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► **To cite this version:**

Fahima Djelil, Cécile Obeid, Grégory Smits. A Taxonomy of Digital Inequalities in the French Education System. 35th conference of the Society for Information Technology and Teacher Education, Association for the Advancement of Computing in Education (AACE), Mar 2024, Las vegas, NV (US), United States. pp.16. hal-04534229

HAL Id: hal-04534229

<https://hal.science/hal-04534229v1>

Submitted on 5 Apr 2024

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A Taxonomy of Digital Inequalities in the French Education System

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Abstract: Digital inequalities in education have been largely studied through the lens of technology access and usage. Although, they are recognized as a multidimensional phenomenon, there is a need for a comprehensive typology that provides useful explanations of their nature. In this paper, we propose a taxonomy of digital inequalities in the French education system, that defines their multiple dimensions, what they cover and who they affect. It defines seven dimensions including technological skills and usage, social, economic, geographical, and public policy factors, affecting students, teachers, and schools. It is based on existing literature and provides a framework for analyzing diverse educational data that will help to predict useful indicators of digital inequalities in education. This work will help to evaluate the impact of a public policy program in the French education system.

Keywords: Digital Inequalities in Education, Open Data, Public Policy Evaluation, Taxonomy

Introduction

Digital inequalities in education have become an important issue at a time when digital tools are essential for teaching and learning. These inequalities largely predate the Internet expansion, and although they are expressed in the field of Information and Communication Technologies (ICT), they are social, economic, geographical, and cultural (Fenoglio, 2021). In France, public policies have developed equipment strategies to close the gap in access to technological equipment, mutualize educational content and train teachers and families. Various programs have been proposed, such as the *Digital Plan* (2015), and more recently, the *Digital Education Territory* (2021), launched during the pandemic crisis, which has intensified this pre-existing phenomenon.

Furthermore, in the context of a broad opening of public data, to facilitate the exchange of data between all stakeholders (central administrations, regional and local authorities, private sector, etc.), the French Ministry of National Education and Youth is extending this proactive approach to open and share new public data on school education. The aim is to enable everyone - citizens, partners, public and private actors - to be transparent and to encourage innovation, i.e., to easily find, understand and enrich data related to school education, and to imagine and propose useful services in the field of education (MENJ, 2023).

This provides a rich context for academic research, allowing researchers to access educational data to propose indicators on the quality of education, and to help evaluate the impact of public policies. It is in this context that our work is situated. In this paper, we describe a preliminary work carried out in the context of a project funded by the French Ministry of National Education and Youth (*GoDATA project*) (Djelil, Smits, Labarthes, & Pélissier, 2024), which aims to use open educational data to help analyze the initial conditions of an implemented educational program focused on digital inequalities (the *Digital Education Territory program*). To make it easier to explore and understand existing data, we proposed a taxonomy that defines digital inequalities in education, what they cover and

who they affect. The taxonomy is based on existing literature and provides a framework for identifying available data. It will also help to find and use key data to characterize digital inequalities in the French education system.

This paper is structured as follows: Section 1 describes the research background, including a brief state-of-the-art on what digital inequalities in education are, the French Program *Digital Education Territory* that defines the research context, and the GoDATA project in which this research is carried out. Section 2 describes the method used to develop the taxonomy. Section 3 describes the resulting taxonomy, and a discussion and implications are given in section 4.

Background

Digital Inequalities

Awareness of the existence of digital inequalities began to take shape in the 1990s (Irving, et al., 1999), when the concept of *digital divide* was first introduced into political discourse (Plantard, 2021), to describe the differences in access to the Internet and the consequent need for policies to facilitate this access (Ollivier, 2006). Very soon, this awareness spread to the academic dimension. Researchers began to realize that most of the digital differences were rooted in pre-existing social, economic, geographical, and cultural inequalities (Brotcorne, 2019; Vendramin & Valenduc, 2003): an aspect that, until then, has been downplayed using the term *divide* (Fenoglio, 2021). In addition, the academic literature emphasized that digital divide is not only related to access to the Internet, as originally conceived, but is rather a complex and multidimensional phenomenon (Hargittai, 2001), which also includes usage, skills, and knowledge (Brotcorne & Valenduc, 2009).

