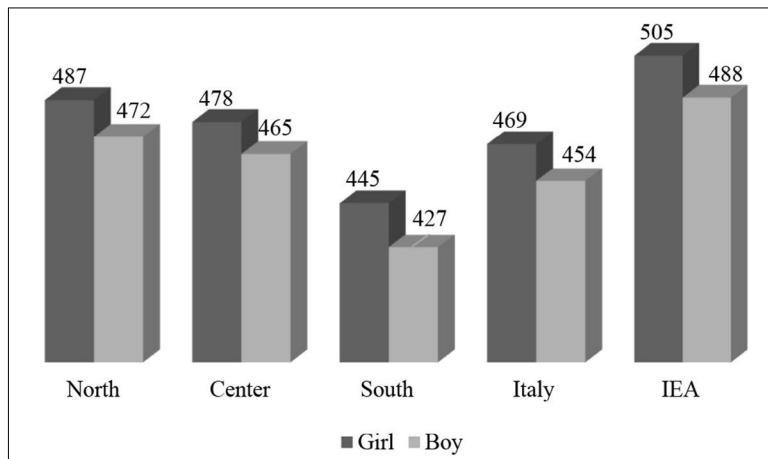
Fig. 6 – Averages for CIL by geographical area and gender in Italy

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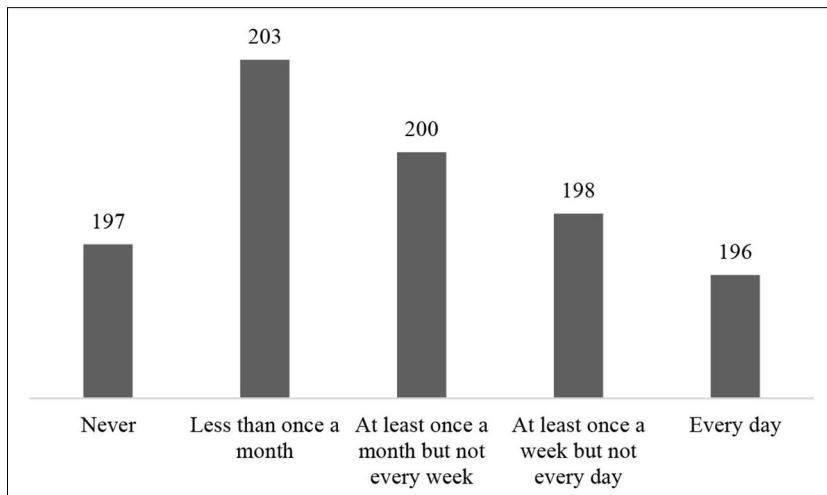
Fig. 7 – Student questionnaire ICILS "How often do you use ICT in these places?" – Item "Outside of school for school-related purposes" and score Mathematics INVALSI
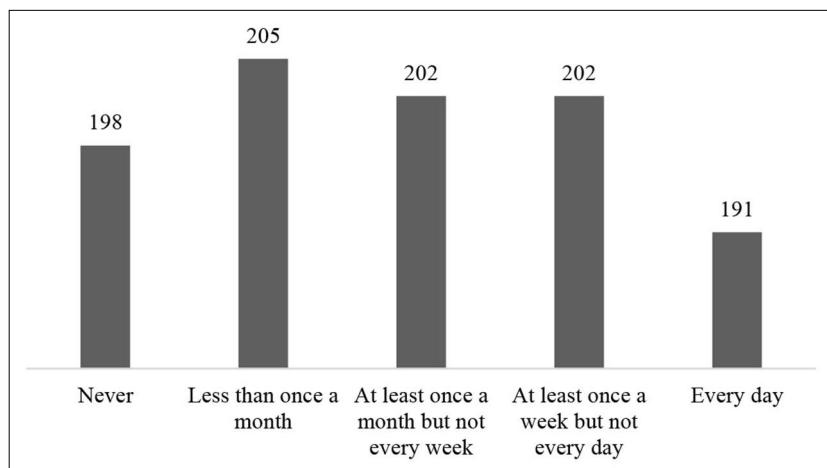
Fig. 8 – Student questionnaire ICILS "How often do you use ICT in these places?" – Item "Outside of school for school-related purposes" and score italian INVALSI

In order to analyze whether digital competence correlates with performance in Italian and Mathematics, the question on the use of digital technologies in the places most frequented by students was

analyzed. This question included a response scale from "never" to "every day". One of the most important items in terms of ICT use was the "Outside of school for school-related purposes", so that reason, this item was compared with the results obtained by students in the Mathematics and Italian sections of the INVALSI tests. From the "never" responses, the results show that ICT use does not increase digital literacy (Figures 7 and 8).

