

THE IMPACT OF DIGITALIZATION ON EDUCATIONAL ACHIEVEMENT: A LITERATURE REVIEW FROM A SOCIOLOGICAL PERSPECTIVE

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There is still a great optimism concerning the impact of ICT (Information and Communications Technology), including CAI (Computer Assisted Instruction) on the effectiveness of education. The article is a brief synthesis, mostly with a sociological leaning, of the current empirical literature devoted to the various ways in which digitalization has an influence upon the results of education. We found that the investigations of educational impact of digitalization follows the trend from the general literature concerning the social effects of ICT which reveals an empirical perspective of multi-layered divisions in which the first and the second levels (or orders) are the most thoroughly researched and theorized while current developments tentatively regard issues of third, fourth and international digital divisions. As a general overview of the domain it can be concluded that as it develops the more and more the initial optimism vanes making space for anguish over the possible socially divisive potential of ICT use in education. The digital revolution in education not only does not solves previous issues but apparently creates new ones as differences in access, in skills and in use patterns are able to increase the various offline gaps between people of different socio-economic backgrounds.

Keywords: digitalization in education; second order digital divide; digital skills; literature review.

INTRODUCTION

New technologies change all areas of life including education. On the one hand ICT (Information and Communications Technology) can be used as a tool in formal education transforming regular educational practice in what is called Computer Assisted Instruction (CAI) which require certain infrastructure and skills, both from students and teachers. On the other hand, one cannot ignore that as society immerses into the 4th Industrial Revolution, contents have also to be correspondingly adapted and learning likewise. Moreover, not only formal learning is changed by the digital revolution but the context of it, including the various

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instances of informal learning, which requires renewed perspectives in approaching the whole process of education.

As said in the first paragraph of this article, there is a great optimism concerning the impact of ICT, including CAI, on the effectiveness of education. Given the huge expectations, and amounts of money notwithstanding, invested in the digitalization of education it is worthy a sober look into the actual evidence concerning the way ICT influences the results of education. The current article is a brief synthesis of the current empirical literature devoted to the various ways in which digitalization has an influence upon education.

Articles included in the current review have been identified using the Google Scholar service and lectured with regards to two aims: elaborating a *map of the problematique* of ICT effects in education and a review of the current empirical evidence of the actual effects and the causal mechanisms behind them. No time limits to the publication date have been imposed as the topic is recent by itself. However, we were more interested in the latest results than in the earlier ones, as the methodologies have improved themselves in time (Skryabin et al., 2015). The focus of the review was mostly on articles devoted to actual assessment of the effects and less on articles describing digitalization in education. Moreover, priority was given to articles describing meta-analyses, quasi-experimental evaluations and replicable assessments – most of which use large publicly available datasets like PISA or TIMMS. The review is not exhaustive nevertheless and its added value resides more in identifying the key points of discussion around the actual impact of digitalization in education than in formulating firm conclusions about the current state of the research and concerning the effect of digital revolution in education. It is worth adding also that obviously the review bears a sociological bias given the interest of the authors and as such is leaning somewhat towards a sociological interpretation of the current literature in the field.

The article will start by framing the topic in the context of the great expectations that are invested in the potential of digital technology to improve the overall effectiveness of education as well as to contribute to a more just access to educational resources. We found that the general literature of social effects of ICT reveals an empirical perspective of multi-layered divisions in which the first and the second levels (or orders) are the most thoroughly researched and theorized while current developments tentatively regard issues of third, fourth and international digital divisions. We will consequently pay more attention to the issues of first order digital divide – the gaps in individual access, second order digital divide – the gaps emerging from differences in patterns of use across socio-economic groupings and will provide a less thorough incursion in the more advanced topics of third-, fourth-order digital divides.

