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# Bridging or Deepening the Gap? Interaction Effects of Education and Disability on Digital Inclusion

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## Abstract

The digital divide remains a critical challenge, as unequal access to technology reinforces existing social inequalities. Although education is a well-established factor in promoting digital inclusion, closing the gap requires a comprehensive examination of the interplay between education and other factors. Drawing on the social model of disability, this study examines whether the digital access gap between persons with and without disabilities widens at higher educational levels. This study evaluates digital disparities across four stages of digital access (mental, material, skills, and usage access) using Taiwan's Digital Access Survey from 2020, 2022, 2023, and 2024. Multiple logistic regression models are employed to examine the interaction between education and disability status. The findings show that higher education is associated with more positive attitudes toward technology, greater internet adoption, stronger digital skills, and higher engagement in online activities such as financial and government services. However, these benefits are generally less pronounced for persons with disabilities. In contrast, more fundamental domains, such as social and healthcare usage, show more comparable patterns across people with and without disabilities. These results suggest that digital inequality is not uniform across different dimensions of digital access and may be shaped by inaccessible environments and structural inequalities embedded within digital and social systems. As such, merely raising overall educational levels may be insufficient to bridge the digital divide and may even allow inequalities to persist beneath the appearance of educational equality. Digital inclusion policies should therefore pay greater attention to the structural conditions that continue to marginalize persons with disabilities.

## Keywords

digital inclusion; disability; education; social model of disability; structural barriers

## 1. Introduction

Digital development is often associated with greater opportunities and social advantages; consequently, ensuring inclusive participation in digital transformation has become a critical issue (Reisdorf & Rhinesmith, 2020). For persons with disabilities, however, digital technologies represent both opportunities and risks. Although digital development may bridge inequalities by reducing stigma and promoting social participation (Raja, 2016; Scanlan, 2022), it may also widen disparities when accessibility barriers and ableist norms persist (Cocq & Ljuslinder, 2020; Ellis & Goggin, 2015).

A growing body of research has examined the relationship between disability and the digital divide. Studies suggest that persons with disabilities experience disadvantages in certain forms of digital access, while variation also exists across socioeconomic backgrounds (Duplaga, 2017; Pettersson et al., 2023). Research has also shown that different impairment groups may encounter distinct forms of digital barriers (Tsatsou, 2020). In response, prior studies have explored various approaches to improving digital inclusion, including inclusive educational design, assistive tools, and accessibility-oriented technologies (Putri et al., 2025; Samaniego López et al., 2025; Zorec et al., 2025). These efforts substantially advance understanding of the digital disability divide.

Nevertheless, although education is widely recognized as a key driver of digital inclusion (Lythreatis et al., 2022; van Deursen & van Dijk, 2014), less is known about whether educational advantages are equally shared between persons with and without disabilities. This concern resonates with the perspective of intersectionality, which emphasizes that inequalities emerge through overlapping social positions (Atewologun, 2018). For example, Crenshaw (2015) argued that Black women remain disadvantaged because their experiences cannot be explained by race or gender alone. Likewise, while education is expected to shape individuals' motivation, digital literacy, and ability to perform complex online tasks (van Dijk, 2017), disability status may reflect structural and contextual barriers that constrain the returns to educational capital (Vicente & López, 2010). Accordingly, digital inclusion should be understood through the interaction of these factors rather than examined independently.

In light of these perspectives, this study asks: *To what extent does disability status moderate the effect of education on digital access?* As educational expansion and inclusive education continue to be strongly advocated, there remains limited evidence on whether higher educational attainment truly eliminates the digital divide for persons with disabilities or instead allows less visible forms of inequality to persist at higher educational levels.

This study addresses this concern empirically using Taiwan's Digital Access Survey and incorporates van Dijk's (2002) four-stage framework to provide a more comprehensive understanding of different dimensions of digital access, with a particular focus on the interaction between education and disability.

In doing so, this study makes several contributions. Theoretically, it deepens the multi-stage framework of the digital divide by integrating the social model of disability to explain how structural inequalities may unfold across different dimensions of digital access. Practically, it provides evidence to inform policies by addressing the often-overlooked barriers to digital inclusion faced by persons with disabilities. Methodologically, it demonstrates the potential of quantitative analysis in a field where disability research

has traditionally relied more on qualitative approaches, showing how structural inequalities can be examined using large-scale data.

## 2. Literature Review

### *2.1. Digital Divide and Four Stages of Digital Access*

The digital divide refers to disparities in access to digital technologies that may reinforce broader social and economic inequalities, particularly among already vulnerable groups (Vassilakopoulou & Hustad, 2023). While "access" and "digital divide" are widely used terms, they should not be viewed as single-dimensional concepts. To illustrate this complexity, van Dijk (2002) proposed a four-stage framework of digital access:

- *Mental access* refers to individuals' interest, motivation, and anxiety toward engaging with technology (van Dijk, 2002). Rooted in technology acceptance theories, this suggests that adoption is driven by perceived usefulness and subjective norms, while constrained by technology-related anxiety (van Dijk, 2017).
- *Material access* indicates whether individuals possess digital devices or Internet connectivity, capturing the basic infrastructure required for digital participation. However, access alone does not guarantee meaningful engagement, which requires the consideration of digital skills and actual usage (van Dijk, 2002).
- *Skills access* refers to the capacity and literacy to effectively find, evaluate, and use digital information. Insufficient digital skills may restrict online activities and access to essential services (van Deursen & Helsper, 2015).
- *Usage access* reflects how individuals participate online. Rather than simply indicating whether people use the internet, this dimension captures the breadth and diversity of activities, including key domains such as finance, social interaction, healthcare, and access to government services (Duplaga, 2017; Fayyad & Al-Sinnawi, 2024; Lopez de Coca et al., 2022). van Dijk (2012) argues that limited participation may restrict access to social and economic resources, reinforcing digital inequality.

In sum, these four stages demonstrate that the digital divide is a multidimensional phenomenon, with each dimension reflecting distinct forms of digital inequality.

### *2.2. Disability Model and Digital Disability Divide*

Previous research has identified several sociodemographic determinants of digital inequality, including age, gender, income, and educational attainment (Acilar & Sæbø, 2023; Phochai et al., 2024). Among these, educational attainment appears to emerge as one of the strongest predictors of digital inequality (Lythreatis et al., 2022). Nevertheless, digital inequality among persons with disabilities cannot be explained by individual characteristics alone, but it also requires perspectives from disability studies.

When examining inequality among persons with disabilities, two perspectives are frequently discussed: the medical model and the social model (Haegele & Hodge, 2016). The medical model views disability as the result of impairment, attributing it to individual biological, neurological, or physiological deficits. Under this perspective, disability is regarded as undesirable, and individuals are expected to adopt the "sick role" and

cooperate with professionals for rehabilitation (Parsons, 1991). Disability is framed as a "personal tragedy" (Oliver, 1986).

