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FROM DIGITAL DIVIDE TO EMERGING ALGORITHMIC EXCLUSION: BARRIERS TO ACCESS TO HIGHER EDUCATION AMONG ROMA COMMUNITIES IN BULGARIA

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This study examines how digital inequalities and the growing role of artificial intelligence (AI) shape barriers to access to higher education among Roma communities. It aims to identify the mechanisms through which limited digital resources, skill deficits, and increasingly algorithmically mediated systems may contribute to emerging forms of educational exclusion. The analysis is based on a qualitative research approach, drawing on in-depth interviews conducted with members of Roma communities from different types of settlements. The study focuses on access to technologies, the level of digital skills, autonomy in the use of digital resources, and the ability to navigate increasingly digitalised educational environments. The findings show that digital inequalities extend beyond limited access to technologies and encompass informational barriers, dependence on intermediaries, and difficulties in navigating complex digital systems. These factors combine into an accumulating mechanism of exclusion that reduces both the visibility of and the effective access to educational opportunities. In the context of artificial intelligence, these processes may acquire a new dimension, as access to information, services, and educational pathways is increasingly mediated through algorithmic and AI-based systems that require specific digital and AI-related competences. At the same time, the study identifies alternative pathways of inclusion, where higher levels of digital and AI competences, early access to technologies, and the presence of a supportive social environment enable participation in higher education. The findings contribute to the understanding of the transition from the digital divide to emerging algorithmic exclusion, highlighting how AI-mediated systems may become an additional mechanism of social stratification. The study underscores the need for integrated policies aimed at developing digital and AI skills, enhancing user autonomy, and addressing broader social inequalities that shape access to education.

Keywords*: digital divide; algorithmic exclusion; artificial intelligence; Roma communities; higher education; digital inequalities*.

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INTRODUCTION

In recent years, digital technologies have become a structural element of contemporary society, exerting a significant influence on access to education, employment, and social participation. In this context, the issue of the digital divide remains highly relevant. Initially, the concept was primarily associated with unequal access to the internet and digital devices; however, contemporary research has expanded its scope to include differences in levels of digital skills and patterns of technology use (van Dijk 2020; Helsper 2021). Earlier studies also demonstrate that digital inequalities cannot be reduced solely to access to technologies, but must be understood in relation to digital competences, usage practices, and the broader social context (Selwyn 2004; van Dijk and van Deursen 2014). In the context of increasing digitalisation and the growing use of artificial intelligence, these inequalities may acquire new dimensions. Algorithmically structured systems increasingly mediate access to information, services, and educational opportunities, with the potential to transform the mechanisms of social inclusion and exclusion. Within this context, digital competences become a key prerequisite not only for accessing resources but also for effective participation in digitally and algorithmically mediated educational environments. The concept of "algorithmic exclusion" has gained prominence, as a framework for understanding situations in which formally available opportunities may remain inaccessible due to the ways digital systems operate (Eubanks 2018; Noble 2018). Recent studies further highlight that the integration of generative artificial intelligence in education is transforming not only learning practices but also the conditions for access and participation, introducing new requirements for learners' digital competences (Batista, Mesquita, and Carnaz 2024; Belkina*et al.* 2025). Despite the growing scholarly interest in digital inequalities and their social implications, there is still limited understanding of how artificial intelligence and algorithmically mediated systems shape access to higher education, particularly among socially vulnerable groups. This gap is especially significant in the context of Roma communities in Bulgaria, which remain among the most disadvantaged groups in terms of access to education and digital resources. Limited educational attainment, unstable employment, and socio-economic marginalisation constrain opportunities for developing digital skills and for engaging in educational pathways (Stoilova and Haralampiev 2025; Katsarska 2023). Research in the context of Central and Eastern Europe also shows that digital inequalities are closely linked to structural socio-economic factors that reproduce the marginalisation of vulnerable groups (Barbovschi and Fizeşan 2013).

This study aims to examine how digital inequalities within Roma communities may create barriers to access to higher education in the context of the growing use of artificial intelligence. To address this question, the research is based on the analysis of in-depth interviews with members of Roma communities,

focusing on access to technologies, levels of digital skills, and the challenges encountered in their use. In doing so, the study seeks to provide a deeper understanding of the mechanisms through which existing digital inequalities may be transformed into barriers to educational mobility and access to higher education in an increasingly digital and algorithmically mediated environment. This study contributes to the existing literature in three main ways: first, it extends discussions of the digital divide by exploring the concept of emerging algorithmic exclusion; second, it provides qualitative evidence on digital and administrative conditions that may constrain access to higher education among Roma communities; and third, it examines how the growing use of AI-mediated systems may contribute to the reproduction of existing social inequalities in access to higher education.