CONTEXT: THE PROMISES OF ICT AND CAI BENEFITS FOR EDUCATION

Access to computers, smartphones and internet in schools and at home promises to have the potential to improve student outcomes in several ways and is understandable that ICT holds the promise of an equalizing force in society, including education. Information and Communications Technology (ICT) and computer aided instruction (CAI) have, apparently, the capacity of increasing the quantity of instruction that students receive (Barrow et al., 2009), and monitoring student involvement via: 1) Self-paced instruction that is typically difficult to achieve in classroom group-based teaching (Koedinger et al., 1997); 2) Likewise, the content of individualized instruction can be adjusted to the strengths and disadvantages of the students.

Besides, Internet represents a potentially valuable resource for finding out information about a wide range of educational topics, reduces the costs of access to information (i.e. Wikipedia) as well as facilitating communications between individuals and across groups. ICTs, due to their interactive nature, may engage students in learning in more effective ways than traditional teaching (Cuban, 2003). In addition to this, digital skills may increase the economic returns to education, especially areas of employment where computers are used extensively. Being computer literate has also direct positive effects in the workplace, society and higher education (Bulman and Fairlie, 2016). ICT holds the promise of an equalizing force in society, including education.

Despite the generic optimism related to the impact of ICT and CAI on education the current empirical evidence provides a mixed diagnostic concerning the net effect of use ICT in teaching and learning. (Bulman and Fairlie, 2016).

EVIDENCE OF DIRECT POSITIVE AND NEGATIVE EFFECTS

Recent meta-analyses of effectiveness research indicated positive but small to moderate impacts (Skryabin et al., 2015). Bayraktar conducted a meta-analysis of 42 studies (1970–1999) to compare computer-assisted instruction to traditional instruction and revealed that the computer-assisted teaching environment outperformed the traditional one generally (Bayraktar, 2001). Torgerson and Zhu (2003) reported mixed evidence in their systematic literature review on the effectiveness of ICT in literacy learning (ages 5–16 years). For example: Banerjee et al. found that a computer-assisted learning programme for mathematical skills reinforcement showed a large and positive impact on achievement in mathematics as well (Banerjee et al., 2007).

Some evaluations of programs of digitalization of education provide generally positive, if small, results: 1) Assessments of effects of blended learning environments is usually positive. (Demirer and Sahin, 2013; Kuzu and Demirkol, 2014). 2) 1:1 laptop programmes found to have positive effects: Zheng, B., et al. (2016): meta-analyzed 10 studies examining the impact of laptop programs on

students' academic achievement and found significant positive effects in fields like English, writing, mathematics, and science.

Other assessments highlighted the positive impact of ICT besides academic achievement on other desired outcomes of education. Rashid (2016) i.e. showed that use of ICT has a (presumably) direct positive relationship with students' engagement and self-directed learning, whereas no significant direct effect was found between technology use and academic performance.

More worrisome are the contrary results, that warn against the careless use of ICT in education which concern two related phenomena: direct detrimental effects upon the results of education and indirect (or relative) negative effects which can be subsumed to the concept of second order digital divide.

Evaluation of net effect on achievement of Introduction of home computers is found to find a decline in math and science achievement in US (Vigdor et al., 2014). PISA 2012 and 2015 (OECD, 2015) provide mixed if not entirely pessimistic view on the impact of use of computers and internet at home or at school on achievement in all three areas (maths, sciences and language) (Papanastasiou, 2002). Further, a surprising result of the TIMSS 1995 survey is that computer use in the classroom was negatively associated with high student achievement in a number of countries (Papanastasiou, 2002). However is replicated in most of the 68 countries participating in PISA2015 (see also Hatos 2018, forthcoming). The most common hypothesis concerning this topic is that between ICT use and learning outcomes the relationship is inverse U-shaped and thus medium and high intensity users would not gain from addition ICT use (Rodrigues and Biagi, 2017).

Digitalization in education, sometimes enthusiastically adopted, seem to have unexpected detrimental impact on education. Online learning is found usually to have lower educational effectiveness than offline learning (Coates et al., 2004). Time spent on internet for other purposes than educational (Kim et al., 2017) appears also as having a negative effect. Mobile devices/smartphones use in teaching bring many challenges too. Among them, the most salient are: distraction, dependency, lacking hands on skills, and the reduce quality of face-to-face interaction. (Anshari et al., 2017). Similarly, Lepp, Barkley, and Karpinski (2014) and Samaha and Hawi (2016) found that cell phone use/texting was negatively related to GPA and positively related to anxiety, stress and consequently negatively with satisfaction with life. This negative result was replicated in Portugal by Belo, Ferreira and Telang (2013).

