Equity Issues derived from Use of Large Language Models in Education

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Abstract. One of the emerging challenges in Education refers to diversity. Existing differences in a classroom can be a source of wealth and beauty. But they can also be a source of tensions that can generate conflicts. These conflicts are directly associated with the existence of privilege deriving from these differences. One source of these privileges can be provoked by the emerging new media. They can increase what is called the digital divide, challenging the educational stakeholders to promote an equitable and fairer learning environment. We will discuss in this essay some dimensions of the digital divide that can emerge from the called large language models (LLM, e.g., ChatGPT) in computing education. Issues concern not only plagiarism problems but also another level of digital literacy, referred to as lifelong learning competencies. Part of the domain of these competencies will require a level of mediatization through LLMs, leading us to understand another kind of literacy: the prompt literacy (concerning the ability to interact appropriately via prompt with LLM).

Keywords: Equity · Large Language Models · Computing Education.

1 Introduction

The differences can be a source of wealth and tension. These tensions can originate conflicts that, in turn, can directly be related to privilege [38]. One source of this privilege can arise due to the so-called new media [8]. ChatGPT, Bard, and Midjourney are examples of emergent new media classified as large language models (LLM) [30,22] according to how their algorithms are built.

The digital divide [13,52] existing due to the emergence of new media affects the educational environment, specifically when we consider the LLM impacts. Thus, this work discusses large language models (LLM) as a new media and their equity impacts. We will defend that there is a LLM divide. This affects education in a general way but brings a specific agenda for Computing Education at all teaching levels.

Computing Education became a global agenda due to the pervasiveness of Computing Literacy [18]. This literacy is part of the leading digital competencies necessary to form a democratic citizen in the 21st century [25], bringing many challenges to its implementation [15]. Several national curricula have been proposed to provide a solid foundation for computing literacy since the early years of school [47,41,14], encompassing all levels of education.

The remainder of this paper is as follows. Section 2 presents the concept of the digital divide. Section 3 defines what LLM is and offers some practical uses and challenges from an educational perspective. Section 4 delineates the arising of prompt literacy from web access to the current uses of search engines. Section 5 structures what we define as LLM divide from the theoretical basis of the capabilities approach. And, at last, Section 7 points out the final remarks and future perspectives.

2 Digital Divide

Digital divide is the existing abyss between the people with ready access to information and communication technology (ICT) tools (and, as a consequence, the knowledge provided by them), and those without such access or skills [13]. We present as follows the more common barriers to ICT use (Section 2.1), the potential mitigation actions for the digital divide problem (Section 2.2), and elements to signalize the subjacent structural problem as its roots (Section 2.3).

2.1 Barriers to ICT use

There is a list of barriers that can limit or even prevent ICT use. Physical access can be a barrier when the necessary infrastructure is not guaranteed for ICT use. Let us see a Latin American context. The IBGE[4] conducted a national survey in 2018 relating to the ICT theme. This survey revealed that one in four Brazilian people does not have internet access. Suppose we admit that a fraction of these Brazilians who do not have internet access were composed of students. What would be the impact of this reality on their formation quality? What would be the difference in the formation of these students concerning computing literacy relating to other ones? Physical access can provoke a social abyss in educational contexts.

Although physical access is essential, it is not the only one. The lack of ICT skills also matters because those who access ICT and cannot use it are limited and unable to enjoy it fully. Computing literacy is another essential step in tackling the digital divide. One student that can appropriately explore a web search engine has better conditions to enrich your learning than others cannot.

Another barrier refers to the attitudinal dimension. Misconceptions about who can have intellectual conditions to use ICT are related to this barrier. Erroneous assumptions like “Computers are for ‘brainy’ people”, “Computers are for

[4] IBGE stands for Brazilian Institute of Geography and Statistics.

males", or even "Computers are for young people" can restrict the disposition to ICT use. Self-efficacy is the general umbrella for this attitudinal barrier and refers to the person's belief in their ability to achieve a goal. Studies explore the self-efficacy impact on digital literacy in both students and teachers [39,19,1].

