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# Undividing Digital Divide

## Digital Literacy

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Editors

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Springer

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# Internet Access and Educational Achievement: The Digital Divide Among OECD Countries



Kutay Uzun

## 1 Introduction

With the advances in technology, many aspects of life including education have taken a sharp turn towards a very wide availability of knowledge and materials. However, this availability also revealed a divide regarding who can access this widely-available knowledge and how often. Commonly referred to as the digital divide, this gap in accessing digitally available knowledge is defined as the separation between those with and without access to technology for any purpose (West, 2011). It refers to the privileged status of a portion of the world population through owning computers, accessing the internet and having digital literacy in relation to another portion that does not possess those qualities or opportunities (Sanders & Scanlon, 2021).

Although the digital divide was initially perceived through the presence or absence of internet access, a somewhat narrow perception, it has more recently been referred to as the sum of digital disadvantages in the use of information technologies including the knowledge and skills necessary to use them (Alam & Imran, 2015; van Dijk, 2005, 2006). According to Mossberger et al. (2003), the digital divide is a multidimensional phenomenon whose dimensions consist of access to technology, skills to use it and having the economic and democratic means to utilize technology because having access to technology necessitates having the economic means to obtain it and one also needs computer literacy and skills to use it in addition to a democratic political environment that allows its use.

Another framework that focuses on the multidimensionality of the term digital divide is by van Dijk (2002), which uses four categories related to access, namely mental, material, skills and usage types of access. In this framework, mental access refers to one's interest in, lack of anxiety about and fondness of digital tools. Material access refers to computer ownership. Skills access means possessing digital skills

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based on education and the user-friendliness of the digital tools. Lastly, usage access refers to the opportunities to use digital tools through distribution equality. Van Dijk describes these different categories as successive, cumulative, recursive and general and obviously, all these categories refer to a continuum or binary opposition signalling inequality among the peoples of the world.

The digital disadvantages were emphasized in the previous paragraphs because connecting one's self to the modern society nowadays depends on internet access, which means a lack of it severs that connection, leaving the deprived in a disadvantaged position (Zappalà et al., 2000). The social inequality brought about by the digital divide has been subject to numerous academic studies. For instance, Kahan (2019) show that the digital divide is present especially in rural areas where people do not have access to the internet as much as those in urban areas. African countries also seem to be disadvantaged regarding internet access in comparison to the rest of the world (Friederici et al., 2020). Similarly, Central Asian countries have difficulties in internet access due to the high costs and limited availability (World Bank, 2020a, 2020b). Southeast Asian countries have also been found to be disadvantaged regarding internet access (Watts, 2020). Indeed, such difficulties reveal social inequalities in terms of age, immigration, civil issues, income and education (Haight et al., 2014).

The present study deals with the educational aspect of the digital divide because through computers, learners can access information, extend opportunities for communication, cooperation and collaboration, be it with their peers, teachers or other experts that are not physically accessible (Rao, 2005). Crucial as all these are for education, access to a computer with an internet connection makes it possible for learners to share the learning experiences and benefit from the social aspect of learning in real time (Sife et al., 2007). At the same time, the absence of access as reviewed in the previous paragraph indicates a widening digital divide in education (Warschauer & Ames, 2010).

It is known that learners spend more time with computers at home than at school and access to computers at home is a related construct to learning through digital resources at home (Kerawalla & Crook, 2002; Yuen & Park, 2012). However, access to computers at home is, by itself, a construct that is tied to the purchasing power of a household so, in the case of developing countries where the income per capita levels are low, education is negatively affected by the absence of access to computers at home (Alvarez, 2020), deepening the digital divide in education.

From the relevant literature, it is seen that education and internet access are related concepts and the digital divide has the potential to result in educational inequalities in addition to social ones. In that respect, this study aims to find out if internet access can explain educational achievement in OECD countries. As an exploratory factor regarding the possible relationship between educational achievement and internet access, the availability of a computer in the household is also investigated in relation to internet access. To meet the aims of the study, the following research questions have been formulated:

1. Does educational achievement differ according to internet access at home?
2. Is there a difference in the availability of a computer at home in the OECD countries divided by internet access?

## 2 Methodology

The study adopted a quantitative design to model if access to the internet was a related construct to the educational achievement of OECD countries. For educational achievement, the PISA results of 2018 were used for the models as they were the latest available (OECD, 2021a, 2021b, 2021c, 2021d). In line with the date of the PISA results, the percentage of households with access to internet 2018 data were retrieved from OECD Databases (OECD, 2021a, 2021b, 2021c, 2021d). Those that did not have internet access data pertaining to 2018 were excluded from the study. As such, 30 out of 38 OECD countries were included in the study. The excluded ones due to the lack of 2018 data were Australia, Canada, Chile, Costa Rica, Japan, New Zealand, Switzerland and the USA. Since educational spending on secondary education was correlated with internet access ( $r = 0.50, p < 0.01$ ), PISA reading ( $r = 0.53, p < 0.01$ ), maths ( $r = 0.62, p < 0.001$ ), science ( $r = 0.58, p = 0.001$ ) scores and the average scores ( $r = 0.58, p = 0.001$ ), the 2017 data (latest available) was taken from World Bank Databases (World Bank, 2020a, 2020b) and used as a confounding variable.