CAUSAL MECHANISMS OF DIRECT EFFECTS

A great deal of attention has been spent on revealing the causal mechanism behind these negative results. An impressive variety of mediating variables was found to explain the negative correlations listed above: gender (Kim et al., 2017;

Salmela-Aro et al., 2017); subject (Bulman and Fairlie, 2016); computer home availability (Carrasco and Torrecilla, 2012; Lee and Wu, 2012) and home use and type of used device (Nævdal, 2007; Papanastasiou et al., 2003; Valentine et al., 2005). Teaching strategy when using ICT, student and teacher comfort, type of use and students' socio-economic background are the ones that gain the most of researchers' attention.

Teaching strategy (which depends on the degree of ICT integration in teaching practice too (Suárez-Rodríguez et al., 2018)). According to the conclusions of early researches in order for technology to have an effect on student achievement must be challenging and focused on higher-order thinking skills, on the one hand, and the teachers must be capable of using and teaching it and have the appropriate support, on the other. Besides, inquiry oriented teaching approaches are more effective than lectures, also positive effects have the use of ICT in self-directed study, cooperative learning, game-based-learning, for mobile use in teaching. In addition, it is better to use informal than formal learning for mobile use in teaching and is recommended to have medium and short duration than long duration for mobile use in teaching (Sung et al., 2016). Obviously, these recommended teaching strategies require adapted contents and skilled teachers.

Comfort, anxiety, ease of use, digital self-efficacy influence significantly the impact of digital education. Based on the PISA 2003 results, it was discovered that regular computer users have higher achievement in key school subjects (OECD, 2007). Similarly, based on the PISA 2009 results, Delen and Bulut indicated that students' familiarity with digital technology and their exposure to ICT could contribute to explain math and science achievement differences recorded between individuals and schools (Delen and Bulut, 2011). Level of comfort, or confidence in ICT equipment correlate positively with academic achievement (Papanastasiou et al., 2003) even if mediated by their engagement in online reading (Lee and Wu, 2012).

Type of use point to the so-called “intelligent use” of ICT contrasted to other modes of employment both at school and at home. The issues of home use includes the issue of excessive internet use. Intelligent use of electronic device (Drain et al., 2012) or academic use of the internet could be a means of achieving good school performance (Kim et al., 2017). Excessive internet use, or internet addiction among teenagers have been shown to be in a causal loop with school burnout and disengagement (Salmela-Aro et al., 2017). As a novel phenomenon, the use of social networking sites has already been investigated against academic performances but the review of 23 studies published until 2017 provide mixed results. (Doleck and Lajoie, 2018). For instance, use of Facebook for academic purposes correlates again positively with academic performances (Lambić, 2016) but Instant messaging is found to have negative effect on academic results (Fox et al., 2009).

Students' socio-economic status and resources pertains for the so called second order digital divide.

SECOND ORDER DIGITAL DIVIDE

The digital divide has been defined as “the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the Internet for a wide variety of activities.” (OCDE, 2001). This idea included such dimensions as autonomy and continuity of access (Van Deursen and Helsper, 2015).

While variations in access and the impact on access is referred to usually as first order digital divide differences in ICT use and benefits along socio-economic differences are referred to usually as the second order digital divide. It can be understood as different patterns of use among individuals or organizations that already have similar access to ICT.

