Digitalisation of Education in the Global South: Conditions and Concerns

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Abstract. This paper seeks to contribute to a broader discussion on the critical research agenda in development and technology studies in education. Particularly the situation after pandemic school closures has revealed immense global inequalities and disparities in online education. With new efforts to remedy the situation, attention has to be paid to the constraints and risks that are incurred in the digital transformation of education. This paper explores and analyzes the risk areas dividing them into technological infrastructure and software and platform concerns, and to wider social, ethical, political, epistemological and cultural issues. A systematic analysis will help in risk evaluation for better decision making and planning in the global south. The paper argues that technological transitions need support in the form of considerable expertise and involvement of the communities to ensure sustainable solutions in education.

Keywords: digital education, development, infrastructures, technology risks

1 Introduction

This paper discusses some aspects of the current state of use of information technology in education and related infrastructures in the global south, especially in African countries. It aims to shed light on the conditions and concerns of digitalisation of education in the present-day environment of continuing crisis and increasing on-line hazards.

Digitalisation of education has had a tremendous boost in recent years, mainly due to forced distance learning caused by pandemic measures such as school closures (World Bank, UNESCO & UNICEF 2021; GEM report 2022). Most countries were caught unprepared, without strategies or means to transfer the mode of education successfully. Even in the few countries that were somewhat prepared and had adequate technology in place, the transition was smooth for only a small segment of the educational system. Currently, the new situation and lessons learnt need to be reflected in order to build an improved infrastructure for distance learning.

As educational technologies tend to be less advanced and more highly priced than commercial applications and platforms, the control of governments with limited means over the transition to new modes of learning is seriously restricted. In this pa-

per, I will discuss infrastructural and social constraints and concerns in the process of digitalisation of education, with a particular emphasis on the global south.

1.1 Theoretical position

The communities of the world are becoming interrelated and integrated in various ways. This takes place globally on the internet communication platforms that are increasingly part of the educational infrastructure, as well. Notably, information technology originates in the US, and it has been markedly based on western science and modes of thinking. Computer technologies and software are still mainly developed by US and western companies.

However, the assumption that technologies are universal and incorporate shared conceptual meanings and structures is not necessarily valid in other cultural environments, nor are the contexts and conditions for use of technology. These will be discussed in chapter 3 based on anthropological understanding of knowledge and cultures, and the colonial history of western science. The study is located in the field of critical and decolonial technology studies. (Lengwiler 2008, Sleeter & Delgado Bernal 2004)

2 Risks and vulnerabilities in digital services

Digitalisation is dependent on physical infrastructures, software platforms and applications. All these are expensive to develop and maintain, and they are prone to disruption. Moreover, an efficient use of these technologies requires a robust level of knowledge. In the planning of virtual learning environments and distance education, the constraints that are involved in their use need to be taken into consideration. In this chapter, the risk areas are classified to physical infrastructures, and software and application related issues. Each area is described in relation to educational systems. A comprehensive risk analysis should consider the aspects that are listed here. Moreover, social, ethical and cultural issues that are presented in chapter 3 deserve to be analysed.

2.1 Physical infrastructures

Information technology infrastructures include power supplies, cable connections, satellites, mobile networks, and internet servers. Failures of cable or satellite connections and power cuts cause disruption of services. Failures can happen because of simple break-downs, human errors, or extreme weather conditions; more dramatically they are caused by natural disasters, large-scale emergencies, and conflicts. Because modern economies are heavily reliant on internet services, their failures are costly to citizens everywhere in the world. For example, the volcanic eruption near Tonga cut submarine cables on 14th January 2022 and destroyed the connection to international banking services, which prevented overseas money transfers, and in addition to all other difficulties left many people without means to buy necessary supplies.

Submarine cables are the backbone of the internet. First, they connected North America and Europe in the 1970s, then North America and East Asia. Since then, all continents are covered, the cable connection to East Africa being one of the last major lines that opened in 2012. Areas without cable have only satellite access to the internet. Satellite connections are expensive, and their capacity is limited. They are vulnerable to meteorites and geomagnetic storms, which happen rarely but regularly, like in January 2022 when 40 communication satellites were disabled. However, a major geomagnetic storm is predicted within the next 12 years, and it could seriously damage power supplies and communications all over the world. Additionally, GPS satellites and mobile networks are used in tracking locations. Disturbing GPS signals has taken place in conflict situations, such as after the Russian invasion GPS signals were erroneous on Russian borders.