THEORETICAL FRAMEWORK

Over the past decades, the digital divide has become a key concept for analysing social inequalities in the context of technological development. Classical approaches conceptualise it as a multi-layered process encompassing access to technologies, levels of digital skills, and the benefits derived from the use of digital resources (van Dijk 2005; Helsper 2021). In this sense, the digital divide is not limited to the availability of infrastructure, but also includes individuals' ability to use technologies effectively and to derive meaningful benefits from them. Contemporary research expands this perspective by emphasising that digital technologies function as a mechanism for reproducing broader social inequalities. In this context, Manuel Castells (2010) conceptualises digital networks as a fundamental structural element of contemporary society, simultaneously generating new opportunities and reinforcing existing disparities. Analyses by Tarleton Gillespie (2014) and David Beer (2017) draw attention to the role of algorithms as mechanisms that structure access to information and shape the visibility of content. Similarly, Kate Crawford (2021) conceptualises artificial intelligence as a system embedded in existing power and economic relations, raising concerns about the uneven distribution of technological benefits. In the context of increasing digitalisation and the growing implementation of artificial intelligence, classical models of the digital divide are further extended. The digital divide is no longer understood solely in terms of access and skills, but is increasingly discussed in relation to participation in algorithmically structured systems that mediate access to information, services, and opportunities. In this sense, artificial intelligence can be understood not only as a technological tool but also as a social mechanism that may influence how access to resources is structured and distributed. Research by Virginia Eubanks (2018) demonstrates that automated systems often reproduce existing social inequalities, particularly among vulnerable groups with limited access to resources. Similarly, SafiyaUmoja Noble (2018) shows that algorithms are not neutral, but rather reflect and amplify social and cultural biases. In a similar

vein, O'Neil (2016) argues that data-driven and algorithmic systems can reproduce structural inequalities, as they often rely on biased data and opaque decision-making processes that disproportionately disadvantage vulnerable groups. These studies provide an important theoretical foundation for discussions of algorithmic exclusion as a concept describing situations in which access to opportunities may remain formally open but be practically constrained by the ways digital systems operate. More recent research further develops this perspective, highlighting that algorithmic systems can reproduce inequalities if issues of fairness and bias in data and models are not adequately addressed (Mehrabi*et al.* 2021). In this study, however, it is important to distinguish algorithmic exclusion from digitalised administrative barriers. Difficulties in accessing online information, completing electronic forms, registering on institutional platforms, or submitting documents digitally constitute digital or administrative barriers in themselves and should not automatically be interpreted as algorithmic exclusion. Algorithmic exclusion refers more specifically to situations in which access to information, services, or opportunities is shaped by automated or algorithmically mediated processes, for example through the filtering, ranking, recommendation, or automated processing of information. The empirical material analysed here primarily documents digital and administrative barriers; the concept of emerging algorithmic exclusion is therefore used as an analytical perspective on how such existing inequalities may acquire an additional dimension as educational environments become increasingly mediated by algorithmic and AI-based systems. Within this context, artificial intelligence plays an increasingly significant role in educational processes. Access to information about education, applications to higher education institutions, and participation in educational programmes are increasingly supported and mediated through digital and AI-based platforms. This requires not only basic digital skills, but also more advanced competences related to navigating algorithmically structured environments. International organisationsemphasise the need to develop specific AI competences as a prerequisite for equitable participation in education, particularly in the context of the growing use of generative artificial intelligence (UNESCO 2023; UNESCO 2024).

At the same time, access to artificial intelligence is unevenly distributed. Reports by the OECD (2020) and the European Commission (2022) indicate that the use of AI-based technologies is strongly dependent on socio-economic status, level of education, and digital skills. As a result, individuals from vulnerable groups are less likely to use such tools, potentially leading to the emergence of a new dimension of the digital divide related to unequal access to AI resources and competences. Similar findings are reported in UNESCO (2023), Gatti*et al.*(2016), and European Union Agency for Fundamental Rights (2021), which highlight that vulnerable communities including Roma populations in Europe are among the most affected by these processes due to the accumulation of socio-economic and educational inequalities. In this sense, the digital divide and algorithmic exclusion

should not be analysed in isolation, but rather as interconnected dimensions of broader structural inequalities that may be reproduced and transformed in the context of increasing digitalisation and the expanding use of artificial intelligence.

METHODS

This study is based on a qualitative research approach, employing in-depth interviews with members of Roma communities. Qualitative methods are particularly suitable for examining social processes and subjective experiences related to digital inequalities, as they enable an in-depth understanding of individual practices and interpretations (Creswell 2013). In line with the theoretical framework, the study explores not only access to digital technologies and levels of digital skills, but also respondents' interactions with digital and algorithmically structured platforms, including their limited use of and perceptions regarding AI-based tools.

A total of 25 interviews were conducted in 2024. The selection of respondents followed an intersectional approach, aiming to capture diversity in terms of age, gender, educational level, employment status, and type of settlement. The sample includes participants from large cities, small towns, and rural areas, allowing for the identification of differences in digital practices across diverse socio-spatial contexts. It also includes respondents with varying levels of education, including individuals with primary or incomplete education, as these groups are particularly relevant for understanding structural barriers to access to higher education. The inclusion of respondents with lower levels of education enables the identification of early stages of educational exclusion and their connection to digital inequalities.

The interviews lasted between 40 and 60 minutes, depending on the participants' willingness to elaborate on their experiences and the complexity of the issues discussed. The analysis followed an iterative process involving repeated reading of the interview transcripts and successive coding in order to refine the thematic categories and ensure consistency in the interpretation of the data. Throughout the analytical process, the identified themes and categories were continuously compared across interviews. The analysis indicated that no substantially new themes emerged in the final interviews, suggesting that thematic saturation had been achieved.

