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Is the Internet creating a 'learning gap' among students? Evidence from the Italian PISA data

Marco Gui[*]*, Marina Micheli*[**] *and Brunella Fiore*[***]

Abstract: The notion of a digital divide between Internet haves and have-nots has now evolved into the broader concept of digital inequality. Based on this framework, people get greater or fewer opportunities from Internet use according to their cultural, social and professional resources. However, empirical research has focused mainly on the description of Internet usage between different social groups, without testing whether these differences actually translate into social inequalities. In this study we use learning outcomes as a proxy for high-school students' future social opportunities. Using the Italian dataset of the PISA 2009 survey we test whether students from advantaged social backgrounds gain more benefits from Internet use than their less privileged counterparts. The results show that using the Internet for schoolwork does not prove to have different impacts on students' learning outcomes depending on their social background. The challenges of these results for theories of digital inequality are discussed.

Keywords: digital divide, digital inequality, Internet use, learning outcomes, OECD-PISA data

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Introduction

In the last 20 years concerns about the role of digital media in interaction with existing social inequalities have gradually switched their focus. Initially, ownership of a home computer and connection to the Internet was seen as the first immediate step to taking part in the new information society (NTIA, 1999). Since 2000 we have witnessed an impressive spreading of Internet use in many parts of the world, which has taken penetration figures well above 50% in many developed countries, and in some of them to near saturation (Eurostat, 2013). Consequently, the initial concept of 'digital divide' between Internet haves and have-nots gradually changed into that of 'digital inequality', where not only Internet access is considered as a source of inequality, but also - and in particular - differences in Internet usage (Di Maggio et al., 2004; Van Dijk, 2005; Hargittai, 2008). Digital inequality theorists claim that systematic differences in the use of digital media can produce social inequalities, measured at an economic, social, relational and educational level. The same idea is found in the work of scholars using Bourdieu's theory of capital conversion in the field of ICT: those with a higher capital in ICT use will be able to convert it into other forms of capital, such as economic or cultural capital (Jung et al., 2001; Sutherland-Smith et al., 2003; Thiessen & Looker, 2007; North et al., 2008). Studies on the digital inequality framework have pointed out the many differences in people's use of the Internet, in terms of skills, usage types and range of online activities. These are mainly based on age, educational level and socio-economic status (Van Dijk, 2005). Significant differences in skills and the range of uses of the Internet have been found to exist also among youngsters, in contrast with journalistic claims about the so-called 'digital native' generation (Livingstone & Helsper, 2007; Hargittai, 2010; Gui & Argentin, 2011).

However, thus far research in this field has rarely tested whether the differences in skills and usage types are actually translating into social inequalities. While the positive effects of Internet use compared with non-use are being confirmed empirically (Di Maggio & Bonikowski, 2008), we do not have sufficient evidence about the impact of different usage types or skills levels on social opportunities. This is still difficult to verify, both because long-term effects could still be invisible and because this impact is not easy to detect using traditional social indicators. Research investigating

the social consequences of digital differentiation is urgently needed (Selwyn, 2004; Peter & Valkenburg, 2006).

If one looks at the different variables with which it is possible to overcome the lack of empirical evidence on the consequences of differential Internet use on young people, educational performance emerges as one of the most interesting ones. On the one hand, it is now well established that education is associated with enhanced social opportunities at many different levels (Stiglitz et al., 2009). Students' performances in learning are therefore excellent indicators of future opportunities related to the job market, social mobility and self-esteem (Hanushek et al., 2008; OECD, 2010). The level of reading literacy, in particular, has shown to be a reliable predictor of economic and social well-being, more than the quantity of education measured by years at school or in post-school education (OECD, 2010b; OECD, 2010c). Furthermore, performance in standardized tests is used to measure the percentage of students at risk of dropping out, the reduction in which is a shared objective of EU countries (OECD, 2013). On the other hand, academic performance has been suggested as an indicator which scholars can use to detect the social outcomes of Internet use (Di Maggio et al., 2004; Selwyn, 2011). An additional reason that makes learning outcomes increasingly interesting for research about digital inequality is that international standardized tests (such as the Programme for International Student Assessment – OECD/PISA, Progress in Maths – PiM and Progress in International Reading Literacy Study – IEA/PIRLS) are devoting an increasing amount of attention to the use of new media questionnaires have become more detailed on the matter and new learning dimensions related to digital literacy have been added for measurement (OECD, 2009).

In recent years the use of digital media in school-related activities has grown considerably, and there has been much debate concerning their role in enhancing learning. Therefore, it is an urgent goal for research to verify whether Internet use for schoolwork can reinforce learning inequalities, thus producing a 'learning gap'. According to the digital inequality framework, one should expect both benefits and risks of Internet use for school-related purposes to be distributed unequally, according to social background. In this way, students from higher cultural and socio-economic backgrounds should show a more positive relationship between the use of the Internet for schoolwork and their performance at school compared with students coming from disadvantaged backgrounds. The Italian case is

particularly interesting to test this hypothesis. While the relationship between Internet use and learning outcomes is very similar to that of most European countries (OECD, 2011) segregation existing in the upper secondary school system in Italy makes it easier to control for students' social background. In fact, the high school system is divided into three different types of school (*liceo*[1], technical and professional), where inequalities in students' social origins and ability-related characteristics tend to accumulate systematically (Barone & Schizzerotto, 2006). In this way, the 'school-type' profoundly discriminates between students with different social positions, and therefore represents a key control variable for our analysis. In this paper we use data from the Italian 2009 PISA survey to test whether the use of the Internet for schoolwork at home has different relationships with learning outcomes depending on students' social background.

Literature Review

The 'digital inequality' framework and student population

The overarching idea of the digital inequality framework, according to Hargittai (2008, p. 940), is that 'certain types of ICT uses can result in increased human capital, financial capital, social capital and cultural capital while other types of uses may outright disadvantage the uninformed'. This point of view has renewed interest in the knowledge gap theory (Tichenor, Donohue, & Olien, 1970), as – similarly to what this theory argued for the mass media environment – it has been stated that people who already possess more resources are more able to benefit from Internet usage (Bonfadelli, 2002; Di Maggio et al., 2004; Van Dijk, 2005; Bentivegna, 2009). Some authors (Zillien & Hargittai, 2009) have also referred to the so-called 'Saint Matthew effect', firstly mentioned in sociology by Robert K. Merton (1968), which consists in the accrual of greater wealth for people who are already in an advantaged situation, and the withholding of such wealth from people who have less ('the rich get richer and the poor get poorer').

