# Teachers' Pedagogical Autonomy, Professional Development and Students' Digital Skills: *New Evidence from Italy*


## Abstract

In light of the recent education reforms in Italy (*La Buona Scuola, Law 107/15)* featuring autonomy and digital skills, this paper examines the impact of teachers' pedagogical autonomy on students' computer literacy. The empirical analysis is conducted using data from the latest cycle of the *International Computer and Information Literacy Study* (ICILS 2018) in which Italy participated for the very first time. Our results show that teachers' pedagogical autonomy in itself is not significantly associated with students' digital skills, but that when combined with certain types of professional development, it can positively influence students' computer literacy. Based on our results, we argue for more localised resources and opportunities to be used for teachers to engage in reciprocal professional development via spontaneous peer support and learning over top-down standardised professional development programmes.



## Keywords

Teacher pedagogical autonomy, decentralisation, digital skills, computer literacy, professional development, student achievement, Buona Scuola, ICT


## Introduction

The *The Buona Scuola* or The Good School reform (La Buona Scuola, 2015, Law 107/15) was introduced in 2015 to address the prevailing challenges in education and to transform it into an effective education system. The act underpinning the reform includes several measures related to autonomy, recruitment of new teachers, the introduction of a merit-based component to teachers' salaries, mandatory teacher development practices, and the development of digital innovation and skills in schools. These measures are expected to improve the educational outcomes of students.

Some key initiatives of the reform are summarised as follows,

- Granting more autonomy to schools
- Students are given more educational choices covering both traditional subjects (e.g. music and arts) and future-oriented subjects (e.g. foreign languages and computer and

information literacy). High schools are encouraged to establish optional subjects that better respond to students' diverse educational needs.

- Incentivizing teachers and principals to improve school performance
- Allocating specific resources to teacher training
- Improving students' digital skills to better prepare them for the future

The changes brought to the Italian education system have been met with a mixed response. However, There has not been sufficient scrutiny of the existing body of empirical evidence and there is a lack of deeper contextual engagement in formulating some of the strategies within the reform, and also in criticising various aspects of reform.

One of the central topics of the reform is the autonomy of school principals and, to some extent, teachers. There is not, however, solid evidence to demonstrate that autonomy is positively associated with school outcomes (Xxxx *et al.* 2020). In fact, some studies have highlighted the negative effects of autonomy on other proximate factors (e.g. teacher attendance, motivation, and stress) which might, in turn, affect student achievement (Bardhan and Mookherjee 2006; Lucia and Cristian 2010). Empirical studies show ambiguous results concerning the effects of autonomy and its effective implementation is argued to be dependent on the context where it is implemented (Hanushek, Link and Woessmann 2013; Faguet and Sanchez 2008, Treisman 2007).

The reform (La Buona Scuola, 2015, Law 107/15) lays out incentive structures but there seems to be little support based on previous empirical research. There are some lessons that could be learned from the countries which have used incentives such as performance-based pay, merit-based pay, test score-based accountability to improve the quality of education. Scholarly literature points out these incentive structures have paved way for other problems, many unintended consequences and wider levels of inequality (Murnane and Cohen 1986; Ballou 2001; Lavy 2007; Darling-Hammond 2007; Ryan 2004; Neal and Schanzenbach 2010; Stecher and Barron 2001; Jones and Egley 2007).

The present research has novelty also because most large scale international comparative studies, including PISA, TALIS, and PIRLS, as well as smaller-scale national studies, narrowly measure students' academic achievements in literacy and numeracy (e.g. Bevel and Mitchell 2012; Feyisa *et al.* 2016; Hou *et al.* 2019). Very few studies examined a key competence for

the 21st century, computer and information literacy. This study aims to identify the relationship between teachers' pedagogical autonomy and students' computer and information literacy performance and how two forms of teachers' professional development (structured learning and reciprocal/peer to peer learning) moderate this relationship.

This article starts with a literature review on key concepts, including teachers' pedagogical autonomy, teachers' professional development, and computer and information literacy. This is followed by the methodology section in which we present the data collection and analysis strategies. The results section delineates the relationship between Italian teachers' pedagogical autonomy and students' computer and information literacy performance as well as how teachers' professional development moderated this relationship. Lastly, we discussed our findings in relation to previous studies conducted in other countries to unpack the complex relationships among teachers' pedagogical autonomy, professional development, and students' digital skills.