The method of in-depth interviewing was chosen to explore in detail individual experiences, attitudes, and practices related to the use of digital technologies. The interviews were conducted using a semi-structured guide covering key thematic areas such as access to the internet, types of devices used, levels of digital skills, perceived benefits of digital technologies, as well as challenges and barriers encountered in their use. Particular attention was paid to the ways in which respondents interact with online platforms and digital services,

including processes such as information searching, registration, application procedures, and engagement with automated or algorithmically structured systems. This approach allows for the examination not only of traditional dimensions of the digital divide, but also of conditions that may contribute to emerging forms of algorithmic exclusion. The collected data were analysed using thematic analysis, which enables the identification of recurring patterns and differences in digital practices and their associated forms of social inclusion and exclusion (Braun and Clarke 2006). The analysis followed the six-phase approach proposed by Braun and Clarke (2006), including familiarisation with the data, initial coding, the development and refinement of themes, and the interpretation of the findings in relation to the study objectives. Special attention was given to the relationship between digital practices and educational opportunities, including potential barriers to access to higher education. In this context, the analysis also considers how limited digital skills and lack of experience with algorithmically mediated systems may hinder participation in educational processes that are increasingly structured through digital and AI-based platforms. Interview excerpts presented in the text are illustrative, while all interviews were included in the thematic analysis.

For the purposes of the analysis, respondents were assigned unique identifiers (R1–R25), which are used in the presentation of empirical data and interview excerpts. This facilitates the linkage between individual characteristics and observed patterns of digital practices.

Table no. 1

Characteristics of respondents and coding (N = 25)

Code	Gender	Age	Education	Employment Status	Type of Settlement	Internet Access
R1	Female	35	Primary	Unemployed	Rural area	Mobile only
R2	Female	68	Primary	Inactive	Rural area	Mobile only
R3	Male	19	Secondary	Self-employed (hairdresser)	Small town	Mobile only
R4	Female	48	Higher	Social worker	Large city	Mobile + fixed
R5	Female	30	Higher	Labour mediator	Small town	Mobile + fixed
R6	Male	26	Higher	Administration/activist	Large city	Mobile + fixed
R7	Female	36	No formal education	Unemployed	Small town	Mobile only
R8	Male	62	Secondary	Employed (industry)	Small town	Mobile
R9	Female	21	Secondary	Employed	Large city	Mobile
R10	Female	19	Secondary	Employed	Large city	Mobile
R11	Female	25	Secondary	Employed	Large city	Mobile
R12	Female	23	Secondary	Employed	Large city	Mobile
R13	Male	29	Primary	Employed	Large city	Mobile

				(construction)		
R14	Male	27	Secondary	Employed (taxi driver)	Large city	Mobile
R15	Female	40	Primary	Inactive	Rural area	Mobile only
R16	Male	50	Primary	Employed	Small town	Mobile
R17	Female	45	Secondary	Employed	Small town	Mobile
R18	Male	55	Primary	Employed	Rural area	Mobile only
R19	Female	33	Secondary	Employed	Small town	Mobile
R20	Male	38	Secondary	Employed	Large city	Mobile
R21	Female	60	Primary	Inactive	Rural area	Mobile only
R22	Male	42	Secondary	Employed	Small town	Mobile
R23	Female	31	Secondary	Employed	Large city	Mobile
R24	Male	24	Secondary	Employed	Large city	Mobile
R25	Female	52	Primary	Inactive	Rural area	Mobile only

Source: Author's own elaboration.
Note: Internet access was classified into three categories: "Mobile only" (access exclusively through a mobile phone), "Mobile" (access through mobile Internet using one or more mobile devices, without a fixed broadband connection), and "Mobile + fixed" (access through both mobile Internet and a fixed broadband connection).

The interviews were conducted in Bulgarian, and the excerpts quoted in the manuscript were translated into English by the author, with particular attention to preserving the meaning of the participants' statements. Participants were recruited with the assistance of informal Roma community leaders in the respective settlements. Formal ethical approval was not obtained for this non-interventional qualitative study. Participation was voluntary, all participants were adults, and informed consent was obtained prior to the interviews. Anonymity and confidentiality were ensured throughout the research process.

RESULTS

The analysis of the in-depth interviews reveals several interrelated dimensions of digital inequalities that shape access to higher education among Roma communities. These include limited access to digital technologies, low levels of digital skills, dependence on intermediaries, the influence of broader social and structural factors, as well as the increasingly visible role of artificial intelligence and algorithmically structured digital environments. Taken together, these dimensions do not operate in isolation but form an accumulating mechanism that constrains educational opportunities in the context of increasing digitalisation and the expanding use of AI-based tools. The following subsections examine these processes in greater detail.

Limited Access to Technologies as a Primary Barrier

One of the main factors shaping digital inequalities among Roma communities is limited access to digital technologies and the internet. The

interview data show that some respondents rely exclusively on mobile devices and mobile internet, which substantially restricts their ability to engage in more complex activities related to education and learning.

• *"I only have a phone, I don't have a computer. I do everything on my phone, but it's difficult, not everything opens properly. When something more complicated comes up, I can't manage" (R1);*

• *"I don't have a laptop or anything like that, I only use my phone. It's fine for basic things, but when you have to do something more serious, it doesn't work. I also don't know how to do it, because I've never used a computer" (R15);*

• *"I have mobile internet. I don't have a fixed connection… Here in the neighbourhood, very few people work with computers. Everyone has a phone and that's enough" (R3).*

These accounts point to a specific pattern of "limited mobile access", in which digital participation is possible only in its most basic form. Although smartphones provide a certain level of connectivity, they do not compensate for the lack of a computer, particularly when it comes to activities such as completing forms, working with documents, registering on platforms, or participating in online educational processes. Similar limitations are also evident in access to educational resources, which often require a computer and a stable internet connection. The lack of an appropriate device makes it difficult to participate in online courses, submit applications, and use university platforms, placing respondents at a disadvantage from the very early stages of the educational process.