Rather than viewing disability as the result of individual misfortune, the social model argues that the barriers experienced by persons with disabilities are socially constructed. At the macro level, it emphasizes structural barriers, such as attitudes, stigma, and cultural norms that restrict participation across different types of impairment (Deacon et al., 2022; Samaha, 2007). At the micro level, the social relational model highlights how biological differences are intertwined with interpersonal experiences of oppression, which in turn produce negative psycho-emotional impacts on individuals' lives (Deacon et al., 2022).

Although both models have their advocates, the medical model is often criticized for overemphasizing disability as a personal misfortune, overlooking the social structures that shape inequality (Hogan, 2019). By contrast, the social model suggests that disability is largely shaped by social ideology and cultural structures. As such, "impairment may be a human constant, but 'disability' need not and should not be" (Barnes, 2012, p. 12). This perspective provides a clearer foundation for reforms in social policy and cultural change, making disability-related inequalities more amenable to systemic solutions (Dirth & Branscombe, 2017; Oliver, 1996).

Drawing on the social model, the digital divide is shaped by structural barriers rather than individual impairments. However, at the same time, digital technologies may also empower persons with disabilities.

Digital environments can create alternative spaces for self-representation that are less constrained by physical barriers or face-to-face stigma, thereby enhancing social participation and facilitating the claiming of rights (Cocq & Ljuslinder, 2020). Moreover, digital platforms and content creation may foster community belonging while creating opportunities for flexible employment and income generation (Johnson, 2019). The autonomy enabled by digital technologies is therefore particularly important for persons with disabilities.

Nevertheless, the benefits of digital advancement are not equally shared by persons with disabilities, as persistent barriers continue to constrain inclusion. Ableist assumptions rooted in society portray disability as an imperfect form of human existence (Campbell, 2009), while media representations further reinforce these disadvantageous narratives (Cocq & Ljuslinder, 2020; Figuereo-Benítez et al., 2023). Such cultural narratives shape beliefs, stigma, and stereotypes surrounding persons with disabilities, in turn affecting their self-esteem and expected social roles (Deacon et al., 2022). In addition, because technologies are primarily designed for "normal" users, digital accessibility is often overlooked (Beck, 2024). Moreover, digital participation among marginalized groups depends heavily on mainstream institutions, commercially driven platforms, and crowdfunding, making digital inclusion politically and economically fragile (Ellis & Goggin, 2015).

### *2.3. Contextualisation of the Taiwanese Case*

This study was conducted in Taiwan, one of the leading digital societies, ranking 10th globally and 3rd in the Asia-Pacific (IMD World Competitiveness Center, 2025). Alongside its rapid digital transformation, Taiwan has long recognised digital inclusion as a core policy. Since 2005, it has continuously promoted digital accessibility and conducted a nationwide survey specifically for persons with disabilities every three years to monitor inclusion among this population (National Development Council, 2022).

In 2014, Taiwan further strengthened its commitment by voluntarily incorporating the Convention on the Rights of Persons with Disabilities (CRPD) into domestic law despite not being a member of the United Nations. Guided by the CRPD principles, Taiwan has since expanded initiatives promoting accessible websites, inclusive digital public services, and educational initiatives supporting inclusive education, lifelong learning, and digital literacy for persons with disabilities (Ministry of Education, 2023). Despite these policy efforts, whether educational attainment can offset digital inequalities remains unclear. Taiwan therefore provides a valuable context for examining this question.

### *2.4. Research Gaps in Existing Studies*

First, most studies merely control for sociodemographic factors when comparing individuals with and without disabilities (Pettersson et al., 2023; Scanlan, 2022), rather than examining their interactive effects on digital outcomes. Such analysis is critical because structural inequalities and socioeconomic disadvantage may compound one another, placing vulnerable groups at greater risk of digital exclusion (Raihan et al., 2025).

Second, despite growing attention to the second-level digital divide, first-level inequalities remain unresolved and were further exposed during the Covid-19 pandemic (Aissaoui, 2022). A comprehensive understanding of digital inequality requires examining both levels simultaneously.

Third, existing evidence remains geographically and demographically uneven, with most studies focusing on Western countries and relatively few examining disadvantaged populations (Aissaoui, 2022; Raihan et al., 2025).

To address these gaps, this study investigates digital inequality across disability status and educational attainment in Taiwan by integrating the four stages of digital access within a unified framework. In doing so, it provides more nuanced evidence from a non-Western context and demonstrates how overlapping social positions jointly shape digital inequality.

## 3. Hypothesis

From the perspective of the social model of disability, unequal digital outcomes may persist even among individuals with similar educational attainment because persons with disabilities continue to face inaccessible environments and social oppression (Deacon et al., 2022; Oliver, 1996). At the same time, digital technologies may also compensate for offline barriers and facilitate participation in certain contexts (Chadwick & Wesson, 2016; Suler, 2004). Therefore, rather than assuming that intersecting social positions necessarily produce cumulative disadvantage (Bauer et al., 2021), this study proposes two competing mechanisms explaining how education may be associated with different digital access among persons with disabilities.

Under a "barrier-amplification mechanism," inaccessibility, costs, and stigma may weaken the benefits of education and widen the disability gap at higher educational levels. In contrast, under a "compensation mechanism," digital technologies may help persons with disabilities overcome certain offline barriers and translate education into digital engagement despite these constraints. The following sections develop stage-specific hypotheses to assess which mechanism appears more dominant across different forms of digital access.

### 3.1. Mental Access

Education is widely recognized as a key factor in fostering awareness and positive attitudes toward technology (Phochai et al., 2024; Vicente & López, 2010). However, from a social relational perspective, its effects may operate differently. Research shows that persons with disabilities often report lower digital self-efficacy due to negative social experiences and interpersonal interactions (Partridge, 2007).

Specifically, reliance on assistive technologies reinforces socially constructed disabled identities (Chadwick & Wesson, 2016). Repeated exposure to criticism (Deacon et al., 2022) and overly protective attitudes from caregivers further undermine confidence in online engagement (Lathouwers et al., 2009). Consequently, although education generally enhances motivation and digital readiness, its positive effects may be weaker for persons with disabilities.

> H1: The positive association between education and mental access is greater among persons without disabilities than among persons with disabilities.

### 3.2. Material Access

Higher education is related to higher internet adoption. However, for persons with disabilities, without adequate support and affordable assistive technologies, access to the internet alone is useless (Baumgartner et al., 2023). Consistent with technology acceptance theories, perceived ease of use when learning new technologies can become a major barrier to adoption (Davis, 1989). Anticipated dependence on others for assistance may create feelings of embarrassment or shame among persons with disabilities, leading some to avoid technology use (Baumgartner et al., 2023). In addition, assistive technologies are often essential for effective internet use, yet their costs extend beyond initial purchase expenses to include maintenance, customization, and replacement (Mishra et al., 2024). Consequently, these barriers may continue to constrain technology adoption even among individuals with higher educational attainment.

> H2: The positive association between education and material access is greater among persons without disabilities than among persons with disabilities.

