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# *Computer and Information Literacy at the eighth grade: differences between boys and girls*

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**Abstract**

In recent decades, ICT has radically transformed our daily lives, work and social relationships, trying to understand how young people are prepared for this new challenge is crucial.

This study investigated the gender differences in International Computer and Information Literacy Study (ICILS) results. Italian students participating in ICILS 2018 (n=2810; mean age:13,3) were considered. The sample was representative of Italian students at the beginning of the eighth grade. Students answered the CIL (Computer and Information Literacy) international questionnaire including questions about students' socio-economic and cultural background, future expectations about ICT usage for work and study, ICT skills to complete a range of different tasks, self-efficacy towards ICT.

A structural equation model (SEM) was adopted to perform a path analysis to test a relationship between student characteristics and CIL performance.

The results evidenced that the relationships between CIL, on one hand, and self-confidence and expectations for the use of ICT for work and study, on the other hand, differ between boys and girls. Moreover, self-efficacy mediates the variables' effects for the girls: a higher level of self-efficacy reinforces the relationship between ICT Learning and CIL.

On the basis of the results, some possible implications for the Italian school system are discussed.

**Keywords**: ICILS, gender differences, computer literacy

## Introduction

In recent years, Information and Communication Technologies (ICT) have radically transformed our daily lives, our work, and our social relations. Digital skills have increasingly acquired a key role in the active exercise of citizenship and have become a crucial point in the agendas of every government in all developed countries, especially after the COVID-19 pandemic, and an important part of the contemporary debate addresses the current and future role of ICT in the school curriculum.

For the education field, the need for highly skilled workers required by the economic field requires the development of a high-quality workforce that not only possesses a strong foundation in traditional literacy skills (reading, writing and mathematics) but is also competent in the digital field. In this general context, schools should play a fundamental role in promoting the development of these skills, ensuring that future citizens can participate actively and proactively in the development and economic and social growth of the country. Hence, trying to understand how today's young people are prepared for this new challenge has become crucial. The e-inclusion was already a priority issue for the European Union (EU) in the development of i2010[1] (European Commission, 2005). The e-inclusion policy aims to reduce the gaps in the use of information and communication technologies (ICT) and promotes the use of ICT.

Already since the mid-1990s, there has been talk of a digital divide, to indicate the different opportunities for "physical" access to technology (e.g., availability of a computer, an internet connection, a smartphone).

Today most people in Western countries, regardless of gender, age, socio-economic status, have access to these devices and the digital divide goes beyond the issue of access to technology, and the debate focuses now on digital skills (e.g., Hargittai, 2001; Gorski, 2005): not always having access to these devices corresponds to skills in the use of e-services, effectively hindering the learning of new digital skills using technology. Expanding the concept of digital divide beyond physical access digital skills are recognized as a crucial tool for the social inclusion and professional development of people. In a recent study, for example, Murry and Perez (2014) administered a digital literacy assessment to graduate senior, on the assumption that the university graduate is digitally literate, and they found that most students (about 70%) did not pass the tests, demonstrating that the exposure to the digital technologies differs from understanding and use them competently.

The relevance of this topic is also recognized from the European Commission, in different initiatives, for example The Digital Agenda for Europe (DAE), where lifelong acquisition of e-skills and competences is recognised as a key component in the 21st century (European Commission, 2010; European Commission, 2013), and the digital compass for 2030, based on four cardinal points: skills, government, infrastructures and business (European Commission, 2021). More in general, national efforts to address digital literacy are underway in various countries, nonetheless many educational institutions lag in their efforts to define, measure and amplify the complex construct.

## Gender differences

A vast amount of research, since the last century, has focused on the study of gender digital divide, even tough few studies investigated the difference in actual ICT literacy (e.g. Hargittai & Shafer, 2006; Bunz, Curry, & Voon, 2007; Aesaert *et al.*, 2015; Gnambs, 2021).

Generally, in the last century, the research evidenced differences in favour of males in ICT competence (Reinen & Plomp, 1997). For example, Sutton (1991), in her review, found that boys outperformed girls both on computer literacy and on coding; while, more recently, different research that compares males and females in

[1] i2010 is a comprehensive strategy to guide information society and media policies. The main aims are: a single European information space, innovation and investment in research, better public services, and quality of life.


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their ability on ICT demonstrated no or little disparity in favour of boys (Hargittai, 2001; Hargittai & Shafer, 2006; Bunz *et al.* 2007; van Deursen & van Dijk, 2009; Hohlfeld, Ritzhaupt & Barron, 2013; Gnambs, 2021), and in some cases in favour of girls (ACARA 2015; Aesaert & Van Braak, 2015; Aesaert *et al.*, 2015; Fraillon *et al.*, 2019).

Gui and Argentin (2011) administered a test to eight grade students from Northern Italy and found that boys have also higher theoretical skills than girls, while there is no statistically significant differences on operational and evaluation skills.

Recently, in their literature review, Siddiq and Scherer (2019) highlighted inconsistent findings regarding gender differences in ICT literacy.