[1] In the Italian school system *Liceo* high schools are recognised to be academic and college-preparatory schools.

In fact, as empirical research on young people has found, higher levels of education and upper socio-economic status are systematically associated with a greater use of the Internet for capital-enhancing activities (Bonfadelli, 2002; Hargittai & Hinnant, 2008), a greater number of activities carried out online (Livingstone & Helsper, 2007) and a higher level of digital skills (Hargittai, 2002; Eshet-Alkalai & Amichai-Hamburger, 2004; Van Deursen & Van Dijk, 2009). Gender and ethnicity also play a part in differentiating users (Enoch & Soker, 2006; Liff & Shepherd, 2004), even if these variables seem to reduce in importance as Internet penetration figures rise (Wasserman & Richmond-Abbott, 2005).

With respect to youth, research has shown that young people on average show a good level of operational skills on the Internet but have lower skills compared with adults when complex tasks and critical skills are requested (Van Deursen & Van Dijk, 2009; Calvani et al., 2012). However, significant differences in Internet use according to social, economic and cultural background have also been found. First, theoretical knowledge about the Internet and the operational skills needed to browse and look for information are unequally distributed according to a family's socio-demographics (Livingstone & Helsper, 2007; Hargittai, 2008; Hargittai, 2010; Tsatsou et al., 2009; Gui & Argentin, 2011). Additionally, parents' cultural and economic capital has a role in determining students' attitudes towards ICT and, as a consequence, opportunities taken up online (North et al., 2008). The difference between youngsters using the Internet as an enjoyable activity, fitting into their daily routine and helping them satisfy personal or social objectives, and on the other hand, young people who use the Internet solely for specific tasks or entertainment, in a limited, unadventurous and sometimes frustrating way has been pointed out by researchers (Livingstone, Bober, & Helsper, 2005; Livingstone & Helsper, 2007; Robinson, 2009). In particular, upper-class young people tend to use the web for 'capital-enhancing' activities and employ a greater number of services in a much more sophisticated way. Conversely, lower-class young people more commonly use the Internet for entertainment or recreational reasons (Peter & Valkenburg, 2006; Livingstone & Helsper, 2007; Hasebrink, Livingstone, Haddon, & Olafsson, 2009; Hargittai, 2010). Snyder et al. (2004) have proposed the existence of a new dimension of the 'digital divide' that is the gap between ICT school practices and ICT 'home' practices, related to leisure and socialisation, with disadvantaged students being in a less favorable situation. Finally, engagement in the

production of online content with Web 2.0 online services is also associated with young people's socio-economic status, creating a 'participation divide' (Hargittai & Walejko, 2008).

These converging results confirm that also in the 'digital native' generation pre-existing social inequalities lead to a differentiation in the use of the Internet. However, we do not know if and how these translate into actual social inequality.

ICT and learning: a complex relationship

More and more often scholars are analyzing datasets of surveys that collect information both on students' everyday ICT uses and their learning performance, measured through standardized tests or estimated through their academic achievements.

Two early investigations, based on NELS88[2] and the US section of the PISA dataset, found that students who had a computer available at home obtained better scores in mathematics and reading tests (Attewell & Battle, 1999) and science literacy tests (Papanastasiou et al., 2003). Other studies analyzing students' reported grades in English (Nævdal, 2007) or high school graduation marks (Fairlie, Beltran, & Das, 2009) confirm the positive relationship between PC usage/ownership and academic achievements. This result persisted also when socio-economic and cultural background information was considered. However, a few studies have partly contradicted these findings and contended that previous investigations had failed to properly consider background factors in their analysis (Fuchs & Woessmann, 2004; Wittwer & Senkbeil, 2008). Mixed findings were also obtained when different *types* of computer or Internet activities were considered. Lei and Zaho (2006), for example, find that using educational software is usually positively associated with learning performances, while Internet use and e-mail show a negative association.

On the other hand, studies that considered the *frequency* of computer or Internet use achieved more homogenous findings. Biagi and Loi (2013) using PISA 2009 find that the linear relationship between the frequency of different kinds of Internet use and results on reading or maths is generally negative in most countries, except – quite unexpectedly – for gaming.

[2] The National Educational Longitudinal Study of 1988, known as the NELS88 was a project of the National Center for Educational Statistics, an agency of the U.S. Department of Education.

Other studies have shown how the same relationship has significant curvilinear behaviors: students with the highest scores are those that use the Internet only moderately, and not those that surf the Internet intensively (Thiessen & Looker, 2007; Lei & Zhao, 2007; OECD, 2011). Moderate Internet or computer use (e.g. a few times a month) is associated with *the* highest level of learning performance. Graphics show a mountain-shaped relationship, with a threshold after which an increase in ICT use is associated with a decrease in learning performance. These results do not change when different learning dimensions (reading, mathematics, science) or specific Internet activities are considered (OECD, 2011). If a causal interpretation is to be followed, one could argue that a frequent use of the Internet for schoolwork has a negative impact on learning performance. Since a similar causality cannot be confirmed empirically using cross-sectional data, counter-causal hypotheses are also possible. One explanation, for example, is that students who need more help or time to complete a task tend to look for help on the Internet more frequently, and these students also attain lower scores than others (OECD, 2011).