## Literature review

### *Teachers' Pedagogical Autonomy*

Earlier studies have shown that teachers need autonomy to gain intrinsic motivation and to sustain their psychological wellbeing (Skaalvik and Skaalvik, 2014). According to Wilches (2007), the narrow pedagogical autonomy can be conceptualised as teachers' freedom to design classroom teaching and student assessment, while other key pedagogical works, such as curriculum development and teachers' professional learning, fall out of these conceptual boundaries.

By contrast, a broad definition of teachers' pedagogical autonomy refers to teachers' freedom to define teaching goals, compile teaching materials, select pedagogical methods, utilising resources, and design student assessment that complies with teachers' teaching philosophy and beliefs (Skaalvik and Skaalvik, 2014). According to this broad definition, with the given autonomy, teachers do not only have the freedom to teach in the style that matches their values and philosophy, but also have the liberty to refuse the pedagogical materials, methods, and demands that they do not feel comfortable with.

In a Norwegian study, Mausethagen and Mølstad (2015) examined how teachers' pedagogical autonomy was reconceptualised together with the curriculum reform. They found that when Norway started to adopt a more product-oriented curriculum, teachers' autonomy was redefined as "pedagogical freedom and absence of control, the will and capacity to justify practices, and a local responsibility" (Mausethagen and Mølstad 2015, 30). This multidimensionality of pedagogical autonomy implies that teachers' professional knowledge and work ethics should be coupled with freedom of self-governance and the right to professional development.

In terms of accountability, earlier studies that examined the effect of teachers' pedagogical autonomy on students' academic achievement have shown some positive results. After analysing the PISA 2015 data, Bédard (2015) found that teachers' pedagogical autonomy, together with school leaders' accountability, influence students' achievement scores across 65 countries. Similarly, Gurganious (2017) argued that there was a positive association between science teachers' perceptions of autonomy and district-level student achievement scores. Teachers who have a responsibility in decision making at the classroom level are found to be more effective to improve students' academic performance (Khodabakhshzadeh *et al.* 2018; Berry *et al.* 2010; Hulpia *et al.* 2009).

The above findings suggest that teachers' pedagogical autonomy tends to enhance students' academic performance via an in-between mechanism. According to a meta-analysis study, when teachers form a professional learning community within the school, they exert a small but significant positive impact on student achievement (Lomos *et al.* 2011). This calls for more research to scrutinise the relationship between teacher's pedagogical autonomy and professional development.

*Teachers' Professional Development*

As teachers' professional knowledge and skills invariably affect the quality of teaching, and thereby, students' learning, teachers' professional development occupies a central role in improving education quality. Existing literature suggests a strong connection between teacher proficiency and student accomplishments (Egalite *et al.* 2015; Marchand and Weber 2015; Tucker 2011). According to Phillips (2008, 37), "*most would surely agree that quality teachers*

*can only improve student outcomes*". Desimone's (2009) study shows that effective professional development improves teaching practices in classroom settings. According to Elmore and Burney (1997), teacher professional development should essentially cover three areas. Firstly, it should allow teachers to apply teaching practices to daily work life. Secondly, it should provide an opportunity for teachers to collaborate and the right to get involved in school-level decision-making. Lastly, it should offer feedback and assessment that help teachers to track their professional development (Elmore and Burney 1997; Ingvarson *et al.* 2005).

There are limited studies exploring the relationship between teacher professional development and student achievement. Darling-Hammond (2000) concludes that the professional development of teachers, which is an indicator of the quality of teachers, is important in students' reading and mathematics achievements after analysing the School and Staffing Surveys (SASS) and National Assessment of Educational Progress (NAEP) across 50 states in the USA. Huffman *et al.* (2003) also found that curricular professional development for mathematic teachers had a significant effect on students' mathematics achievement. In a similar tone, Blank & Alas (2009) also showed that teacher professional development had a significant positive effect on student achievement. Didion *et al.* (2020) conducted a meta-analysis review involving the studies published between 1975 and 2017 and found that teacher professional development has a moderate and statistically significant positive effect on students' reading achievement.

Most of the studies predominantly concentrated only on the subjects of mathematics, science and reading as outcome variables or analysed the teachers who only taught the respective subjects. There is a vacuum in empirical studies which analysed the similar phenomenon of teacher professional development and student achievement scores in the domain of ICT. To fill this gap, we employ ICT related teacher professional development practices and student performance in the context of Italy. This investigation is also of interest because the recent reforms introduced important changes such as compulsory teacher professional development, a teacher appraisal mechanism and a one-off yearly bonus for high-performing teachers (Figueroa *et al.* 2017).