Regarding the gender differences on ICT attitudes, previous studies seem to clearly show that males have a higher level of self-efficacy than females (Volman & van Eck, 2001; Liff & Shepherd, 2004; Sáinz & Eccles, 2012; Acara, 2015; Cai, Fan, & Du, 2017) even though this difference is getting reduced over time (Cai, Fan & Du 2017). Males are also more likely to continue ICT school and job career (Volman & van Eck, 2001; Clayton, Von Hellens & Nielsen, 2009). Likewise, the differences between boys and girls in term of ICT use are decreasing over time, even though seems that some difference in using is based on the type of ICT use (Colley, & Comber, 2003; Jackson *et al.*, 2008; Karatsoli, & Nathanail, 2020).

In addition, the results of the NCGM (Net Children Go Mobile) study (Ferreira, 2017), conducted in six European countries, showed that boys have greater digital skills and seem to be more confident in using computers and the Internet than girls (Mascheroni, G., & Ólafsson, K., 2014).

This could be because adherence to gender roles is socially emphasized during adolescence and the ICT competence model is often linked to male characteristics (e.g., Cheryan *et al.* 2013; Sáinz, Meneses, López & Fàbregues, 2016), and since gendered identities of young individuals affect future educational and career choices, particularly concerning science and technology (e.g. Dicke, Safavian, & Eccles, 2019; Eccles, 2007), it would become crucial understanding of the co-production of gender and technologies to promote gender equity (e.g., Bray, 2007; Landström, 2007). For example, Tam, Chan & Lai (2020) evidenced that students' ICT self-efficacy can reduce their gender stereotyping in ICT. The author evidenced that ICT-related gender stereotyping was associated with both ICT self-efficacy and perceived difficulties in using ICT, indicating that gender stereotyping in ICT can be reduced by granting more ICT learning opportunities to female students.

While the debate on gender differences in attitudes, usage, and performance in ICT is still lively (e.g. Qazi, *et al.*, 2021), the study of relationships between use, self-efficacy and performance in ICT is barely undertaken, especially using data from large scale assessment. For example, Rohatgi, Scherer & Hatlevik, (2016) found a positive relationship between ICT self-efficacy and ICT achievement; they also found that ICT self-efficacy was a mediator between ICT use and ICT performance both for male and female students. Moreover, ICT self-efficacy is also positively related to the use of ICT, for example in a study of Tømte, & Hatlevik, (2011): the authors found a positive relationship between ICT self-efficacy and ICT use for both males and females.

## ICILS's study

The IEA's (International Association for the Evaluation of Educational Achievement) ICILS (International Computer and Information Literacy Study) survey aims to collect data to provide educational systems with a better understanding of the phenomenon and thus enable them to develop programmes in line with the changes taking place. ICILS (International Computer and Information Literacy Study) evaluates the digital skills of grade 8 students in order to understand how students are prepared for study, work and life in a digital world. The 2018 cycle has seen the participation of over 46,000 students and 26,000 teachers from twelve countries and two educational systems related to individual provinces or regions (benchmark countries). For the first time Italy also participated.

The first cycle of ICILS 2013 demonstrated the fallacy of the assumption that just because young people grew up surrounded by digital technology, they have excellent ICT skills. Digital natives are not digital experts, "digital native" young people do not develop sophisticated digital skills just by growing up and using digital devices.

Based on the previous evidence, the present study aims at investigating:

1) Whether the relationship between computer and information literacy (CIL) test and different student characteristics varies in function of student gender.

2) Whether the ICT self-efficacy contribute to mediate the relationships between student characteristics and CIL achievement.

### Methods

*Participants*

In the present study, analyses were conducted on the Italian ICILS 2018 data. In Italy, 2,810 students, grouped in 150 schools, participated in ICILS 2018. Cases with missing values in one or more explanatory variables were excluded from the analyses. The final sample consisted of 2,511 (52% girls), clustered in 150 schools, representative of Italian eighth grade students. The exclusion rate did not affect the sample composition.

*Measures*

Computer and Information Literacy scale. The scale was developed by the ICILS working group. Computer and information literacy "refers to 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 in society" (Fraillon *et al.*, 2019 p. 16). The overall CIL test consists of a sequence of tasks contextualized by a real-world theme. CIL encompasses four strands: understanding computer use, gathering information, producing information, and digital communication (Fraillon *et al.*, 2019).

The whole CIL test consists of five modules lasting 30 minutes each, but each student has completed only two of the five modules, through a balanced randomized design. Each module is characterized by 5-8 smaller tasks, each of which usually took about one minute to complete, and a single large task that typically took 15 to 20 minutes to complete and required the development of an information product. Using IRT estimates, a score of mathematics achievement was calculated for each student, drawn from five plausible values: this overall proficiency score was used in the analyses (for a detailed description see Fraillon *et al.*, 2020).