And the last barrier we point out here concerns content. A fear might exist related to the content of what is accessed and consumed in ICT. People are afraid to expose themselves to the content (e.g., threat feeling) or do not think this content is essential (e.g., irrelevance). The emergence of misinformation can provoke a reverse movement concerning the quality of content, affecting the appropriate use of ICT. The preference for misinformation instead of reasonable content is dangerous to a curriculum that promotes citizens' formation. A desirable curriculum for computing literacy should focus on the ability to discriminate and judge the quality of information sources. It is necessary to realize the potential that misinformation can have to destroy the democratic basis of society.

2.2 Potential Mitigation Actions

As an attempt to alleviate the digital divide, we can present potential mitigation actions. Each action refers to a previously discussed barrier that diverse social actors can address.

Concerning physical access, it is possible to promote incentives for organizations to pass on ICT devices to school institutions or non-government organizations (NGO), for instance. Sometimes, a tool can not be a cutting-edge technology for a large organization but can make a difference at lesser institutions. Private organizations could receive tax incentives, and public organizations could earn vouchers to use in future acquisitions of ICT devices. In this case, public policy is strategic.

Related to the skill barrier, it is possible to promote initiatives to form new teachers about ICT use. Actions related to teacher formation are not only necessary for the new ones (usually conducted by colleges and universities). Due to constant ICT evolution, it urges to guarantee a continued pedagogical preparation for these changes to all educational staff. For example, the New Media Pedagogy Conference plays a significant role in providing directions about how stakeholders in K-12 and university education can effectively use the so-called new media. NGOs can also gather the interests of civil society in this direction.

By dealing with the attitudinal barrier, we can promote technology communities of practice. In these spaces, tackling the bounding beliefs in a safer environment is possible, forging a sense of belonging among their members. In Brazil, the *Escola de Games* [28] promotes a partnership between universities and schools aiming to teach computing through digital game building. Data extracted from the pre-tests of this project indicated that various high school students did not believe in your capacity to build a computing game. Undergraduate tutors and high schoolers formed a solid belonging network, paving a new way to learn computing and weakening bounding beliefs.

And, at last, by tackling the content barrier, we can foster innovative ICT use and creation for and with minoritized communities. The strangeness concerning

ICT use can be higher in native and traditional communities (e.g., indigenous, *quilombolas* [36]). Allowing them not only to use an ICT tool but also to create it is a good strategy. The building of electronic textiles from US indigenous [29] and the participatory design of computing artifacts with rural students [37] are examples of reducing the digital divide by counting on the active action of these communities.

2.3 A Structural Problem

We previously discussed potential mitigation actions (and not "solutions" as Cullen asserts [13]). The reason for this expression choice concerns the structural nature of the problem. The structure of capitalism provides the possibility for a digital divide. This economic system defends the concept of a free market, encouraging all "players" to compete among themselves in pursuing profit maximization. Thus, in a competitiveness scenario, each player will look for what is called a competitive edge, aiming to be more attractive to their potential consumers.

Precisely at this moment, ICT plays a crucial role for players, serving as a competitive edge. ICT research and development investments increase the chance of some players providing the same service or product faster or more efficiently (or even disrupting a new service/product through an ICT innovation [9,16]). In this perspective, new technologies will always exist and will be dominated by some players, becoming ICT as a strategic factor and also a business secret, for instance.

Thus, the democratization of technology is associated with the obsolescence of the strategic ICT of these players (e.g., large corporations, public and private organizations). In this perspective, it is not a primary concern to establish a set of educational technologies as a common good. This concern is important but secondary in our economic system. There is also a reflex of this player competition in a micro dimension among people in our society, bearing in mind that each 'individual" needs to improve their curriculum to increase their attractiveness for the so-called labor market. Unterhalter [49] describes the theoretical and historical roots of this discussion, presenting the human capital theory.

3 Large Language Models

LLM stands for large language models. They are "trained on massive amounts of text data and are able to generate human-like text, answer questions, and complete other language-related tasks with high accuracy" [30]. LLMs allow people to interact with computers in a more natural and conversational way compared with search engines (e.g., Google). Beyond this capacity, most LLMs use a large volume of data from the internet as raw material to generate their answers. This answer generation results from using sophisticated algorithms of artificial intelligence (AI), providing outputs to final users with a considerable degree of originality.