This paper focuses on which teacher professional development type (reciprocal professional development or structured professional development) has an impact on student learning

interaction with teacher autonomy rather than how to improve teacher professional development. Mihajlovic (2019) found that the flexibility of the curriculum (teacher autonomy) appears to have a positive effect on the professional practices of the participants. Loucks-Horsley and Matsumoto (1999) stated that effective teacher professional development would bring about increasing student learning. According to Vangrieken *et al.* (2015), reciprocal professional development (collaboration among teachers) plays a crucial role in developing teacher autonomy as influential collaboration might lead to utilities both for teacher effectiveness and school effectiveness. Furthermore, Bellibas and Gumus (2016) argue that traditional professional development programmes in the formats of structured seminars and conferences should be replaced by more interactive and collaborative approaches such as coaching, networking, mentoring and professional learning communities. Another study that examined teaching and student achievement with 78 secondary school teachers and 2237 students also confirmed the effectiveness of interaction-based pedagogical approach between teachers and student (Allen *et al.* 2011).

TALIS Report (OECD 2019) shows that structured professional development (attending courses, seminars and workgroups) is the most extensive professional development type practised currently in various countries. In Italy, approximately 80% of teachers take part in such professional development activities, and just 25% of teachers participate in reciprocal professional development (peer learning, collaboration, and coaching). On the other hand, across OECD countries, teachers consider that professional development does not help them in developing advanced ICT skills. Teachers also report that they require more exposure and practice in the domain of ICT than in other subjects. In Italy, roughly 68% of teachers have participated in professional development activities related to "use of ICT for teaching" over the past year. It was also reported to the most significant activity than by most of the teachers (OECD 2019).

*Digital Skills*

Digital Skills are understood as the ability or competency of individuals to effectively access, engage, manage and use the Information and Communication Technologies (ICT applications or devices) to achieve the required goals (Binkley *et al.* 2012). It is often referred to using different vocabularies such as digital or ICT literacy, computer or internet literacy, information and communication literacy, tech aptitude and digital competence. With the increasing growth of ICT in every walk of modern life and rampant

automatisation of services, digital skills arguably stand out as one of the most vital skills for the 21st century (Becker *et al.* 2017).

Enhancement in digital skills is linked to growth in human capital and higher employability, and nations' overall productivity and economy. A lack of policy focus on enhancing digital skills or training is reported to meet with increasing levels of inequality of access and returns and a bigger divide between populations (Van Dijk 2006). Improving digital skills is shown to have a positive impact on education and labour market outcomes in the context of Italy (Pagani, L., Argentin, G., Gui, M., & Stanca, L. 2016). Pagani *et al.* (2016)'s study employs quantile regression analysis to demonstrate that focusing on ICT literacy has a positive influence on the academic performance of students from a lower socio-economic background and hence help in bridging inequality.

Grand-Clement *et al*. (2017) make a strong case for the immediate need of focusing on digital and technological skills and for its better integration into formal education. It is also reportedly important to focus on the behaviours, such as resilience, collaboration, and flexibility that are intertwined with the delivery of digital skills (Eckhard *et al*. 2014). Many national governments have been improvising their policies, or pushed, to include digital skills in their school curriculum and to develop capacities (infrastructure, teacher competence levels) to deliver them effectively (Capogna 2018; Derrick *et al.* 2016; European Commission 2013, 2017; OECD 2016).

Consequently, large-scale assessment surveys (such as PISA, ePIRLS), among others, have increasingly started focusing on measuring digital skills (OECD 2014). The definitions among various surveys espouse the same concept in essence but vary in the selection of concrete indicators based on the participating countries and their conceptual frameworks (Fau and Moreau 2018). ICILS (2013) was one of the prominent cross-national assessments which exclusively focused on capturing digital skills by measuring Computer and information literacy (CIL). CIL is defined as "*an individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and society.*" (Fraillon *et al.* 2013, 17). This measure is employed in the current study to draw inferences on what are the factors that can potentially improve or hinder students' digital skills.

As Italy participated in this large-scale assessment study (ICILS) for the first time, it provides a unique window to assess the state of students' digital skills and that factors that influence them. In investigating the concepts and issues discussed as a part of the review, this study is significant as it employs nationally representative data which allows for generalisability of the findings. This aspect is important to stress because it allows for scalability of practices that are effective in improving achievement levels. This study is also arguably unique as the focus is laid on digital skills instead of testing the usual cognitive skills and knowledge in subjects.