Data for access to a computer at home was also taken from the OECD databases (OECD, 2021a, 2021b, 2021c, 2021d). For this data, too, 30 out of 38 OECD countries were included due to the availability of internet access data for those countries. It was seen that a sum of 220,278 responses from 30 countries was present in this data set.

Before analysing data, OECD countries were divided into three internet access categories as low, mid and high using a two-step cluster analysis based on log-likelihood. Since the comparison of PISA scores according to those categories using educational spending as a covariance necessitated an ANCOVA model, the assumptions of ANCOVA were initially tested. The results are presented below in Table 1:

**Table 1** Assumption tests for ANCOVA

| Score   | Variance equality                | Heteroscedasticity               | Residual normality               |
|---------|----------------------------------|----------------------------------|----------------------------------|
| Average | $F_{(2, 27)} = 0.297, p = 0.746$ | $F_{(1, 28)} = 0.062, p = 0.805$ | $SW = 0.973, df = 29, p = 0.653$ |
| Reading | $F_{(2, 26)} = 0.596, p = 0.558$ | $F_{(1, 27)} = 0.057, p = 0.813$ | $SW = 0.961, df = 29, p = 0.347$ |
| Maths   | $F_{(2, 27)} = 0.242, p = 0.787$ | $F_{(1, 28)} = 0.029, p = 0.867$ | $SW = 0.965, df = 29, p = 0.445$ |
| Science | $F_{(2, 27)} = 0.915, p = 0.412$ | $F_{(1, 28)} = 0.884, p = 0.355$ | $SW = 0.976, df = 29, p = 0.732$ |

Seeing that all the assumptions were met for all the models, ANCOVA's were run for each model.

The data set including information about access to a computer with a binary set of options (i.e. Yes/No). For this reason, a Chi-Squared test was run to see if the internet access categories were independent regarding the responses. Adjusted residuals were also interpreted to reveal which observed frequencies were significantly different from expected frequencies.

### 3 Findings

The descriptive results and the results of the cluster analysis are presented below in Table 2.

As seen in the table, Colombia and Mexico were clustered in the low internet access group with a mean percentage of 52.76 ( $SD = 0.14$ ). In the mid internet access group, Greece, Hungary, Ireland, Israel, Italy, Lithuania, Latvia, Poland, Portugal, Slovakia, Slovenia and Turkey were present with a mean percentage of 83.55 ( $SD = 4.35$ ). The high internet access group consisted of Austria, Belgium, Czechia, Spain, France, Germany, Denmark, Estonia, Finland, United Kingdom, Iceland, South Korea, Luxembourg, the Netherlands, Norway and Sweden with a mean percentage of 95.06 ( $SD = 2.85$ ).

The descriptive results for the PISA scores of 2018 among those countries are shown below in Table 3.

The descriptive results indicated visible differences among the PISA scores of the OECD countries divided by internet access. For instance, the average score of the mid access group was 74.57 points higher than that of the low access group. Similarly, the average score of the high access group was 17.09 points higher than that of the mid access group. The difference between the average scores of the high and low access groups was 91.66 points. Similar differences in favour of the higher internet access groups were also present when the scores were treated separately as reading, maths and science.

**Table 2** Descriptive results for internet access

| Internet access    | Countries                                                                           | <i>M</i> | <i>SD</i> |
|--------------------|-------------------------------------------------------------------------------------|----------|-----------|
| Low ( $n = 2$ )    | COL, MEX                                                                            | 52.76    | 0.14      |
| Mid ( $n = 11$ )   | GRC, HUN, ISR, ITA, LTU, LVA, POL, PRT, SVK, SVN, TUR                               | 83.55    | 4.35      |
| High ( $n = 17$ )  | AUT, BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, IRL, ISL, KOR, LUX, NLD, NOR, SWE | 95.06    | 2.85      |
| Total ( $N = 30$ ) | OECD                                                                                | 85.72    | 11.14     |

**Table 3** Descriptive results for 2018 PISA scores

| Internet access                   | Score   | <i>M</i> | <i>SD</i> |
|-----------------------------------|---------|----------|-----------|
| Low ( <i>n</i> = 2)               | Average | 410.67   | 7.54      |
|                                   | Reading | 416.00   | 5.66      |
|                                   | Maths   | 400.00   | 12.73     |
|                                   | Science | 416.00   | 4.24      |
| Mid ( <i>n</i> = 17) <sup>a</sup> | Average | 485.24   | 16.39     |
|                                   | Reading | 483.44   | 17.24     |
|                                   | Maths   | 488.12   | 18.44     |
|                                   | Science | 484.24   | 16.62     |
| High ( <i>n</i> = 11)             | Average | 502.33   | 14.71     |
|                                   | Reading | 499.46   | 17.27     |
|                                   | Maths   | 506.09   | 12.69     |
|                                   | Science | 501.46   | 17.52     |
| Total ( <i>N</i> = 30)            | Average | 486.53   | 26.78     |
|                                   | Reading | 484.86   | 26.28     |
|                                   | Maths   | 488.83   | 30.11     |
|                                   | Science | 486.00   | 26.25     |

<sup>a</sup> Spain reading score unavailable

The ANCOVA results for the comparison of average PISA scores among the internet access groups, controlling for secondary education spending, are tabulated below in Table 4.