Therefore, to reflect both the inherent injustice and the plurality of dimensions of digital divide, researchers have suggested to speak rather of *digital inequalities* (DiMaggio, Hargittai, Celeste, & Shafer, 2004) or *social digital inequalities* (Collin, Denouël, Guichon, & Schneider, 2022). This expression is based on the sociological concept of inequalities, understood as social differences in the distribution of resources, with negative consequences for certain individuals or groups (Granjon, Lelong, & Metzger, 2009). These multidimensional inequalities affect many aspects of the digital experience, including digital education.

Indeed, several studies (Denouël, 2017; Plantard, 2016) and reports (Fenoglio, 2021; Miletto, 2018) point to the accentuation of educational inequalities with digital technologies. These inequalities are measured in terms of access to technologies, skills, and intentions to use them, as shown by several authors who defend the idea of a socio-critical approach to digital use in education (Collin, Denouël, Guichon, & Schneider, 2022; Denouël, 2019), considering digital inequalities as the relationships between students' relation to the digital, the determinants of this relation and students' ability to use it for educational purposes (Collin, Guichon, & Ntebutse, 2015). These inequalities arise from a variety of factors: Territorial configuration, socio-professional categories, age, gender, and the socio-cultural background of the students, the latter being particularly discriminatory (Fluckiger, 2008; Fenoglio, 2021). They can be observed at several levels: Between territories (differences in resources and equipment) (Miletto, 2018); between educational communities (differences in teacher training and use); and between students (digital inequalities in and out of school) (Fenoglio, 2021).

These digital inequalities have been accentuated by the COVID-19 pandemic (Netter & Régibier, 2021), which is the case with inequalities in general (Bonnéry & Douat, 2020). In fact, researchers have noted that distance learning in times of pandemic has led to a massification of inequalities, both in terms of digital technology and the form of education, particularly in secondary education (Plantard, 2021). Moreover, the difficulties encountered by all those involved in the system (students, parents, teachers) during the successive periods of restriction associated with the COVID-19 pandemic were exacerbated by the extent of socio-cultural inequalities, access to technology and training (Ria & Rayou, 2020). To respond to these challenges, during the pandemic several institutional actors developed plans to ensure educational continuity, i.e., to ensure a continuation of school activities, that allow students to progress in their learning and to maintain a link with their teachers during the disruptions caused by the health crisis.

The French Program Digital Education Territory

In France, the experience of the pandemic has led to a greater political awareness of the implementation of pedagogical continuity as an essential element to ensure greater resilience in the education system. This led to the creation of a national program called *Territoires Numériques Éducatifs (TNE) – Digital Education Territory* designed by the French Ministry of National Education and Youth (MENJ, 2021). Following on from previous digital education programs, the TNE program focuses on the digital transformation of education, to raise the general level of education, achieve greater social justice and to help accelerate digital transformation and better anticipate the challenges of deploying digital technology in the French territories. More specifically, the TNE program aims to achieve three main objectives: Enriching teaching practice and improving student performance; ensuring greater cooperation and strengthening the link between schools and families; strengthening the resilience of the education system, particularly in times of crisis (MENJ, 2021).

With regard to the actors involved, TNE focuses on a triptych (MENJ, 2021): 1) Teachers and supervisors in public or private education, giving them access to high performance equipment, quality resources, and personalized training tailored to their needs; 2) students, enabling them to benefit from the advantages of digital education, regardless of their educational, social or geographical environment (equal opportunities); 3) parents, making them familiarize with the challenges of digital education and encouraging their involvement in their child's schooling.

Finally, the TNE implements four kinds of actions: 1) Training for each teacher, based on their needs, background, and expertise, as well as training on topics related to the integration of digital technology into teaching practice; 2) equipment for each classroom, teacher and student, providing new and high performance hardware to encourage the use of digital technology in the classroom; 3) resources and tools for face-to-face and distance digital teaching; 4) support for families, i.e., encouraging the involvement of parents in their child's education by helping them to master the technologies available to them (MENJ, 2021).