# Research questions

To fill the above-mentioned research gaps, this study aims to answer the following questions.

- In the context of Italy, how is teachers' pedagogical autonomy linked to student's computer and information literacy achievement?
- How does teachers' professional development affect the relationship between teachers' pedagogical autonomy and students' computer and information literacy achievement?

# Methods

## Data and Sample

This study uses data from the International Computer and Information Literacy (ICILS) survey to answer the research questions. ICILS is a quinquennial survey conducted by the International Association for the Evaluation of Educational Achievement (IEA) since 2013. The main aim of ICILS (2018) was to capture the eighth-grade students' competence levels with regard to the use of information and communication technology (ICT) and their prospect of capitalising on their digital skills in terms of their future careers (Fraillon *et al.* 2019). The survey was implemented in 12 countries including Italy.

It uses a two-stage cluster sampling strategy where schools are chosen, in the first stage, using probability proportional to size (PPS) sampling based on the student enrolment rates. In the second stage, 20 students from eighth grade, within each sampled school, were selected using random sampling (Fraillon *et al.* 2019). In the context of Italy, 146 schools, 1754 teachers and 2810 students were part of the assessment survey. The survey questionnaires covered many aspects of student background, their behavioural traits, teacher characteristics, their challenges and working culture, and school-level factors.

## Variables

The outcomes variable used in the study is Computer and Information Literacy Scores (CIL). These CIL scores measure the student preparation levels and skills that are imperative for effective participation in the digital age (Mikheeva and Meyer 2020). These scores, for each student, are obtained by scaling the individual student responses to the test items using item response theory (IRT). The scaling approach also involves five imputations of the achieved scores. The imputed scores are the predicted scores (plausible values) given the students based on their pattern of answering. In answering the research questions which involves the outcome variable, the analysis is replicated five times using each plausible value at a time to obtain a composite final estimate including the error. The final reporting scale was chosen to have a mean of 500 and a standard deviation of 100 across all countries (IEA International Computer and Information Literacy Study 2018 International Report, 55).

The explanatory and control variables, both observed and latent (composing items), in this study, that are included in the analytical strategy are listed in detail below.

Table 1. *Indicators Used in this Study from ICILS 2018*

| Variables/Scales | Description | Items |
|---|---|---|
| T_PROFREC | Teacher participation in reciprocal learning professional development related to ICT | How often have you participated in any of the following professional learning activities in the past two years?<br>• *IT2G17D:* Observations of other teachers using ICT in teaching<br>• *IT2G17E:* An ICT-mediated discussion or forum on teaching and learning<br>• *IT2G17F*: The sharing of digital teaching and learning resources with others through a collaborative workspace<br>• *IT2G17G:* Use of a collaborative workspace to jointly evaluate student work<br>(1=Not at all, 2=Once only, 3=More than once; recoding 1=0, 2=1, 3=2). |
| T_PROFSTR | Teacher participation in structured learning professional development related to ICT | How often have you participated in any of the following professional learning activities in the past two years?<br>• *IT2G17A:* A course on ICT applications (e.g., word processing, presentations, internet use, spreadsheets, database)<br>• *IT2G17B:* A course or webinar on integrating ICT into teaching and learning<br>• *IT2G17C:* Training on subject-specific digital teaching and learning resources<br>• *IT2G17H:* A course on use ICT for [students with special needs or specific learning difficulties] |

