Does the pattern of ICT possession exacerbate inequality in educational opportunities between students with and without disabilities? Evidence from Egypt

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Abstract

Purpose – This study aims to analyze to what extent distance education is feasible and efficient with the limited technological infrastructure in Egypt. The study answers this question from the perspective of households' preparedness level regarding possessing information and communication technologies (ICTs). In addition, it assesses whether the pattern of students' ICT ownership is influenced by disability- and socioeconomic-based inequality in education and whether the pattern of ICT ownership exacerbates such biases.

Design/methodology/approach – A three-stage probit model with double sample selection (PMDSS) was applied to estimate the factors likely to influence ICT possession, considering the selection process for school enrollment and education continuation. The authors utilized nationally representative data from the Egypt Labor Market Panel Survey 2018.

Findings – About 40% of students aged 12–25 did not have ICTs. Most socioeconomically poor households, particularly those living in Upper Egypt, were the least likely to obtain ICTs and rely on distance education. In addition, female students, particularly those with disabilities, had the lowest chance of benefitting from distance learning.

Research limitations/implications – The persistent structural deprivation of school enrollment and educational progression has led to the positive selection of well-off children in education, which is extended to ICT possession and internet use. Without addressing these structural biases, the study suggests that distance education will likely exacerbate educational inequalities.

Originality/value – The study analyzed the extent to which Egyptian families were prepared in 2018 regarding ICT possessions for distance education for their children, particularly those with disabilities.

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Data availability statement: The study's data are available from the public repository. ELMPS 2018 data are available in the Economic Research Forum (ERF) data repository at http://www.erfdataportal.com/index.php/catalog/157

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Furthermore, it investigated whether access to distance learning was influenced by disability- and socioeconomic-based inequalities in education.

Keywords Information and communication technologies (ICTs), Distance education, Disability, Socioeconomic selection, Egypt

Paper type Research paper

1. Introduction

Egypt's experience with E-learning began in 2003 with the opening of the Arab Open University (AOU), affiliated with the UK Open University. In 2008, a comprehensive E-learning university, the Egyptian E-learning University (EELU), was established (El-Khouly, 2018). Apart from these two universities, all other public and private universities, higher institutions and colleges have depended exclusively on the traditional teaching model (face-to-face). There were no deliberate plans in these institutions to encourage distance education activities. The internet has often been used to distribute learning materials, organize classroom activities and substitute snail mail. On the other hand, students have used the internet for entertainment, with little engagement in learning activities (El-Zayat and Fell, 2007).

Several studies have highlighted the critical role of information and communication technologies (ICTs) [1] in enhancing education and reducing information costs (Njangang *et al.*, 2022; Xu *et al.*, 2019). However, the expansion of distance education in Egypt has faced several significant obstacles: (1) Severe shortage in ICTs infrastructure (Biltagy, 2021; UNDP and MPED, 2021). (2) Shortage of trained ICTs professionals, experienced teaching staff and the skills required by students to handle ICTs effectively and in E-learning materials (Barteit *et al.*, 2020; Björquist and Tryggvason, 2023; Draxler and Schware, 2011; Weber and Hamlaoui, 2018). (3) The attitudes of the educational circles, students, parents, the job market and the Egyptian society at large toward distance education and its benefits have not been supportive and the mistrust in the quality of education offered through distance learning has been widespread. In addition, the job market has not guaranteed the acceptance of online graduates (El-Khouly, 2018). (4) The limited funding resources (The government's total expenditures on pre-university and higher education in 2021/2022, as a percent of public expenditure, were 5.2 and 3%, respectively) (Central Agency for Public Mobilization and Statistics (CAPMAS), 2022) accompanied by the enormous size of school-age and university students (27.6 m, in the academic year 2020/2021 (CAPMAS, 2022) have contributed to lower quality of education.

Egypt was ranked 133 out of 137, according to the Global Competitiveness Report (2019). It also ranked 106 out of 141 regarding ICTs adoption (Schwab, 2019), 83 out of 132 and 91 out of 132 in ICTs access and use, respectively, in the Global Innovation Index Report 2022 (World Intellectual Property Organization (WIPO), 2022).

Distance education has been introduced worldwide to higher education to provide parallel educational tracks to the central regular education system (Rodrigues *et al.*, 2019; Organization *et al.*, 2021). Most importantly, distance education holds great potential to be an avenue for inclusive and equitable quality education for people with disabilities. It brings several advantages to students with disabilities (SWDs) and meets their diverse needs: convenience, flexibility and accessibility as well as brings them new learning opportunities. Studying online provides SWDs time and a comfortable zone to work and study without worrying about coping with stressful situations and anxiety (Kent, 2015; Organization *et al.*, 2021; Scanlan, 2022; UNICEF, 2017).

However, evidence suggests barriers to accessing ICTs for children with disabilities exist in less developed countries (LDCs). UNICEF (2017) has noted that about half of the

people living with disabilities in LDCs are less likely to have a computer at home, less likely to have internet access and less likely to go online if compared to people without a disability.

Moreover, distance education entails extra costs for educational institutions to deliver educational services. Likewise, on the part of parents, it adds a further financial burden to the already existing expenditure on private tutoring to educate their children [2]. UNESCO (2020) has shown that a substantial proportion of students, including SWDs, live in low-income families who cannot secure ICTs for educational purposes and belong to parents with low levels of education (or illiterate), who suffer from digital illiteracy and who are unfamiliar with the different ICTs devices and applications and platforms.

The outbreak of the COVID-19 pandemic has represented an unprecedented shock for the world's education systems, predominantly in the LDCs. It has forced schools, colleges and universities, public and private, to close and rely heavily on online learning platforms while not ready for such a step. The obligatory move to distance education occurred while Egypt's education system faced immense obstacles.

This move necessitated studying whether and to what extent school-age and university students with and without disabilities were ready for distance education. It also called to investigate whether and to what extent the pattern of ICTs possession impeded marginalized and disadvantaged students from engaging in distance education.

Specifically, the study aims to: (1) Draw a profile of school-age and university students who have been (have not) ready for distance education while focusing on the level and patterns of differentials in ICTs possession by disability status and household's socioeconomic position. (2) Assess whether and to what extent disability- and socioeconomic-based inequality in education has influenced the pattern of students' ICTs possession. (3) Examine whether the pattern of ICTs possession would aggravate such biases.