The results showed that there was a statistically significant difference in the average PISA scores of the internet access groups with a very large effect using secondary educational spending as a covariate ( $F_{(2, 26)} = 18.22$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.58$ ). Pairwise comparisons with Bonferroni tests revealed that the average score of the low access group was significantly lower than both the mid and the high access

**Table 4** Average PISA scores ANCOVA results

| Source                         | <i>SS</i>  | <i>df</i> | <i>MS</i> | <i>F</i> | <i>P</i>     | $\eta_p^2$ |
|--------------------------------|------------|-----------|-----------|----------|--------------|------------|
| Corrected model                | 15,041.451 | 3         | 5013.817  | 22.621   | <b>0.000</b> | 0.72       |
| Intercept                      | 174,751.1  | 1         | 174,751.1 | 788.432  | <b>0.000</b> | 0.97       |
| Secondary educational spending | 755.236    | 1         | 755.236   | 3.407    | 0.076        | 0.12       |
| Internet access                | 8078.645   | 2         | 4039.322  | 18.224   | <b>0.000</b> | 0.58       |
| Error                          | 5762.737   | 26        | 221.644   |          |              |            |
| Total                          | 7,122,244  | 30        |           |          |              |            |
| Corrected total                | 20,804.19  | 29        |           |          |              |            |

 $R^2 = 0.72$  (Adjusted  $R^2 = 0.69$ )

**Table 5** PISA reading scores ANCOVA results

| Source                         | <i>SS</i>  | <i>df</i> | <i>MS</i> | <i>F</i> | <i>P</i>     | $\eta_p^2$ |
|--------------------------------|------------|-----------|-----------|----------|--------------|------------|
| Corrected model                | 12,304.230 | 3         | 4101.41   | 14.591   | <b>0.000</b> | 0.64       |
| Intercept                      | 174,348.3  | 1         | 174,348.3 | 620.261  | <b>0.000</b> | 0.96       |
| Secondary educational spending | 445.447    | 1         | 445.447   | 1.585    | 0.220        | 0.06       |
| Internet access                | 6978.532   | 2         | 3489.266  | 12.413   | <b>0.000</b> | 0.50       |
| Error                          | 7027.218   | 25        | 281.089   |          |              |            |
| Total                          | 6,836.977  | 29        |           |          |              |            |
| Corrected total                | 19,331.45  | 28        |           |          |              |            |

$R^2 = 0.64$  (Adjusted  $R^2 = 0.59$ )

groups ( $p < 0.001$ ). On the other hand, the average scores did not differ between the mid and the high access groups ( $p > 0.05$ ).

The results of the ANCOVA for the PISA reading scores are presented in Table 5.

ANCOVA results showed that the PISA reading scores of the internet access groups were significantly different with a very large effect when secondary educational spending was used as a covariate ( $F_{(2, 25)} = 12.41$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.50$ ). In the pairwise comparisons, it was seen that the reading scores of the low access group were significantly lower than those of the mid ( $p = 0.001$ ) and the high ( $p < 0.001$ ) access groups. The scores did not differ significantly between the mid and the high access groups ( $p > 0.05$ ).

The ANCOVA results for the PISA maths scores are shown in Table 6.

Analyses showed that, after controlling for secondary educational spending, the maths scores of the internet access groups were significantly different with a very large effect ( $F_{(2, 26)} = 22.86$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.64$ ). The results of the pairwise comparisons revealed that the maths scores of the low access group were significantly lower than those of the mid and the high access groups ( $p < 0.001$ ). There was no significant difference between the scores of the mid and the high access groups ( $p > 0.05$ ).

The ANCOVA results for the PISA science scores are shown in Table 7.

**Table 6** PISA maths scores ANCOVA results

| Source                         | <i>SS</i>  | <i>df</i> | <i>MS</i> | <i>F</i> | <i>P</i>     | $\eta_p^2$ |
|--------------------------------|------------|-----------|-----------|----------|--------------|------------|
| Corrected model                | 20,454.000 | 3         | 6818      | 30.416   | <b>0.000</b> | 0.78       |
| Intercept                      | 165,912.6  | 1         | 165,912.6 | 740.152  | <b>0.000</b> | 0.97       |
| Secondary educational Spending | 1386.507   | 1         | 1386.507  | 6.185    | <b>0.020</b> | 0.19       |
| Internet access                | 10,247.25  | 2         | 5123.623  | 22.857   | <b>0.000</b> | 0.64       |
| Error                          | 5828.167   | 26        | 224.16    |          |              |            |
| Total                          | 7,195,023  | 30        |           |          |              |            |
| Corrected total                | 26,282.17  | 29        |           |          |              |            |

$R^2 = 0.78$  (Adjusted  $R^2 = 0.75$ )