Surprised by the results of the descriptive analysis, an indicator on the use of ICT for school purposes was therefore calculated in order to better understand the extent to which it might be related to learning in Italian and Mathematics. The indicator was constructed on the basis of the answers to the question "How often do you use ICT for the following school purposes?". Figure 9 shows the results of the correlation between students' scores in Italian and Mathematics in the INVALSI tests and the index. Interpreting these data, there seems to be a negative correlation between the index on the ICT use for school purposes and INVALSI scores in both Italian and Mathematics. In other words, it seems that students who use ICT less for school purposes score higher on INVALSI tests in Italian and Mathematics.

|	*INVALSI Italian score*	*INVALSI Mathematic score*
Index "Using ICT for school-related purposes	-.126**	-.093**

Fig. 9 – Correlation between use of ICT index and INVALSI scores in Italian and Mathematics

In order to better understand the possible relationship between students' characteristics in terms of Italian and Mathematical competence and CIL in more detail, three types of regression models were used, with the results in Italian and Mathematics as dependent variables and the independent variables Digital skills, Economic, Social and Cultural Status index, Gender and Geographical Area (Fig. 10). We have chosen the variables that have been found to be most influential in national and international research. The variables have been standardized to allow cross-comparisons to be made, so that the impact (unitary) can be assessed in terms of standard deviation.

The three regression models were per subject:
- the first regression model has three explanatory variables (ESCS index score, gender and geographical macro area);
- in the second model we added the variables related to the CIL digital literacy index;
- in the third model there are only the three variables with the most predictive values are included.

The explained variance increases from 17% in model 1 to 37% in model 2; the main positive factors for the first model are the student's ESCS, for the second model it is the CIL digital literacy index.
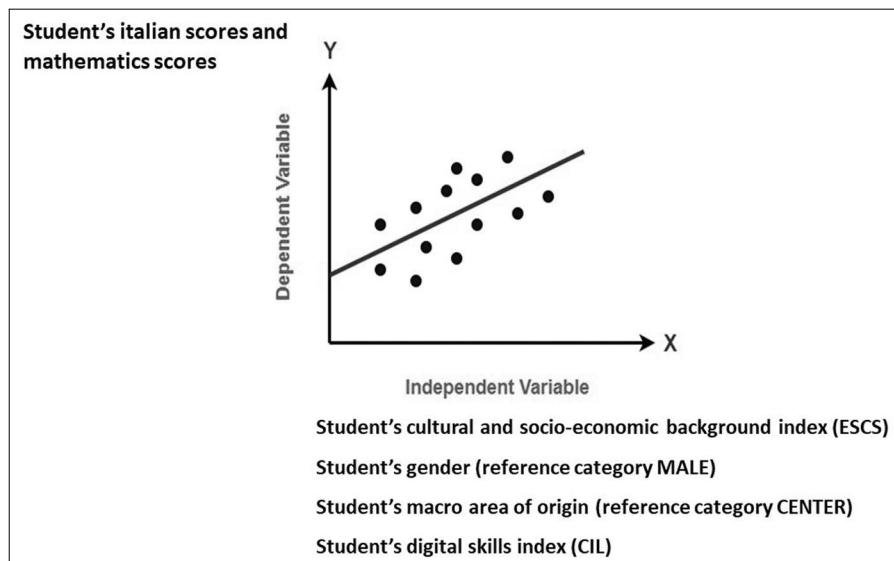
Fig. 10 – Linear regression analysis INVALSI scores and in Italian and Mathematics

Analyzing the data with the italian INVALSI results, the results suggest that ESCS_STUDENT, GENDER_D1 (D1 is girl) and CIL are all significant variables in predicting the value of the dependent variable (Fig. 11)[4].

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[4] The geographical variables included in the regression are North (D1), Centre (D2) and South (D3).