The Research Project GoDATA

In France, public policies on digital education and digital inequalities have led to the promotion of academic research on these issues. For example, the importance of educational inequalities as a research area has been established in a contract signed between the government and the *National Centre for Scientific Research (CNRS)*, known as the *Contract of Objectives and Performances (COP)* (Vidal & Petit, 2020). This contract specifies the importance of research on educational inequalities, which have an impact on the development of the country and can lead to other forms of inequality: economic, social, geographical, etc. The COP stresses the importance of researchers having access to data, to develop representative approaches and propose innovative indicators of education quality.

It is in this context that the GoDATA project was launched. Funded by the French Ministry of National Education and Youth, this project aims to support decision-making in the TNE program, through a data-driven approach. Its main objective is to collect and understand diverse educational data to predict useful indicators on digital inequalities in education. More specifically, through the production and exploitation of data on the actors involved in school education, GoDATA aims to analyze the initial conditions of the implementation of the TNE program and to provide the actors with the necessary tools to make informed decisions in relation to digital inequalities.

Taxonomy Development Method

To build our taxonomy we followed the method proposed by Nickerson, Varshney, & Muntermann (2013), who defined a taxonomy T as a set of n dimensions $D_i (i = 1, \dots, n)$ each consisting of $k_i (k_i \geq 2)$ mutually exclusive and collectively exhaustive characteristics $C_{ij} (j = 1, \dots, k_i)$ such that each object under consideration has one and only one C_{ij} for each D_i : $T = \left\{ D_i, i = 1, \dots, n \mid D_i = \{ C_{ij}, j = 1, \dots, k_i; k_i \geq 2 \} \right\}$.

The mutual exclusive restriction means that no object can have two different characteristics in a dimension. The collectively exhaustive restriction means that each object must have one of the characteristics in a dimension. Together these conditions mean that each object has exactly one of the characteristics in each dimension.

Moreover, Nickerson, Varshney, & Muntermann (2013) proposed qualitative attributes to consider when developing a taxonomy, which should be: 1) concise, i.e., should contain a limited number of dimensions to be meaningful without being overwhelming (a possible number of dimensions falls in the range of seven plus or minus two (Miller, 1956)); 2) robust, i.e., should contain enough dimensions and characteristics to clearly differentiate the objects of interest.; 3) comprehensive or complete, i.e., includes all dimensions of objects of interest and allows for the classification of all known objects within the domain under considerations; 4) extendible, i.e., should allow for inclusion of additional dimensions and new characteristics within a dimension when new types of objects appear; and 5) explanatory, i.e., contains dimensions and characteristics that provide useful explanations of the nature of the objects under study.

This method is iterative and starts with the definition of the purpose of the taxonomy, based on its expected use by the users. This method combines two design approaches, and the researcher starts to choose one of them depending on whether he has a significant understanding of the domain or not and whether significant data about the objects are available or not. Ending conditions are checked at each step, including the quality attributes. Our goal is to draw a typology of digital inequality factors to facilitate further educational data processing in the context of the TNE program. Based on the literature, we choose an inductive approach to identify the objects of interest, their characteristics and grouped these characteristics into dimensions to create the taxonomy.

Resulting Taxonomy

Some typologies and models have been proposed in the literature to define the dimensions and characteristics of digital inequalities. Several authors have focused on the importance of user skills, categorizing them into the following triplets (e.g., Vendramin & Valenduc, 2003; Van Dijk, 2002; Collin, 2013): know-how skills (instrumental skills), skills related to information treatment (informational skills), ability to make sense of information and make decisions (strategic skills). Van Dijk (2002) proposed a framework of digital inequality as a model of access, covering four dimensions: motivation, material access, skills access and usage access. Collin (2013) has adopted the three-levels typology proposed by Bihr & Roland (2008): Access to technology, skills and usage, ability to take advantage from the technological skills and usage. Plantard (2013), describes a four-levels typology: Access to computers and Internet, software usages, interpretation derived from these usages, and the socialization of digital practices. Fenoglio (2021) distinguishes between three types of structural dimensions: Macro-structural (governmental and institutional), meso-structural (academic, regional) and micro-structural (students, teachers, and families). These dimensions are related to a variety of factors: Geographical configuration, socio-professional categories, age, gender, ethnic origin, and the socio-cultural background (Fluckiger, 2008; Fenoglio, 2021).