There is a huge quantity of LLM tools today, but we can highlight ChatGPT, BERT, and Bard[5]. For materializing this technology use, we asked to ChatGPT the following prompt: "Critique my short story: ⟨Ugly-Duckling⟩" . ⟨Ugly-Duckling⟩ stands for a summary composed of a single paragraph of the classical history "The Ugly Duckling" by Hans Andersen. The ChatGPT answered us by praising the story theme as "timeless" and "heartwarming narrative" , but indicating the need to deepen in the emotional description of characters. We finally asked to it "On a scale from 0 to 10, what is the similarity between this story and 'The Ugly Duckling' by Hans Andersen?" , receiving as answer "The similarity [...] would rate quite high, around an 8 or 9" [6].

The LLM reach increases if we expand our understanding of what text is and include images, videos, and other ways to express and establish communication in this comprehension. There is a vast number of LLM tools that provide as answers from your prompt: images (e.g., Midjourney, DALL-E), videos (e.g., Synthesia, VideoGAN), or even presentations (e.g., Beautiful.AI[7]). We present as follows opportunities for LLM use in education (Section 3.1) and existing challenges to be considered (Section 3.2).

3.1 Opportunities in Education

There are a range of opportunities for LLM use in education [35,30,17,50]. For teachers, a LLM can help in the lesson planning creation process. We asked to ChatGPT the following prompt: "Create a structured plan for a class about digital safety with a duration of 50 minutes, encompassing definitions, examples, and good practices. Suggest other exciting possibilities if possible" . The ChatGPT answered us by proposing a detailed plan composed of six topics, including the expected duration for each. It recommended possibilities for interactive activities beyond good methodological suggestions about how to conduct the class[8].

Another opportunity is for students. An LLM can collaborate during their self-directed learning. We asked to ChatGPT the following prompt: "Create a study plan about digital safety. I am available to study on Tuesdays (30 min) and Fridays (1h). This plan needs to last from February 2 to 13, 2024. Suggest

[5] These tools are available as web services or open-source for further installations: ChatGPT (`chat.openai.com`), BERT (`github.com/google-research/bert`), and Bard (`bard.google.com`).

[6] All this example conversation is available here: `chat.openai.com/share/90e2c314-5e6e-40df-b9ff-31915e139ff2`.

[7] These tools are available as web services or open-source for further installations: Midjourney (`www.midjourney.com`), DALL-E (`openai.com/dall-e-2`), Synthesia (`www.synthesia.io`), VideoGAN (`github.com/GV1028/videogan`), and Beautiful.AI (`www.beautiful.ai`).

[8] All this example conversation is available here: `chat.openai.com/share/d4a4fc39-9ef3-4849-a4a1-dcc00e2eaba5`.

exciting options if possible." .The ChatGPT answered us by proposing a detailed study plan for each day of the informed period, including the topic title and all learning objectives for that day. It recommended interesting possibilities as weekend and throughout activities (e.g., "Engage in online forums or communities related to digital safety")[9].

The last opportunity refers to assisting in identifying short essays' potential strengths and weaknesses. We asked to ChatGPT the following prompt: "Feedback on the following argument: 'Large language models (LLM) always prejudice digital safety"'. The first phrase that ChatGPT answered us was: "That statement seems a bit too absolute" . Next, it presents three potential risks (e.g., "Potential for Misinformation") accompanied by a short paragraph for each one. Finally, it describes three substantial benefits (e.g., "Education" and Accessibility") also accompanied by a short description for each one, concluding with a final paragraph[10].

3.2 Challenges in Education

Although there are opportunities to use LLM in education, its adoption also has challenges. Among several existing challenges [30], we list three ones concerning ethics, bias, and wrong expectations.

Regarding copyright and data privacy issues, the main highlight refers to the raw data used to train these models. An LLM usually uses the vast amount of data available on the internet to extract information and, consequently, generate its answers. The problem is related to the authorization of use. For example, The New York Times [23] sued OpenAI and Microsoft under suspicion of misuse of millions of its articles to train ChatGPT. The newspaper argues that this unauthorized use may cause a loss of billions of dollars of profit from advertisement that could usually be earned during a typical access to its website, for instance. From an educational perspective, it is possible that a generated LLM answer can be miscited because the model is unable to trace precisely from which source this data was collected. When an LLM answer generates a computing code, for example, we cannot assure if it is using (or not) some excerpt licensed exclusively for non-commercial use [54].