Cable connections are locally damaged by construction works, bulldozers, and like. Major damage to submarine cables occurs less often even though there are several incidents, such as happened a decade ago when a cable was cut in the Eastern Mediterranean stopping banking transactions in India. Internet is built on a principle that when one route is not available, another route is selected. However, a large amount of traffic cannot be redirected without disturbance. Hostile actions are in increase even outside conflict areas: In January 2022 two submarine cables were damaged near the Svalbard islands, apparently by human action, when some Russian submarines were sighted in the area. Additionally, governments are disabling internet connections when there are internal conflicts, rebellions or demands for democracy.

Hostile actors are an increasingly serious threat to communication systems and infrastructures. There are numerous cases where financial, logistics or industrial operations have been disturbed or prevented by governmental and economic criminals. North Korea earns foreign currency and cryptocurrency by hacker attacks that make bank robberies or demand ransom money from companies. Several other countries are known to have intelligence services that employ hackers. Several so-called Advanced Persistent Threat (APTs) operations have been located in Russia, China, Iran, North Korea, and Israel. However, all major powers have intelligence operations on the internet, but all may not try to cause direct harm during peacetime. (Hyppönen 2021)

On the other hand, several organizations and companies try to introduce ethical principles in IT production, for instance EcoVadis monitors and evaluates sustainability of production chains for large companies. Sustainability is defined to include human and environmental aspects. (http://ecovadis.com)

2.2 Software and application platform risk areas

The Risk Mitigation Manual by Institute for the Future presents eight risk zones for new tech products such as software applications where they believe hard-to-anticipate and unwelcome consequences are most likely to emerge. This list of Ethical OS is used here to assess use of digital technologies in schools and education. (http://ethicalos.org)

Truth, disinformation, and propaganda. One of the first questions a software developer or a startup creator has to ask is "Could your tech be used to generate or spread misinformation to create political distrust or social unrest?" The social media giants, including Meta (Facebook + Whatsapp +Instagram), Google (mail + apps for education + Youtube), Tiktok and several other Chinese companies, Twitter, and LinkedIn provide platforms that are not sufficiently monitored. Government regulations require actions from the companies, but these usually come late or are misguided. European and US governments have imposed fines and demands on platform monitoring, but in many countries the government has done little or even used the platforms to spread misinformation like in Myanmar. Many governments (China, Gulf countries, Russia) act through social media, web sites and discussion fora in order to influence citizens by spreading fake news, or deep-fake videos using bots or trolls in these operations. In addition to influencing political views, they act in order to undermine trust in established social institutions in other countries, like media, medicine, democracy, and science.

Addiction and the dopamine economy. Online games are particularly designed to be interesting and addictive. The monetization models in the game industry rely on addiction, even though educational games rarely are addictive enough. However, students who have mobile phones spend hours a day playing games or using social media, which applies similar principles of attention and unhealthy engagement. In addition to being addictive, social media and dating apps influence users' perceptions of themselves and promote beauty ideals that can damage young people's self-esteem. Applications like Twitter have a potential for toxic materials like conspiracy theories and propaganda to drive high levels of engagement, which is exacerbated by its algorithms. Unfortunately, negative emotions and excitement are also addictive.

Economic and asset inequalities. Digitalisation of education is costly. Institutions need to have the necessary hardware in place, and students need equipment that can access the systems. Hardly in any country all staff members, let alone students have a personal computer or mobile device that can be used for studying (GEM 2022). According to ITU, approximately 4.9 billion people – or 63 per cent of the world's population – are using the Internet in 2021. More than one third has no access. (ITU 2021)

Even though there is some free educational software, most products have a high price, such as plagiarism checking or school administration software. Moreover, the access to international publications is expensive, even for universities in affluent countries. Therefore, researchers in developing countries have to rely on open access publications, which severely limits their chances to conduct high class research.

Machine ethics and algorithmic biases. The social media platforms, search engines, and businesses on the internet all use machine learning software and algorithms in their operation. Machine learning systems use the existing data, and therefore tend to reinforce or amplify existing bias. Basically they favour the majority and therefore result in bias against non-white and non-male people, and all minorities, but the con-

sequences can be even more complicated (Ganesh & Moss 2022) The algorithms seldom are transparent to the people impacted by them. According to security analysts the algorithms that Google search or Instagram use are not known by any human person anymore, as they have started to develop their own way already years ago (Hyppönen 2021).