These typologies allowed to highlight that students and families, teachers and schools are the main objects of digital inequalities in education. We also note that digital inequalities are not only reflected in technological skills and usage, but are also rooted in social, economic, geographical, and cultural dimensions. The data needed should relate to students and families, teachers, and schools, and should cover different dimensions of digital inequalities. This led to a taxonomy of 7 dimensions of factors, affecting students, teachers, and schools (primary and secondary education) (Table 1).

The first dimension relates to the digital culture of teachers and students, including digital literacy, digital use, and digital training. Digital literacy in the context of education, refers to the technical skills and ability of individuals to locate available resources and use digital tools for educational purposes, including communication, workspace management, digital identity, hardware, and networks (Fougère, Azmat, Lermite, & Lobut, 2022). Digital use refers to a set of digital practices and the interpretation of the resulting information (Plantard, 2016). Uses occur both in and out of school (Fenoglio, 2021), and include representations, which refer to the way in which students make sense of their digital practices (Collin, Guichon, & Ntebutse, 2015). This also includes attitudes to digital technology in general and motivation for technological uses (Reisdorf & Rhinesmith, 2020). Digital training is related to teachers and includes pedagogical use of digital tools such as digital workspace or digital teaching platforms (Fougère, Azmat, Lermite, & Lobut, 2022).

The second dimension relates to access to technological equipment and digital resources for students and teachers. This includes access to the Internet, which has been widely emphasized by several authors (Fenoglio, 2021; Guichard, 2011). Indeed, access to fixed or mobile wireless Internet and low bandwidth, can be a barrier to the use of digital technologies in education (Fougère, Azmat, Lermite, & Lobut, 2022). Technological equipment also includes the availability of a computer at home (Guichard, 2011; Collin, Guichon, & Ntebutse, 2015), and can refer to any type of equipment in the school and its quality (e.g., desktop computers, laptops, smartphones, digital tablets, projectors, interactive digital boards, etc.) (Fougère, Azmat, Lermite, & Lobut, 2022). Digital resources are mainly resources used by teachers to design learning content (Fougère, Azmat, Lermite, & Lobut, 2022). This includes the ability to create customized learning content, which leads to an increase in collaborative approaches to sharing resources on digital platforms and networks between teachers (Azmat, 2022).

The third dimension refers to the school's characteristics, such as class size (Fougère, Azmat, Lermite, & Lobut, 2022), school size, level (elementary, middle or high), type (e.g., vocational or general and technological high school) and sector (public or private) (Bocognano, 2021), as well as the information on whether it is part of the REP (Priority Education Policy¹), and finally information on the status and seniority of teachers (Bocognano, 2021; Touahir & Maugis, 2021).

An important category of digital inequality factors is social and can be described in three different dimensions: Socio-demographic, socio-educational and socio-economic. Socio-demographic characteristics (fourth dimension) of students include age, gender, place of residence (Fenoglio, 2021; Guichard, 2011; Le Mentec, 2015; Selwyn, 2019), living environment (rural or urban) (Touahir & Maugis, 2021), and ethnic origin or nationality (Fenoglio, 2021; Guichard, 2011). Two socio-educational characteristics are also worth to be noticed (fifth dimension), namely the educational level of the parents (Guichard, 2011; Plantard, 2016; Selwyn, 2019) and the rules in the family regarding the use of technology (Collin, Steeves, Burkell, & Skelling-Desmeules, 2019). Socio-economic factors (sixth dimension) include the socio-professional category of the parents (Fenoglio, 2021; Fougère, Azmat, Lermite, & Lobut, 2022), the family income (Plantard, 2016; Guichard, 2011) and their housing conditions (Fenoglio, 2021).

The seventh and final dimension relates to public policy in relation to the geographical territory (Fenoglio, 2021) of the school, and the national or local digital equipment plans from which it has benefited (Fougère, Azmat, Lermite, & Lobut, 2022; Miletto, 2018).