| | | |
|---|---|---|
| | | • *IT2G17I:* A course on how to use ICT to support personalized learning by students<br><br>(1=Not at all, 2=Once only, 3=More than once; recoding 1=0, 2=1, 3=2). |
| T_RESRC | Availability of computer resources at school | To what extent do you agree or disagree with the following statements about using ICT in teaching at your school?<br>• *IT2G14B* My school has sufficient ICT equipment (e.g., computers)<br>• *IT2G14C* The computer equipment in our school is up to date<br>• *IT2G14D* My school has access to sufficient digital learning resources<br>• *IT2G14E* My school has good connectivity to the Internet<br>• *IT2G14F* There is enough time to prepare lessons that incorporate ICT<br>• *IT2G14G* There is sufficient opportunity for me to develop expertise in ICT<br>• *IT2G14H* There is sufficient technical support to maintain ICT resources<br><br>(1=Strongly agree, 2=Agree, 3=Disagree, 4=Strongly disagree; recoding 1=3, 2=2, 3=1, 4=0). |
| P_RATTCH | Ratio of school size and teachers | What are the total numbers of full-time and part-time teachers in your school?<br>• *IP2G06A* Total number of full-time teachers<br>• *IP2G06B* Total number of part-time teachers<br><br>To create this scale, the total number of teachers/the total enrolment |
| S_GENEFF | ICT self-efficacy regarding the use of general applications | How well can you do each of these tasks when using ICT?<br>• *IS2G27A* Edit digital photographs or other graphic images<br>• *IS2G27C* Write or edit text for a school assignment<br>• *IS2G27D* Search for and find relevant information for a school project on the Internet<br>• *IS2G27I* Create a multi-media presentation (with sound, pictures, or video)<br>• *IS2G27J* Upload text, images, or video to an online profile<br>• *IS2G27K* Insert an image into a document or message<br>• *IS2G27L* Install a program or [app]<br>• *IS2G27M* Judge whether you can trust the information you find on the Internet<br><br>(1= I know how to do this, 2= I have never done this, but I could work out how to do this, 3= I do not think I could do this; recoding 1=2, 2=1, 3=0). |
| S_NISB | | *S_HISEI* Derived from the highest occupational status of parents |

| | | |
|---|---|---|
| | National index of socio-economic background | *S_HISCED* Highest educational level of parents<br>*S_HOMLIT* the number of books at home<br>Scale scores with a mean of 0 and a standard deviation of 1 for equally weighted countries. |
| IP2G08BB | Come from economically disadvantaged homes | Approximately what percentage of students in your school have the following backgrounds?<br>1) 0-10% 2) 11-25% 3) 26-50% 4) > 50% |

Source: Adapted from Fraillon *et al.* (2020)

The variables (except gender, teacher-student ratio and percentage of students from disadvantaged households) are latent and continuous in nature. They are scaled indices (using IRT) of dichotomous or Likert-type items to have a mean of 50 and a standard deviation of 10 units (Mikheeva and Meyer 2020).

Among the variables listed, the teacher level variables, have been aggregated to the school level including the appropriate weights (WGTFAC3T) (chapter 3, Userguide). The teacher (aggregated) data were merged with school data and student data files using the unique school ID.

In contrast to the variables included in Table 1, the main analysis variable, i.e. Teacher's pedagogical autonomy, is not included in the publicly available ICILS data set. For this reason, we constructed this variable using the following items in the school questionnaire administered to the school principal.

Q 14) Who has the main responsibility for making decisions about each of the following aspects of ICT in this school? *(Please mark one choice in each row)*

| | | *Teacher = 7* | |
|---|---|---|---|
| IP2G12B | The choice of non-digital learning materials | Yes = 1; No = 0; missing = . | *Task 1* |
| IP2G12C | The choice of digital learning materials | Yes = 1; No = 0; missing = . | *Task 2* |
| IP2G12D | The selection of a learning management system | Yes = 1; No = 0; missing = . | *Task 3* |
| IP2G12F | Decisions about whether ICT is used in teaching | Yes = 1; No = 0; missing = . | *Task 4* |
| IP2G12G | The implementation of ICT-based approaches in teaching | Yes = 1; No = 0; missing = . | *Task 5* |
| IP2G12I | The use of ICT-based approaches to assessment | Yes = 1; No = 0; missing = . | *Task 6* |
| IP2G12J | The assessment of students' computer and information literacy | Yes = 1; No = 0; missing = . | *Task 7* |

**Teachers' Pedagogical Autonomy**

Each question was recoded as a dichotomous variable to capture the participation of just the teachers (among other school and non-school actors) in the listed tasks. These seven observed binary items were used to construct the latent variable of teacher autonomy. The latent construct is tested for its goodness of fit using confirmatory factor analysis. This model is estimated using Weight Least Square Mean and Variance Adjusted (WLSMV) estimation using Mplus 7.4 software (Muthén and Muthén, 2015). The model-to-data consistency is determined by the fit measures of Comparative Fit index (CFI) and the Tucker-Lewis index (TLI) and Root-Mean Squared Error of Approximation (RMSEA) as residual fit statistics.