ICILS 2018 also collected information on student engagement with ICT through a 30-minute questionnaire. The questionnaire consisted of questions related to students' background characteristics, their experience and use of ICT to solve different tasks in and out of school, and their attitudes towards ICT use. For the sake of brevity, only the measures that are directly relevant to this study will be described (for a detailed description see Fraillon *et al.*, 2020).

Socio-economic and cultural status (SES). Based on the answers in the ICILS Student Questionnaire a general index of each student's socio-economic and cultural status was created by the IEA: (1) student home environments, including the parents' educational level (2) the number of resources for study available at home, and (3) the number of books in the home.

Learning about ICT at school. The scale was created based on students' answers to what extent they had learned how to do eight ICT tasks, such as "Provide references to internet sources" and "Present information for a given audience or purpose using ICT". A four-point Likert type-scale (ranging from "to a large extent," to "not at all") was used.

Students' ICT self-efficacy regarding the use of general applications. Students were asked to answer eight questions related to their skill perceived regarding the use of general applications, such as "Create a multimedia presentation (with sound, pictures, or video)". An index of Students' ICT self-efficacy regarding the use of general applications was created based on the answers given by the students. Students had to respond on a 3-point scale ranging from "I do not think I could do this" to ""I know how to do this".

Students' use of general applications for activities. Students answered three questions related the frequency use of general applications for activities, such as "Write or edit documents". A five-point Likert-type scale (ranging from "never," to "every day") was used. Expectations of future ICT use for work and study. Students were asked to answer three questions, such as "Learning how to use ICT applications will help me to do the work I am interested in". The response options were on a three-point Likert-type scale ranging from "Strongly agree" to "Strongly disagree". Based on the students' answers, an index of *Expectations of future ICT use for work and study* was constructed.

In addition, students answered one single item:

Computer experience in years. Students answered one question regarding the use of computer in years. The categories of answer are two: 1) five or more years of experience (experienced users) and 2) less than five years of experience (inexperienced users).

## Data analysis

The descriptive and correlational analyses by gender were conducted using the software IEA IDB Analyzer. A mediation analysis with structural equation modeling assessed the mediation role of "self-efficacy in ICT", by means of MPLUS.

A structural equation model (SEM) was utilized to perform a path analysis to test a relationship between student characteristics, SES and CIL performance (see Figure 1). The following conditions applied to the model:

- The SES have been used as an independent variable.

- Computer experience in years, expectation of future ICT use for work and study, learning of ICT tasks at school, use of general application for activities were used as independent variables of self-efficacy regarding the use of general applications and CIL performance.
- Self-efficacy regarding the use of general applications were considered as mediation variable.
- The score on the CIL test was considered as the dependent variable.

Both observed variables, represented in the graph by rectangles, and latent variables, represented by ovals, were considered, according to the standard conventions in this field. For the construction of the latent variables, the parceling method was used on the basis of item-total correlations (Little, 2002). To estimate the model, two different indices were used: the CFI (comparative fit index; Bentler, 1990), where a value greater than 0.90 is considered a good adaptation of the data to the model (Byrne, 2001), and the RMSEA (root mean square error of approximation; Steiger, 1990), where index values lower than 0.08 represent an acceptable adaptation of the data (Browne & Cudeck, 1993).

Considering the difference in CIL between males and females, we verified whether the gender effectively moderate the relationship between socioeconomic and cultural index, student characteristics and CIL achievement in each European country.

## Results

*Descriptive statistics*

Table 1 shows the descriptive statistics divided by gender.

*Table 1. Descriptive statistics by gender*

| | **Boys** | | **girls** | |
|---|---|---|---|---|
| | mean | s.e. | mean | s.e. |
| **Computer experience in years** | 2.0 | (0.0) | 2.0 | (0.0) |
| **ICT self-efficacy regarding the use of specialist applications** | **50.6** | **(0.3)** | **47.6** | **(0.3)** |
| **ICT self-efficacy regarding the use of general applications** | 49.7 | (0.3) | 50.3 | (0.3) |
| **Use of specialist applications in class** | 50.5 | (0.3) | 49.8 | (0.3) |
| **Use of general applications in class** | 46.1 | (0.3) | 46.8 | (0.4) |
| **Use of ICT for accessing content from the internet** | 51.4 | (0.3) | 51.0 | (0.3) |
| **Use of ICT for exchanging information** | 49.4 | (0.3) | 50.1 | (0.3) |
| **Use of ICT for social communication** | **49.5** | **(0.3)** | **52.3** | **(0.3)** |
| **Learning of ICT tasks at school** | **47.5** | **(0.3)** | **49.05** | **(0.3)** |
| **Use of ICT for study purposes** | 48.1 | (0.3) | 48.1 | (0.3) |
| **Expectations of future ICT use for work and study** | **54.2** | **(0.3)** | **50.0** | **(0.3)** |
| **Socio-economic index** | -0.01 | (0.0) | 0.02 | (0.0) |
| **CIL achievement** | **453,5** | **(3.1)** | **469,3** | **(3.6)** |

In **bold** gender differences statistically significant.