### 3.3. Skills Access

Higher educational attainment is generally associated with better digital skills (van Dijk, 2017). However, even at similar educational levels, learning quality and effectiveness may diverge. Persons with disabilities often require additional support and adaptive resources to fully benefit from education, yet such provisions are frequently lacking due to structural barriers within educational systems (Baumgartner et al., 2023; Stienstra et al., 2007). Thus, while education generally enhances digital literacy, persons with disabilities may face greater difficulties translating educational attainment into proficient digital skills.

> H3: The positive association between education and skills access is greater among persons without disabilities than among persons with disabilities.

### 3.4. Usage Access (Social Usage)

Education is generally expected to promote broader forms of internet use (van Deursen & van Dijk, 2014). Yet, for persons with disabilities, structural barriers may constrain their ability to fully benefit from such opportunities.

Social platforms are often viewed as spaces that help avoid unwelcoming offline environments and promote social interaction. They help increase public awareness (Cocq & Ljuslinder, 2020), as well as promote social and economic participation through online influencer activities (Bonilla-del-Río et al., 2022). However, online spaces and social media are not equally inclusive (Barroso-Moreno et al., 2024). Polarized and hostile environments may reinforce stigma (Anderson, 2023), while persons with disabilities also manage their online expression carefully due to concerns about negative reactions (Bitman, 2021).

Nevertheless, despite the risks and hostility present in some online environments, online interaction still provides net benefits for persons with disabilities by increasing anonymity, reducing face-to-face stigma, and expanding opportunities for social participation (Chadwick & Wesson, 2016; Suler, 2004). Empirical studies further suggest that persons with disabilities tend to spend more leisure time online than those without disabilities (Duplaga, 2017). Given the fundamental need for social connection and the relatively accessible nature of online interaction, social internet use appears to exhibit comparatively smaller participation gaps across disability and educational groups.

> H4a: The positive association between education and social usage is not significantly greater among persons without disabilities than among persons with disabilities.

### 3.5. Usage Access (Financial Usage)

Evidence shows that education improves financial literacy and decision-making (Finke & Huston, 2014). However, for persons with disabilities, the ability to act on this knowledge is often constrained. For example, commercial banks rarely recognize the business opportunities associated with serving persons with disabilities and often fail to prioritize digital accessibility due to profit-driven motives (Fayyad & Al-Sinnawi, 2024; Wentz et al., 2019). Meanwhile, persons with disabilities are often treated in an infantilizing manner or assumed to lack literacy, thereby restricting their access to digital banking (Kameswaran & Marathe, 2023).

As long as financial platforms remain inaccessible and fail to accommodate diverse needs, they prevent persons with disabilities from translating knowledge into actual digital participation. Consequently, although higher education may improve financial literacy, its effects are weaker for persons with disabilities.

> H4b: The positive association between education and financial usage is greater among persons without disabilities than among persons with disabilities.

### 3.6. Usage Access (Healthcare Usage)

Improved literacy generally enhances the ability to utilize health services (Smith & Magnani, 2019), while persons with disabilities may still find certain online healthcare tasks challenging (Pettersson et al., 2023).

Nevertheless, the benefits of eHealth are substantial, and the greater healthcare needs of persons with disabilities may compel them to rely on digital platforms. By improving healthcare access and delivery, eHealth enhances healthcare efficiency and quality (Eysenbach, 2001), while also creating greater decision-making flexibility (Vine, 2020). Patients with long-term health conditions also rely more heavily on online appointment systems due to their need for continuous symptom management (Fischer et al., 2014). Studies further suggest that persons with disabilities are more likely to seek health-related information online (Duplaga, 2017).

Based on the above literature and the present findings, I hypothesize that persons with disabilities may prioritize applying their digital skills and educational resources to healthcare-related engagement. Accordingly, among individuals with similar educational attainment, the educational effect may not differ substantially.

> H4c: The positive association between education and healthcare usage is not significantly greater among persons without disabilities than among persons with disabilities.

### *3.7. Usage Access (Government Service Usage)*

As government services become digitalized, bureaucratic encounters increasingly occur online. However, many platforms are designed around assumptions of general usability rather than accessibility (Beck, 2024). Even as co-design and inclusive governance are advocated, limited institutional support and reluctance to share power often leave inclusion merely symbolic (Van Toorn, 2024). Beyond institutional and technological barriers, persons with disabilities may also experience higher psychological costs from perceived discrimination during bureaucratic encounters (Vogel et al., 2025). Serious health conditions often negatively affect executive functioning, reducing individuals' ability to navigate administrative procedures (Christensen et al., 2020). Consequently, although education can promote e-government engagement, persons with disabilities may exhibit lower levels of digital government service usage.

> H4d: The positive association between education and government service usage is greater among persons without disabilities than among persons with disabilities.

## 4. Method

### *4.1. Data Source and Collection*

This study draws on four waves of nationally representative data from the Digital Access Survey, conducted by the Taiwanese government in 2020, 2022, 2023, and 2024. The 2021 wave was suspended due to the Covid-19 pandemic. Since its launch in 2002, the survey has served as Taiwan's primary official survey for monitoring digital development and informing national digital policymaking. Following a major revision in 2020 to reflect the growing international emphasis on digital well-being, subsequent waves have adopted the same survey framework (Ministry of Digital Affairs, 2024), enabling the four waves to be pooled into a single analytical dataset.

These surveys, targeting Taiwanese residents aged 12 and above, were conducted through computer-assisted telephone interviews using random sampling of residential and mobile phone numbers. After excluding observations with missing values on variables used in the analyses, the pooled dataset included 55,289 respondents, of whom 2,307 (4.17%) were officially registered as persons with disabilities, a proportion comparable to the average official disability prevalence of 5.17% in Taiwan over the study period (Ministry of Health and Welfare, 2026). The unit of analysis was the individual.

### *4.2. Variable Measurement*

#### 4.2.1. Dependent variables

All dependent variables are binary indicators, coded as 1 if the respondent reports the specified type of digital access and 0 otherwise.

(1) *Mental access* captures individuals' attitudes toward digital technology, measured by: "How connected do you feel to current technology trends?"
(2) *Material access* is assessed by: "Have you ever used a computer, mobile phone, television, tablet, or other information devices to access the internet?"
(3) *Skills access* reflects individuals' ability to locate, evaluate, and use online information, measured by: "Have you used the internet to purchase products, pay for apps or software, or use services such as food delivery, ride-hailing, or accommodation booking?"
(4) *Usage access* is measured by four binary indicators, with an affirmative response indicating usage:
    - Social usage: use of instant messaging or social networking platforms to post text, photos, or videos.
    - Financial usage: use of online or mobile banking services.
    - Healthcare usage: use of online appointment systems.
    - Government service usage: accessing government services or information through government websites or apps.

#### 4.2.2. Independent variable (education × disability)

(1) *Education* is coded as 0 for below senior high school (*low education*) and 1 for senior high school and above (*high education*).
(2) *Disability* is coded as 1 for persons holding an official disability identification card or certificate and 0 otherwise.
(3) *Education* × *disability* is the primary independent variable of interest.