Finally, other studies have questioned whether ICT use associates differently with learning performance according to students' socio-economic and cultural background. There is some evidence that students from higher socio-economic and cultural backgrounds derive more benefits from ICT use, while disadvantaged students derive fewer benefits (Attewell & Battle, 1999). Others (Wainer et al., 2008; Vigdor & Ladd, 2010) have shown that the negative relationship between computer and Internet use and learning outcomes is even stronger among poorer students (Wainer et al., 2008; Vigdor & Ladd, 2010). However, Thiessen and Looker's Canadian study (2007) on PISA data concludes that a higher parental cultural capital does not relate to higher educational achievements connected with computer use. Students from an advantaged social background are not better able to 'convert' ICT use into educational results than students from disadvantaged backgrounds. Controlling for gender, they find that only among girls was ICT use slightly more effective if parents were better educated. Overall, they conclude that 'at the present time, ICT use has a limited capacity to be converted into other human capital skills' and it 'is not educationally transformative but neither detrimental to reading achievement, except when used excessively' (2007, p. 177).

This paper aims to contribute to this field of research, adopting more recent and in-depth data. With the recent spread of Internet access across

Europe and developing countries, it is not feasible to consider only whether students use computers or whether they simply access/surf the Internet. Therefore we investigate the impact of using the Internet at home specifically *for school-related purposes* and adopt the latest PISA standardized tests available (2009). Additionally, in order to test the theoretical approach of digital inequality we will concentrate on both the cultural and socio-economic status and the type of school attended by the student, as they are the two most important indicators of Italian students' social and cultural condition.

Hypotheses

Considering both the theoretical framework and the empirical evidence on ICT and learning, we expect to find evidence that Internet use for schoolwork has different impacts on learning performances according to the social position of students. We choose to test this main hypothesis using the two most important indicators of students' social position at our disposal: family cultural and socio-economic background and type of school attended. Therefore, this research aims to test the following specific hypotheses.

Hypothesis 1

Students coming from families with higher cultural and socio-economic status will gain more benefits from their use of the Internet for schoolwork than their less privileged counterparts.

Students from the most advantaged families use the Internet for capital-enhancing activities, possess higher digital skills and, in general, have more cultural, economic and social resources at home. Following the argument of the knowledge gap theory, we expect to find a 'learning gap', where students with higher social backgrounds are better able to convert their use of the Internet into positive learning outcomes. In statistical terms, this means that we expect a positive interaction effect between socio-economic status and Internet use for schoolwork when explaining learning outcomes.

Hypothesis 2

Students of schools with higher learning performances will gain more benefits from using the Internet for schoolwork.

In Italy there are three types of high-schools: 'vocational schools' (that allow students to pursue an occupation upon graduation), 'technical high-schools' (which give both the possibility to pursue an occupation or additional education); '*liceo* high-schools' (which are specifically designed to prepare students for higher education). Within each school type socio-economic backgrounds and ability levels tend to be homogeneous and different from the other types along a hierarchy, with *liceo* at the top and vocational courses at the bottom (Barone & Schizzerotto, 2006). Therefore, we expect the capability to positively convert the use of the Internet for schoolwork into better learning outcomes to be higher for students from *liceo* and not equally distributed among the different schools. In statistical terms, we expect a positive interaction between type of school and the quantity of Internet use for schoolwork in explaining learning outcomes.

Method

Sample

In this analysis we use the Italian sub-dataset of the fourth edition of the OECD/PISA, a survey of 15-year-olds conducted in 65 countries around the world in 2009. PISA uses a two-stage sampling process. First there is a random selection of schools in each country and then a second selection of students in each school. In each country, a set of stratification variables has been implemented (i.e. regions, public/private, size etc). In the case of Italy, these are the region and type of school.

PISA is a comprehensive and rigorous international programme promoted by OECD to assess the 'quality, equity and efficiency' of the school system of different countries and for 'defining and implementing educational goals about the skills that are relevant to adult life' (OECD, 2010a). In particular, rather than examining how well they perform a particular curricula specified by the school system, information from this survey focuses on how well students are prepared to meet the challenges of life. Since 2000, PISA surveys are carried out every three years. Every edition has a different major subject area of inquiry selected from the three which are tested every time: reading, mathematics and science. For the 2009 edition the main focus was on 'reading literacy'.

The 2009 survey has a total weighted sample of 470,000 students representing about 26 million students worldwide. The Italian subsample

used for the present research is composed of 29,284 students attending 991 different high schools[3]. This sample represents about 482,195 15 year-old students.

Measures

Dependent variable

Performance in reading. Performance in reading is chosen in this study as the dependent variable to explore the relationship between ICT use and learning outcomes for three reasons. First, reading literacy measured by PISA is among the best predictors for future economic and social well-being of teenagers. In particular, it is a better predictor of future earnings compared to the quantity of education as measured by years at school or in higher education (OECD, 2010b; OECD, 2010c). The PISA conception of reading literacy involves 'the capacity of an individual to understand, use, reflect on and engage with written texts in order to achieve his/her goals, to develop his/her knowledge and potential, and to participate in society. In addition to decoding and literal comprehension, reading literacy also involves interpretation and reflection, and the ability to use reading to fulfill one's goals in life' (OECD, 2010d, p. 1). Second, 'reading literacy' is the main focus of PISA 2009 research: the results of the test on this subject are therefore more reliable, since they come from a deeper investigation (more tasks on the test). Third, we expect that if any effects of Internet use for schoolwork are to be found on learning, these should have more to do with reading literacy than with mathematics or science literacy, as many activities done on the Internet relate to searching, selecting and reading information, often in the form of texts.

The reading literacy score used as our dependent variable is deducted from an analysis of the answers to a set of questions related to text evaluation and comprehension (OECD, 2012) during a 2-hour test administered to each student. Through a statistical procedure based on the Rasch-type 'partial credit model' (Masters, 1982), PISA measures learning

[3] In our analysis we did not consider the small number (1621) of 15 year-old students of the italian sub-sample who do not attend high schools in the national education system (some of these students were still in middle school, others were attending regional vocational schools).

performances on a scale developed in the 2000 survey, with 500 points as the average and a standard deviation of 100 points. This scale serves as a benchmark for the following surveys. In 2009, the average score was 493 for the OECD countries involved, slightly below the 2000 average.[4] In the 2009 survey, the average performance of Italian students on the reading literacy test was 486 points, slightly below the OECD average.