• *"You can't do everything on a phone; some things simply cannot be done. If you have to fill something in or apply somewhere, you need a computer. I don't have one and there's nowhere I can use one" (R21);*

• *"When you have to go into certain websites or register somewhere, it's very difficult on the phone. Sometimes the pages don't open properly. That discourages me from dealing with such things" (R7).*

This pattern is observed not only in rural areas but also in urban contexts, suggesting that the issue is not solely territorial, but also related to how technologies are used, perceived, and integrated into everyday practices. As a result, a limited digital horizon is formed, within which access to more complex educational activities remains significantly constrained. In addition, the quality of internet connectivity emerges as an additional factor, particularly in smaller settlements, where unstable access creates further barriers to the use of online resources and services.

• *"The internet here is weak, it keeps disconnecting. Sometimes I can't open anything, let alone watch something longer or study. If you have to join something online, it's simply not possible" (R2);*

• *"In the village, the connection is not good, it often stops. When you're watching something, it cuts off and you have to start again. That makes everything much more difficult, especially if you want to write some kind of project" (R18);*

• *"For example, in a village 15 km from Kotel – the village of Gradets, the largest Roma village in Bulgaria, with over 5,000 residents and now even more than 6,000, in one part of the village, since it is very close to the forest, there is no signal at all, no coverage. There are no mobile operators there and there is no way to participate in online learning, even with an optical cable, because there is simply no coverage" (R21).*

In this sense, limited access to technologies emerges as a primary barrier that restricts not only participation in the digital environment, but also access to educational opportunities, including higher education.

Low Levels of Digital Skills as a Barrier to Educational Inclusion

Alongside limited access to technologies, a key factor in the reproduction of digital inequalities is the low level of digital skills. The data show that even when devices and internet access are available, some respondents experience difficulties in using digital platforms and services. This limits their ability to participate independently in digital environments, including educational processes.

• *"I can use my phone for basic things, but when I have to do something more complicated, I get confused. I don't know where to click or what to do. That's why I avoid such things" (R7);*

• *"I'm not used to using the internet for more serious things. If I have to search for information or fill something in, I worry that I might make a mistake. That's why I prefer someone else to do it for me" (R21);*

• *"My phone skills are good… but I can't manage on a computer… we learned in school, but I've forgotten everything… now I don't need it" (R3).*

These examples clearly illustrate the distinction between basic and more advanced digital skills. While respondents demonstrate a certain level of confidence in using mobile applications, the lack of competencies for working with computers limits their ability to engage in activities that require a higher level of digital literacy. This is particularly evident in tasks such as searching for information, registering on platforms, and completing online forms.

Low levels of digital skills are also associated with limited confidence in using technologies, which often leads to the avoidance of more complex tasks and a reluctance to act independently.

• *"When I don't understand something, I just give up. It's not easy for me to learn on my own because there's no one to show me. So I just stick to what I already know" (R12);*

• *"Everything new is difficult for me, especially on the phone. If someone showed me, maybe I would learn, but on my own I can't. That stops me from trying new things" (R15).*

In this way, formally available access to resources remains practically constrained by deficits in competencies. This points to an important analytical conclusion: access to technology in itself does not guarantee meaningful participation in digitally mediated educational processes if it is not accompanied by sufficiently developed functional skills and confidence.

Structural and Social Constraints Shaping Educational Aspirations

Beyond digital factors, the findings indicate that educational aspirations and opportunities are shaped by an interaction between family trajectories, economic constraints, social expectations, and broader structural inequalities. The patterns identified in the interviews should therefore not be interpreted primarily as cultural characteristics of Roma communities, but situated within persistent inequalities in education and material conditions. Recent data from the European Union Agency for Fundamental Rights (FRA) Roma Survey 2024 illustrate this structural context in Bulgaria: 42% of Roma aged 20–24 had completed at least upper-secondary education, while 70% of Roma children attended schools in which all or most pupils were Roma. At the same time, 53% of Roma in Bulgaria were at risk of poverty (FRA 2025). Against this structural background, early family formation, early labour-market participation, and limited access to educational role models may interact to narrow the perceived feasibility of continuing into higher education.

• *"Girls in our community get married early. When they turn 16–17, they already think about starting a family, not about school. After that, it's too late to go back and study" (R15);*

• *"I'm 19 and I already have a child. I can't think about university, I have to take care of my family. That's more important, even though I've always wanted to study higher education. It would give me the opportunity to find a good job" (R10).*

These intersecting family, economic, and social constraints may contribute to interruptions in educational trajectories at an early stage, thereby limiting

opportunities for progression to higher education. The interviews also indicate that early entry into the labour market, including informal employment, may further shift priorities away from continued education.

• *"I started working early because I had to help at home. School stayed in the background. I've never even thought about university" (R13);*

• *"In our community, the focus is on earning income, not on studying for a long time. If you work, that's more important than diplomas" (R8);*

• *"I work as a hairdresser… I have my own clients, they come to me… I like what I do… for me, that's the most important thing" (R3).*

In addition, some interviews highlight the limited availability of educational role models and supportive environments that could encourage the continuation of education. Respondents describe social contexts in which higher education is relatively uncommon, which may constrain the perceived feasibility of pursuing a university education and reduce expectations of educational mobility.