Control variables: *Gender* and *employment* are coded as binary variables (male = 0, female = 1; not employed = 0, employed = 1). *Generation* is classified into four cohorts: Older Generation (1928–1964), Generation X (1965–1980), Generation Y (1981–2000), and Generation Z (2001 and later), following Çoklar and Tatli (2021). *Region* is categorized into Northern, Central, Southern, Eastern, and outlying islands, based on Taiwan's official regional classification. *Survey year* is also included to account for temporal variation across the survey waves. Descriptive statistics are presented in Table 1.

**Table 1.** Descriptive statistics of the study sample.

| Variable | | Count | Percentage (%) |
|---|---|---|---|
| Education | Low education | 16,067 | 29.06 |
| | High education | 39,222 | 70.94 |
| Disability | Without disabilities | 52,982 | 95.83 |
| | With disabilities | 2,307 | 4.17 |
| Gender | Male | 25,784 | 46.63 |
| | Female | 29,505 | 53.37 |
| Generation | Older generation (1928–1964) | 20,094 | 36.34 |
| | X Gen (1965–1980) | 13,838 | 25.03 |
| | Y Gen (1981–2000) | 12,589 | 22.77 |
| | Z Gen (2001 and later) | 8,768 | 15.86 |
| Employment | Unemployed | 36,191 | 65.46 |
| | Employed | 1,9098 | 34.54 |
| Region | Northern | 19,568 | 35.39 |
| | Central | 10,234 | 18.51 |
| | Southern | 15,662 | 28.33 |
| | Eastern | 4,776 | 8.64 |
| | Outlying Islands | 5,049 | 9.13 |
| Year | 2020 | 14,900 | 26.95 |
| | 2022 | 10,867 | 19.65 |
| | 2023 | 14,753 | 26.68 |
| | 2024 | 14,769 | 26.71 |
| Mental access | No access | 17,221 | 34.70 |
| | Has access | 32,414 | 65.30 |
| Material access | No access | 10,821 | 19.57 |
| | Has access | 44,468 | 80.43 |
| Skills access | No access | 16,170 | 36.67 |
| | Has access | 27,931 | 63.33 |
| Social usage | No access | 2,250 | 5.12 |
| | Has access | 41,726 | 94.88 |
| Financial usage | No access | 21,490 | 48.87 |
| | Has access | 22,486 | 51.13 |
| Healthcare usage | No access | 24,530 | 55.78 |
| | Has access | 19,446 | 44.22 |
| Government service usage | No access | 26,175 | 47.34 |
| | Has access | 29,114 | 52.66 |

### 4.3. Model Specification and Interpretation

Following the analytical framework illustrated in Figure 1, this study employs a series of logistic regression models to examine digital access. For individual i, the probability of achieving a given type of digital access is modeled as:

$$\text{logit}(P(Y_i = 1|X_i)) = \beta_0 + \beta_1 \text{Education}_i + \beta_2 \text{Disability}_i + \beta_3(\text{Education}_i \times \text{Disability}_i) + \gamma' Z_i + \delta_t.$$

The dependent variable $Y_i$ is a binary indicator of digital access for individual $i$. Seven separate models are estimated for different dimensions of access, all using the same model specification.

$\text{Education}_i$ represents the educational attainment, $\text{Disability}_i$ denotes disability status, and their interaction term captures whether the effect of education on digital access differs by disability status. The vector $Z_i$ repreaents the control variables, while $\delta_t$ denotes year fixed effects.

Since the logit model is nonlinear, interaction effects cannot be appropriately interpreted directly from the coefficient of the interaction term (Ai & Norton, 2003). It is therefore critical to evaluate these effects on an additive scale (Bauer et al., 2021). Following the recommendations of Mize (2019), this study interprets interaction effects using predicted probabilities. The analysis first presents plots of predicted probabilities and examines interaction effects through first differences and second differences, along with statistical significance tests. First differences represent the average marginal effects (AMEs) of education within each

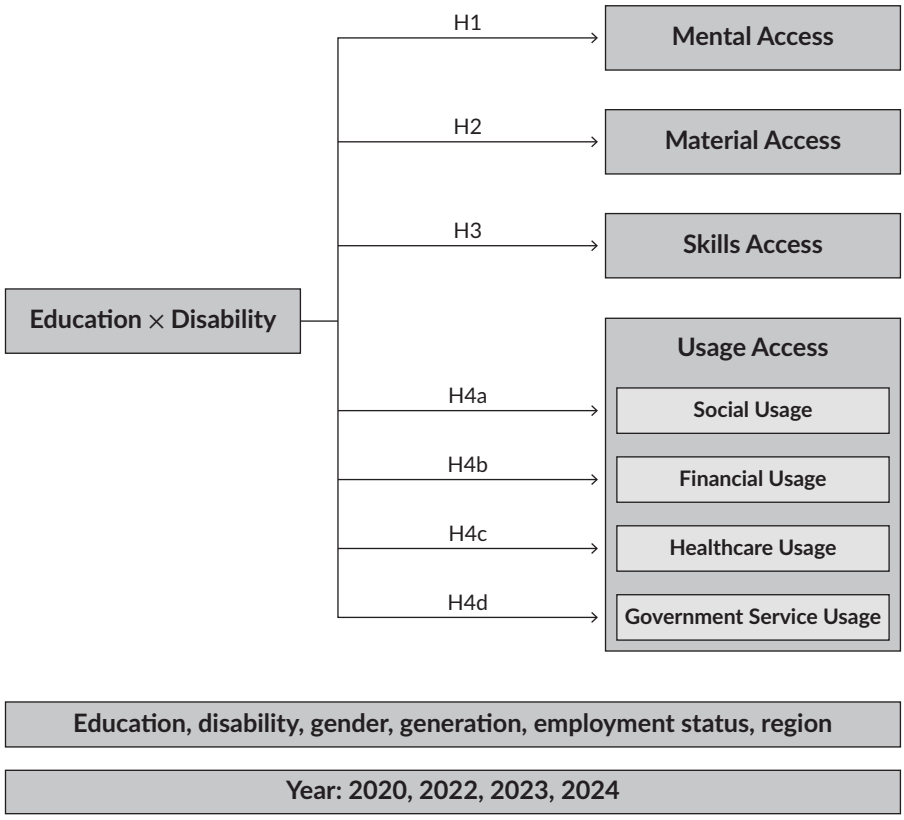


**Figure 1.** Hypothesis and analytical framework of this study.

disability group, whereas second differences represent differences in AMEs between disability groups. Details of these procedures and additional results are provided in Appendix A of the Supplementary File.

## 5. Findings

### 5.1. Mental Access

Results for mental access (Table A1–1 and Table A1–2 in Appendix A of the Supplementary File) show that higher education is associated with higher mental access for persons without disabilities (AME = 0.297, $p < 0.001$) and with disabilities (AME = 0.217, $p < 0.001$). However, the significant second difference (0.081, $p < 0.001$) indicates that the educational effect is 8.1 percentage points larger among persons without disabilities. Figure 2 further shows that the gap remains small at lower education but becomes more pronounced at higher educational levels, supporting H1.