Table 1. Taxonomy of digital inequalities in the French education system.

Dimension	Characteristics	Objects	References
Digital culture	Digital literacy	Teachers, students	Brotcorne & Valencuc (2009); Fenoglio (2021); Fougère, Azmat, Lermite, & Lobut (2022)
	Digital use	Teachers, students	Fenoglio (2021); Collin, Steeves, Burkell, & Skelling-Desmeules (2019); Collin, Guichon, & Ntebutse (2015); Plantard (2016); Reisdorf & Rhinesmith (2020); Granjon, Lelong, & Metzger (2009); Mons, Tricot, Chesné, & Botton (2020); Fluckiger (2008)
	Digital training	Teachers	Fougère, Azmat, Lermite, & Lobut (2022)
Equipment and resources	Access to the internet	Students, teachers	Fenoglio (2021); Plantard (2016); Guichard (2011); Fluckiger (2008)
	Technological devices	Students, teachers	Fenoglio (2021); Guichard (2011); Fougère, Azmat, Lermite, & Lobut (2022); Collin, Guichon, & Ntebutse (2015); Plantard (2016); Fluckiger (2008)
	Access to digital resources	Teachers	Fenoglio (2021); Fougère, Azmat, Lermite, & Lobut (2022)
	Classroom size	School	Fougère, Azmat, Lermite, & Lobut (2022)

¹] In France, the REP (*Réseau d'Éducation Prioritaire*) is an education policy that aims to contribute to equal opportunities and to combat social territorial inequalities in terms of educational success.

Educational environment	School size	School	Brotcorne & Valenduc (2009)
	School level	School	Brotcorne & Valenduc (2009); Fougère, Azmat, Lermite, & Lobut (2022)
	School type	School	Brotcorne & Valenduc (2009); Fougère, Azmat, Lermite, & Lobut (2022)
	School sector	School	Brotcorne & Valenduc (2009); Fougère, Azmat, Lermite, & Lobut (2022)
	School inside or outside REP	School	Brotcorne & Valenduc (2009); Fougère, Azmat, Lermite, & Lobut (2022)
	Teacher status	Teachers	Fougère, Azmat, Lermite, & Lobut (2022)
	Teacher seniority	Teachers	Brotcorne & Valenduc (2009); Touahir & Maugis (2021)
Socio-demographic factors	Age	Students, teachers	Fenoglio (2021); Fougère, Azmat, Lermite, & Lobut (2022); Plantard (2016); Guichard (2011); Le Mentec (2015); Selwyn (2019)
	Gender	Students, teachers	Fenoglio (2021); Fougère, Azmat, Lermite, & Lobut (2022); Guichard (2011); Le Mentec (2015); Selwyn (2019); Bocognano (2021)
	Place of residence	Students	Guichard (2011); Le Mentec (2015); Selwyn (2019)
	Rural, suburban, or urban environment	Students	Touahir & Maugis (2021); Fenoglio (2021); Plantard (2016); Mons, Tricot, Chesné, & Botton (2020); Le Mentec (2015)
	Ethnic origin or nationality	Students	Fenoglio (2021); Guichard (2011)
Socio-educational factors	Education level	Students (families)	Guichard (2011); Plantard (2016); Selwyn (2019)
	Education regarding the use of technology	Students (families)	Fenoglio (2021); Collin, Steeves, Burkell, & Skelling-Desmeules (2019)
Socio-economic factors	Socio-professional category	Students (families)	Fenoglio (2021); Fougère, Azmat, Lermite, & Lobut (2022); Bocognano (2021)
	Income	Students (families)	Plantard (2016); Guichard (2011)
	Housing conditions	Students (families)	Fenoglio (2021)
Public policy	Geographical territory	School	Fenoglio (2021)
	Local or national equipment plans	School	Fenoglio (2021); Fougère, Azmat, Lermite, & Lobut (2022); Miletto (2018)

Discussion and Implications

The taxonomy of digital inequalities in the French education system is developed iteratively, as suggested by Nickerson, Varshney, & Muntermann (2013). In fact, once the purpose of the taxonomy is established, and objects concerned by digital inequalities in education identified, i.e., students, teachers, and schools, we identified from the literature related characteristics, and we grouped them into seven dimensions. Keeping in mind the qualitative attributes of a taxonomy (concise, robust, comprehensive, extendible, and explanatory), we checked at each step whether the number of the dimensions allows the taxonomy to be meaningful without being overwhelming, whether our objects of interest can be well and adequately characterized, whether new dimensions can be added and finally, whether the dimensions and characteristics allow to explain digital inequality in education.