This study contributes to the existing literature as it is the first to be conducted in Egypt and is among the few worldwide. It provides quantitative evidence to the little literature on distance education's challenges and consequences, particularly in LDCs. In this regard, the study estimates the factors likely to influence ICTs possession, considering that there are two selection processes: selection in school enrollment and selection in continuing education – the first type of modeling to be conducted on this research topic.

Achieving the study objectives will help policymakers foresee, plan and enhance their capacity to implement distance education when needed successfully. Significantly, the study will help policymakers develop programs targeting vulnerable and marginalized groups of students to achieve equitable and inclusive quality education for all.

The study is organized in the following sections: Section 2 provides the theoretical framework. Section 3 describes the data sources, the "Egypt Labor Market Panel Survey (ELMPS 2018)". Section 4 details the applied statistical method, namely the three-stage probit model with double sample selection (PMDSS). We provide the study results in Section 5, conclude in Section 6, and highlight some policy implications in Section 7.

2. Theoretical framework

Most literature worldwide has documented disability-, gender- and socioeconomic-based inequalities in school enrollment and completion of education (Klein *et al.*, 2020; Klugman and Lee, 2019; Ismail *et al.*, 2016). In Egypt, previous research has shown that disability tremendously reduces the chance of school enrollment. For example, about 25% of children (7–17 years old) and 35% of youth (15–29 years old) with disabilities were not enrolled in education compared to 1.4 and 4.4% among their peers, respectively (El-Saadani and Metwally, 2019; Rabee, 2019). Furthermore, dropout rates were significantly higher among

SWDs than among their peers without disabilities (El-Saadani and Metwally, 2018). Literature also has noted other essential factors influencing educational opportunities, particularly in the LDCs, including child labor, birth order, family instability, gender of the household head and place of residence (see, for example, Buis, 2015; Eide and Kamaleri, 2009; García and Weiss, 2017; Kuno *et al.*, 2021; Lamichhane and Kawakatsu, 2015; Mitra *et al.*, 2011; Mizunoya *et al.*, 2016; Takeda and Lamichhane, 2018; UN-ESCWA, 2018).

The critical question is whether inequalities based on disability status and socioeconomic status in attending school and dropping out of education will extend to ICTs possession. There is a concern that reliance on distance education may aggravate the existing socioeconomic- and disability-based inequity and exclusion by leaving behind the marginalized segment of students (Dobransky and Hargittai, 2006; Humanity and Inclusion, 2022; International Telecommunication Union, 2013; Jones *et al.*, 2021; Santamaria-López and Ruiz, 2023).

Unfortunately, there is a dearth of literature concerning the profile of students who own ICTs and the factors likely to influence their obtaining of them in Egypt. We assume these socioeconomic and disability biases extend to ICTs possession among Egypt's current school and university students.

Concerning the possible role of disability-based biases in obtaining ICTs, the literature reveals that people with disabilities were half as likely to access ICTs at home as someone without a disability (UNICEF, 2017). Disability among children has been associated with parental low socioeconomic status and living in rural places, which have a bearing on securing ICTs. Parents of SWDs sought to acquire ICTs to compensate for their children's impairment and help them with schoolwork. Parents with high levels of education and those who are economically better off were more likely to purchase ICTs for their children than parents with low education and who were financially poor. Gender gap, according to numerous studies, in school enrollment and scholastic achievement persists (see, for example, El-Saadani and Metwally, 2019; Ismail *et al.*, 2016; Takeda and Lamichhane, 2018; UNESCO, 2018). We assume that this gender gap may extend to digital literacy. UNESCO and the International Telecommunication Union (ITU) found persistent digital gender inequality, particularly in the LDCs (Scanlan, 2022). In addition, the study assumed that older students are more likely to purchase ICTs and use the internet for educational purposes than students of younger ages (age is closely linked to the student's academic stage).

Other factors have been found to affect ICTs possession include family instability induced by parental divorce or the loss of a child's mother or father and having more members with disabilities in the family, which may cause family dysfunction and significant economic hardships that negatively affect the children's educational enrollment and their academic advancement (Bernardi and Radl, 2014; Mahaarcha and Kittisuksathit, 2009), and purchasing e-learning necessities such as ICTs.

Further, the study anticipates that two community factors may influence obtaining ICTs: school type and residence area. Whether private or public, the kind of school in Egypt entails a substantial gap disfavoring the latter. The quality of educational services offered in terms of teaching, availability of ICT infrastructure and school infrastructure, in general, is expected to be low in public schools. It is worth mentioning that the type of school is closely correlated with family affluence. Place of residence mirrors the communities and their schools' ICTs infrastructure; whereas, in rural areas, means of ICTs infrastructure are less available than in urban locations (UNICEF, 2017).

3. Data sources

The study utilized the available nationally representative household survey, "The Egypt Labor Market Panel Survey (ELMPS 2018)", conducted by the Economic Research Forum

(ERF) in cooperation with CAPMAS in 2018. The ELMPS 2018 gathered information on ICTs possession, internet access and educational purposes. Additionally, it provided information on the disability status of household members by applying the UN-Washington Group on Disability Statistics' suggestion of a short set of questions (UN-WG, 2009). This set addresses six domains: vision, hearing, remembering and concentration, mobility, self-care and communication. Each question's response categories are: "no difficulty," "some difficulty," "a lot of difficulties" and "cannot do it."

Out of 15,746 households in the survey, the sample size of school-age and university students between 12 and 25 years amounted to 14,150, including 936 with disabilities (representing 6.6% of the study sample). Subjects who had never attended school represented 4.8%, current students 60.5%, those who dropped out of education 12.7% and those who completed their education 22%.

4. Method

4.1 Three-stage probit model with double sample selection (PMDSS)

Literature concerned with the chances of education denotes disability- and socioeconomic-based inequity in educational opportunities. Therefore, selection is at this study's core (for modeling selection, see Heckman, 1979; Van de Ven and Van Praag, 1981). Enrollees in schools are a non-random sample of the children eligible for school enrollment – a process that leads to selection (first selection process). Likewise, current students are a non-random sample of those enrolled (second selection process), and students who own ICTs and have internet access are non-random samples of current students (third and fourth selection processes).

Although analyzing the factors likely to influence the use of ICTs for educational purposes is crucial, this goal requires modeling five processes with four simultaneous selections. To the best of the authors' knowledge, this model is complex to develop and entails many constraints.

Ownership of ICTs is an essential and preliminary requirement for using ICTs to implement distance education. Thus, the study examined the factors likely to influence ICTs possession, controlling for the factors likely to affect ever attending school and those likely to affect being a current student, i.e. modeling three processes with two simultaneous selections.