Concerning bias and fairness, the central aspect refers to how the raw data used to train these models was produced. Data are the result of human actions, and "actions are not neutral; they are carriers of value" [46, p. 40]. Thus, several implicit biases can exist and reflect values that a given data producer community accepts. These values can become biased or harmful concepts affecting society and, consequently, educational spaces [5]. LLM can generate racist or stereotyped

[9] All this example conversation is available here: `chat.openai.com/share/7689884b-1d52-4fd9-a09c-71395379ff59`.

[10] All this example conversation is available here: `chat.openai.com/share/0494d575-c659-4bf0-a913-8e06932f6a52`.

answers, for instance, because its data is "contaminated" for this perspective [10]. Various equity issues can emerge when we use AI in education [8].

And lastly, it is related to the wrong expectations of learners and teachers. Learners may rely too heavily on the model, assuming LLM is a knowledge authority (similar to a human expert). Otherside, teachers may become too reliant on the models, denying themselves the use of LLM probably due to a lack of appropriate knowledge of its benefits for education. A trade-off of benefits and risks should be performed to comprehend better the use (or not) of an LLM in your educational context.

4 Arising of Prompt Literacy

The World Wide Web can be the first ICT resource that provoked the advent of digital divide expression. However, there is an evident evolution in terms of the complexity and impact of ICT, like web access (Section 4.1), search engines and LLMs (Section 4.2). Each one of these brings opportunities and challenges concerning ICT democratization. The competency to use them appropriately is crucial in an information society.

4.1 Web Access Literacy

Web access literacy guarantees access and, consequently, the knowledge provided on the internet, specifically on the first generation of user-friendly pages after the rise of the World Wide Web [4]. This literacy involves a set of primary digital competencies [24], three of them detailed as follows.

Although this can seem trivial for experienced users, differing between email and site addresses is evidence of a basic understanding of the subjacent technologies of the internet. This competency may not be accessible for the illiterate population in our society [12]. Some people in this group can even use smartphones and instant messaging apps (e.g., WhatsApp) but can not comprehend the differences between email and hosting services, for instance.

Another digital competency is sending and receiving emails. Nowadays, there are several ways to exchange information using the internet. However, emailing has still been a crucial means because it occupies a central role in formal communications, guaranteeing more capability to access public and private services. The domain of this competency also allows more possibilities for effective democratic participation of citizens, paving other ways for advocacy actions, for instance.

Lastly, recognizing and avoiding malicious pages enables users to be safe when browsing the internet. Guaranteeing the development of this competency (i) avoids the arising of attitudinal barriers involving fear of exploring web pages at their full potential and (ii) protects users from exposing themselves to harmful situations. Users can also stand not only as a digital consumer but report to the page responsible or even public authorities about these web pitfalls, performing actively as a digital citizen.

4.2 Search and Prompt Literacies

These competencies signalize basic web access competencies. But they do not allow us to explore all potential on the web in depth. Search and prompt literacies take a step further toward more complex requirements to dominate other avenues of the internet.

Search literacy, in turn, guarantees not only access but higher navigability on the web and, consequently, better access to knowledge available there. This literacy involves a set of essential digital competencies such as (i) knowing how to use keywords in a search, (ii) realizing when to give up and re-search, and (iii) considering the quality of the retrieved resource. It performs these searches in specific web pages called search engines (e.g., Google, Bing, DuckDuckGo[11]). These competencies signalize a basic web navigability, but explores superficially other web resources like LLMs.

Lastly, prompt literacy guarantees a new level of knowledge access from the internet. This literacy involves a distinct competency concerning the ability to interact with a web page conversationally, making this interaction similar to a dialogue between humans. An LLM can extract implicit information from the web (which is impossible to do using only search engines). It involves a set of competencies like (i) building a prompt appropriately, (ii) realizing when to give up and re-search a prompt, and (iii) obtaining insights from initial prompts for advanced ones.

A prompt is a kind of requisition similar to that presented in Section 3.1. Formally, a prompt is a set of instructions provided to an LLM that sets it by (i) customizing and/or enhancing it, or (ii) refining its capabilities [34]. Part of what we call prompt literacy is denominated prompt engineering [27,20]. Prompt engineering (PE) is the necessary skill set to dialogue with LLMs effectively [32]. One of PE's concerns is about prompt patterns, identifying successful approaches for systematically obtaining specific kinds of goals when working with LLMs [53].