• *"There are no people around me who have studied at university. I've never seen something like that and I don't know how it works. It feels very distant to me" (R7);*

• *"No one in my family has higher education. That's why I've never thought in that direction. It's not something that is expected from us" (R22).*

In this sense, access to higher education appears as the result of the interaction between technological, economic, social, and structural conditions, rather than solely the presence or absence of resources. This highlights that digital inequalities are embedded within a broader system of structural constraints that shape educational choices and life trajectories.

Dependence on Intermediaries

Dependence on intermediaries emerges as a significant barrier in the context of access to educational opportunities that require individual initiative and autonomous interaction with digital platforms. Processes such as applying to universities, registering in institutional systems, or participating in online learning environments presuppose a certain level of autonomy, which is often lacking in this case. As a result, even when interest is present, respondents encounter difficulties in taking concrete steps.

• *"If I have to apply somewhere, I can't do it on my own. Someone has to sit with me and do it. Otherwise, I won't manage. I feel a bit anxious, especially when I have to upload a document in a digital environment" (R15);*

• *"When something more complicated comes up, I wait for someone to help me. If there's no one, I simply don't do it. That way, I miss out on many things" (R7).*

Beyond these practical limitations, dependence on others also creates a sense of insecurity and lack of control over one's own actions in the digital environment. This reduces motivation to engage in activities that require independence and confidence.

• *"I don't feel confident doing things on my own. I always think I'll make a mistake. That's why I prefer someone else to do it" (R2);*

• *"If there's no one to help, I just don't bother. It's easier that way than struggling and not succeeding" (R18).*

In the context of the growing role of digital platforms and artificial intelligence in education, this dependence becomes even more significant, as participation in higher education increasingly requires not only basic skills but also the ability to navigate digital systems independently, follow sequential steps, and make decisions in environments that do not provide direct human support.

Alternative Pathways: Digital Competence and Access to Higher Education

Alongside the identified constraints, the in-depth interview data also reveal the existence of alternative educational pathways through which access to higher education becomes possible. These cases are associated with higher levels of digital skills, earlier access to technologies, and the presence of a supportive environment. They demonstrate that, under certain conditions, digital resources can function as a tool for educational mobility rather than a barrier. Respondents with higher education clearly emphasise the importance of digital competences as a key factor for both educational and professional realisation. In contrast to other participants, they demonstrate a high degree of autonomy and confidence in working with technologies, as well as the ability to independently search for and process information.

• *"I have constant access to the internet—both mobile and fixed. I use a computer, phone, and tablet every day, mainly for work—writing documents, emails, checking information. Everything in my work is connected to the internet, and it simply cannot function without it" (R4);*

• *"I started using the internet already in school because I needed it for preparation. At first, I had difficulties, but gradually I learned—both from teachers and on my own. Later, at university, it's unthinkable without the internet and a computer. There's no way to prepare without them. Now I can confidently work with different programmes and manage on my own" (R6).*

In these cases, digital skills are not merely technical competences, but a resource that enables the accumulation of knowledge and participation in educational and professional processes. Participants with higher levels of education actively use the internet for self-learning, participation in training, and professional development, which further expands their opportunities.

• *"I constantly look for opportunities to develop myself, including through online courses. If I have a problem with something, I search for information and learn on my own. This helps me both at work and in life" (R5);*

• *"Nowadays it is impossible to work without digital skills. They are necessary to find a job and to develop. At the very least, you need them to apply and prepare documents" (R4).*

The contrast between these respondents and participants with lower levels of education shows that digital inequalities are not merely a matter of access, but are closely linked to educational trajectories and the social environment. While for some individuals digital technologies function as a resource for development, for others they remain limited to basic use or are not utilised for educational purposes at all.

Digital Administrative and Informational Barriers to Access to Higher Education

The interview findings show that digital inequalities are not limited to a lack of access or insufficient skills. They also manifest through more subtle barriers related to the ways in which digital systems organise access to services and information. In the context of increasing digitalisation, many educational processes—such as applications, registration, and information searching—are carried out through online platforms and automated systems. This requires specific skills, confidence, and the ability to navigate sequential and often non-intuitive procedures. Several respondents describe difficulties in interacting with digital platforms that require step-by-step processes, form completion, and engagement with multiple interfaces.

• *"When I enter a website and have to fill things in, I get confused. There are many steps and I don't know what is important. Sometimes I give up right at the beginning" (R7);*

• *"There are many things you have to do one after another. If you make a mistake somewhere, you don't know how to go back. That worries me and I avoid such websites. Also, I still have difficulties using an electronic signature. It requires quite a lot of knowledge" (R15);*

• *"When I have to fill something in online, I'm not sure how to do it. There are many fields and I don't know which ones are important. That's why I often give up" (R20).*

These cases illustrate how digitalised administrative and educational processes can become a barrier already at the stage of access. Although opportunities are formally available, effective participation requires skills, confidence, and experience that not all respondents possess. Some interviews also reveal a psychological dimension of this exclusion, related to fear of making mistakes and lack of confidence.

• *"I'm afraid of making a mistake on the internet. If I do something wrong, I don't know how to fix it. That's why I avoid doing such things" (R11).*

In addition, respondents often lack sufficient information about existing opportunities, as access to such information is itself digitally mediated.