The model had three latent variables measuring the utility incurred from attending school, Y^{*}_{1i}, continuing the education Y^{*}_{2i} and having ICTs Y^{*}_{3i}, where:

$$Y^{*}_{1i} = X_{1i}\beta_1 + u_{1i} \quad \text{Eq. (1)}$$

$$Y^{*}_{2i} = X_{2i}\beta_2 + u_{2i} \quad \text{Eq. (2)}$$

$$Y^{*}_{3i} = X_{3i}\beta_3 + u_{3i} \quad \text{Eq. (3)}$$

Where for observation *i*;

X_{ji}: a vector of independent variables for $j = 1, 2$ and 3. X_{ji} need not be identical in the three equations.

β_j: a vector of coefficients of the corresponding independent variables X_{ji}.

And u_1, u_2 *and* u_3 are error terms and are assumed to be normally distributed $N(0, 1)$, with nonzero correlations, $\rho_{12}, \rho_{13}, \rho_{23}$, among the three error terms.

$$\text{corr}(u_1, u_2) = \rho_{12}, \text{corr}(u_1, u_3) = \rho_{13} \text{ and } \text{corr}(u_2, u_3) = \rho_{23}.$$

When ρ's $\neq 0$, the model provides consistent, asymptotically efficient parameter estimates.

Three corresponding dichotomous dependent variables realized the three latent variables:

Y_{1i}: denoted whether the observation had ever attended school. Y_{1i} took the value one in case the individual *i* had ever attended school, and zero otherwise.

Y_{2i}: indicated whether the observation was a current student. Y_{2i} took the value of one if the subject was a current student and zero if he/she dropped out of education, given that the student had been enrolled in education [3], and

Y_{3i}: represented ownership of ICTs, given that the observation was a current student. Y_{3i} took the value one if the subject had ICTs and zero if he did not, given that he was a current student.

To estimate such a hierarchical model with three dichotomous dependent variables, the study applies a three-stage PMDSS (Carreón and García, 2011). We estimated the likelihood ratio (LR) to test whether the correlations between the error terms equaled zero. We used Stata version 14.2, command conditional mixed process (CMP) (Roodman, 2011). The CMP command considers that children of the same household are not independent. We also estimated the corresponding average marginal effects (AME).

4.2 Variables

The model's three dependent variables included school enrollment (yes/no), continuing education (yes/no) and ever had ICTs (the outcome variable) (yes/no). To measure whether the student ever had ICTs, we found that the percentages of students who owned personal laptops, tablets and iPod/MP3 were small (6.03, 4.98 and 0.20%, respectively). Therefore, we considered that if any household member had any of the ICTs items, such as a desktop computer, laptop, tablet, iPod/MP3, notepad or mobile phone, all other household members had it, under the assumption that household members cooperated and shared their ICTs when it came to, notably, distance learning.

4.2.1 The explanatory variables. Measuring disability status: We measured disability status as a dummy variable that takes the value of one if a student reported having "some difficulty," "a lot of difficulties" or "cannot do it" in at least one domain, and zero otherwise.

We used age brackets corresponding to three educational stages: middle school (12–15), high school (16–18) and college/university (19–25) [4]. Gender was coded as a dummy variable, taking a value of one for female youth. We measured the student's socioeconomic status by the parent's education and wealth index. We used the mother's educational status, as it provided a more differentiating effect than the father's, with the categories: illiterate/read and write, less than high school, high school and college/university or above. The household's wealth index was estimated using Filmer and Pritchett's (2001) methodology [5] and then classified into three categories (low, middle and high) with equal sample sizes. Family instability was proxied by the gender of the household head. In Egypt, females heading households are more likely to be widowed or divorced, with the majority being widows. Regarding the community variables, the type of school/university was classified into public and private. Place of residence included four regions: Greater Cairo, Alexandria (Alex) and Suze Canal, Lower Egypt and Upper Egypt.

We added other controls to the model. The subject's marital status was presumed to strongly affect the likelihood of enrollment in education, notably for female youth and markedly on continuing their education. The marital status is classified into two categories: married and never married/underage. We expected children of higher birth order to have a lower chance of attending and completing education. Our assumption had significance based on the child quality investment model (Becker and Tomes, 1986) and the resource dilution argument (Singh *et al.*, 2012). Finally, we measured whether any household member other

than the indexed child had a disability with two dummies: disability status among those under age 12 and disability status among those above 25.

4.3 Limitations

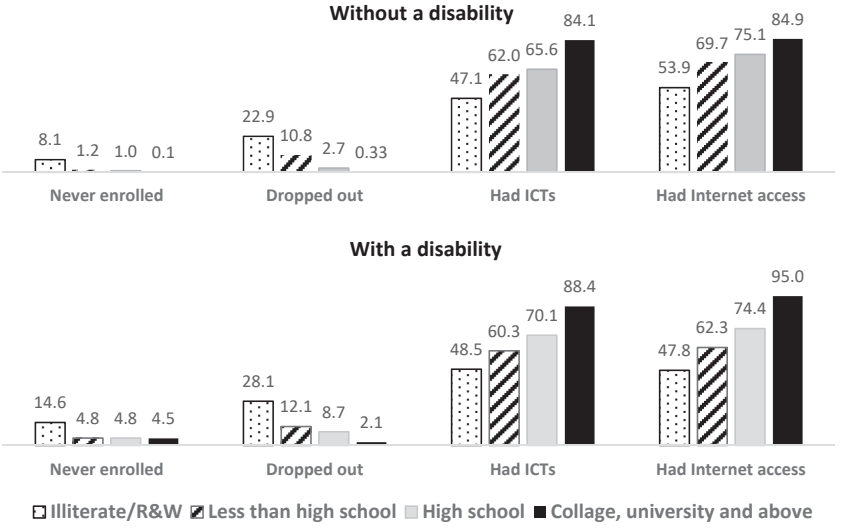
There are several limitations: (1) employing the assumption that household members share their ICTs has yielded an overestimation of the percentage of students who own them. (2) There is a possibility that the lack of information on the onset of disability in the data set may have caused an underestimation of the estimated impact of disability on school enrollment and continuing education. There is a risk that disability occurs after entering or continuing education to higher levels (during the youth's adolescent years or after). (3) Some girls may marry because they dropped out of education. However, this occurrence is trivial as results show that the vast majority (95%) dropped out of education before reaching 16 years old. Furthermore, (4), we could not examine the probable interaction between disability status and each of the other factors or run the analysis separately for each type of disability due to the relatively small sample size of subjects with disabilities.