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Concerning CIL achievement, females outperform males. The variation between the two groups is approximatively 16 points. Female stated to use ICT for social communication more frequently than males. Males perceived themselves more confident than females in using ICT for specialist applications and reported higher level of expectations of future ICT use for work and study and frequency of use of general applications for activities. Females reported higher levels on Learning of ICT tasks at school index. In the table 2 the correlation analyses between student characteristics and CIL achievement were reported.

*Table 2. Correlation analyses by gender*

| | EXCOMP | SPECEFF | GENEFF | SPECLASS | GENCLASS | ACCONT | USEINF | USECOM | USESTD | ICTFUT | LRNSC | SES | CIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Computer experience in years (EXCOMP)** | | 0.11 | 0.20 | 0.02 | 0.09 | 0.15 | 0.06 | 0.11 | 0.06 | 0.04 | 0.04 | 0.11 | 0.19 |
| **ICT self-efficacy regarding the use of specialist applications (SPECEFF)** | 0.18 | | 0.40 | 0.19 | 0.15 | 0.25 | 0.25 | 0.24 | 0.31 | 0.23 | 0.14 | -0.04 | -0.02 |
| **ICT self-efficacy regarding the use of general applications (GENEFF)** | 0.24 | 0.47 | | 0.05 | 0.15 | 0.21 | 0.07 | 0.22 | 0.21 | 0.13 | 0.3 | 0.11 | 0.35 |
| **Use of specialist applications in class (SPECLASS)** | 0.06 | 0.26 | 0.06 | | 0.58 | 0.18 | 0.20 | 0.13 | 0.40 | 0.13 | 0.23 | 0.00 | -0.07 |
| **Use of general applications in class (GENCLASS)** | 0.12 | 0.18 | 0.10 | 0.69 | | 0.16 | 0.10 | 0.10 | 0.33 | 0.07 | 0.31 | 0.04 | 0.12 |
| **Use of ICT for accessing content from the internet (ACCONT)** | 0.17 | 0.25 | 0.23 | 0.21 | 0.19 | | 0.35 | 0.44 | 0.39 | 0.16 | 0.12 | -0.01 | 0.00 |
| **Use of ICT for exchanging information (USEINF)** | 0.11 | 0.28 | 0.03 | 0.30 | 0.20 | 0.42 | | 0.55 | 0.34 | 0.18 | 0.08 | -0.03 | -0.13 |
| **Use of ICT for social communication (USECOM)** | 0.18 | 0.24 | 0.22 | 0.19 | 0.16 | 0.52 | 0.48 | | 0.33 | 0.16 | 0.18 | 0.01 | -0.01 |
| **Use of ICT for study purposes (USESTD)** | 0.14 | 0.27 | 0.21 | 0.44 | 0.36 | 0.43 | 0.38 | 0.36 | | 0.18 | 0.23 | 0.01 | -0.05 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Expectations of future ICT use for work and study (ICTFUT)** | 0.17 | 0.25 | 0.28 | 0.08 | 0.11 | 0.17 | 0.08 | 0.16 | 0.18 | | 0.11 | -0.06 | -0.04 |
| **Learning about ICT at school (LRNSC)** | 0.07 | 0.15 | 0.24 | 0.21 | 0.22 | 0.14 | 0.04 | 0.11 | 0.25 | 0.14 | | 0.06 | 0.19 |
| **Socio-economic index (SES)** | 0.09 | -0.01 | 0.14 | -0.04 | 0.05 | 0.03 | -0.04 | -0.01 | 0.03 | -0.01 | 0.05 | | 0.26 |
| **CIL** | 0.20 | 0.03 | 0.36 | -0.14 | 0.08 | 0.00 | -0.18 | 0.00 | -0.06 | 0.16 | 0.10 | 0.33 | |

At the top right of the diagonal are the coefficients of females, at the bottom left those of males

ICT self-efficacy regarding the use of general applications had the strongest correlation with CIL, both for males and females. In addition, the socio-economic index was correlated positively and strongly with CIL, stronger for males. Students with more years of experience in using the computer obtained better results in CIL.

Use of general application for activities was positively associated with CIL, both for males and females.

Expectations of future ICT use for work and study was positively related with CIL for males, and negligibly (and negatively) for females.

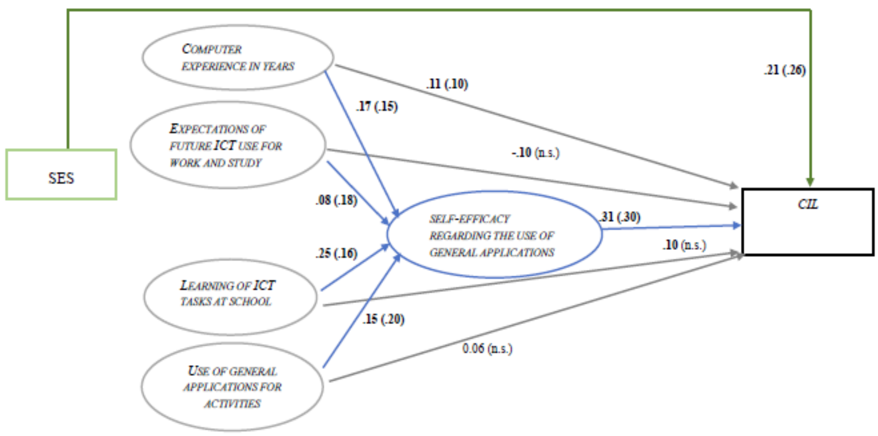
Learning about ICT at school was positively associated with CIL, more for female than males.