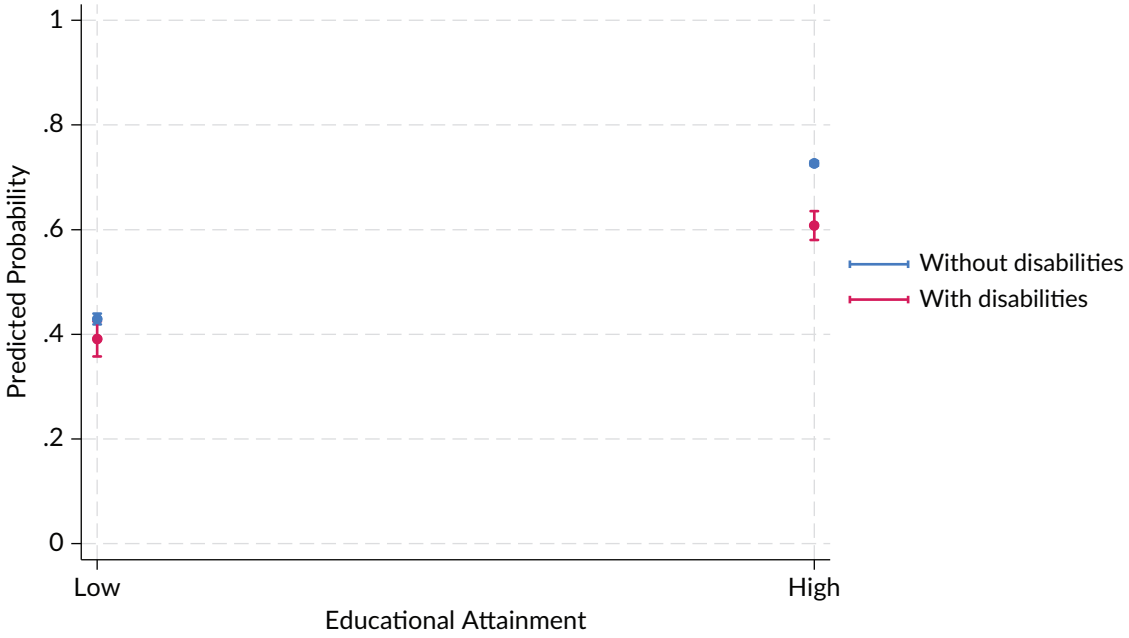


**Figure 2.** Predicted probability of mental access by education and disability.

### 5.2. Material Access

Results for material access (Table A2–1 and Table A2–2 in the Supplementary File) reveal that higher education is associated with higher material access for individuals without disabilities (AME = 0.314, $p < 0.001$) and with disabilities (AME = 0.265, $p < 0.001$). Nevertheless, the significant second difference (0.049, $p < 0.001$) suggests that the educational advantage is greater among persons without disabilities, implying that higher educational attainment may widen the disparity between the two groups. Figure 3 similarly shows that differences are limited at lower educational levels but become evident at higher educational levels. These results support H2.

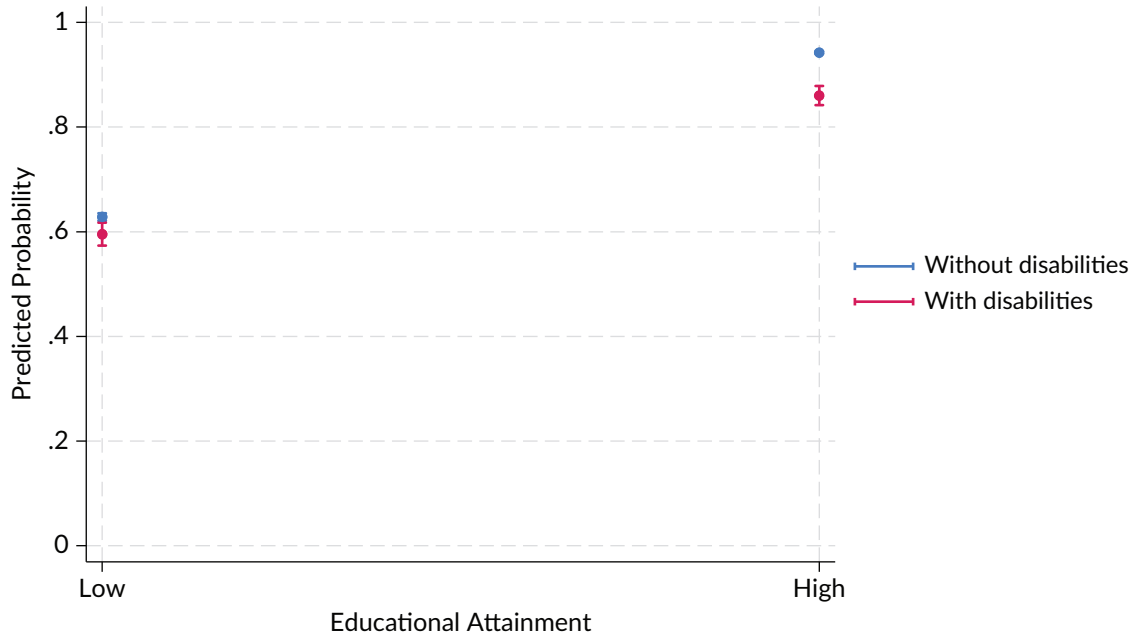


**Figure 3.** Predicted probability of material access by education and disability.

### *5.3. Skills Access*

Results for skills access (Table A3–1 and Table A3–2 in the Supplementary File) reveal that higher education is associated with higher skills access for individuals without disabilities (AME = 0.345, $p < 0.001$) and with disabilities (AME = 0.195, $p < 0.001$). Nevertheless, the significant second difference (0.149, $p < 0.001$) suggests that the educational advantage is substantially greater among persons without disabilities. Figure 4