As the aim of the taxonomy is to provide an understanding of the nature of digital inequalities in education, and to help analyze existing education data, we discuss the usefulness of the taxonomy, in relation to available datasets in terms of dimensions and characteristics it covers. Indeed, as shown in Table 2, most of the identified characteristics can be provided by existing datasets which are mainly open data. These data are collected by the French national organism DEPP (Department of Evaluation, Forecasting and Performance), which is responsible for

evaluating and measuring the performance of the French education system, and contributes to the evaluation of policies carried out by the Ministry of National Education and Youth. The available datasets cover the dimensions related to the socio-demographic characteristics of students and their educational institution, including its geographical territory and public policies. Although information on digital equipment and access to the Internet may be available, data on available digital resources and digital use may be scarce. Data on the socio-educational and socio-economic characteristics of students are also not fully available and are subject to data protection. Data providing information on teachers' status and participation in training programs are private, but they can be provided by institutional partners within the GoDATA project.

The taxonomy allows us to understand how digital inequalities in education are defined, what they cover, and who they affect. It goes beyond the existing typologies, which mainly focus on technological skills and usage, by considering social, economic, geographical, and public policy factors. It also highlights the objects concerned by digital inequalities (students, teachers, and schools), and characteristics that affect them. It provides a framework for analyzing existing data, to create a map of educational performance and digital practices within the context of the TNE program. It can help improve data quality by organizing data in an understandable way, making it easier to find and use key data attributes. This will help to profile schools in terms of educational digital inequalities, based on their characteristics (equipment, resources, digital practices, socio-demographic and socio-economic characteristics of students, ...) to analyze the impact on academic success. Finally, this will help to evaluate the implementation of the TNE program and its impact on education.

Table 2. Available datasets related to the dimensions of the Digital Inequalities Taxonomy.

Dataset	Description	Covered taxonomy dimensions
“Base centrale Scolarité – 2021” Education central data base (DEPP, 2021)	These data cover 99% of students in public and private secondary schools in France under the authority of the Ministry of National Education (metropolitan France and overseas departments). Students are enrolled at the beginning of the school year 2021-2022.	These data describe, on the one hand, the socio-demographic characteristics of students (age, gender, place of residence and geolocation, social origin, nationality) and, on the other hand, the school (administrative and geographical characteristics).
MicroTic2D Survey (DEPP, 2022)	Open data collecting information on the use of Information and Communication Technologies (ICT) for educational purposes at secondary level.	Describes technological equipment such as number of desktop computers, number of mobile devices, number of projectors and whether the institution benefited from the national digital plan 2015 ² .
DNMA (National Audience Measurement Disposal) (DEPP, 2023)	DNMA (open data) is an attendance monitoring system for digital working environments in educational institutions, based on an external marking solution.	Provides information on profiles of users of digital working environments (students, parents, teachers, administration), and the frequency and duration of use.
ARCHIPEL (DEPP, 2023)	Application for the research and selection of indicators for the management of schools	Private data providing information on teachers' status and seniority, age, gender, as well as their involvement in training programs.
ARCEP (ARCEP, 2023)	Open data produced from data provided by Internet service providers.	Provide information on fixed Internet broadband coverage and very high-speed broadband, as well as the technologies available.

Acknowledgement

This work is supported by the French Ministry of National Education and Youth (MENJ), Digital Education Division (DNE), within the program Digital Thematic Working Groups (GTNum) 2022-2025. We would like to

²] An education policy which aimed at increasing the rate of digital equipment in schools in France.

thank particularly Hugues Labarthe, Assistant to the Regional Academic Delegate for Digital Education, for his enriching contribution during the project.

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