Despite the correlation coefficients were significant, it was decided not to consider for the path model coefficients with CIL lower than |0.1|, which can be considered negligible (Cohen, 2013).

The SEM path analysis tested to measure the relationships between student characteristics, SES and CIL performance is illustrated in Figure 1.

*Figure 1. The relationships between student characteristics, SES and CIL*

$R^2$ CIL =0.22 (0,22) , p<0.01;
RMSEA = 0.08; CFI=0.95




[Outside of the parentheses, the coefficients of girls; in parentheses, the coefficients of boys.]

This model had good fit indices according to recommended cut-off values (Byrne, 2001): RMSEA=0.08 and CFI=0.98, and explained 22% of the variance in CIL, both for males and females.

SES is associated with CIL. Self-efficacy is strongly associated with CIL both for males and females; the more students perceived themselves able to use general applications, the better they performed in CIL. Learning of ICT tasks at school and use of general applications for activities are positively associated with CIL for females, while they are not significantly associated with CIL for males. Expectation of future ICT use for work and study is not associated with CIL for boys and negatively associated with CIL for females.

All independent variables considered are positively associated with self-efficacy. The relationship between self-efficacy and Expectation of future ICT use for work and study is stronger for boys than for girls, while the relationship between Learning of ICT tasks at school and self-efficacy is stronger for girls than boys.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With regard to mediation, the estimation of the indirect effects in the model allowed to clarify how much experience on use of computer, learning of ICT tasks at school, expectations of future ICT use for work and study, and use of general applications for activities were related to CIL achievement through their effect on the mediating variable considered, i.e., self-efficacy regarding the use of general applications. The crucial parameter considered was the significance of indirect effect estimates (Zhao *et al.*, 2010; Iacobucci *et al.*, 2007). Table 3 illustrates the mediating effect.

*Table 3.* Direct, indirect, and total effects with self-efficacy as mediator variable

| | Females | | | Males | | |
|---|---|---|---|---|---|---|
| | DIRECT | INDIRECT | TOTAL | DIRECT | INDIRECT | TOTAL |
| | | Self-efficacy | | | Self-efficacy | |
| Computer experience in years | 11 (.03) | .05 (.01) | .16 (.03) | .10 (.03) | .05 (.01) | .15 (.03) |
| Expectations of future ICT use for work and study | -.10 (.03) | .02 (.01) | -.07 (.03) | -n.s. | .06 (.01) | .10 (.03) |
| Learning of ICT tasks at school | .10 (.03) | .08 (.01) | .17 (.03) | n.s. | .05 (.01) | .06 (.03) |
| Use of general applications for activities | .06 (.03) | .05 (.01) | .10 (.03) | .05 (.03) | .06 (.01) | .11 (.03) |

Self-efficacy mediated the effect of the four variables considered for the girls. A higher level of self-efficacy reinforces, in particular, the relationship between Learning of ICT tasks at school and CIL. The role of mediation between CIL and Expectations of future ICT use for work and study is less relevant.

Regarding the males, Expectations of future ICT use for work and study and Learning of ICT tasks at school seems to not have significant direct effects on CIL.

## Discussion

The main aim of this study was to investigate the relationship between student characteristics and ICT competence in function of gender in the pre-pandemic period from COVID 19. The model tested proved to be successful in explaining the CIL performance: the predicted model showed a good fit to the data with 22% of the variance explained. According to a part of the literature, the results of this study seem to demonstrate that Italian female students perform better on CIL test than their male counterparts (ACARA 2015; Aesaert & Van Braak, 2015; Aesaert *et al.*, 2015; Fraillon *et al.*, 2019).

Context factors, reflecting the availability or unavailability of economic and cultural resources within the family, play a relevant role in predicting the performance of students in different subjects (e.g., Sirin, 2005; Chiu & Xihua, 2008; Levpušček *et al.*, 2013). This aspect is confirmed by the present study, in which the socioeconomic index was found to be linked to CIL achievement (Aesaert *et al.*, 2015; Hatlevik, Throndsen, Loi & Gudmundsdottir, 2018).

Student's high expectations that they will pursue scientific studies seems to be positively associated with achievement only for girls (Singh *et al.*, 1995; Fan & Chen, 2001; Shute *et al.*, 2011).