Fit indices for the latent variable of teacher autonomy are found to be, CFI = 0.948, TLI = 0.922 and RMSEA =0.094. This indicates a good fit as the values of CFI and TFI are found to be closer to 1 and RMSEA to be closer to zero. The acceptance of the goodness of fit is guided by the cut-offs [CFI >.90; TLI > .90] and [RMSEA <0.10] as suggested by Hu and Bentler (1999) and Rutkowski and Svetina (2014). In addition to the goodness of fit, the internal consistency of the latent scale is also established by calculating Cronbach's alpha which was found to be 0.76 (Cronbach 1951). After testing for the goodness of fit values of teacher autonomy are predicted with the standardised factor loadings.

## Analytical strategy

Teacher autonomy, along with other variables were set up for modelling the data. As it is the case with most education data sets, observations cannot be treated as independent units because students are clustered into schools. In the case of Italy, the intraclass correlation coefficient is found to be around 0.30. That is, 70% of the differences in student achievement scores can be attributed to differences between schools the students are enrolled into. To account for the clustering effects, hierarchal linear modelling was adopted to conduct the analysis (Goldstein 2011). The student-level covariates were laid on level 1 and school-level characteristics were added to level 2 as shown below.

$$
\begin{aligned}
\text{Score (CIL)}_{ij} = {} & \alpha_0 + \gamma_1(\text{Teacher autonomy})_j + \gamma_2(\text{Participation in reciprocal PD})_j \\
& + \gamma_3[(\text{Teacher autonomy})_j \text{ x } (\text{Participation in reciprocal learning PD})_j] \\
& + \gamma_4(\text{Participation in structured learning PD})_j \\
& + \gamma_5[(\text{Teacher autonomy})_j \text{ x } (\text{Participation in structured learning PD})_j] \\
& + \gamma_6(\text{Computer resources at school})_j + \gamma_7(\text{Ratio of teachers to students})_j \\
& + \gamma_8(\text{Percentage of students from economically disadvantaged homes})_j \\
& + \beta_1(\text{Girl})_{ij} + \beta_2(\text{Socio} - \text{economic background})_{ij} \\
& + \beta_3(\text{Student's ICT self} - \text{efficacy})_{ij} + (e_{ij} + u_j)
\end{aligned}
$$

$$e_{ij} \sim N(0, \sigma_e^2) \; ; \; u_j \sim N(0, \sigma_u^2)$$

Score (CIL) $_{ij}$ refers to the plausible value imputations of achievement score, in the computer and information literacy test, of student 'i' enrolled in school 'j'. $\gamma$ and  represents the unbiased estimates of school level and student-level characteristics. The student-level and school-level variables have been centred around the group mean and the grand mean respectively. Covariates such as the ratio of students to teachers and the availability of ICT resources are added to the model as controls. They are chosen as controls as they are known, based on the literature review, to have a direct influence on achievement scores. Hence, it would help in estimating the distilled and real effect of variables of interest to this study.

The robustness of the study was ensured by accommodating for the features of complex research design deployed in international large-scale assessments. The sampling weights, WGTADJ3S*WGTFAC3S (final student weight and its adjustment) and

WGTFAC1*WGTADJ1S (final school weight and its adjustment) have been added to level 1 (student level) and level 2 (school level) of the model respectively (Mikheeva and Meyer 2020, chapter 3, 28). The model was run for all plausible values available in the dataset.

The analysis is carried out in Stata (StataCorp 16) using Macdonald's (2008) *pv* package (test version 2017-May-16). This package accounts for the five imputed plausible values of computer and information literacy scores. Maximum likelihood estimation (MLE) technique is used in place of restricted (or residual or reduced) maximum likelihood (REML) due to the build and restrictions of the statistical package (Gould *et al.* 2003).

## Results

The data is fitted into the following multilevel models. Model 1 regresses student scores on just the teacher pedagogical autonomy variable. The interaction terms, between autonomy and participation rates in the two types of professional development, are added in models 2 and 3. School and student-level are added to construct the subsequent models. Model 6 represents the full model with all the relevant explanatory and control variables. The table below demonstrates the results of the analysis.