1st model

	Standard coefficient	Standard coefficient (t-value)
ESCS_student	0.34	19.25
Gender_D1	-0.13	7.45
Geogr_area_D1	0.01	0.47
Geogr_area_D3	-0.12	-3.82

2nd model

	Standard coefficient	Standard coefficient (t-value)
ESCS_student	0.22	12.55
Gender_D1	-0.09	-61
Geogr_area_D1	-0.01	-5.62
Geogr_area_D3	-0.04	-1.47
CIL	0.5	31.78

3rd model

	Standard coefficient	Standard coefficient (t-value)
ESCS_student	0.23	13.15
Gender_D1	-0.09	-5.6
CIL	0.5	30.49

Fig. 11 – Linear regression analysis – INVALSI scores Italian

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1st model

	Standard coefficient	Standard coefficient (t-value)
ESCS_student	0.3	16.47
Gender_D1	-0.04	-2.29
Geogr_area_D1	0.07	2.08
Geogr_area_D3	-0.14	-4.12

2nd model

	Standard coefficient	Standard coefficient (t-value)
ESCS_student	0.19	10.98+5.15
Gender_D1	0.09	1.12
Geogr_area_D1	0.05	-1.97
Geogr_area_D3	-0.06	30.14
CIL	0.49	31.78

3rd model

	Standard coefficient	Standard coefficient (t-value)
ESCS_student	0.2	11.25
Gender_D1	0.09	5.1
CIL	0.51	30.18

Fig. 12 – Linear regression analysis – INVALSI scores Mathematics

In the three models the results obtained with Mathematics scores mirror those in Italian: ESCS_STUDENT, GENDER_D1 and CIL are all significant variables in predicting the value of the dependent variable, the Mathematics score (Fig. 12).

In ICILS the questions were asked about the use of technological tools for school, and the results show that daily use does not contribute to improving digital literacy. However, if ICT were used as an educational technology resource in school, it would also help to improve performance in Italian and Mathematics.

7. Concluding remarks

In recent years, information and computer technologies have had a profound impact on our lives, work and social interactions. ICILS addresses the basic knowledge, skills and understanding that students need to succeed in this dynamic information environment. Participation in ICILS provides countries with reliable and comparable data on the development of young people's digital literacy in the 21st century.

The results of ICILS showed that, although students were digital natives, they had not achieved sophisticated digital skills. Being a digital native did not mean being a digital expert; young people did not automatically develop advanced digital skills simply by growing up using digital devices.

The 2018 cycle showed that while most students reached the minimum level of basic software knowledge, only 2% reached the highest level, demonstrating the ability to apply critical thinking skills when searching for information online.

Our study shows a relationship between the mathematical skills measured by the INVALSI tests and the ICILS digital skills, which is an interesting topic that deserves further investigation. Certainly, the study could produce even clearer and more specific results with computational thinking skills.

In conclusion, this is a preliminary work and there are some important questions that we want to consider in the next future.

We will conclude the presentation by answering the two research questions we posed.

Are digital skills a crossroads of inclusion for education? Yes, the contribution of digital skills, all other variables being equal in the regression model, is significant, in fact there is a significant increase in skills in Italian and Mathematics as digital skills increase. It is now well known how important digital skills are for the world of work and for active citizenship in today's society. And we have seen how important they can be for academic performance.

Are digital skills a crossroads for innovation? In ICILS asked about the use of technology tools in school, and the results show that daily use does not help improve digital skills. The role of schools in the developing CIL is important, as these skills need to be integrated into teaching and learning. The countries with the best CIL scores have the highest percentage of students attending schools where they frequently learn and practise ICT tasks; these schools have adequate infrastructure, teaching materials and professional support for teachers. Most likely if ICT were used as an educational technology resource in school, it would also help to improve performance in Italian and Mathematics.

Future perspectives of this study will include analyzing the reinforcing effect of other forms of parental involvement later on and a better understanding of parental characteristics that favour early literacy parent-child activities (e.g. working conditions).

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These papers were presented at the eighth edition of the "INVALSI Data: A Tool for Teaching and Scientific Research" seminar (Rome, 23–26 November 2023).

Taken together, these contributions offer a comprehensive and up-to-date overview of some of the key challenges currently facing the education system. As a statistical service, we hope that this volume will be of interest to researchers, educators, and anyone concerned with the functioning and improvement of the school system.

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