• *"I don't know where to look for information about universities. There are many things on the internet, but what I need doesn't come up. Sometimes I don't even know what exactly to type" (R1);*

• *"No one has shown me how to look for such things. If it doesn't appear by chance, there's no way to find out. I haven't come across information about universities" (R21).*

• *"When I search for something, many different things come up and I get confused. I don't know what is correct and what is important. That's why I often give up" (R24).*

In this way, digitalised administrative and informational processes may create additional barriers at an early stage, potentially constraining individuals' ability to identify and pursue educational opportunities.

Artificial Intelligence as a New Dimension of Educational Inequality

An additional dimension of digital inequalities that becomes particularly visible in the context of the growing role of artificial intelligence is related to the limited use of and unequal access to AI-based tools. The interview data indicate that 15 of the 25 respondents were either unfamiliar with or did not use AI-based tools, with their interaction with the digital environment remaining largely confined to basic digital functions. At the same time, participants with higher levels of education and more advanced digital skills report experience in using AI tools for writing texts, searching for information, and preparing documents. These findings suggest the emergence of a potential new dimension of inequality, in which access to artificial intelligence may become a resource for educational

development, yet remains limited for certain socially vulnerable groups. In this sense, the lack of knowledge, skills, and financial resources required to use AI tools may create an additional barrier to engaging with educational opportunities in increasingly digitalised environments. This lack of familiarity with AI technologies is illustrated by the following statement:

• *"I have heard people mention ChatGPT several times, but I don't really know what it is or how it works. I have never used anything like that because I don't know how to access it or what I would do with it." (R12).*

Beyond limited awareness and digital skills, another important barrier is related to the economic accessibility of such technologies. Some contemporary AI tools used for learning, writing, project development, and document preparation require paid access or subscription-based models.

• *"I know these tools can be very helpful—especially when you're writing projects or documents. But most of them require a paid subscription, and not everyone can afford that every month" (R4);*

• *"I have used such programmes and I see how much they facilitate the work, but without the paid version the possibilities are limited. This puts people with fewer resources at a disadvantage" (R5).*

These findings suggest a potential new type of barrier, whereby access to artificial intelligence itself may become a factor in the reproduction of educational inequalities. While earlier stages of inequality are associated with access to devices, internet connectivity, and basic skills, the rapid integration of AI into education may introduce an additional layer of differentiation, linked to the ability to use intelligent tools as a resource for learning, self-organisation, and institutional navigation.

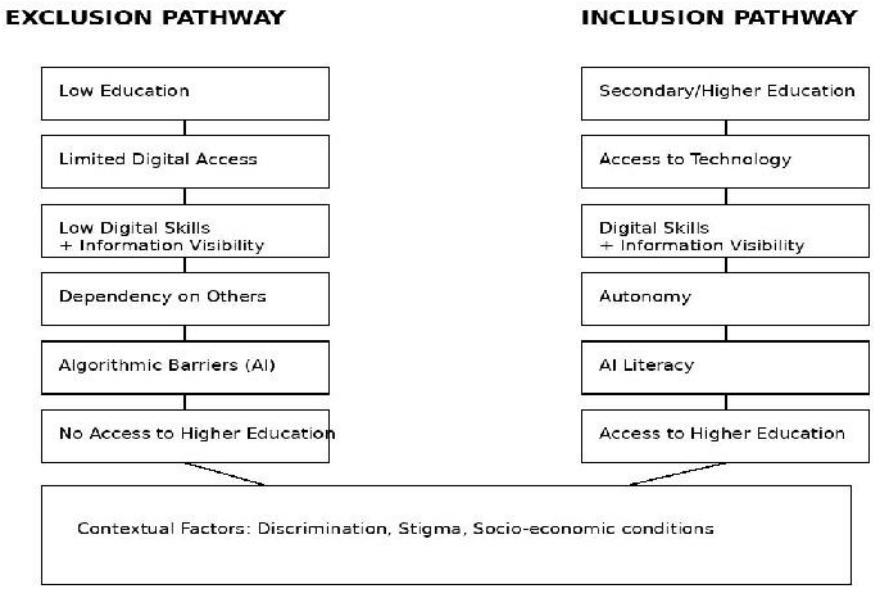
Accumulation of Inequalities and Patterns of Educational Exclusion

The shared experiences suggest that barriers to access to higher education among Roma communities do not operate as isolated factors, but rather reflect the accumulation of interrelated inequalities. Limited access to technologies, deficits in digital skills, dependence on intermediaries, and broader social and structural constraints do not act independently; instead, they combine into persistent patterns that hinder educational mobility. In many cases, the lack of access to devices and stable internet connectivity is combined with limited digital competences, leading to low levels of autonomy in the use of technologies. This, in turn, creates dependence on others and restricts the ability to participate independently in digitally mediated processes. These factors are further reinforced by early family formation, the economic necessity of early labour market participation, the absence

of educational role models, and the limited visibility of educational opportunities. Algorithmically structured systems, through which access to information and services is increasingly organised, may further complicate this process, as they require a certain level of literacy and autonomy. For respondents who lack these resources, formally available opportunities—including access to higher education—may remain practically inaccessible. In the context of the expanding use of artificial intelligence, this process may be further intensified, as existing limitations are compounded by unequal access to AI tools and the competences required to use them. At the same time, the presence of alternative pathways associated with higher levels of education and more advanced digital skills indicates that these processes are not inevitable. The contrast between different groups of respondents suggests the importance of digital competence, social support, and the educational environment as key factors in overcoming inequalities. In this sense, access to higher education emerges not merely as a matter of individual choice, but as the outcome of structurally conditioned differences that are reproduced and amplified in the context of the growing role of artificial intelligence. Figure 1 illustrates the contrasting pathways of exclusion and inclusion, showing how digital access, skills, and AI-related competences shape opportunities for higher education.