However, it is necessary to highlight that prompt literacy has a broader commitment beyond prompt engineering, preparing students as citizens for a democratic society (and not only under a technicist lens). Although these competencies signalize a primary LLM information extraction, sociotechnical aspects should be considered to guarantee a more holistic education.

5 LLM Divide

Thus, by extension (see Section 2), we can define LLM divide as the gap between those with ready access to LLM tools, and the knowledge that they provide access to, and those without such access or skills. We will develop this topic in two parts. First, we will define what would be LLM capability under the Capabilities Approach lens (Section 5.1). And second, it will be listed the primary sources of LLM equity issues from this perspective (Section 5.2).

[11] These tools are available as web services: Google (`www.google.com`), Bing (`www.bing.com`), and DuckDuckGo (`www.duckduckgo.com`).

5.1 LLM Capability

Some concepts are essential when we refer to inequality of opportunities in education. Lewis and colleagues [33, p. 482] assert that:

> "*Equality* refers to the state where everyone has or is allocated the same things in the same degree, whereas *equity* typically refers to having access to what is needed. [...] In general, [...] equity, and not equality, defines fair and just learning opportunities" (our emphasis).

Although the authors signalize to equity and equality concepts, they does not define equity in a strict way. Aiming to theorizing equity appropriately, we will present the capability theory.

The Capabilities Approach (CA) framework addresses and nominates the essential concepts in an equity analysis. CA was proposed originally by Amartya Sen [44] and improved by Melanie Walker [51] for education purposes. This approach allows identifying not only the resources that are supposed to be absent in inequity settings but also mapping the capabilities that a student cannot develop (in educational scenarios).

The main question raised by Sen [44, p. 12] is "equality of what?". Sen's concerns concentrated on the higher risk of reducing the efforts to deal with inequalities to a single-dimensional analysis. The inequality problem is complex and multidimensional by nature. Thus, when we analyze the problem only with the incoming inequality lens, for instance, probably other sources of inequalities can be neglected and, in some cases, even aggravated. Although the race lens, for example, can contribute to informing essential aspects that can not be overlooked by all stakeholders responsible for analyzing a given scenario, this one is not enough to inform a decision maker with quality and robustness if isolated from others.

Using more rigorous concepts, CA is a theoretical framework based upon two normative claims: (i) the freedom to achieve well-being is of primary moral importance, and (ii) the understanding of well-being is directly related to people's capabilities and functionings. Functionings are beings and doings that are "various states of human beings and activities that a person has achieved"; and capabilities are "the real, or substantive, opportunity that they [human beings] have to achieve these doings and beings" [43]. The freedom of being educated is one of the aims in this perspective, understanding it as a part of the broad problem of liberating people for a fulfilling life. In this direction, we can define equity as the equality of capabilities.

Contextualizing for our discussion, an LLM capability is the real opportunity that people have to use and effectively explore an LLM in all its potential. A student who has access to ChatGPT but cannot use it, for example, does not have some LLM capability related to prompt literacy. A teacher who does not have access to ChatGPT for use as educational technology in a computing class [6], for instance, may not have some LLM capability related to infrastructure or even social aspects in which this educational environment is situated.

5.2 LLM Equity Issues

From LLM capability, we will unfold potential LLM equity issues that can emerge. Three important sources of equity will be explored as follows: (i) access, (ii) prompt literacy, and (iii) personal, social, and environmental factors.

Access to an LLM arises naturally as the first equity source. Once crossing the infrastructure barrier (a classical digital divide), we can face access barriers concerning the business model adopted by most private organizations. The "freemium"[12] business model allows users to freely have the first contact with an application through its basic features, needing to pay only when they want to use more advanced functionalities. This equity dilemma is two sides of the same coin. It is good because users do not pay (with money) for the access and use of an LLM, which is a means to pave the way for future and democratic access. In contrast, the simple fact of existing restricted access for a selected group of users promotes a divide between those with freemium access and everybody else. As noted previously (Section 2.3), it is a structural problem of our society, and it is necessary to understand how to build a pedagogical environment that considers these aspects.