Independent variables

Socio-economic status. To analyze students' socio-economic background we rely on the PISA index ESCS (Economic Social and Cultural Status), calculated using information gathered through the 30 minute questionnaire that followed completion of the test. It considers home possessions (students' room and space in the house, cultural and technological commodities at home and other similar elements), parental education and occupation[5] as a proxy for the family's socio-economic condition (OECD, 2012). This index is standardized on the national average with mean 0 and standard deviation 1 and it has a range of -3.40 to 3.15 .

Type of school. The analysis also considers a specific variable that indicates the *type* of secondary school students are attending at the moment of the survey. The question asked ''What type of school are you attending?'' (the equivalent of 'Which programme are you in?'). Possible answers are '*liceo'*, 'technical school', 'vocational school', 'lower secondary school', 'regional vocational school'. As said, the Italian school system is strongly differentiated according to students' learning skills and socio-economic status. Therefore, each type of school has a quite homogeneous population of students based on their learning skills and, secondly, on their socio-economic and cultural background. For example, the average performance in reading in higher-ranking schools (*liceo*) is 541 points, while in technical schools it drops to 476 and in vocational schools to 417. Moreover, in the Italian school system the type of school attended is predictive of university enrolment and, overall, of future job opportunities (Barone & Schizzerotto, 2006). This form of school segregation, specific to the Italian context, makes this variable particularly meaningful as a control

[4] This difference is not statistically significant and is mostly due to the performances of new countries joining OECD since 2000.

[5] PISA considers the higher occupational status and level of education among parents.

when studying the consequences of digital inequalities (Bratti, Checchi, & Filippin, 2007).

Browsing the Internet at home for schoolwork. In the PISA dataset the 'Index of computer use at home for schoolwork' collects the answers to five different questions on the Likert scale focusing on Internet use related to school activities[6]. However, we found the index to be too *broad* for our goal as it includes activities such as 'checking the school's website for announcements' or 'using e-mail to communicate with other students about schoolwork', which have a communicative or functional nature instead of the learning one that we aimed to focus on. Therefore we use a single variable which identifies ICT activities carried out by students specifically for school and learning purposes. The question posed to students was 'How *often* do you browse the Internet for schoolwork (e.g. preparing an essay or presentation) *at home*?'. Possible answers to this question were 'Never or hardly ever', 'Once or twice a month', 'Once or twice a week' and 'Every day or almost every day'.

Statistical procedure

The present analysis considers the particular structure of the PISA dataset which uses the five plausible values (PVs) for parameter estimation and replicates for standard error estimation. The PVs are meant to prevent biased inferences, which can occur as a result of measuring non directly observable student skills. Instead of directly indicating one single value, a probability distribution is estimated and five random values are selected for each student. These values have to be considered together when performing statistical analyses in order to obtain a correct standard estimation (OECD, 2012).

Given the PISA complex sample design, the use of replicates is needed to obtain reliable sampling variances. These methods work by generating

[6] The *index of computer use at home for schoolwork* (HOMSCH) was derived from students' reports on how often they use a computer for the following activities at home (IC05): *i)* browse the Internet for schoolwork; *ii)* use e-mail to communicate with other students about schoolwork; *iii)* use e-mail to communicate with teachers and submit homework or other schoolwork; *iv)* download, upload or browse material from the school's website; and *v)* check the school's website for announcements. Higher values on this index indicate more frequent computer use at home for schoolwork (OECD, 2011, p. 226).

several subsamples (replicates), from the whole sample. The statistic of interest is then estimated for each of these replicates and then compared with the whole sample estimate to provide an estimate of the sampling variance (OECD, 2012). The analysis has been supported by the HLM (Hierarchical Linear Model) and SPSS programme (Statistical Package for Social Science). SPSS macros provided by OECD for analyzing PISA datasets were used.

Findings

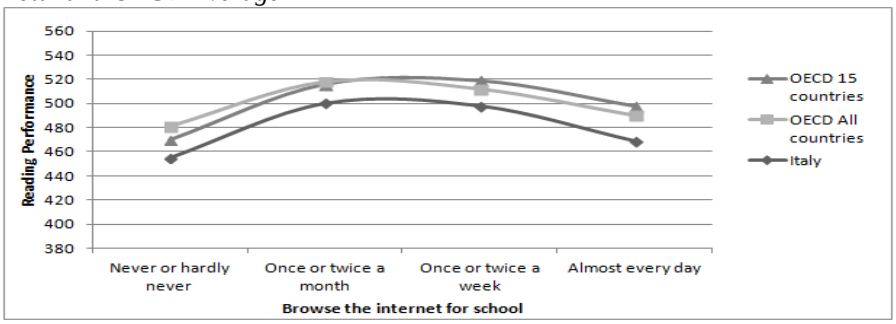
Of the 29,284 students of the Italian PISA 2009 weighted and selected sample 50.0% are males and 50.0% are females. Students attending *liceo* account for 47.5%, while 32.1% attend a technical school and 20.4% a vocational school. Of these 20.8% never use the Internet for schoolwork at home, 32.4% use it once or twice a month, 32.3% one or twice a week and 14.5% use it almost every day or more. Genders are equally represented among frequent users (about 14.0%), while moderate users are in the majority women. Males are more present among students who never browse the Internet for schoolwork (24.9% vs. 17.0%). A total of 52.7% of students from *liceo* belong to the higher quartile of ESCS, while the same is only true for 28.0% of students from technical schools and 20.0% of students from vocational schools. Students belonging to the lower quartile are 17.7% from vocational schools, 10.1% from technical schools and 4.2% from *liceo*. Frequent users mainly belong to the higher quartile (43.0%), while those who never or hardly never browse the Internet for school are mainly from the lower quartile of socio-economic status (18.0%).

In Italy, as in the whole PISA 2009 sample, the relationship between performance in reading and browsing the Internet at home for schoolwork is curvilinear and mountain-shaped (see Figure 1)[7]. Performance rises from rare users to moderate users (monthly use), then falls from weekly users to daily users. The difference between rare and moderate users is always statistically significant and has – in our opinion – substantial relevance (about 40 percentage points). The same applies to the difference between

[7] Very similar curvilinear patterns emerge when mathematics, science or digital literacies are considered (see OECD, 2011, pp. 192-193).

moderate and daily users (about 20 percentage points). The shape of the Italian curve is very similar to that of OECD countries on average.