Figure no. 1

Model of educational inclusion and exclusion pathways



Source: Author's own elaboration.

DISCUSSION

This study contributes to ongoing debates on the digital divide by demonstrating that, in the context of increasing digitalisation and the expanding use of artificial intelligence, these inequalities may acquire new and more complex dimensions. Classical theoretical approaches to the multi-layered nature of the digital divide (van Dijk 2005; Helsper 2021) are extended by the understanding that, in the contemporary context, it may evolve into a process of cumulative exclusion. This process may encompass not only access to technologies and levels of digital skills, but also the ability to participate in digitally mediated and, in some cases, algorithmically structured social and educational systems. The findings indicate that limited access to technologies, deficits in digital skills, and dependence on intermediaries should not be viewed as isolated barriers. Instead, they intersect with broader social and structural constraints, including early family formation, economic pressure, and the absence of educational role models, thereby contributing to persistent mechanisms of exclusion. In this sense, the digital divide is embedded within broader processes of social stratification (DiMaggio and Hargittai 2001; Robinson *et al.* 2015), in which technological inequalities are intertwined with social and economic disparities. Particular significance can be attributed to the "hidden" forms of exclusion associated with the ways in which digital platforms and algorithms structure access to information and services. Such processes have been examined in the work of Eubanks (2018) and Noble (2018), who demonstrate that automated systems can reproduce and intensify existing inequalities. In this study, difficulties in navigating digital platforms, completing online forms, using electronic signatures, and locating relevant information are understood primarily as digitalised administrative and informational barriers rather than as direct manifestations of algorithmic exclusion. However, as access to educational information and services becomes increasingly mediated by automated and algorithmic systems, these existing barriers may interact with algorithmic processes and contribute to emerging forms of exclusion. This is especially relevant in the context of higher education, where access to application procedures, administrative processes, and educational resources is increasingly mediated through digital and algorithmic systems. The findings suggest that the identified barriers combine into a sequential mechanism that constrains access to higher education. More specifically, the findings show that digital inequalities affect access to higher education at several critical stages of the educational pathway. Limited digital skills and restricted access to technologies reduce the ability to search for information about higher education programmes, complete online application procedures, prepare the required documentation, and communicate effectively with educational institutions. These barriers do not necessarily prevent participation directly, but they may substantially reduce the likelihood of successfully entering higher education, particularly for socially vulnerable young

people. Limited access to devices and internet connectivity hinders initial engagement with educational information and opportunities, while low levels of digital skills impede the understanding and effective use of available resources. This, in turn, leads to dependence on intermediaries and reduces autonomy in taking concrete actions. The complexity of digital and algorithmically structured platforms may introduce additional points of difficulty at early stages of accessing educational information and opportunities. These challenges are further compounded by economic constraints related to access to more advanced digital and AI-based tools used for preparing documents, projects, and applications. In this context, access to higher education cannot be understood solely as the formal availability of opportunities. Rather, it depends significantly on the accumulation of resources, skills, and confidence required for participation in digital environments. This observation highlights the importance of developing "AI literacy" as a key component of educational preparation (Stracke *et al.* 2025), as well as the need for a broader integration of digital skills into educational policies. The present findings align with broader research indicating that the integration of generative artificial intelligence into higher education can simultaneously create new opportunities and deepen existing inequalities, depending on the level of digital and AI literacy (Al-Emran *et al.* 2025; Zhou and Fang 2025). These findings also underscore the importance of institutional support throughout the educational pathway. Schools, universities, and community-based organisations can play a crucial role in assisting young people in navigating increasingly digitalised educational systems by providing guidance on application procedures, access to digital resources, and opportunities to develop digital and AI competences. Such support may help reduce barriers associated with digital inequalities and facilitate more equitable access to higher education. At the same time, the existence of alternative educational pathways suggests that these processes are not deterministic. Where higher levels of digital skills, earlier access to technologies, and supportive social environments are present, digital tools can function as resources for social mobility and inclusion. This highlights the importance of targeted interventions that combine the development of digital competences, support for navigating educational systems, and the reduction of social barriers that constrain educational opportunities. An additional emerging dimension of digital inequalities relates to the economic accessibility of artificial intelligence. Many contemporary AI tools used for learning, writing, and project development operate on the basis of paid subscriptions or limited free access. This may create a new type of barrier, whereby participation in educational and professional processes depends not only on digital skills but also on financial resources. In this sense, inequalities in access to artificial intelligence may be understood within broader debates on digitally mediated forms of power and algorithmic governance, where unequal access to digital resources may reinforce existing social inequalities (Gillespie 2014; Beer 2017).

More broadly, the findings suggest that the digital divide in the age of artificial intelligence may increasingly be interpreted through the lens of emerging algorithmic exclusion, characterised by the accumulation of technological, social, economic, and structural barriers that may limit access to education and opportunities for development. This underscores the need for an integrated approach that combines improved access to technologies, the development of digital and AI competences, and the addressing of broader social inequalities.