5. Results

5.1 Profile of university and school-age students and the pattern of ICTs possession

Regarding objective one of the study, results reveal that the level of never attending school among SWDs was more than twofold the level among their peers without disabilities (9.6 vs 4.4%). The difference was statistically significant at a p-value<0.01. After entering school, the overall dropout rate was not trivial (13.3%). Dropping out of school started at the early stages of education, where more than two-thirds (69.5%) of the dropped-out SWDs withdrew from school in the primary stage (Table A1 in Appendix), then one-quarter (25.3%) in the middle stage. Comparable figures for their peers without disabilities were also considerable (64.9 and 29.7%). However, the differences between the two groups were statistically insignificant.

The selection process started in early childhood and continued afterward during school progression. As Figures 1–3 show, there were significant disability- and socioeconomic-based



Source(s): Developed by authors

Figure 1. Percentage who had never enrolled in education, dropped out of education, had ICTs and had internet access by mother's level of education and disability status: ELMPS 2018

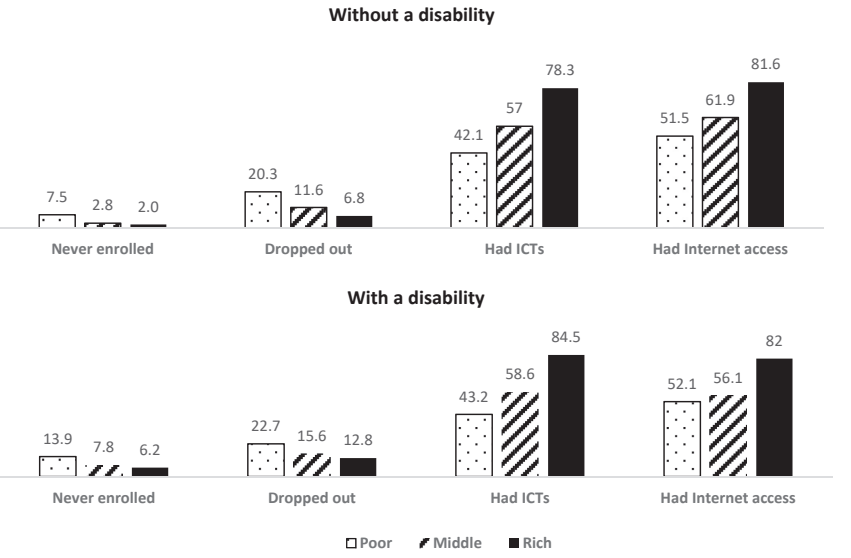


Figure 2.
Percentage who had never enrolled in education, dropped out of education, had ICTs and had access to the internet by wealth and disability status: ELMPS 2018

Source(s): Developed by authors

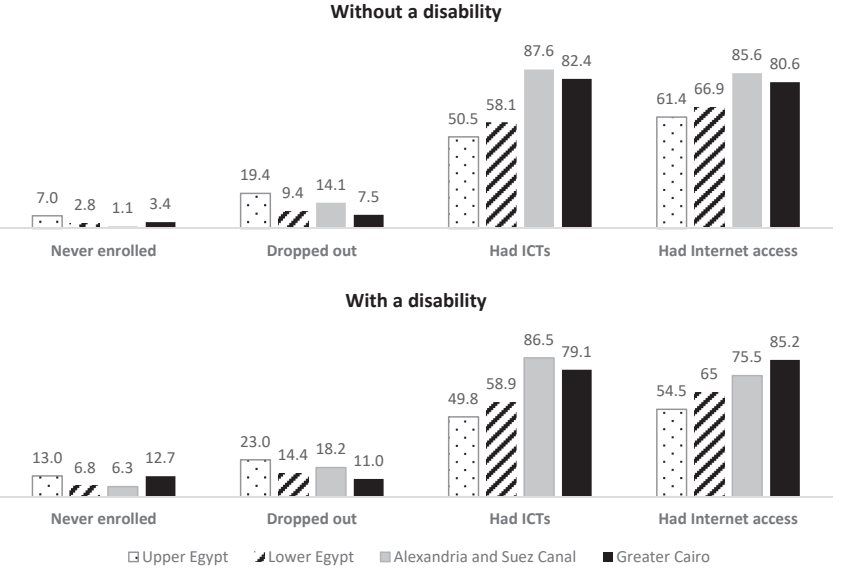


Figure 3.
Percentage who had never enrolled in education, dropped out of education, had ICTs and had access to the internet by region of residence and disability status: ELMPS 2018

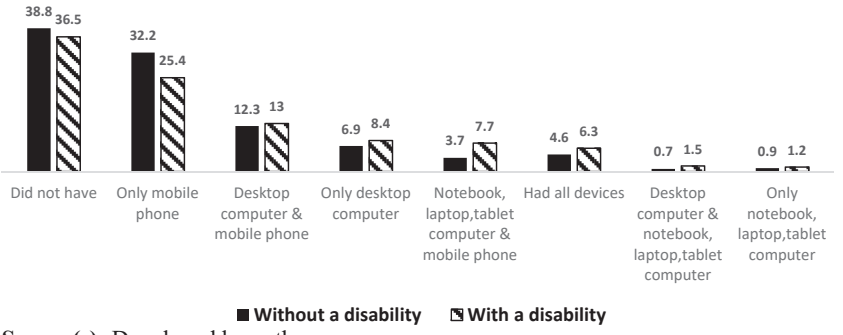
Source(s): Developed by authors

disparities in school enrollment rates among children. Notably, school deprivation demonstrated a descending gradient among children according to their mother's level of education and family affluence. These disparities also extended to the region of residence. Children in Upper Egypt were the most deprived of education, followed by Lower Egypt,

Greater Cairo, Alexandria and the Suez Canal. More critically, SWDs were disproportionately affected by the socioeconomic context and were the least likely to attend education.

Dropping out of education exhibited a disability and socioeconomic association similar to deprivation from schooling, with SWDs having the greatest likelihood of educational withdrawal. Again, dropout rates were most significant in Upper Egypt and were the lowest among students in Greater Cairo. Interestingly, the dropout rates were entirely from public schools (Table A1).

Concerning the possession level of ICTs, Figure 4 and Table 1 indicate that about four out of every ten students were deprived of ICTs (38.6%). A little over one-third of SWDs were deprived of ICTs (36.5%), and close to 40% of their peers without disabilities did not have ICTs (38.8%). The difference between the two proportions was statistically insignificant. One-quarter of SWDs and nearly one-third of students without disabilities had mobile phones only; the difference was statistically significant. SWDs had more diverse ICTs than their peers without disabilities; the difference was statistically significant.