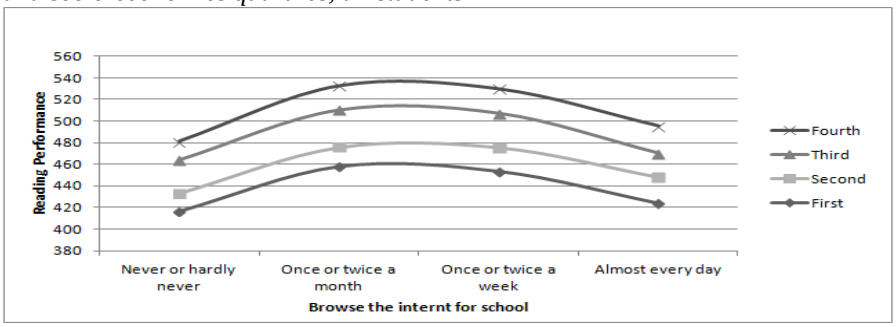
Figure 1. Browsing the Internet for school and reading performance, Italy, OECD Total and OECD Average



Source: Own elaborations based on OECD, 2011.

In the present analysis we are mainly interested in testing whether there is interaction between students' social backgrounds and their browsing the Internet for schoolwork in explaining learning outcomes. First, we test this hypothesis through a graphical representation. In figure 2, curves showing the relationship between the frequency of browsing the Internet for schoolwork and reading literacy are drawn for each cultural and socio-economic quartile of the PISA index.

Figure 2. Browsing the Internet for school and reading performance by cultural and socio-economics quartiles, all students

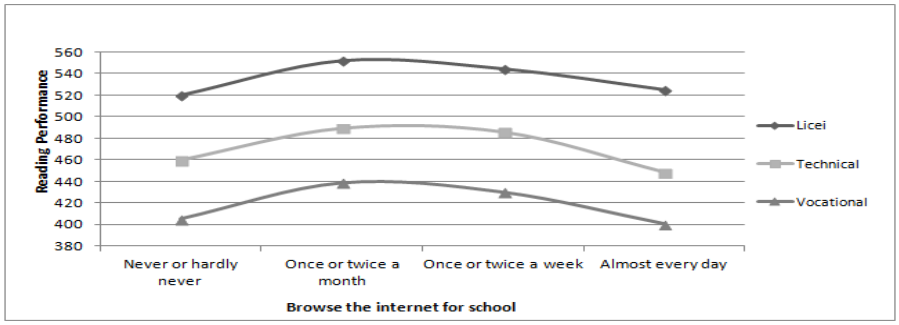


Source: Own elaborations based on OECD-PISA 2009 dataset.

It can be seen that the curves formed by the four quartiles are practically identical and run parallel, suggesting that the relationship of interest is not different in the different quartiles, contrary to our expectations.

In order to test the existence of a learning gap, the relationship of the frequency of browsing the Internet for school and reading performance has been analyzed also within each school type, the second most important indicator of students' social condition.

Figure 3. Browsing the Internet for school and reading performance by type of schools



Source: Own elaborations based on OECD-PISA 2009 dataset.

Again, the shape of the relationship between reading performance and 'browsing the Internet at home for school' is the same for students coming from different schools (Figure 3), except for a very slight divergence between *liceo* and technical schools in the 'almost every day' modality.

In order to statistically confirm what emerged from these graphical analyses, we use multilevel linear regressions. The dependent variable is the PISA score in reading literacy. In order to convert our ordinal independent variable ('browsing the Internet for schoolwork') into a continuous variable, a numerical value has been assigned to each modality which refers to the monthly frequency of Internet use expressed by each modality and weighted on a range of between 0 and 10[8]. Among the many possible ways to do this, we chose this method as the most appropriate

[8] Never or hardly ever has been assigned an arbitrary value of 0.1; once or twice a month has been considered as a frequency of 2 days a month; once or twice a week as 8 days a month; almost every day as 28 days a month.

because it mirrors the different distances between the four modalities. In particular, a weight of 0.1 has been assigned to the modality 'never or hardly ever'; 'once or twice a month' and 'once or twice a week' have been recorded respectively as 0.7 and 2.7 and 'almost every day' has a weight of 9.3. However, we made sure that the results do not change significantly if a simple recoding into an ordinary scale is carried out (such as, for example, when the modalities are recoded into 1, 2, 3 and 4)[9]. The variable has been then normalized with mean 0 and standard deviation 1 (the range goes from -0.75 to 2.39).

Preliminary analyses show that the linear relationship between the frequency of browsing the web for schoolwork and reading literacy, controlling for ESCS, is negative and significant both for males and females (the coefficient is -4.3 for both genders, with standard errors of 0.74 and 0.86 for males and females respectively).

To test our two hypotheses, we ran two models with the aim of estimating the interaction between browsing the web for schoolwork and students' social background, with reading literacy as the independent variable. The first model takes into account the interaction between the frequency of Internet use and the socio-economic condition (ESCS) of students. Independent variables included in the model are: *browsing the Internet for schoolwork (a)*, the quadratic term of browsing the Internet for schoolwork, to account for the *curvilinearity* found in the graphical analysis (a*a), ESCS (b). Furthermore, we added the interaction effect between *browsing the Internet for schoolwork* and ESCS (a*b) to check whether the impact of Internet use on students' learning outcomes varies according to their social background. The same model was run separately for males and females[10].

Table 1 shows the results of this model. First, we notice that among both boys and girls a curvilinear trend emerges and the linear coefficient is negative but not significant. However, what is most important for our analysis is that the interaction effect between browsing the Internet for schoolwork and ESCS is substantially low and not statistically significant,

[9] We will report some of the results of this alternative methodology afterwards.