In terms of LLM educational capability, this mismatch can reveal potential disparities in the assessment process. Imagine if we identify that a group of students can not access a necessary resource to achieve their learning goals. Now imagine that our assessment instrument does not consider this difference and collects indicators to assess the learning of all students indistinctly. Students can be retained in an educational structure due to factors that extrapolate their desire or free disposition to pursue their education. When it occurs, there is no freedom of being educated (the real opportunity of being educated if a person so wishes). If there is no this freedom, thus there is no capability for it, and an equity issue is identified.

Prompt literacy is a second equity issue that can emerge from LLM use. Students can underuse LLM even if they have access to it. Teachers cannot explore its potential because does not have the appropriate competency developed for this. The question about equity will always be if people have the real opportunity to do or to be (in CA, doings and beings). An equity issue emerges if any educational stakeholder is limited by a lack of access or, in this case, skills or competencies. Let us see the examples presented in Section 3.1. How do we explore the LLM power if a student (or a teacher) does not realize the universe of existing prompt possibilities? Is it possible to explore this technology appropriately without a practical knowledge of prompt engineering or prompt patterns (as presented in Section 4.2)? These questions refer not only the access to information, but the fact that LLM can help students and teachers to build a road of metacognitive strategies [2]. The equality of opportunities to develop these skills matters to promote a more fair and equitable classroom.

Finally, the personal, social, and environmental factors are the third important source of equity issue. During the Covid-19[13] pandemic, for instance,

[12] Freemium combines "free of charge" and "premium". See more in [3].
[13] Covid-19 stands for Corona Virus Disease (2019).

Brazilian students that lived in disadvantaged regions had available for all members of their families only a single computational device (normally a cellphone with restricted access to internet) [7]. This is not only an access difficulty, but an structural problem, strongly pervading the social reality of a surrounding educational area. Although the Covid-19 pandemic had unstructured the society as a whole, the underlying social problems usually emerges in middle of the circumstances provoked by a crisis.

6 Related Work

The first group of related work concentrates on those that approach large language models and education but do not explore equity specificities or equality of opportunities. We can cite three works in this group. Cain [11] explores the transformative potential of Large Language Models of Artificial Intelligence (LLM AI) in educational contexts. Kasneci and colleagues [30] present challenges such as the potential bias in the output, the need for continuous human oversight, and the potential for LLM misuse in education. Finally, Head and colleagues [26] explore the ethical implications of LLM training concerning data sources like the perpetuation of biases (racism, sexism, ethnocentrism, and more) and the exclusion of non-majority languages.

The second group of related work focus on those that approach large language models and equity but do not research inside an educational context. We can cite three works in this group. Singh and colleagues [45] explore health equity issues that emerge in large language model deployment. Korateng and colleagues [31] evaluate the ethics of LLMs in medicine along two key axes: empathy and equity. At last, Rillig and colleagues [42] present the risks and benefits of Large Language Models for the Environment, listing issues concerning enhancing the digital divide in environmental research.

Lastly, the third group of related work concentrates on those that approach education and equity but do not explore the specificity of LLMs arising. We can cite three works in this group. Gorski [21] deepens the discussion of the digital divide in terms of educational equity. Unterhalter [48] discusses gender equality in education from the lens of the capability approach. Finally, Resta and colleagues [40] address two main concerns: digital equity for social inclusion and digital equity in education.

7 Final Remarks

This essay aimed to discuss dimensions of the digital divide focusing on LLM in a perspective of computing education. We presented the concept of the digital divide, defined what LLM is, and delineated the arising of prompt literacy. At last, we defined LLM divide from the capabilities approach lens and discussed LLM equity issues. The educational issues derived from LLM use extrapolates the access problem or even plagiarism detection. Our purpose was to underline the digital divide provoked by LLM focusing on lifelong learning competencies.

The LLM divide causes at least an inequality of opportunities concerning the potential use of LLM to assist the learner in building their metacognitive strategies.

We conclude this paper with three essential attitudes that can forge a new 21st-century teacher. The first attitude is increasing awareness about this discussion inside your educational space, observing all dimensions approached here, including the structural root of the problem. The second one is identifying the main challenges in their educational contexts, putting on the table critical equity variables that need to be considered in a detailed equity analysis. Finally, the third one is giving a more advanced step, being a changing vector, proposing an equity-minded curriculum for your educational program. All these attitudes can generate future works, extending the contributions brought forth by this paper.

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