Source(s): Developed by authors

Figure 4. Types of ICTs owned by 12–25 years-old students by disability status, ELMPS 2018

Age group	Had ICTs: Did not have any ICTs	Had ICTs: Had only a mobile phone†	Had ICTs: Others*	Number of cases	Among those who had ICTs: Percent had access to the internet	Among those who had ICTs: Number of cases
All sample	38.6	31.7	29.7	7,693	70.1	4,064
With a disability						
12–15	54.3	12.8	33.0	214	56.9	66
16–18	22.2	41.4	36.4	111	66.5	81
19–25	13.5	35.0	51.6	95	80.8	83
Total	36.5	25.4	38.1	420	68.9	230
Without a disability						
12–15	57.5	15.6	27.0	3,857	65.8	1,196
16–18	24.3	47.7	28.0	2,042	62.9	1,420
19–25	7.7	55.6	36.7	1,374	82.9	1,218
Total	38.8	32.1	29.1	7,273	70.2	3,834

Note(s): †Includes smartphones and non-smartphones
*Includes desktop computer, notebook, laptop or tablet
Source(s): Calculated by the authors

Table 1. Percent distribution of students according to the type of ICTs owned and by disability status and age group: ELMPS 2018

As expected, ownership of ICTs increased with age or the students' educational stage. However, an interesting finding was that substantial percentages of university and high school SWDs (35.0 and 41.4%, respectively) and their peers without disabilities (55.6 and 47.7%, respectively) had mobile phones only; the difference was statistically significant for university students. Neither member of their family had a computer – which had a bearing on the likelihood of using the ICTs for study purposes with ease and satisfaction.

Moreover, the level of internet access, an indicator of the capacity to use and benefit from distance learning, was worrying. About 70% of students had internet access, meaning that about 30% were without access to the internet. However, for every age group, the difference between SWDs and their peers without disabilities was statistically insignificant.

It is worth noting that the disability and socioeconomic patterns of association with ICTs ownership and access to the internet among those with ICTs, Figures 1–3, conflict with the socioeconomic pattern of association with school enrollment and continuation. The ICTs' ownership ascending gradient by the parents' education and household wealth was quite evident among SWDs and those without disabilities. For example, nearly half of the students (with and without disabilities) who belonged to illiterate mothers had ICTs (48.5 and 47.1%, respectively) less than their peers who belonged to highly educated mothers (88.4 and 84.1%, respectively). The relation to wealth exhibited a similar pattern of association. Additionally, geographical biases were apparent. Students in Upper Egypt were the least likely to own ICTs and had access to the internet. They were followed by those living in Lower Egypt and then students in Greater Cairo, Alexandria, and Suez Canal Governorates. The results demonstrate persistent selection processes.

5.2 Factors impacting ICTs possession among university and school-age students: a three-stage PMDSS

In modeling the likelihood of ICTs ownership among Egyptian students, the prime factor of interest was the disability status of the students to examine whether SWDs will be prepared for distance learning similarly to their peers without disabilities. The model was extended to include three sets of controls. The first set included individual-level variables: gender, age, birth order and marital status. The second set included household-level factors: the mother's level of education, wealth index, gender of the household head and having other family members with disabilities. Lastly, the community factors comprised the place of residence and type of school.

To accomplish the study's objectives two and three, Table 2 estimates the average marginal effects (AMEs) of the factors presumed to affect ICTs ownership in Model 3 after controlling for the two selection processes (Models 1 and 2) [6].

Model (1) estimates the likelihood of attending school (the first selection equation). Results reveal that the following variables were statistically significant: Individuals' disability status, marital status, birth order, mother's level of education and family affluence. On the other hand, the gender and age of the student, disability of other family members, gender of the household head and place of residence in no instance influenced the likelihood of school enrollment, things being equal. Results reveal that the average probability of schooling for children with disabilities was six percent points less than that of students without disabilities. The ever-married chance of education was nine and a half percent points less than the never married.

Children of higher birth order were less likely to attend education. An interesting finding was that the level of statistical significance became more robust with higher birth order. In line with other studies, the inequalities in the chances of education linked to parental education and poverty were evident. For example, having an illiterate mother decreased the estimated average likelihood of going to school by five percent points (4.6%) compared with

Background characteristic	Model 1 Ever-attended school	Model 2 Current student	Model 3 ICTs possession
Disability (12–25 years)			
Any disability	−0.062***	−0.041	−0.018
Disability (0–11 years)			
Any disability	−0.004	−0.058*	−0.062
Disability (26 + years)			
Any disability	0.003	−0.001	0.022
Gender			
Female	0.012	0.0143	−0.039**
Age			
16–18	−0.007	−0.093***	0.299***
19–25	−0.012	−0.244***	0.434***
Birth order			
2	−0.009	Omitted	omitted
3	−0.016*	Omitted	omitted
4+	−0.022**	Omitted	omitted
Marital status			
Ever married	−0.094***	−0.406***	omitted
Gender of the head of household			
Female	−0.012	0.0137	0.025
Education of mother			
Illiterate and read/write	−0.046***	−0.273***	−0.145***
Less than high school	−0.008	−0.179***	−0.093**
High school	−0.014	−0.073***	−0.063**
Wealth index			
Poor	−0.043***	−0.068***	−0.213***
Middle	−0.017**	−0.01	−0.136***
Region			
Alex. and Suze Canal	0.032	−0.086**	0.067*
Lower Egypt	0.024	−0.01	−0.16***
Upper Egypt	0.012	−0.054**	−0.163***
Type of school and university			
Public	Omitted	Omitted	−0.143**

Note(s): Ref. groups: disability 12–25 (without disability); disability 0–11 years (without disability); disability 26 + years (without disability); gender (male); age group (12–15 years); marital status (never married/underage), birth order (first); gender of the household head (male); education of the mother (college and university and above); wealth (richest); region (Greater Cairo) and type of school (private)
***$p < 0.001$, **$p < 0.01$ and *$p < 0.05$
Source(s): Calculated by the authors

Table 2. Average marginal effects of factors impacting ICTs possession among university and school-age students (12–25): ELMPS 2018

having a highly educated mother. Likewise, living in low-income families decreased the average chance of schooling by four percent (4.3%) compared to living in better-off families. Living in a household where another child(ren) had a disability had no statistical significance on school enrollment, albeit it had the expected negative sign for the relationship.