Furthermore, according with the literature, there is evidence of a positive relationship between self-efficacy in ICT use and performance in CIL (Aesaert *et* *al.*, 2015). Moreover, as found in prior studies (Rohatgi, Scherer & Hatlevik, 2016), the mediating effect was statistically significant and suggested that self-efficacy in ICT use plays a mediating role on the effects of several variables on CIL achievement, especially for the females, as evidenced by the significant indirect effects observed in the SEM analysis: the self-efficacy mediates and reinforces the effects of the Expectations of future ICT use for work and study and of Learning of ICT tasks at school.

We are aware of the limitations of this study. A first limitation is the cross-sectional research design and, hence, the correlational nature of the study, which prevents the evaluation of the causal links underlying the observed associations. Longitudinal studies would instead allow us to monitor the same group of subjects over the years and would be valuable in clarifying the role that self-efficacy plays in ICT student performance in function of the gender. Furthermore, this study used only Italian student data in only one school grade, thus generalizations should be made with caution.

Notwithstanding these limitations, few studies adopted objective, performance-based measures to investigate gender differences, and this study seems to suggest that the relationships between CIL achievement and student characteristics varies in function of gender. Learning of ICT tasks at school is related to better performance only for girls, suggesting that it is especially important for girls to work with computers at school.

Concerning the use of computers, it has been shown repeatedly that higher levels of computer self-efficacy are correlated with higher levels of computer use, more efficient user strategies, more positive affect when using computers (Dickhäuser & Stiensmeier-Pelster, 2002, 2003; Shapka & Ferrari, 2003). This study seems to indicate that self-efficacy plays a mediation role between ICT achievement and student characteristics, such as learning of ICT tasks at school, for female students (Tam, Chan & Lai, 2020). It is crucial to identify the key factors that could explain variations in students' use of digital technologies in learning, such as students' confidence in using technology, experiences of technology use and learning, especially for female students, and the study of the relationship between gender and ICT perceptions and abilities. In fact, women continue – both nationally and internationally – to pursue careers in ICT-related fields to a much lesser extent than men (Anderson *et al.* 2008; Vitores & Gil-Juárez, 2016). The relationship between gender and ICT skills is also important for educational policies because the school could help reduce social inequities Attewell 2001; Harper 2003; Warschauer *et al.* 2004): gender stereotypes can influence and determine the future educational and professional choices of young people, contributing to the maintenance of stereotypes in a cyclical process. Schools have an important role in disrupting this process, supporting the diversity of students' interests and encouraging both girls and boys to develop their technological competencies further. The relationship between gender and technology is not unchanging and the understanding of the co-production of gender and technologies would become crucial to promote gender equity (e.g. Bray, 2007; Landström, 2007). Thus, measuring variables that may impact gender differences in ICT learning and future career choice is necessary to implement *ad hoc* interventions for achieving gender equity (Qazi, *et al.*, 2021). Thus, although today's girls use computers as often as boys, it seems that their use is more instrumental and without going into exploration and technical details (Liff & Shepherd, 2004; Gui & Argentin, 2011). This finding could explain why girls are able to benefit more than boys from learning ICT at school and should contribute to push policy makers at the national level to include ICT competence in the curriculum, from primary to upper secondary school, as happens in other European countries (e.g., Innovative Technologies for Engaging Classrooms- ITEC, http://itec.eun.org/).

## References


Aesaert, K., & Van Braak, J. (2015), *Gender and socioeconomic related differences in performance based ICT competences*. Computers & Education, 84, 8-25.

Aesaert, K., Van Nijlen, D., Vanderlinde, R., Tondeur, J., Devlieger, I., & van Braak, J. (2015), *The contribution of pupil, classroom and school level characteristics to primary school pupils' ICT competences: A performance-based approach*. Computers & Education, 87, 55-69.

Anderson, N., Lankshear, C., Timms, C., & Courtney, L. (2008), *'Because it's boring, irrelevant and I don't like computers': Why high school girls avoid professionally-oriented ICT subjects.* Computers & Education, 50(4), 1304-1318.

Attewell, P. (2001), *The first and second digital divides*. Sociology of Education, 74, 252-259.

Australian Curriculum, Assessment and Reporting Authority (ACARA) 2015, *National Assessment Program – ICT Literacy Years 6 & 10 Report*, available at http://www.nap.edu.au/verve/_resources/D15_8761__NAPICT_2014_Public_Report_Final.pdf.

Bentler PM. (1990), *Comparative fit indexes in structural models*. Psychol Bull 107:238-46. doi: 10.1037/0033-2909.107.2.238.

Browne MW, Cudeck R. (1993), *Alternative ways of assessing model fit*. Sage focus editions,. 154:136. doi: 10.1177/0049124192021002005.

Bunz, U., Curry, C., & Voon, W. (2007), *Perceived versus actual cmputer-email-web fluency*. Computers in human behavior, 23(5), 2321-2344.

Bray, F., 2007. Gender and technology. Annual Review of Anthropology, 36:37-53

Byrne, B. M. (2001), *Structural equation modeling with AMOS, EQS, and LISREL: Comparative approaches to testing for the factorial validity of a measuring instrument*. International journal of testing, 1(1), 55-86.