Table 2. *Multilevel Models*

| Dependent variable = CIL scores | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| *Level 2 - School level covariates* | | | | | | |
| Teacher autonomy | 17.75 | 13.94 | 11.79 | 9.53 | 17.58 | 16.4 |
| | (28.83) | (27.12) | (26.39) | (26.36) | (24.12) | (22.75) |
| Reciprocal learning PD | | -0.04 | 0.58 | -0.01 | 1.41 | 1.48 |
| | | (1.1) | (1.25) | (1.41) | (1.29) | (1.27) |
| Teacher autonomy x Reciprocal learning PD | | 7.14 | 8.86 | 8.95 | 13.15** | 13.03** |
| | | (5.46) | (6.08) | (6.41) | (5.95) | (5.76) |
| Structured learning PD | | | -1.14 | -1.25 | -1.86 | -2.07 |
| | | | (1.06) | (1.1) | (1.33) | (1.27) |
| Teacher autonomy x Structured learning PD | | | -2.41 | -2.6 | -4.68 | -4.55 |
| | | | (5.91) | (6.02) | (5.36) | (5.22) |
| Computer resources at school | | | | 0.99 | 1.23 | 1.27 |
| | | | | (0.99) | (1.08) | (1.03) |
| Teacher-student ratio | | | | | 10.81*** | 10.67*** |
| | | | | | (4.04) | (3.94) |
| % of students from economically disadvantaged background | | | | | | |
| 1. Less than 10% = reference category | | | | | | |
| 2. 11-25% | | | | | -24.51** | -24.51** |
| | | | | | (11.65) | (11.04) |
| 3. 26-50% | | | | | -30.92*** | -28.77** |
| | | | | | (11.82) | (11.52) |
| 4. More than 50% | | | | | -44.06*** | -42.65*** |
| | | | | | (11.97) | (11.39) |
| *Level 1 - Student level covariates* | | | | | | |
| Girl | | | | | | 13.51*** |
| | | | | | | (3.76) |
| Socio-economic background | | | | | | 16.44*** |
| | | | | | | (1.89) |
| Student Self efficacy related to ICT | | | | | | 2.66*** |
| | | | | | | (0.18) |
| Constant | 459.7 | 463.5 | 463.31 | 463.23 | 486.72 | 481.21 |
| | (5.2) | (4.54) | (4.3) | (4.22) | (6.07) | (6.11) |
| lns1_1_1 | 3.74 | 3.64 | 3.63 | 3.63 | 3.57 | 3.53 |
| | (0.09) | (0.08) | (0.08) | (0.07) | (0.08) | (0.08) |
| lnsig_e | 4.27 | 4.27 | 4.27 | 4.27 | 4.27 | 4.16 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Observations (n) | 2,735 | 2,704 | 2,704 | 2,704 | 2,063 | 2,011 |

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

The results espouse an interesting pattern concerning the digital skills of eight grade students in Italy. Teachers' pedagogical autonomy in itself is found to have a positive but not statistically significant association with students' digital skills performance (see Table 2, Model 1-6). However, when moderated by teacher's level of participation in reciprocal learning (also known as collaborative or peer learning), teacher autonomy shows a statistically significant positive effect on student achievement (see Table 2, Model 5-6).

Apart from the main findings related to teachers' pedagogical autonomy and this particular ad hoc reciprocal professional development a teacher engages in, the models above help us to decipher or reinstate some interesting trends in the Italian education systems in general. For example, the number of teachers for a given school size can be observed to be very crucial and has a positive effect. The good school reform captures this reality and attempts to fix it by recruiting more teachers (La Buona Scuola, Law 107/15).

Girls tended to outperform boys with respect to digital skills and student self-efficacy was found to be helpful although in a relatively smaller magnitude. One of the factors found to have the strongest association with student achievement is the school SES composition. Schools which are comprised of a majority of students from disadvantaged background significantly underperformed. School composition (average school SES) and socio-economic background of students stand out as core issues that the reform and policies in Italy need to consider in order to make satisfactory progress in improving digital skills.

## Discussion

Among all the participating countries in the ICILS 2018, the performance of Italy appeared very poor (Fraillon et al. 2020, table 3.4, p. 75). The average score of Italy was 461 (standard deviation = 82) which was the lowest compared to all the other European countries and only stood higher than Uruguay and Kazakhstan. The ICT development index which is a strong prerequisite to teaching and learning of skills related to ICT was also found to be lowest in Italy across all participating European countries. These indicators call for immediate introspection and reforms to enhance the quality of education in Italy. In 2015, Italy launched educational reforms to improve the quality of education with a special focus on students' digital skills. With the datasets, we are able to track and evaluate some effects of these reforms. In particular, we have found that teachers' pedagogical autonomy moderated by teachers'

reciprocal professional development in the school context has a positive and statistically significant correlation to students' digital skills performance.