[10] There is solid evidence that girls outperform boys in literacy standardized tests and that the pattern of the relationship between the frequency of students' use of computers and learning performance is different for girls and boys (see: OECD, 2011; Thiessen & Looker, 2007). In order to account for this gender difference we chose to consider males and females separately when showing empirical results.

confirming previous graphical analyses in that the effect of Internet use on learning outcomes does not depend on students' socio-economic context. The lack of significance in the interaction coefficients persists also when controlling for gender. This result partially confirms previous findings by Thiessen and Looker (2007), where no interaction with family's cultural capital was found among boys (and only to a small extent among girls).

Table 1. Regression model 1

		Girls		Boys	
		Value	S.E.	Value	S.E.
Intercept		**509**	(2.9)	**475**	(3.1)
Browsing the Internet for schoolwork	**(a)**	-1.33	(0.9)	-0.24	(0.79)
Browsing the Internet for schoolwork (squared)	**(a*a)**	**-4.98**	(0.5)	**-7.70**	(0.7)
ESCS	**(b)**	**7.04**	(0.6)	**4.58**	(0.9)
Browsing the Internet for schoolwork*ESCS	**(a*b)**	-0.53	(0.5)	-0.08	(0.7)

Note: Bold types show statistically significant values for confidence intervals derived moving 1.96 standard deviations in both directions from the mean of a normal distribution.

To test hypothesis 2, we ran a model controlling for type of school attended (level 2) and testing the interaction effects between attending each type of school and frequency of web use for schoolwork (level 1). In model 2, we used multilevel (or hierarchical) linear regression in order to take into account the hierarchical structure of the data: students grouped into schools (see: Snijders & Bosker, 1999; Martini & Ricci, 2006; OECD, 2010). We used dummy variables for each type of school where the omitted category is *liceo* (d1), the highest performing school in terms of learning outcomes.

As we have said, the type of school is a variable that strongly differentiates among different levels of learning performances in Italy, and it is a strong predictor of future opportunities in the job market. Therefore, the type of school attended is a very significant indicator of a student's social milieu, influenced by both academic and social factors.

Table 2. Multilevel regression model 2

		Girls		Boys	
		Value	S.E.	Value	S.E.
Level 1					
Intercept		**547**	(1.9)	**527**	(3.3)
Browsing the Internet for schoolwork	(a)	0.9	(0.8)	1.8	(1.4)
Browsing the Internet for schoolwork (squared)	(a*a)	**-5.54**	(0.5)	**-8,0**	(0.7)
Level 2					
School type *Rif. liceo (d1)*					
Technical	(d2)	**-51**	(3.3)	**-63**	(5.5)
Vocational	(d3)	**-109**	(4.1)	**-125**	(5.8)
Browsing*Technical	(a*d3)	-2,6	(1.4)	-1.4	(1.8)
Browsing*Vocational	(a*d4)	-3,0	(1.6)	-3.2	(2.1)

Note: Bold types show statistically significant values for confidence intervals derived moving 1.96 standard deviations in both directions from the mean of a normal distribution.

As can be seen in table 2, we did not find any significant interaction effect between this variable and the use of the Internet for schoolwork in their impact on reading literacy levels[11].

Discussion

The digital inequality framework, the 'knowledge gap theory' (Donohue, Tichenor, & Olien, 1975) and Bourdieu's theory of capital conversion (Bourdieu, 1986) have been used to design the research topic of this paper. Following the arguments of these theoretical approaches, we expected that the social benefits students gain from Internet use to vary according to their social position. We hypothesized that, given their greater economic and cultural resources, students from a more advantaged social

[11] Analyses carried out with the alternative recoding method for the variable 'Browsing the Internet for schoolwork' give similar results: the coefficients for the interaction effect in Model 1 are -1.04 (S.E. 0.8) for boys and -0.73 (S.E. 0.7) for girls. Also in Model 2 all the interaction coefficients are not significant.

background would be able to benefit more from Internet usage for school-related purposes in terms of learning performance than students from families of a lower socio-economic status.

In this paper we used Italian students' reading performances in the PISA 2009 standardized test as a proxy for the social consequences of Internet use for schoolwork. Preliminary analyses on the linear relationship between the frequency of 'browsing the Internet for schoolwork' and reading literacy have produced negative and significant coefficients for both boys and girls. However, later quadratic regressions show that among both boys and girls this relationship is better described in a curvilinear way. Mountain-shaped curves resulting from our analyses show that moderate users of the web for schoolwork perform better than both non-users and frequent users of the Internet for the same purpose. Translated graphically, our hypotheses did not anticipate that these curves would show the same shape for students of different social conditions. We expected the curves representing more advantaged students to diverge in their final part, showing a positive trend. The findings do not confirm our hypotheses. Through a descriptive analysis and two regression models we found that there is neither interaction between students' socio-economic status and their Internet use for schoolwork in their impact on learning outcomes, nor is this interaction present when the type of school is considered as an indicator of students' social position. Unlike Thiessen and Looker (2007), we found that neither male nor female students get more benefits in terms of reading performances when their families' socio-economic condition or the type of school attended improves. Considering that our study is based on a more recent dataset, focuses specifically on Internet use for homework and adopted a more comprehensive index of families' socio-cultural backgrounds, we argue that today no 'reading literacy gap' deriving from Internet use for homework exists among students from different backgrounds and school types.

Two primary comments can be made on these results. First, it is indeed telling (and unexpected) that reading literacy decreases as the frequency of Internet use for homework increases. On the one hand, it could be that the potential of the Internet for school-related activities has not yet been exploited, even by students from the best social and cultural contexts, so that frequent Internet use ends up being more detrimental than beneficial to traditional learning. In this perspective, even if we do not see signs of a learning gap today, we could be seeing them soon, as this potential is

unequally exploited in learning. On the other hand, it could also be that through Internet use students are developing skills that are not measurable with traditional standardized learning indicators. In this case, the impact of Internet use on inequality would be better measured by looking at different indicators. A possible limitation of this study has to be considered. We have focused only on 'browsing the Internet for schoolwork'. While this choice has the advantage of clarifying the exact source of possible impacts on learning outcomes, it only considers a small portion of Internet activities potentially influencing reading literacy. Therefore, we cannot conclude that the Internet is not currently impacting reading literacy inequalities across the whole range of its usage. Other types of Internet activity, also not directly pertaining to school, could have stronger impacts on literacy inequalities.