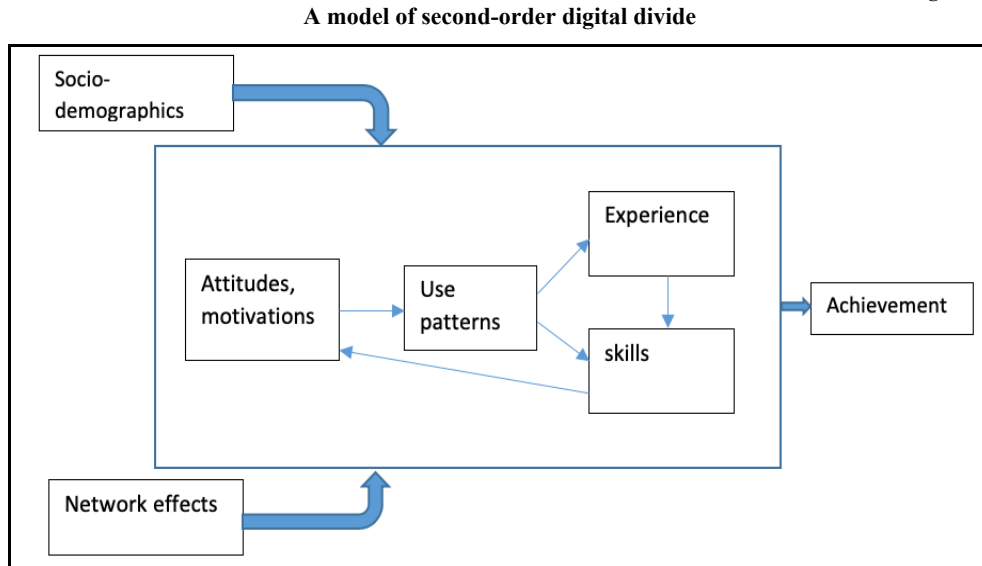
Although any new electronic (and not only) media has been predicted as an equalizing tool, concerning the new electronic and/or digital technologies rather quickly the assessments became more nuanced. Against the expectation that electronic media will be an equalizing tool, Tichenor, Donahue and Olien (1970) were among the first to state that higher status individual will take larger benefits from access to information arguing that people with higher socioeconomic status tend to acquire information easier than the those from the lower strata of the society, so that the differences in knowledge and skills between these categories tends to increase. At that moment Tichenor and his colleagues attributed this advantage to higher media competence, a higher knowledge level, relevant social connections, and more selective media use.

Battle (1999) was among the first to notice the higher status persons' advantage from using ITC, in the area of education itself calling it another 'Sesame Street effect'. His results shown that the advantage of having home computers were higher for those from higher socio-economic strata, for boys and lower for minorities.

However, the concept of second order digital divide has been coined by DiMaggio and Hargittai (DiMaggio and Hargittai, 2001; Hargittai, 2001). On the basis of our literature review we draw a model of second order digital divide which assumes equal access.

Socio-demographics in this model stands for the gender and age and for family socio-economic background including type of residence. Novo-Corti and Barreiro-Gen (2015) studied the ICT adoption in different Spanish regions, finding that net of ICT infrastructure, households' characteristics such as income, education, and age of its individuals, affect the adoption of ICT. Residence is another background variable which can affect ICT usage net of access. Correa and Pavez (2016) and Chen, Lin and Lai (2010) show that residents in urban areas use internet in ways different from their rural counterparts due to social isolation, ageing population and specific economics even in conditions of similar income, education and access.

Figure 1



Network effects: students learn from their connections (families and peers) patterns of ICT use. Families adopt technology and patterns of use through influence via social connections. Social network constructs contributed significantly to the explanation of technology use (Venkatesh and Sykes, 2013).

Use patterns refers to the consistent ways in which ICT, computers and smartphones and internet connections are used. Although spend less time online, higher status people tend to engage online in more capital-enhancing activities (Hargittai and Hinnant, 2008; van Deursen and van Dijk, 2014). In return, people with lower levels of socio-economic status tend to use the Internet in more general and superficial ways (Helsper and Gal acz, 2009). Numerous researches have been devoted to classifications of ICT usage types they usually recording the correlations of these types with users socio-economic status (Blank & Groselj, 2014). Among them ones we can refer to:

- Kalmus et al. (2011) suggest that classifications can be used to differentiate between the use of online social, leisure and information services;
- Social, leisure and academic Internet use (Landers and Lounsbury, 2006);
- Technical, information exchange and leisure motives (Swickert et al., 2002);
- Ritualized and instrumental use (Papacharissi and Rubin, 2000);
- Non-Users (42%), Sporadic Users (18%), Instrumental Users (18%), Entertainment Users (10%), and Advanced Users (12%). according to a classification by Braendtzaeg, Heim and Karahasanovic (2011).