This study also has certain limitations. The qualitative research design and the relatively small number of interview participants do not allow for generalisation of the findings to wider populations. Additionally, the focus on Roma communities in Bulgaria limits the direct transferability of the results to other national and social contexts. At the same time, the study does not include quantitative measurements of the examined processes, which opens avenues for future research. A further limitation concerns the relationship between the empirical findings and access to higher education. None of the participants was actively navigating a higher education application process at the time of the interviews. Consequently, the links drawn between the identified digital and administrative barriers and access to higher education are largely inferential, based on participants' broader experiences of navigating digital environments and institutional procedures rather than on direct observation of barriers encountered during university application. The findings should therefore be interpreted as identifying conditions that may constrain access to higher education, rather than as direct evidence of exclusion from a specific application process. Nevertheless, the analysis provides an in-depth understanding of the interplay between digital inequalities, algorithmic exclusion, and access to higher education.

CONCLUSIONS

This study suggests that digital inequalities among Roma communities extend beyond the issue of access to technologies and constitute a multi-layered phenomenon encompassing digital skills, autonomy in the use of digital resources, and broader social and structural conditions. The findings indicate that limited access to devices and internet connectivity, deficits in digital competences, and dependence on intermediaries intersect with family, economic, and structural constraints, including early family formation, economic pressure, and limited educational expectations. Together, these factors may contribute to persistent patterns of educational exclusion.

In the context of increasing digitalisation and the expanding use of artificial intelligence, these inequalities may acquire an additional dimension that can be analytically understood as emerging algorithmic exclusion when access to information, services, and educational opportunities becomes shaped by automated or algorithmically mediated processes. Access to education, including higher

education, is increasingly mediated through digitalised and, in some cases, algorithmically structured systems, which impose additional requirements on individuals. In the absence of the necessary resources, skills, confidence, and AI competences, formally available opportunities may remain practically inaccessible for segments of socially vulnerable groups. In this sense, artificial intelligence should be understood not only as a technological context of change, but also as a new mechanism through which existing inequalities may be reproduced and intensified. At the same time, the presence of successful educational trajectories among some respondents demonstrates that these processes are not inevitable. Digital skills, access to technologies, the early accumulation of competences, and a supportive social environment can become key factors in overcoming inequalities and promoting educational mobility. This underscores the need for targeted policies aimed not only at improving infrastructural access to technologies, but also at developing digital and AI competences, creating supportive educational environments, and facilitating effective access to higher education for socially vulnerable groups. In this way, the study contributes to a broader understanding of emerging forms of social inequality in the age of artificial intelligence by showing that educational inclusion depends not only on the formal availability of opportunities, but also on the capacity of different social groups to recognise, access, and utilise them. It is precisely here that the wider contribution of the study becomes evident. More broadly, the study suggests that the transition from the digital divide towards emerging algorithmic exclusion represents a useful analytical perspective for understanding how digital transformation may shape access to education and opportunities for social mobility.

Use of Artificial Intelligence

During the preparation of this manuscript, the author used ChatGPT (OpenAI) exclusively for language editing, stylistic refinement, and improvement of readability. The AI tool was not used for data collection, data analysis, interpretation of findings, or generation of scientific conclusions. All AI-assisted output was carefully reviewed and edited by the author, who retains full responsibility for the accuracy, originality, integrity, and scientific content of the manuscript.

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Acest studio analizează modul în care inegalitățile digitale și rolul tot mai important al inteligenței artificiale (AI) modelează barierele de acces la învățământul superior în rândul comunităților rome. Scopul cercetării este de a identifica mecanismele prin care resursele digitale limitate, deficitul de competențe și sistemele din ce în ce mai mediate algoritmic pot contribui la forme emergente de excluziune educațională. Analiza se bazează pe o abordare calitativă, utilizând interviuri în profunzime realizate cu membri ai comunităților rome din diferite tipuri de localități. Studiul se concentrează asupra accesului la tehnologii, nivelului icompetențelor digitale, autonomiei în utilizarea resurselor digitale și capacității de a naviga pe platforme online și în medii structurate algoritmic. Rezultatele arată că inegalitățile digitale depășesc simplul acces limitat la tehnologii și include bariere informaționale, dependența de intermediary și dificultăți în utilizarea sistemelor digitale complexe. Acești factori se combină într-un mechanism cumulativ de excluziune care reduce atât vizibilitatea, cât și accesule fectiv la oportunitățile educaționale. În contextual inteligenței artificiale, aceste procese pot capătă o nouă dimensiune, întrucât accesul la

informații, servicii și traiectorii educaționale este din ce în ce mai mediat de sisteme algoritmice și bazate pe AI, care necesită competențe digitale și competențe specifice în utilizarea AI. În același timp, studiul identifică traiectorii alternative de incluziune, în care niveluri mai ridicate de competențe digitale și AI, accesul timpuriu la tehnologii și existența unui mediu social favorabil facilitează participarea la învățământul superior. Rezultatele contribuie la înțelegerea tranziției de la decalajul digital la excluderea algoritmică, emergentă, evidențiind modul în care sistemele mediate de AI pot devein un mechanism suplimentar al stratificării sociale. Studiul subliniază necesitatea unor politici integrate orientate spre dezvoltarea competențelor digitale și AI, consolidarea autonomiei utilizatorilor și reducerea inegalităților sociale mai largi care influențează accesul la educație.

***Cuvinte-cheie**: decalaj digital; excludere algoritmică; inteligență artificială; comunități rome; învățământ superior; inegalități digitale.*

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