Cai, Z., Fan, X., & Du, J. (2017), *Gender and attitudes toward technology use: A meta-analysis*. Computers & Education, 105, 1-13.

Cheryan, S., Plaut, V. C., Handron, C., & Hudson, L. (2013). The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women. *Sex roles*, *69*(1), 58-71.

Chiu, M. M., & Xihua, Z. (2008), *Family and motivation effects on mathematics achievement: analyses of students in 41 countries*. Learning and Instruction, 18(4), 321-336.

Clayton, K. L., Von Hellens, L. A., & Nielsen, S. H. (2009), *Gender stereotypes prevail in ICT: A research review*. In Proceedings of the special interest group on management information system's 47th annual conference on Computer personnel research, 153-158.

Cohen, J. (2013), *Statistical power analysis for the behavioral sciences*. Academic press.

Colley, A., & Comber, C. (2003), *Age and gender differences in computer use and attitudes among secondary school students: what has changed?*. Educational Research, 45(2), 155-165.

Dicke, A. L., Safavian, N., & Eccles, J. S. (2019). Traditional gender role beliefs and career attainment in STEM: A gendered story?. *Frontiers in psychology*, 1053.

Dickhäuser, O., & Stiensmeier-Pelster, J. (2002), *Gender differences in computer work: evidence for the model of achievement-related choices*. Contemporary Educational Psychology, 27, 486-496.

Dickhäuser, O., & Stiensmeier-Pelster, J. (2003), *Gender differences in the choice of computer courses: applying an expectancy-value model*. Social Psychology of Education, 6, 173-189.

Eccles, J. S. (2007). *Where Are All the Women? Gender Differences in Participation in Physical Science and Engineering*. American Psychological Association.

European Commission. (2005), *i2010: A European Information Society for growth and employment. Communication from the Commission to the Council, the European Economic and Social Committee and the Committee of Regions*. Retrieved October 31, 2015, from http://eur-lex.europa.eu.

European Commission (2010), *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A digital agenda for Europe*. Available from https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52010DC0245R(01).

European Commission (2013), *Digital agenda for Europe: A Europe 2020 initiative*. Available from http://ec.europa.eu/digital-agenda/digital-agenda-europe.

European Commission (2021), *Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 2030 digital compass: the European way for the digital decade*. Retrieved from https://ec.europa.eu/info/sites/default/files/communication-digital-compass-2030_en.pdf.

Fan, X., & Chen, M. (2001), *Parental involvement and students' academic achievement: A metaanalysis*. Educational Psychology Review, 13(1), 1-22.

Ferreira, E. (2017). The eco-production of gender and ICT gender stereotypes in schools. *First Monday*, 22(10). https://doi.org/10.5210/fm.v22i10.7062

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D., & Friedman, T. (2019), *IEA International Computer and Information Literacy Study 2018 assessment framework*. Cham, Switzerland: Springer. Retrieved from https://link.springer.com/content/pdf/10.1007%2F978-3-030-19389-8.pdf

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Duckworth, D. (2020), *IEA International Computer and Information Literacy Study 2018. Technical Report*. International Association for the Evaluation of Educational Achievement.

Gnambs, T. (2021), *The development of gender differences in information and communication technology (ICT) literacy in middle adolescence*. Computers in Human Behavior, 114, 106533.

Gorski, P. (2005), *Education equity and the digital divide. AACE Review (Formerly AACE Journal)*, 13(1), 3-45.

Gui, M., & Argentin, G. (2011), *Digital skills of internet natives: Different forms of digital literacy in a random sample of northern Italian high school students*. New media & society, 13(6), 963-980.

Hargittai, E. (2001), *Second-level digital divide: Mapping differences in people's online skills*. arXiv preprint cs/0109068.

Hargittai, E., & Shafer, S. (2006), *Differences in actual and perceived online skills: The role of gender*. Social Science Quarterly, 87(2), 432-448.

Harper, V. (2003), *The digital divide (DD): A reconceptualization for educators*. Association for the Advancement of Computing in Education Journal, 11(1), 96-103.

Hatlevik, O. E., Throndsen, I., Loi, M., & Gudmundsdottir, G. B. (2018), *Students' ICT self-efficacy and computer and information literacy: Determinants and relationships*. Computers & Education, 118, 107-119.

Hohlfeld, T. N., Ritzhaupt, A. D., & Barron, A. E. (2013), *Are gender differences in perceived and demonstrated technology literacy significant? It depends on the model*. Educational Technology Research and Development, 61(4), 639-663.

Iacobucci, D., Saldanha, N, Deng, X. (2007), *A Meditation on Mediation: Evidence that Structural Equations Models Perform better than Regressions*, Journal of Consumer Psychology, 17(2), 139-153.

Jackson, L. A., Zhao, Y., Kolenic III, A., Fitzgerald, H. E., Harold, R., & Von Eye, A. (2008), *Race, gender, and information technology use: The new digital divide*. CyberPsychology & Behavior, 11(4), 437-442.