These different usage patterns have been explained using the highly similar theories of Media Uses and Gratifications Model (LaRose and Eastin, 2004) and

the Model of Media Attendance that states that web usage is an effect of expected outcomes: activity outcomes (playing games, entertainment, cheering-up), monetary outcomes (shopping and prize comparisons), novel outcomes (news and information), social outcomes (talk and support), self-reactive outcomes (pass time and relaxation) and status outcomes (improve life prospects and familiarize oneself with new technology) (LaRose and Eastin, 2004).

Not only we expect that higher status students use ICT in more “intelligent” ways but we also expect that due to absence of interaction/social influence effects digital divide type of uses are stronger in the case of rural Roma students that learn in segregated schools and classes.

Technology related attitudes differ across social categories. One’s attitude toward the Internet is crucial to using it. Hsieh et al (2008) identified several attitudinal, normative, and control beliefs that would predict continued intentions to use technology among the privileged and underprivileged. One of their key findings was that facilitating conditions were particularly important among the underprivileged. Negative attitudes toward technology such as computer anxiety have been shown to decrease access and use of Internet (Van Dijk, 2005) in addition to inhibiting the extent of use (Durdell and Haag, 2002). Internet anxiety negatively influences patterns of Internet use (Cazan et al., 2016) or prevents minorities from accessing it (van Deursen and van Dijk, 2015). Others refer to digital trust to refer to describe and measure acceptance or avoidance of ICT in their everyday life (West, 2015).

Internet experience People experienced with the Internet are most likely to engage in personally advantageous activities (Hargittai and Hinnant, 2008; Livingstone and Helsper, 2007). Skills accrue usually along with use. Digital literacy is a key concept here describing the capacity of effectively using digital technology (West, 2015). Eastin and LaRose (2000) highlighted that self-efficacy is an essential factor in Internet use, and self-reported skill is an important factor in predicting the types and the number of Internet activities in which people get involved (Hargittai and Hinnant, 2008; Livingstone and Helsper, 2007), as well as the palpable products of Internet use (Helsper et al., 2015). More concrete proofs on the importance of capabilities can be derived studies devoted to digital inequality that measure Internet skills in actual performance tests. Van Deursen and Van Dijk (2011), for example, measured medium-related and content-related skills using a large sample of the Dutch population. Medium-related skills involve so called operational skills which are basic skills necessary to operate ICT – in this case internet, and formal skills, which refer to capabilities related to navigating the hyperlinked structure of Internet. Secondly, content-related skills encompass what the authors call information skills, i.e. knowledges of how to seek information, and strategic skills, which contribute to the efficient accomplishment of solutions.

MULTIPLE ORDER AND INTERNATIONAL DIGITAL DIVIDES

Recently, in the context of universal access to ICT, there is talk about a third-grade digital divide although the difference from the second-order digital divide is not entirely clear and the concept appear more as a refining of the idea of second-order digital divide for the case of internet use (Robles et al., 2011; Szeles, 2018). According to Van Deursen and van Dijk (2015) the third-level digital divide would refer to disparities in the returns from internet use within populations of users with broadly similar usage patterns and who enjoy relatively unrestrained access to ICTs. Third-level divides, therefore, relate to gaps in individuals' capacity to translate their internet access and use into favorable offline outcomes (van Deursen and Helsper, 2015). Banaji et al. (2017) however do not entirely respect this distinction, for example, as they distinguish between gaps caused by differences in media appropriation within families and in skills and literacy (second-order divide) and the divides that accrue due to differences in usage patterns.