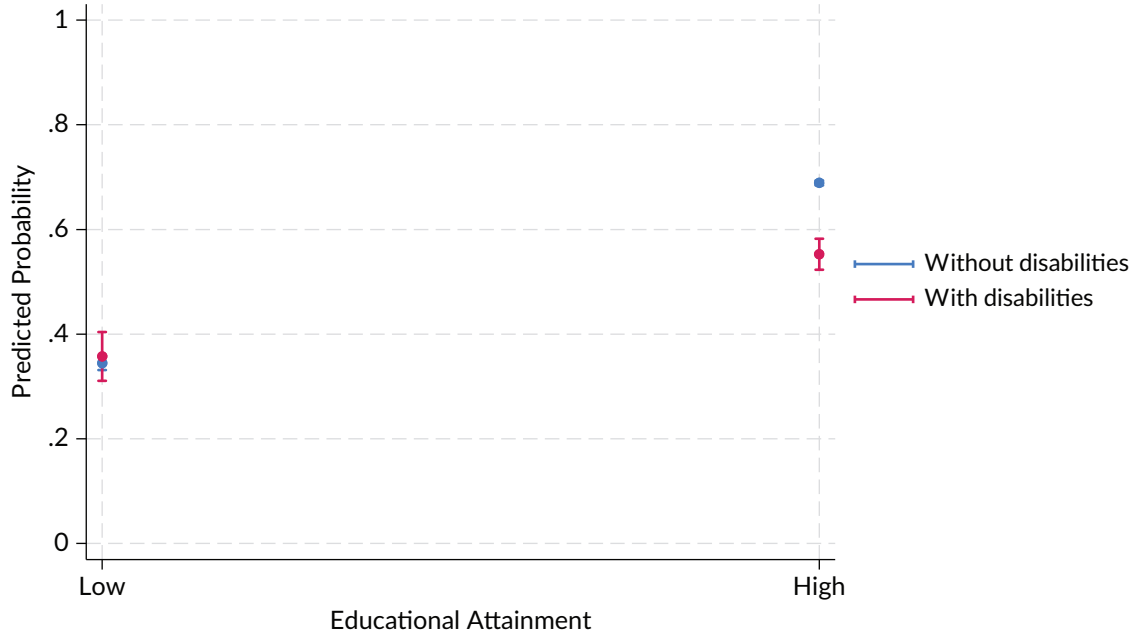


**Figure 4.** Predicted probability of skills access by education and disability.

also shows that differences become considerably more pronounced at higher educational levels. These results support H3.

### 5.4. Social Usage

Results for social usage (Table A4–1 and Table A4–2 in Supplementary File) reveal that higher education is associated with higher social usage for individuals without disabilities (AME = 0.045, $p < 0.001$) and with disabilities (AME = 0.040, $p < 0.01$). However, the second difference is not significant (0.005, $p > 0.05$), suggesting that the educational effects on social usage are relatively similar across disability groups. Figure 5 likewise shows overlapping patterns across disability groups. These findings failed to find evidence of widening gaps between people with and without disabilities, which supports H4a.

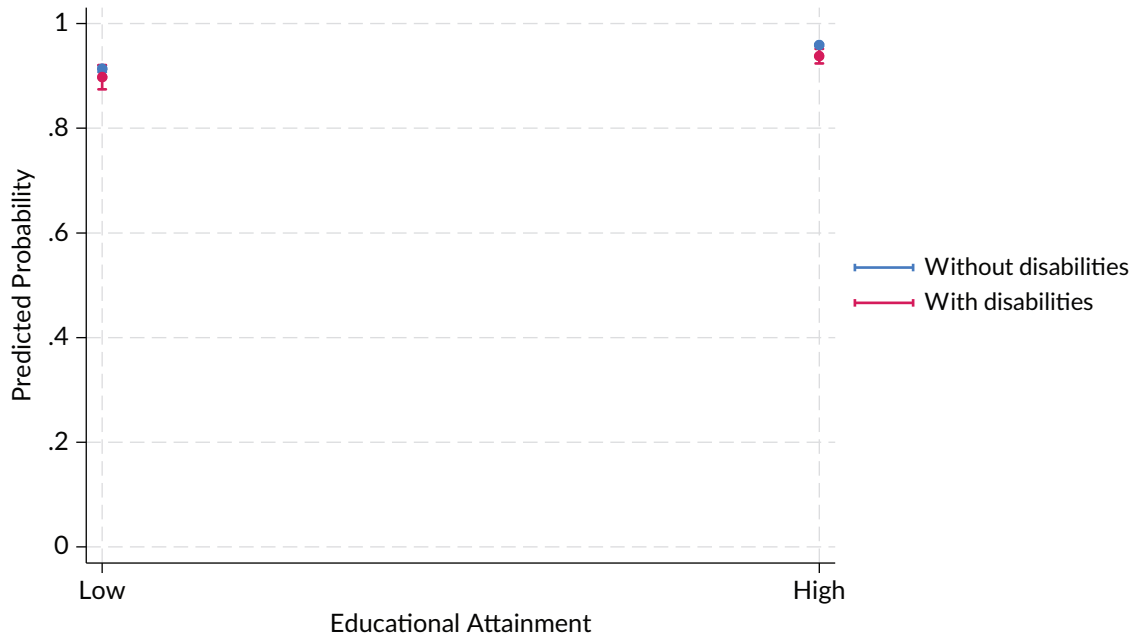


**Figure 5.** Predicted probability of social usage by education and disability.

### 5.5. Financial Usage

Results for financial usage (Table A5–1 and Table A5–2 in the Supplementary File) reveal that higher education increases financial usage for both individuals without disabilities (AME = 0.419, $p < 0.001$) and with disabilities (AME = 0.211, $p < 0.001$). Nevertheless, the significant second difference (0.208, $p < 0.001$) suggests that the educational advantage is substantially greater among persons without disabilities. Figure 6 similarly shows that differences become more pronounced at higher educational levels. These results support H4b.

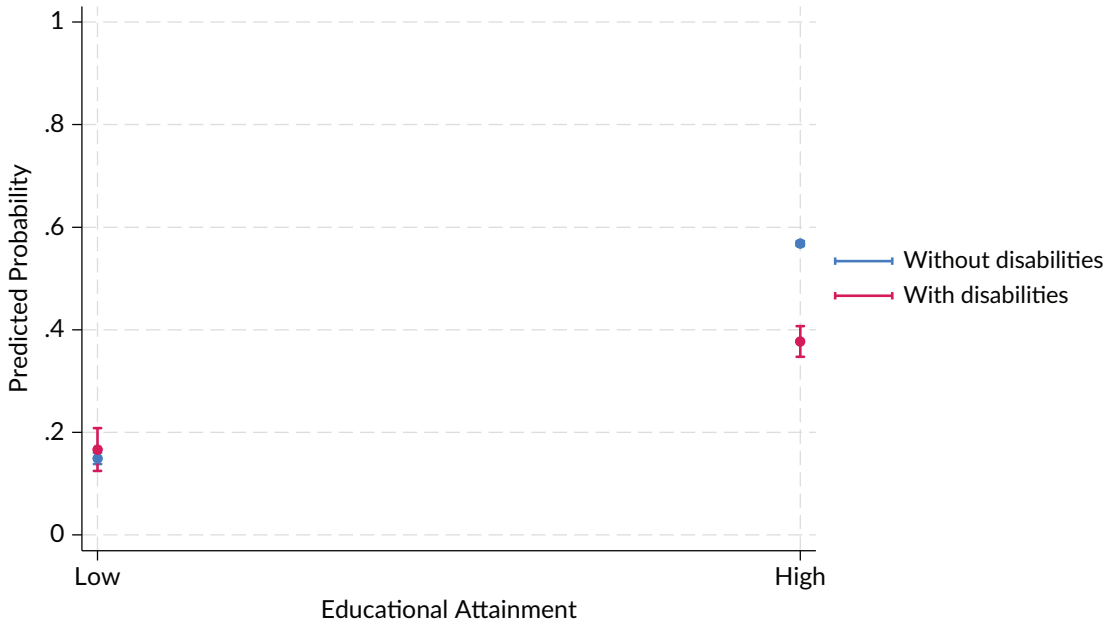


**Figure 6.** Predicted probability of financial usage by education and disability.

### *5.6. Healthcare Usage*

Results for healthcare usage (Table A6–1 and Table A6–2 in the Supplementary File) reveal that higher education increases healthcare usage for both individuals without disabilities (AME = 0.297, $p < 0.001$) and with disabilities (AME = 0.249, $p < 0.001$). However, the second difference is not statistically significant (0.049, $p > 0.05$), suggesting that the educational effect on healthcare usage is relatively similar across disability groups. Figure 7 likewise shows almost no differences across disability groups. These findings failed to find evidence of disparity, therefore supporting H4c.