Future research should first examine the relationship between Internet use for schoolwork and students' learning outcomes in more detail. This is urgent, as in recent years a lot of investments have been made in the diffusion of new media in both schools and the home around the world with the aim of enhancing learning. Second, research should investigate whether other forms of Internet use apart from doing homework online show relationships with learning inequalities. Third, the impact of Internet use on other variables related to young people's future opportunities should be also taken into account (e.g. skills useful for future job possibilities and social relationships). From a methodological point of view, there is an urgent need to go beyond simple measurements of association and to conduct randomized experiments or other types of counterfactual studies, in order to directly measure the causal effect of different uses of technology on learning and on other socially relevant outcomes. Following along these lines, research into digital inequality will be able to move beyond the simple description of differences in Internet access, use or skills, and will directly test whether and how these differences are actually impacting social inequality.

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References

Attewell, P., & Battle, J. (1999). Home Computers and School Performance. *The information society*, *15*(1), 1-10.

Barone, C., & Schizzerotto, A. (2006). *Sociologia dell'istruzione*. Il Mulino: Bologna.

Bentivegna, S. (2009). *Disuguaglianze digitali. Le nuove forme di esclusione nella società dell'informazione.* Laterza: Roma-Bari.

Biagi F., & Loi, M. (2013). Measuring ICT Use and Learning Outcomes: Evidence from Recent Econometric Studies. *European Journal of Education*, *48*(1), 28-42.

Bonfadelli, H. (2002). The Internet and Knowledge Gaps: A Theoretical and Empirical Investigation. *European Journal of Communication*, *17*(1), 65-84.

Bourdieu, P. (1986). The Forms of Capital. In J.C., Richardson (Eds.), *Handbook of Theory and Research in the Sociology of Education* (pp. 241-258). New York: Greenwood Press.

Bratti, M., Checchi, D., & Filippin, A. (2007). Geographical Differences in Italian Student's Mathematical Competencies: Evidence from PISA 2003. *Giornali degli economisti e annali di economia*, *66*(3), 299-333.

Calvani A., Fini A., Ranieri M., Picci, P. (2012). Are Young Generations in Secondary School Digitally Competent? A Study on Italian Teenagers. *Computers and Education*, 58, 797-807.

Di Maggio, P., Hargittai, E., Celeste, C., & Shafer, S. (2004). From Unequal Access to Differentiated Use: A Literature Review and Agenda for Research on Digital Inequality. In K. Neckerman (Eds.), *Social Inequality* (pp. 355-400). Russell Sage Found, New York.

Di Maggio, P., & Bonikowski, B. (2008). Make Money Surfing the Web? The Impact of Internet Use on the Earnings of U.S. Workers. *American Sociological Review*, 73, 227-50.

Donohue, G. A., Tichenor, P. J., & Olien, C. N. (1975). Mass Media and the Knowledge Gap: A Hypothesis Reconsidered. Communication. *Research*, *2*(1), 3-23.

Enoch, Y., & Soker, Z. (2006). Age, Gender, Ethnicity and the Digital Divide: University Students' Use of Web-based Instruction. *Open Learning*, *21*(2), 99-110.

Eshet-Alkalai, Y., & Amichai-Hamburger, Y. (2004). Experiments in Digital Literacy. *Cyberpsychology and Behavior*, 7, 421-429.

Eurostat (2013). *Individuals Regularly using the Internet. Information Society Statistics*. http://epp.eurostat.ec.europa.eu/portal/page/portal/information_society/data/main_tables

Fairlie, R. W., Beltran, D. O., & Das, K. K. (2009). Home computers and educational outcomes: Evidence from the NLSY97 and CPS. *Economic Inquiry*, *48*(3), 771-792.

Fuchs, T, & Woessmann, L. (2004). Computers and Student Learning: Bivariate and Multivariate Evidence on the Availability and Use of Computers at Home and at School'. *Brussels Economic Review*, *47*(3-4), 359-386.

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. (2002). Second-Level Digital Divide: Differences in People's Online Skills. *First Monday*, 7, 4.

Hargittai, E. (2008). The Digital Reproduction of Inequality. In D. Grusky (Eds.), Social Stratification (pp. 936-944). Boulder, CO: Westview Press.

Hargittai, E. (2010). Digital Na(t)ives? Variation in Internet Skills and Uses Among Members of the 'Net Generation'. *Sociological Inquiry*, *80*(1), 92-113.

Hargittai, E., & Walejko, G. (2008). The Participation Divide: Content Creation and Sharing in the Digital Age. *Information, Communication and Society*, *11*(2), 239-256.

Hargittai, E., & Hinnant, A. (2008). Digital Inequality: Differences in Young Adults' Use of the Internet. *Communication Research*, *35*(5), 602-621.

Hasebrink U., Livingstone, S., Haddon, L., & Olafsson, K. (2009). *Comparing Children's Online Opportunities and Risks across Europe: Cross-national Comparisons for EU Kids Online.* 2MD edition, London: LSE EU Kids Online. Retrieved from http://eprints.lse. ac.uk/24368/

Hanushek, E. A., Dean, T., Jamison, E. A., & Woessmann, L. (2008). Education and Economic Growth: It's not just going to school but learning that matters. *Education Next*, *8*(2), 62-70.

Invalsi (2011). *Le competenze in lettura, matematica e scienze dei quindicenni italiani*. Invalsi: Roma.

Peter, J., & Patti M. Valkenburg (2006). Adolescents' Internet Use: Testing the 'Disappearing Digital Divide' Versus the 'Emerging Digital Differentiation' Approach. *Poetics*, *34*(4-5), 293-305.

Jung, J. Y., Linchuan, Qiu, J., & Kim, Y.-C. (2001). Internet Connectedness and Inequality: Beyond the Divide. *Communication Research*, *28*(4), 507-535.

Lei, J., & Zhao, Y. (2007). Technology Uses and Student Achievement: A Longitudinal Study. *Computers & Education*, *49*(2), 284-296.