Model (2) estimates the chance of continuing education (the second selection equation). Results indicate that as long as a child with a disability could attend schooling, his disability

had no significant impact on continuing education, though it had the expected negative relationship. Results also reveal no statistically significant gender gap in the likelihood of continuing school once girls enter education.

Students' age and marital status, disability among other household members, mother's educational level, wealth and place of residence had statistically significant effects on continuing education. Older cohorts of students had more dropouts than younger cohorts. The probability of continuing education among those aged 16–18 was nine percent points less than among the cohort aged 12–15 years and remarkably declined to 24.4% less among those aged 19–25. The ever-married had less probability of continuing education than their peers who were never married, reflecting that the effect of marital status was more substantial in deciding to continue education than enrolling in education. Having another child(ren) with a disability reduced the average chance of the indexed child continuing education by six percent points.

Mother's education was vital in not dropping out of education, and its gradient effect was apparent. On average, the estimated chance of continuing education among those who belonged to an illiterate mother was 27% points less than it was for their peers who had a tertiary-educated mother, 18% points less for those who had a mother with a basic level of education and seven percent points less for those who had a mother with a high school level of education. In addition, the household's economic status significantly influenced the decision to continue education. Poor children's average probability of continuing education was about seven percent points less than their peers living in better-off families. The corresponding marginal effect of those belonging to middle-income families was statistically insignificant, albeit it carried a negative sign.

Although there were no significant differences in the chances of school enrollment among the different regions of Egypt, the area of residence had substantially different effects on continuing education. As results show, students living in Alexandria, the Suze Canal governorates and Upper Egypt were less likely to continue their education than their peers in Greater Cairo.

Concerning Model (3), results reveal that if SWDs succeeded in enrolling in school and continuing their education, disability no longer hindered them from obtaining ICTs. However, the estimated marginal effect carries the expected negative sign. Female students were less likely to own ICTs than their male counterparts by, on average, four percent points. As expected, the likelihood of ICTs possession increased with the students' age or in other words, with their educational stage. For example, university and high school students' chances of obtaining ICTs were 43% and 30% greater than those of preparatory-stage students. The mother's education level significantly affected getting ICTs, and the gradient impact was apparent. When the mother's education level declined, the student had a lower average probability of owning an ICT device – likewise, the household's wealth level. Economically worse-off families hardly secured ownership of ICTs for their children. Poor and middle-level wealth students were less likely to obtain ICTs by, on average, 21 and 14% points, respectively, lower than their peers living in economically better-off students.

Surprisingly, students in urban areas such as the Alexandria and Suez Canal governorates could own ICT about seven percent higher than their peers living in Greater Cairo. Greater Cairo contains two governorates, Giza and Kalyoubia, with about 39 and 57% of their population living in rural areas, which might partially explain this surprising finding. On the contrary, living in Lower Egypt or Upper Egypt entailed a 16% less chance of obtaining ICTs. Public school or university students had 14% less chance of owning ICTs than their private education peers.

We obtained substantial revelations concerning the likelihood of successfully and equitably engaging in distance education when we estimated the probabilities of ICTs

possession among current university and school-age students according to disability status, their mother's education, family wealth and area of residence [7], Table 3:

(1) SWDs constantly had less probability of obtaining ICTs than their peers, students without disabilities.

(2) Female students persistently had a lower chance of getting ICTs than male students.

(3) Upper Egypt students and those of low socioeconomic status were less likely to have ICTs than Greater Cairo students and those from affluent families.

(4) Considering these compounding factors, findings indicate that the most marginalized and disadvantaged students were female students with disabilities who lived in poor households with illiterate parents in Upper Egypt.

These findings had far-important implications regarding the chance of disadvantaged groups of students engaging in distance learning. Most of the socioeconomically poor households of Upper Egypt were not prepared for distance learning, Table 3. For example, among poor students of Upper Egypt, the chance of obtaining ICTs by at least one middle school member ranged between 0.13 and 0.18, and that in high school ranged between 0.42 and 0.52. On the other hand, the corresponding groups living in Greater Cairo had chances ranging between 0.34 and 0.42 for middle education and 0.70 to 0.77 for high school. Socioeconomically affluent students, on the contrary, particularly Greater Cairo residents, were well-equipped for distance learning (the estimated probabilities for middle and high school ranged between 0.85 to 0.89 and 0.98 to 0.99, respectively). Moreover, poor university students in Upper Egypt had much lower chances of obtaining ICTs and consequently

Age group	Student's attribute	Greater Cairo		Upper Egypt	
		With a disability	Without a disability	With a disability	Without disability
12–15	*Living in a poor household and having an illiterate mother*				
	Male	0.3973	0.4248	0.1658	0.1840
	Female	0.3385	0.3647	0.1299	0.1454
	Living in a wealthy household and having a highly educated mother				
	Male	0.8820	0.8954	0.6826	0.7073
	Female	0.8483	0.8643	0.6250	0.6515
16–18	*Living in a poor household and having an illiterate mother*				
	Male	0.7528	0.7745	0.4892	0.5173
	Female	0.7009	0.7249	0.4272	0.4551
	Living in a wealthy household and having a highly educated mother				
	Male	0.9834	0.9861	0.9220	0.9318
	Female	0.9757	0.9795	0.8965	0.9087
19–25	*Living in a poor household and having an illiterate mother*				
	Male	0.8967	0.9088	0.7098	0.7334
	Female	0.8658	0.8805	0.6541	0.6798
	Living in a wealthy household and having a highly educated mother				
	Male	0.9966	0.9973	0.9772	0.9807
	Female	0.9946	0.9956	0.9673	0.9721

Note(s): The estimated probabilities are calculated based on the PMDSS estimates holding the other variables in the Model at baseline: disability status among children (0–11 years) and adults (26 + years) is no; gender of the household head is male, and type of school and university is public. It is important to note that the first three variables are not statistically significant. However, the school and university types are statistically significant; most students (above 95%) were in public institutions
Source(s): Calculated by the authors

Table 3. Estimated probabilities of ICTs ownership among current school and university students in the age group (12–25): ELMPS 2018

benefiting from distance learning (the estimated probabilities ranged between 0.65 and 0.73) than their peers living in Greater Cairo. Interestingly, the socioeconomic-based gap in acquiring ICTs was much more substantial than the disability- or gender-based gap.