Karatsoli, M., & Nathanail, E. (2020), *Examining gender differences of social media use for activity planning and travel choices*. European Transport Research Review, 12(1), 1-9.

Landström, C. (2007). Queering feminist technology studies. *Feminist Theory*, *8*(1), 7-26.

Levpušček, M. P., Zupančič, M., & Sočan, G. (2013), *Predicting achievement in mathematics in adolescent students the role of individual and social factors*. The Journal of Early Adolescence, 33(4), 523-551.

Liff, S., Shepherd, A., Wajcman, J., Rice, R., & Hargittai, E. (2004), *An evolving gender digital divide?.* OII Internet Issue Brief, (2).

Little, T. D., Cunningham, W. A., Shahar, G., & Widaman, K. F. (2002), *To parcel or not to parcel: Exploring the question, weighing the merits.* Structural equation modeling, 9(2), 151-173.

Mascheroni, G., & Ólafsson, K. (2014). Net children go mobile: Risks and opportunities. Milano: Educatt.

Murray, M. C., & Pérez, J. (2014), *Unraveling the digital literacy paradox: How higher education fails at the fourth literacy*. Issues in Informing Science and Information Technology, 11, 85-100. Retrieved from http://iisit.org/Vol11/IISITv11p085-100Murray0507.pdf.

Reinen, I. J., & Plomp, T. (1997*), Information technology and gender equality: a contradiction in terminis?*. Computers & Education, 28(2), 65-78.

Rohatgi, A., Scherer, R., & Hatlevik, O. E. (2016), *The role of ICT self-efficacy for students' ICT use and their achievement in a computer and information literacy test*. Computers & Education, 102, 103-116.

Qazi, A., Hasan, N., Abayomi-Alli, O., Hardaker, G., Scherer, R., Sarker, Y., & Maitama, J. Z. (2021). Gender differences in information and communication technology use & skills: a systematic review and meta-analysis. *Education and Information Technologies*, 1-34.

Sáinz, M., & Eccles, J. (2012), *Self-concept of computer and math ability: Gender implications across time and within ICT studies*. Journal of vocational behavior, 80(2), 486-499.

Sáinz, M., Meneses, J., López, B. S., & Fàbregues, S. (2016). Gender stereotypes and attitudes towards information and communication technology professionals in a sample of Spanish secondary students. *Sex Roles*, *74*(3), 154-168.

Shapka, J. D., & Ferrari, M. (2003), *Computer-related attitudes and actions of teacher candidates*. Computers in Human Behavior, 19, 319-334.

Shute, V. J., Hansen, E. G., Underwood, J. S., & Razzouk, R. (2011), *A Review of the Relationship between Parental Involvement and Secondary School Students' Academic Achievement*. Education Research International, 2011, 1-10, doi:10.1155/2011/915326.

Siddiq, F., & Scherer, R. (2019), *Is there a gender gap? A meta-analysis of the gender differences in students' ICT literacy*. Educational research review, 27, 205-217.

Singh, K., Bickley, P, Trivette, P., Keith, T. Z., Keith, P. B., & Anderson, E. (1995), *The effects of four components of parental involvement on eighth grade student achievement: Structural analysis of NELS-88 data*. School Psychology Review, 24, 299-317.

Sirin, R. (2005), *Socioeconomic status and academic achievement: A meta-analytic review of research*. Review of Educational Research, 75(3), 417-453.

Steiger, J. H. (1990), *Structural model evaluation and modification: An interval estimation approach.* Multivariate behavioral research, 25(2), 173-180.

Sutton, R. E. (1991), *Equity and computers in the schools: A decade of research*. Review of educational research, 61(4), 475-503.
Tam, H. L., Chan, A. Y. F., & Lai, O. L. H. (2020). Gender stereotyping and STEM education: Girls' empowerment through effective ICT training in Hong Kong. *Children and Youth Services Review*, *119*, 105624.
Tømte, C., & Hatlevik, O. E. (2011), *Gender-differences in self-efficacy ICT related to various ICT-user profiles in Finland and Norway. How do self-efficacy, gender and ICT-user profiles relate to findings from PISA 2006*. Computers & Education, 57(1), 1416-1424.
Van Deursen, A. J., & van Dijk, J. A. (2009), *Improving digital skills for the use of online public information and services*. Government Information Quarterly, 26(2), 333-340.
Vitores, A., & Gil-Juárez, A. (2016), *The trouble with 'women in computing': a critical examination of the deployment of research on the gender gap in computer science.* Journal of Gender Studies, 25(6), 666-680.
Volman, M., & van Eck, E. (2001), *Gender equity and information technology in education: The second decade*. Review of educational research, 71(4), 613-634.
Warschauer, M., Knobel, M., and Stone, L. (2004), *Technology and equity in schooling: Deconstructing the digital divide*. Educational Policy, 18(4), 562-588.
Zhao, X, Lynch, J.G., Chen, Q. (2010), *Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis*, Journal of Consumer Psychology, 37, 197-206.