The current literature identifies **territorial digital divides** (see Szeles, 2018). The idea of international digital divide for example stands for digital gap across countries which has been also conceptualized recently (Cruz-Jesus et al., 2012; Kraemer et al., 2005). They concern cross-country comparisons in access, use, skills and attitudes related to ICT. However, as Skryabin et al argue (Skryabin et al., 2015) much of international variation are due to differences in socio-economic composition which explains exposure, adoption and use of ICT. Some cross-country variations can be attributed to non-economic factors like the impact of various governmental policies. National policies can influence adoption of ICT technologies. On the other hand, governmental policies and interventions are seen sometimes as contributors to digital divide as DiMaggio noticed as early as 2001 (DiMaggio and Hargittai, 2001; DiMaggio et al., 2004; Hsieh et al., 2008). Moreover, international comparisons of ICT (computer, internet) use show patterns of variations that reveal institutionalized practices, uses, norms that appear as part of the cultural made-up, of relating and using computers and internet in everyday life, including education. (Hatos, 2018, forthcoming). Assessing the impact of cultural settings, of values, frames and social representations on everyday approach to computers and internet is an interesting direction for investigations.

DISCUSSIONS AND CONCLUSIONS

Research on the impact of ICT in education is new as the digital revolution is which explains why much of the current evidence at hand does not admit firmly established conclusions. Due to the infancy of the field, robust methodologies did not have time to be implemented in the evaluation research. It is clear that solid evaluations based on valid and reliable measurement of all the involved constructs

– with observational measures instead of self-reports, for instance, and on experimental designs too – involving randomized trials if possible, are rather rare.

Furthermore, the phenomenon itself develops at a pace that sometimes makes results not older than 5 years obsolete: the current salience of mobile device use and of the social networking sites makes the previous analyzes on the impact of computer use or of Internet seem irrelevant. While the current research focuses on the impact of smartphones or of web2.0 services like Snapchat or Instagram we can expect that the next wave of research will deal with topics like the assessment of AI-assisted online learning tools.

As a general overview of the domain it can be concluded that as it develops the more and more the initial optimism vanes making space for anguish over the possible socially divisive potential of ICT use in education. The digital revolution in education not only does not solve previous issues but apparently creates new ones as differences in access, in skills and in use patterns are able to increase the various offline gaps between people of different socio-economic backgrounds. One crucial direction for future investigation that is of high relevance for educational policies is that of exploring and investigating the ways in which ICT and CAI can be implemented to reduce the various digital divides.

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Persistă o mare doză de optimism în ceea ce privește impactul TIC (Tehnologia informației și comunicațiilor), inclusiv CAI (Computer Assisted Instruction – Predarea asistată de calculator) asupra eficienței educației. Articolul meu este o scurtă sinteză, cu o puternică tentă sociologică, a literaturii empirice actuale dedicată diverselor moduri în care digitalizarea are o influență asupra rezultatelor educației. Am constatat că investigațiile privind impactul educațional al digitalizării urmăresc tendința regăsită în literatura generală privind efectele sociale ale TIC, care dezvăluie o perspectivă empirică a diviziunilor cu mai multe niveluri. Primul și al doilea nivel sunt cele mai bine cercetate și teoretizate în timp ce evoluțiile actuale, mai degrabă exploratorii privesc aspecte ale diviziunilor digitale de la nivelurile al treilea, al patrulea și diviziunea digitală internațională. Ca o prezentare sintetică a domeniului, se poate concluziona că, pe măsură ce se dezvoltă din ce în ce mai mult, optimismul inițial face loc angoasei în legătură cu potențialul diviziv din punct de vedere social al utilizării TIC în educație. Revoluția digitală în educație nu numai că nu rezolvă problemele anterioare, ci aparent creează altele noi, deoarece diferențele de acces, competențele și patternurile de utilizare sunt capabile să mărească diferențele dintre oameni din diferite medii socio-economice.

Cuvinte-cheie: digitalizare în educație; diviziunea digitală de ordinul doi; competențe digitale; trecere în revistă a literaturii.

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