6. Discussion and conclusion

The outbreak of the COVID-19 pandemic has highlighted the role of distance education worldwide as a complementary/alternative to traditional modes of teaching in times of crisis. The move to distance education faces challenges, particularly in LDCs, which can affect achieving quality and equitable education. Prompted by these challenges, this research analyzes the extent to which Egyptian families were prepared for distance learning for their children, particularly children with disabilities, in 2018, the year preceding the COVID-19 pandemic. Reliance on distance learning is studied regarding the possession of ICTs (a prerequisite to engaging in e-learning).

The study estimates a three-stage PMDSS to rigorously investigate the drivers behind the level and pattern of ICTs ownership and the probable inequality of distance education opportunities after controlling for selection biases. Thus, the study helps identify the marginalized groups that likely fail to engage in distance education in instances of school and university closure – a situation that ultimately leads to widening educational inequality. The study analyzes the only available data from a nationally representative survey conducted in 2018 [8].

The study's major results lie in two parts: First, the selection processes in education: the results highlight that disability plays a central role in attending education compared to other selection factors, while in continuing education; it has a less significant role than the other selection factors.

In line with other literature, the results reveal significant socioeconomic and structural exclusion among the marginalized in education. School enrollment and dropout rates demonstrate a descending gradient according to parents' levels of education and wealth. The study finds that these disparities also extend to the region of residence, wherein children in Upper Egypt are the most deprived of education. Moreover, these selection processes start in early childhood and continue afterward during school progression.

The child's gender does not affect the chance of school enrollment or continuing education. This finding contrasts with El-Saadani and Metwally's (2019) findings for Egyptian youth (15–29) and Rabee's (2019) findings among Egyptian children (7–17), in which they find that being a female is a severe hindrance to education. It also contradicts other literature findings (see, for example, Cerna *et al.*, 2020; UNICEF, 2021). Nevertheless, it is in line with Langston and Hassan's (2018) study, where they find that, in Egypt, females achieved parity in primary school enrollment. This finding calls for further analysis. Children of older age cohorts are more likely to be deprived of education. Moreover, they are less likely to continue their education (when male youth become ready to participate in the labor force and female youth are prepared for marriage). Thus, marriage significantly hinders attending education and has tremendous negative leverage on continuing education, which, we believe, is entirely confined to female children [9].

Living in a household with other children with any disability has no statistical significance for school enrollment, which can be attributed to the fact that, in recent decades, attending school has been compulsory and tuition-free. Nevertheless, it negatively influences the likelihood of completing education.

Second, patterns and factors likely to influence ICTs possession among students (the study's central goal): in 2018, about two-thirds of the students had ICTs, with SWDs having a little more ICTs than their peers without disabilities. SWDs have different types of ICTs other than mobile phones, slightly more than their peers without disabilities. Many students have

only mobile phones, questioning the possibility of successfully relying on online education with ease and satisfaction. We should note that the study overestimates the number of those with ICTs (with a considerable segment having only mobile phones) [10]; thus, the number of students adequately prepared for distance learning is worryingly small.

One substantial finding of the study is that once SWDs could overcome obstacles in enrolling in school, disability status, contrary to the study's assumption, no longer hinders continuing education and obtaining ICTs. This is a conclusion that needs further analysis.

Results provide evidence that structural deprivation of school enrollment and educational progression leads to the positive selection of well-off children in education, which extends to the possession of ICTs. After controlling the selection processes, the ICTs' ownership ascending gradients by the level of parents' education and household wealth are quite evident. Furthermore, the wealth-related gap in ICT possession is the greatest compared to other sources of bias.

The study points to the significant gaps between the different geographical regions in Egypt. Students in the metropolitan areas (Greater Cairo, Alexandria and Suez Canal) have greater chances of obtaining ICTs than those in Lower or Upper Egypt. Furthermore, public school and university students have fewer opportunities to get ICTs than their peers in private education. Besides, possession of ICTs is linked to the educational stage and type of school and university. Pre-university students, particularly middle school, have a much lower chance of getting ICTs, thus benefiting from distance learning.

In agreement with other findings, female students with disabilities from economically-worst-off families are the most ICTs-deprived compared with other groups of different socioeconomic backgrounds. Finally, without addressing structural biases and challenges, the study suggests that distance education will likely exacerbate educational inequalities.

7. Policy implications

The study highlights Egyptian families' preparation level for distance education for their children in 2018; ensuring access to inclusive and equitable education by 2030 will require a disability-inclusive and socioeconomic equity-responsive approach to ICT expansion and distance learning.

After the outbreak of COVID-19, which prompted the closure of schools and universities, Egypt has made significant progress in increasing access to digital means. Egypt has introduced the Egyptian Knowledge Bank for free to all households and students nationwide. High school students and teachers have received millions of free tablets. About 9,000 school laboratories, 27,000 modern classrooms and all secondary schools have been equipped with internal network connections and information servers and 11,000 interactive screens have been introduced (UNDP and MPED, 2021; Hussein, 2019, cited in Amer, 2020).

In support of the obligation of the Egypt education system not to exclude marginalized groups; therefore, it becomes essential for policymakers to conduct follow-up nationally representative data collections and generate evidence to monitor and evaluate the government's efforts that have been exerted so far to support families and children's distance education, particularly the disadvantaged and marginalized groups. Moreover, policymakers must develop well-informed programs targeting students with disabilities, particularly females from illiterate and low-income families living in Upper Egypt, to achieve equitable and inclusive quality education for all.

Notes

1. ICTs is defined as "an umbrella term that includes any communication device or application encompassing radio, television, cellular phones, computer and network, hardware and software,

satellite systems as well as the various services and applications associated with them, such as videoconferencing and distance learning." (Redwood *et al.*, 2017, pp. 805–806).

2. Rizk (2020) has noted that families spend substantially on private tutoring, particularly those with children in public schools.
3. Children and youth aged 12–25 who had ever attended school included current students, those who completed their education and those who dropped out of education. Those who had completed their education represented a distinct group. They were the oldest ones, 92–95% aged 19–25, and the vast majority (95%) completed their high school or university degree, Table A1. Regarding the factors that underlie selection, they occupied the middle position compared to the current students and those who had dropped out of education. As this group had already completed high school or university degrees and was out of risk considering the study objectives, we dropped it from the sample.
4. As the age bracket 12–25 encompasses children (12–17) and youth or young adults (18–25), we henceforth used the terms children, youth and students interchangeably.
5. We excluded the ICTs items from the calculated wealth index.
6. The corresponding probit estimated coefficients of the three equations are displayed in Table A2.
7. The other variables in the model were held at the baseline.
8. No recent national survey has been conducted up to this moment.
9. We could not test the influence of child labor, which is likely more among male children, on the likelihood of not attending school or dropping out of education because ELMPS data provide information on employment status at the time of survey.
10. See limitation (1).