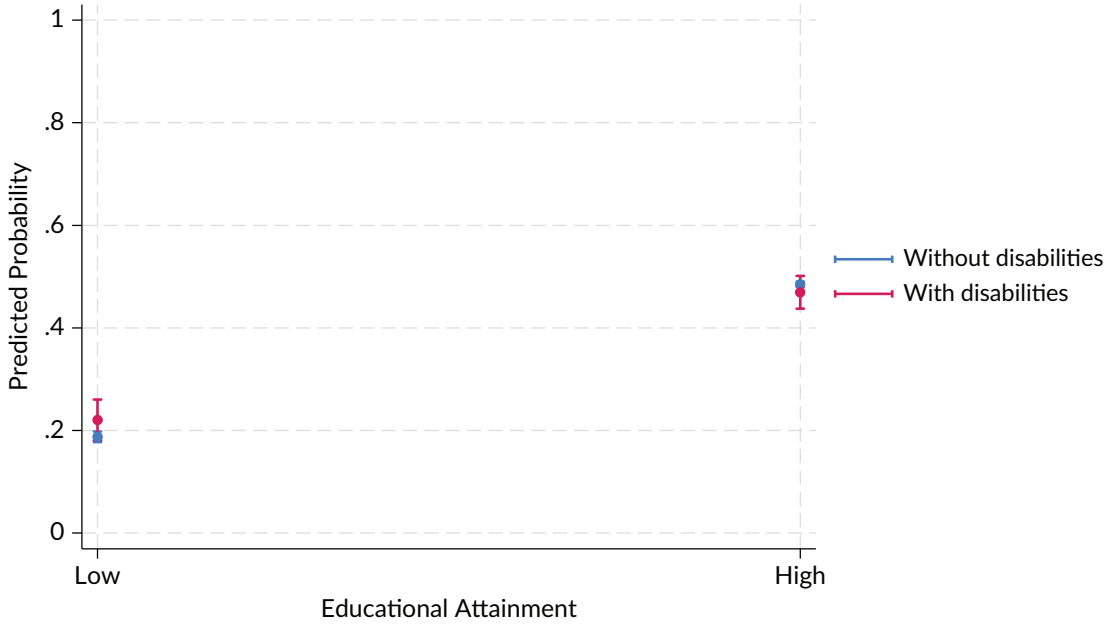


**Figure 7.** Predicted probability of healthcare usage by education and disability.

### 5.7. Government Service Usage

Results for government service usage (Table A7–1 and Table A7–2 in the Supplementary File) reveal that higher education increases government service usage for both individuals without disabilities (AME = 0.454, $p < 0.001$) and with disabilities (AME = 0.341, $p < 0.001$). Nevertheless, the significant second difference (0.113, $p < 0.001$) suggests that the educational advantage is greater among persons without disabilities. Figure 8 similarly shows that differences become more pronounced at higher educational levels. These results support H4d.

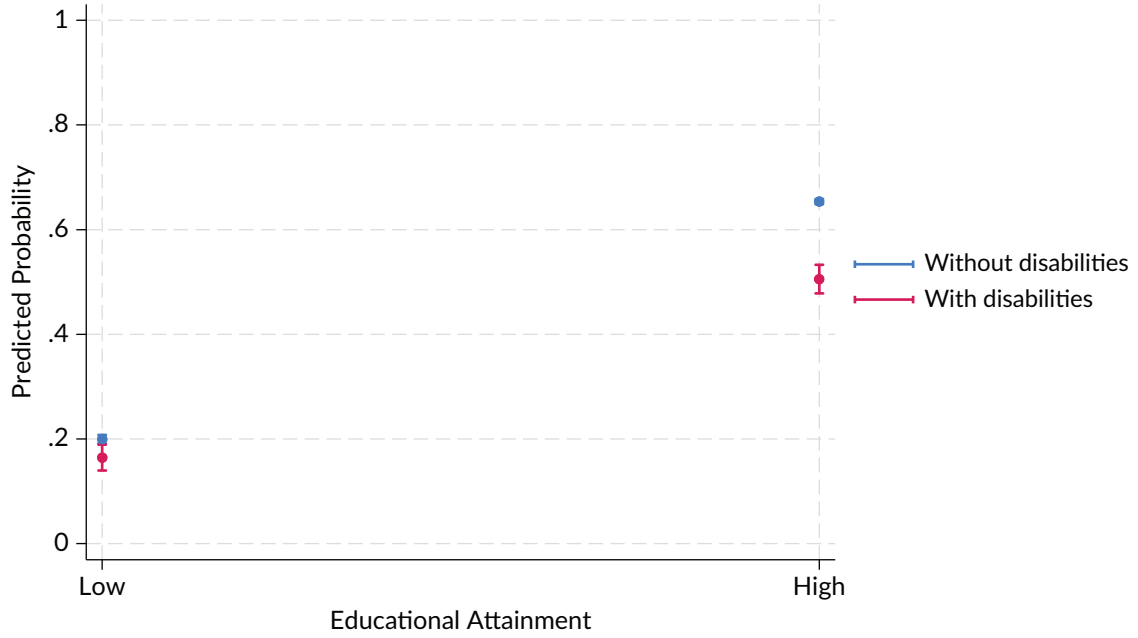


**Figure 8.** Predicted probability of government service usage by education and disability.

Overall, the findings suggest that while education generally improves digital access, its benefits may be less pronounced for persons with disabilities at higher educational levels. The following sections further elaborate these patterns.

## 6. Discussion

Before discussing the findings, it is important to note that the measures in this study primarily capture basic forms of digital access rather than deeper forms of digital engagement. The findings therefore likely provide a conservative estimate of the digital divide, as individuals lacking basic access are less likely to achieve meaningful digital participation.

The patterns observed in these findings raise a broader question regarding the extent to which education can function as an equalizing force in digital inclusion. Across most dimensions of digital access, including mental, material, and skills access, as well as usage access related to financial and government services, the interaction effect between disability and education is statistically significant. These results indicate that although higher education improves digital access for both groups, the educational advantage appears to be greater for persons without disabilities in general.

Conversely, different patterns emerge for social and healthcare usage, where the interaction effects are not statistically significant. This suggests that educational advantages in these two domains may be relatively similar between persons with and without disabilities. One explanation is that when digital services are highly necessary or provide substantial benefits, persons with disabilities may have stronger motivation to engage, potentially reducing disparities associated with educational attainment.

For social internet use, the internet may mitigate offline inequalities by providing greater anonymity and greater control over how and when to present their "true self." This "online disinhibition effect" helps reduce social stigma and, in turn, increase the likelihood of social participation (Furr et al., 2016; Suler, 2004). This fundamental human need for social connection helps explain why digital disparities may be less pronounced in this domain.