Our findings echo those of authors like Bellibas and Gumus (2016) and Allen and colleagues (2011), who argue that interactive and collaborative approaches seem to be more effective than the more traditional approaches to teacher professional development, such as structured seminars and conferences. Following this line of thinking, to optimise teacher-teacher and teacher-student interactions, the most effective way is to provide localised resources and opportunities for teachers to acquire pedagogical skills through their professional community. Hence, this well explained why, according to our study, the ad hoc reciprocal professional development at the school level appears more effective than pre-planned structured training programmes. This is because the former provides more tailored solutions to specific problems in a particular context whilst the latter offers more generic information and skills regarding teaching computer and information literacy.

Relating to teachers' pedagogical autonomy, a Norwegian study has shown that teacher autonomy positively predicted their engagement and job satisfaction and negatively predicted emotional exhaustion (Skaalvik and Skaalvik, 2014). Importantly, this study also discovered that the association between autonomy and engagement was perceived stronger among teachers with low self-efficacy. This can be interpreted that when teachers are less confident in teaching certain subjects, they rely more on their peer support to model how to use pedagogical autonomy in an effective way. In our study, the Italian students in general performed relatively poorly in computer and information literacy compared to their counterparts in other countries according to the ICILS 2018 data. To develop students' digital skills, Italian teachers need to be highly resourceful. Drawing on our findings, we strongly recommend education authorities in Italy to shift more resources to local schools in addition to providing centralised professional development training to teachers.

To summarise, this study was conducted in the background of the Italian Buona Scuola reforms with a focus only on the aspects of autonomy and digital skills. This study employed the latest ICILS 2018 data to examine the link between teachers' pedagogical autonomy and students' digital skills. The study was also interested in looking at how teachers' professional development interacts with teachers' autonomy in shaping student achievement. These objectives were achieved by constructing multilevel models adding different explanatory and

control variables that are associated with the outcome. The analysis suggests that just granting more autonomy to teachers and schools is not sufficient to significantly shaping students' skills. Also, enforcing or incentivising teachers to participate in professional development alone also would not improve the situation significantly. However, the combination of autonomy and professional development in the form of reciprocal learning could exercise a positive influence on students' computer literacy.

This paper aimed to tackle one of the important knowledge gaps which has direct policy and practical implications concerning the effects of two predominant forms of professional development activities. This study makes a strong case to promote reciprocal learning (peer to peer or collaborative learning) based professional development alongside granting teachers more autonomy in matters of pedagogy. It is significantly beneficial to the schools and students, to facilitate interaction among teachers as part of professional development activities especially when they are responsible for taking decisions concerning's ways and methods of teaching and assessing student learning.

## Strengths and limitations

The results of this study can be generalised to all Italian eight-grade students, their teachers and schools, as the sample is nationally representative. Additionally, our analyses take into account both the complex sample (i.e. sampling weights; stratified, clustered sample design) and complex assessment (i.e. plausible values) design of ICILS.

This study, like others, has its own limitations that cannot be overlooked. The target population of the survey is eighth-grade students, their schools and teachers. One may not infer the same patterns for elementary or higher secondary school populations. Our results, however, remain indicative of the pattern at other educational levels.

Even when we could expect different results for different types of school (e.g. public and private), our results cannot be disentangled at this level. This is because the data on school types is not publicly available owing to issues of anonymity. We have tried to account for these differences by using information on the percentage of children from disadvantaged households enrolled in a given school. We acknowledge that this variable might be partially, but not conclusively, suggestive of the characteristics of the schools. Hence, the observed effects are the average effects across all schools.

The evidence presented here cannot be claimed to be causal in nature or definitively conclusive. However, it helps in generating an important perspective which is strongly grounded in empirical data. This research attempts to throw light on the processes and strength of association of key factors, such as teacher pedagogical autonomy and engagement in reciprocal learning professional development, in shaping students' digital skills. Further research using in-depth qualitative designs can potentially unravel the complex and contextual interactions that shape these outcomes.

Some of the suggestions that could be considered, but ought to be rigorously tested, involve enabling mechanisms to enhance teacher autonomy as, under certain circumstances, it may have a positive effect on student outcomes. These potentially positive effects could be achieved if teachers are well trained and well equipped to deal with, negotiate and implement the latest technological changes and are able to contextualise them in a pedagogic format. In addition, incentivising and motivating teachers to translate autonomy into participation in reciprocal learning and effective collaboration seems to be a mechanism that contributes to improving the overall quality of the education. Along these lines, school climate ought to be developed in a way that it facilitates constructive interactions and teachers collaboration in discussing and addressing pedagogical changes and challenges.

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