Liff, S., & Shepherd, A. (2004). An Evolving Gender Digital Divide? *Oxford Internet Institute, Internet Issue Brief, 2*, 1-17.

Livingstone, S., Bober, M., & Helsper, E. (2005). Active Participation or Just More Information? *Information, Communication & Society*, *8*(3), 287-314.

Livingstone, S., & Helsper, E. J. (2007). Gradations in Digital Inclusion: Children, Young People and the Digital Divide. *New Media & Society*, *9*(4), 671-696.

Martini, A., & Ricci, R. (2010). Un esperimento di misurazione del valore aggiunto delle scuole sulla base dei dati PISA 2006 del Veneto. *Rivista di Economica e Statistica del Territorio*, 3, 78-105.

Masters, G. N. (1982). A Rash Model for Partial Credit Scoring. *Psychometrika*, 47, 149-174.

Merton, R. K. (1968). The Matthew Effect in Science. *Science*, 159, 56-63.

Nævdal, F. (2007). Home-PC usage and Achievement in English. *Computers & Education*, *49*(4), 1112-1121.

North, S., Snyder, I., & Bulfin, S. (2008). Digital Tastes: Social Class and Young People's Technology Use. *Information, Communication & Society*, *11*(7), 895-911.

NTIA - National Telecommunication and Information Administration (1999). *Falling Through the Net: Defining the Digital Divide.* A Report on the Telecommunications and Information Technology Gap in America. Washington DC, Ntia.

OECD (2009). *PISA 2009 Assessment framework – Key competencies in Reading, Mathematics and Science*. OECD Publishing: Paris.

OECD (2010). *PISA 2009 Results: Overcoming Social Background – Equity in Learning Opportunities and Outcomes* (Volume II). OECD Publishing: Paris.
OECD (2010a). *Education at a Glance 2010: OECD Indicators*. OECD Publishing: Paris.
OECD (2010b). *The High Cost of Low Educational Performance*. OECD Publishing: Paris.
OECD (2010c). *Pathways to Success: How Knowledge and Skills at Age 15 Shape Future Lives in Canada.* OECD Publishing: Paris.
OECD (2010d). *PISA 2009 Results: What Students Know and Can Do – Student Performance in Reading, Mathematics and Science* (Volume I). OECD Publishing: Paris.
OECD (2011). *PISA 2009 Results: Students on Line: Digital Technologies and Performance* (Volume VI). OECD. Publishing: Paris.
OECD (2012). *PISA 2009 Technical Report.* OECD Publishing.
OECD (2013). *Education at a Glance 2013: OECD Indicators*. OECD Publishing.
Papanastasiou, E., Zembylas, M, & Vrasidas, C. (2003). When computer use is associated with negative science achievement. *Journal of Science Education and Technology*, *12* (3), 325-332.
Robinson, L. (2009). A Taste for the Necessary. *Information, Communication & Society, 12*(4), 488-507.
Selwyn, N. (2004). Reconsidering Political and Popular Understandings of the Digital Divide. *New Media & Society, 6*(3), 341-362.
Selwyn, N. (2011). In praise of pessimism the need for negativity in educational technology. *British Journal of Educational Technology*, *42*(5), 713-718.
Snyder, I., Lawrence, A., & Sutherland-Smith, W. (2004). They're the future and they're going to take over everywhere: ICTs, literacy and disadvantage. In I. Snyder & C. Beavis (Eds.), *Doing literacy online: teaching, learning and playing in an electronic world* (pp. 225-244). Cresskill, N.J.: Hampton.
Stiglitz, J. E., Sen A. & Fitoussi, J. P. (2009). *Report by the Commission on the Measurement of Economic Performance and Social Progress*. Commission on the Measurement of Economic Performance and Social Progress: Paris.
Sutherland-Smith, W., Snyder, I., & Angus, L. (2003). The Digital Divide: Differences in Computer Use between Home and School in Low Socio-economic Households. *Educational Studies in Language and Literature,* 3, 5-19.
Tsatsou, P., Pruulmann-Vengerfeldt, P., & Murru, M. F. (2009). Digital divides. In S. Livingstone & L. Haddon (Eds.), *Kids Online: Opportunities and Risks for Children* (pp. 107-121). Bristol: The Policy Press.
Tichenor, P. J., Donohue, G. A., & Olien, C. N. (1970). Mass Media Flow and Differential Growth in Knowledge. *Public Opinion Quarterly*, *34*(2), 159-170.
Thiessen, V., & Looker, D. (2007). Digital Divides and Capital Conversion: the Optimal Use of Information and Communication Technology for Youth Reading Achievement. *Information, Community and Society*, *10*(2), 159-180.
Wainer, J., Dwyer, T., Dutra, R. S., Covic, A., Magalhaes, V. B., Ferreira, L. R. R., Pimenta, V. A., & Claudio, K. (2008). Too much computer and Internet use is bad for your grades, especially if you are young and poor: Results from the 2001 Brazilian SAEB. *Computers & Education*, *51*(4), 1417-1429.
Wasserman, I. M, & Richmond-Abbott, M. (2005). Gender and the Internet: Causes of Variation in Access, Level & Scope of use. *Social Science Quarterly*, 1, 252-270.

Wittwer, J., & Senkbeil, M. (2008). Is students' computer use at home related to their mathematical performance at school? *Computers & Education*, *50*(4), 1558-1571.

Van Deursen, A., & Van Dijk, J. (2009). Using the Internet: Skill related problems in users' online behavior. *Interacting with Computers*, *21*(5-6), 393-402.

Van Dijk, J. (2005). *The Deepening Divide. Inequality in the Information Society*. London: Sage.

Vigdor, J. L., & Ladd, H. M. (2010). *Scaling the Digital Divide: Home Computer Technology and Student Achievement.* National Bureau of Economic Research Working Paper, No 16078. Retrieved from http://www.nber.org/papers/w16078

Zillien, N., & Hargittai E. (2009). Digital Distinction: Status-Specific Internet Uses. *Social Science Quarterly, 90*(2), 274-291.