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(The Appendix follows overleaf)

Appendix

Table A1. Percent distribution of the ever-enrolled students in the age category (12–25) according to educational status, disability status and selected background characteristics: ELMPS 2018

Background characteristic	With a disability			Without a disability		
	Current student %	Completed %	Dropped out %	Current student %	Completed %	Dropped out %
Gender						
Male	54.3	66.7	58.7	52.6	50.1	46.3
Female	45.7	33.3	41.3	47.4	49.9	53.7
Age						
12–15	50.9	1.8	15.1	53.0	0.3	11.0
16–18	26.4	2.9	22.8	28.1	6.9	23.0
19–25	22.7	95.3	62.1	18.9	92.8	66.0
Education attainment						
Primary or less	53.9	0.0	69.5	54.5	0.1	64.9
Preparatory	24.1	3.7	25.3	24.7	5.3	29.7
Intermediate and above	21.9	96.3	5.2	20.8	94.5	5.5
Birth order						
1	32.3	30.1	21.8	35.3	29.4	25.1
2	25.5	26.9	33.7	28.3	25.5	20.4
3	23.3	10.8	13.5	17.6	18.8	22.0
4+	18.9	32.3	31.0	18.8	26.3	32.5
Type of school/university						
Private	5.3	3.8	0.0	5.6	3.7	0.1
Public	94.7	96.2	100.0	94.4	96.3	99.9
Gender of household head						
Male	83.5	72.2	74.5	86.3	81.3	86.2
Female	16.5	27.8	25.5	13.7	18.7	13.8
Work of household head						
High skill	19.1	16.0	8.5	22.5	13.7	6.6
Middle skill	53.7	47.7	54.0	53.2	51.6	66.0
Low skill	2.5	0.1	3.9	1.9	1.7	2.6
Others	24.6	36.3	33.6	22.3	33.0	24.8
Disability status of household head						
No disability	44.9	45.0	45.4	77.9	78.3	78.3
disability	55.1	55.0	54.6	22.1	21.7	21.7
Wealth index						
Poor	35.3	31.7	49.0	35.9	35.5	60.5
Middle	23.7	26.3	21.7	22.1	19.8	18.7
Rich	41.0	42.0	29.3	41.9	44.8	20.8
Place of residence						
Urban	44.3	40.8	33.8	40.2	35.3	26.0
Rural	55.7	59.2	66.2	59.8	64.7	74.0
Region						
Greater Cairo	13.8	18.3	8.9	15.8	13.4	8.1
Alex. and Suze Canal	15.8	8.4	15.2	6.3	6.1	6.8

(*continued*)

Background characteristic	With a disability			Without a disability		
	Current student %	Completed %	Dropped out %	Current student %	Completed %	Dropped out %
Lower Egypt	41.9	43.0	34.2	44.5	43.8	30.4
Upper Egypt	28.5	30.3	41.8	33.5	36.8	54.6
Mother's education						
Illiterate/read and write	36.0	47.8	72.9	36.1	60.0	83.9
Less than high school	12.4	20.4	9.4	12.6	11.4	9.9
High school	38.7	25.7	16.5	36.0	21.7	5.9
Collage, university and above	12.9	6.1	1.2	15.3	6.9	0.3
Father's education						
Illiterate/read and write	29.8	44.7	59.3	27.9	46.6	72.1
Less than high school	15.0	19.0	17.0	14.3	14.0	15.8
High school	34.5	26.1	17.3	35.2	27.6	9.5
Collage, university and above	20.7	10.2	6.4	22.6	11.9	2.5

Source(s): Calculated by the authors

Table A1.

Characteristics of the individual	Model 1 Ever attended β_1	Model 2 Current student β_2	Model 3 ICTs possession β_3
Disability (12–25 years)			
Any disability	−0.582***	−0.218	−0.070
	(0.111)	(0.112)	(0.114)
Disability (0–11 years)			
Any disability	−0.049	−0.321*	−0.250
	(0.180)	(0.131)	(0.130)
Disability (26 + years)			
Any disability	0.040	−0.008	0.091
	(0.113)	(0.066)	(0.060)
Gender			
Female	0.160	0.80	−0.157**
	(0.083)	(0.058)	(0.050)
Age			
16–18	−0.107	−0.611***	0.946***
	(0.087)	(0.066)	(0.062)
19–25	−0.171	−1.286***	1.53***
	(0.111)	(0.072)	(0.133)
Marital status			
Ever married	−0.862***	−1.590***	¥
	(0.112)	(0.126)	
Birth order			
2	−0.133		
	(0.088)	¥	¥
3	−0.226*		
	(0.105)		
4+	−0.297**		
	(0.093)		
Gender of the household head			
Female household head	−0.143	0.077	0.104
	(0.102)	(0.083)	(0.076)
Mother's education			
Illiterate/read and write	−0.867***	−1.735***	−0.617***
	(0.207)	(0.288)	(0.122)
Less than high school	−0.283	−1.311***	−0.417***
	(0.247)	(0.239)	(0.119)
High school	−0.415	−0.691**	−0.290**
	(0.288)	(0.237)	(0.095)
Wealth index			
Poor	−0.586***	−0.376***	−0.832***
	(0.086)	(0.074)	(0.071)

(*continued*)

Table A2.
Impact of disability on ICTs' possession among university and school-age students (12–25): a three-stage PMDSS: ELMPS 2018

Characteristics of the individual	Model 1 Ever attended β_1	Model 2 Current student β_2	Model 3 ICTs possession β_3
Middle	−0.293**	−0.061	−0.565***
	(0.099)	(0.088)	(0.076)
Region			
Alex. and Suze Canal	0.428	−0.461**	0.431**
	(0.276)	(0.169)	(0.179)
Lower Egypt	0.301	−0.058	−0.701***
	(0.189)	(0.125)	(0.118)
Upper Egypt	0.131	−0.303*	−0.712***
	(0.184)	(0.120)	(0.117)
Type of school/university			
Public	¥	¥	−0.578**
			(0.180)
Constant	3.045***	3.524***	1.800***
	(0.245)	(0.268)	(0.196)
Rho:			
ρ_{12}	0.110		
ρ_{13}	0.233		
ρ_{23}	−0.449		
Atan rho12	0.110		
Atan rho 13	0.238		
Atan rho 23	−0.484		

Note(s): Robust standard errors are in parentheses
¥: not included
Ref. groups: See Table 2
Source(s): Calculated by the authors

Table A2.

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