Similarly, the absence of a significant disability gap in healthcare-related internet use in Taiwan suggests that greater healthcare needs may encourage individuals to seek health-related information and services online. This interpretation is consistent with previous studies showing that healthcare needs may, to some extent, promote engagement with digital health services among persons with disabilities (Dobransky & Hargittai, 2006; Duplaga, 2017). However, this pattern contrasts with findings from Sweden, where persons with disabilities were found to use eHealth services less frequently than those without disabilities (Pettersson et al., 2023), suggesting that this relationship may vary across contexts.

Notably, although the interaction between disability and education is not statistically significant for either social or healthcare-related internet use, the two domains exhibit distinct patterns. As shown in Figures 5 and 7, social usage remains consistently high across educational groups for both persons with and without disabilities, with predicted probabilities approaching saturation at around 90% (Table A4–2 in the Supplementary File). Accordingly, the marginal effect of education is relatively limited, increasing participation by only about 4% (first differences: 0.045, $p < 0.001$ and 0.040, $p < 0.01$).

In contrast, healthcare usage shows a much stronger educational gradient. Although the disability gap does not significantly widen at higher educational levels, higher education is associated with greater healthcare-related engagement for both groups, with marginal effects of around 25% (Table A6–2 in the Supplementary File: 0.297, $p < 0.001$ and 0.249, $p < 0.001$). These findings suggest that the non-significant interaction effects may arise through different mechanisms across domains. Whereas social internet use is already close to universal regardless of educational attainment, healthcare-related internet use remains substantially shaped by education.

Nevertheless, although social and healthcare domains show relatively equal participation across disability status, broader findings suggest that the digital disability divide may persist or even become more pronounced at higher educational levels. One explanation is that ableist assumptions often portray persons with disabilities as neither needing nor being capable of achieving the same professional outcomes as their non-disabled peers, and once institutionalized, even within the same classroom, such assumptions may limit access to educational resources (Gorski & Clark, 2002). Moreover, repeated usability difficulties and discouraging evaluations from surrounding social networks may further reduce their willingness to engage with digital environments (Dobransky & Hargittai, 2006). In this sense, what truly disables individuals is not the impairment itself, but social systems and institutional arrangements designed primarily around the needs of the majority while neglecting those with impairments (Cocq & Ljuslinder, 2020).

This interpretation also resonates with evidence from Taiwan. The structural barriers faced by people with disabilities may be reflected in what Hong and Li (2025) describe as the "masking effect" in Taiwan's special education system, whereby educational institutions focus excessively on students' disabilities while overlooking their strengths and potential, consequently limiting opportunities for appropriate skill development. Likewise, although Taiwan has actively promoted digital education, including programming, computational thinking, and cloud-based learning (Kuo et al., 2023), students with disabilities, particularly those in inclusive classrooms, still receive insufficient differentiated support because mainstream teachers often lack adequate preparation in special education (Hong & Li, 2025).

In light of these findings, broad educational initiatives should adopt more adaptive and disability-responsive strategies, while systematically identifying and removing structural barriers across family, school, and broader sociocultural contexts to ensure substantive opportunities for participation (Kuo et al., 2024; Su, 2026). Beyond strengthening external support, interventions should also incorporate identity reconstruction, helping students reframe disability labels as personal characteristics and fostering psychological resilience (Kuo et al., 2024). Recent advances in AI and assistive technologies also show promise in complementing these efforts by providing more personalized and scalable solutions to improve digital inclusion (Putri et al., 2025).

## 7. Conclusion

From the perspective of the social model, disability is shaped not only by individual impairments but also by structural barriers that fail to accommodate diversity, making it not merely a medical issue affecting a minority population, but also a broader social issue tied to civil rights and inclusion (Barnes & Oliver, 1993). As such, digital inequalities faced by persons with disabilities cannot be understood solely through differences in physical condition or educational attainment. This study therefore examines how disability status and educational attainment interact to shape unequal digital access.

For educational attainment alone, the finding that higher education generally improves digital access echoes prior literature (Lythreatis et al., 2022). More importantly, when disability status and education are considered jointly, this study further finds that the educational advantages appear stronger for individuals without disabilities, consistent with the argument that an excessive emphasis on individual capability may overlook the deeper social determinants shaping digital exclusion (Van Toorn & Cox, 2024). Furthermore, by examining multiple dimensions of digital access, the findings reveal that the digital disability divide varies across domains, highlighting the importance of adopting a multidimensional perspective.

Taken together, this study contributes to the literature in several ways. First, drawing on the social model of disability, it demonstrates how this theoretical perspective can be operationalized in large-scale quantitative research by examining the combined role of disability and education in digital inclusion. Second, by investigating digital access across four stages spanning both the first and second-level digital divides, this study uncovers more nuanced patterns of digital inequality. Finally, this study extends the predominantly Western literature by providing empirical evidence from Taiwan, demonstrating that digital inequality still remains a critical issue even in a highly digitalized society.

## 8. Limitations and Future Research

While using the government survey offers several advantages, secondary data also involve important limitations. First, although the disability subsample was broadly comparable to the national prevalence, it remained slightly underrepresented, which should be acknowledged when interpreting the findings. Moreover, the cross-sectional design limits causal inference, and some variables may not fully capture the dimensions of digital access. For example, healthcare access is measured only through online appointments, while mental access is proxied by perceived connectedness to technological trends rather than direct measures of digital motivation or technology anxiety in van Dijk's (2002) framework, though it still reflects psychological orientation toward technologies. Additionally, the survey does not include direct income measures, and employment status is therefore used as a partial proxy for economic conditions.

Moreover, while this study adopts a macro-level perspective by treating disability as a broad category, different impairment groups may encounter distinct accessibility barriers across specific types of digital services (Johansson et al., 2021; Pettersson et al., 2023). Future research should therefore examine how different impairment types shape heterogeneous patterns of digital access and participation among persons with disabilities, thereby providing a more nuanced understanding of digital inequality across disability subtypes.

Finally, the heterogeneous patterns of digital access observed across disability and education broadly echo the perspective of intersectionality theory, which suggests that overlapping inequalities may produce within-group variation (Atewologun, 2018; Hudson et al., 2024). However, although the present study moves beyond examining a single social position and thus comes closer to an intersectional perspective, regression models with interaction terms remain limited in capturing the complexity of high-dimensional intersectionality. A more comprehensive analysis would require approaches that incorporate multiple social positions, such as latent variable or clustering methods, with further applications in longitudinal and multilevel analyses and effect-measure modification (Bauer et al., 2021). These methodological advances have the potential to enrich digital divide research, where quantitative applications of intersectionality remain limited (Husain et al., 2022).

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## Conflict of Interests

The author declares no conflict of interest.

## Data Availability

The datasets analyzed in this study were obtained from the Survey Research Data Archive (SRDA).

## LLMs Disclosure

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## Supplementary Material

Supplementary material for this article is available online in the format provided by the author.

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