Surveillance state. Certain countries such as China have extensive digitised systems to monitor their citizens, including face recognition systems and surveillance cameras, follow-up of mobile phones, and surveillance of internet traffic. Everywhere, free software and platforms such as Facebook and Google get their funding and profits by utilising and selling user data. There is a risk that a government or military body tries to utilise this data to increase its capacity to surveil or otherwise infringe upon the rights of its citizens. Platforms are gathering data that could follow users throughout their lifetimes, affect their reputations, and impact their future opportunities. Thus, educational systems that rely on free software take a big risk with their user data.

Most applications collect some kind of surveillance data, and also share it. Photos and videos save their location and time when they are taken. Google, Tinder, fitness apps and social media monitor user locations. Recently in Ukraine, traffic jams could be seen in google maps, which told about movements of refugees and military equipment, and the dating app Tinder revealed that there were many young males near the Belorussian border before the invasion in February 2022.

Data control and monetization. Couldry and Mejias (2021) introduce the concept of data colonialism that they argue is a new social order, based on continuous tracking, and offering unprecedented new opportunities for social discrimination and behavioral influence. They propose that this process is best understood through the history of colonialism, the exploitation of human beings through data. Service providers profit from the use or sale of user data, never sharing that profit with actual owners of the data. There is a great risk incurred in health care and other areas of sensitive information, where the control of data is not available for the users, and where they may not be aware of what type of data is stored about them.

Implicit trust and user understanding. Trust is an essential feature in human social communication. People have an inclination to trust each other unless there is a clear reason against it. Therefore, keeping data secure is difficult. Security experts have conducted several experiments where employees of a business have been contacted by agents to get access to confidential information, and finally they have always succeeded despite strong measures in the company to protect their data. A convincing request by a seemingly pleasant person is bound to succeed. (Hyppönen 2021)

Additionally, criminals take advantage of trustiness by offering money deals, and love scams to extort money or to drag the victim into drug smuggling or other dangerous operations.

However, the current environment on the internet has eroded trust on online information. Still, there are systems that people do not even suspect, such as the IoT in

household appliances, vehicles, and like that collect data and send to companies. When people use applications, they seldom understand the full extent of what those apps do, and what kind of data they appropriate. According to some experiments, nobody reads through the consent forms that state the conditions for use (Hyppönen 2021).

Hateful and criminal actors. Malicious actions are becoming more and more common on the internet. Simple technologies, such as phone scams, SMS and email phishing and fraudulent website links are commonplace. Usually the motive is economical when the criminals either ask money directly, try identity thefts or try to get passwords to banking sites. Ransomware is spread in various ways, either intentionally or as a random consequence of a targeted attack. A dramatic case was the ransomware that was sent by a Russian APT to damage the Ukrainian power grid in 2017, but it spread from offices of the global shipping and cargo company Maersk to its headquarters and to all (but one) its local offices in the world in 15 minutes. The attack closed port operations and cargo all over the world, and it took several weeks to repair the damage and resume operations, and it caused a loss of over 300 million USD. (Lord 2020) A new version of this NotPetya software appeared again in March 2022.

Technology is used to bully, stalk, or harass other people all over the world. There are various political motivations to limit free speech and threaten people. Organised hate groups use technologies to spread hate, and to discriminate against others. Social media algorithms unwittingly help in these activities, such as Twitter's practice to exacerbate conflicts by sharing outrageous opinions.

2.3 Risks in developing countries

Cases of studies concerning school and university closures. The school closures during the covid-19 pandemic have been studied extensively everywhere in the world. Overviews and conclusions by global institutions have been published by the World Bank, UNESCO and UNICEF (2021). This chapter gives a brief summary of some studies made in Tanzania, Ghana and South Africa in order to illustrate the situation in Africa.

The State University of Zanzibar (SUZA) conducted a survey on lock-down effects for students in primary schools. (Ali et al 2021) They had made an intervention by the SUZA TV channel to air the contents of some maths and science lessons for F1 to F6 students. The responses to their survey revealed that 23% of students did not even have a tv at home, and only half of the study group participated in the tv lessons. 75% studied at all during the lockdown, and 40 % did household chores as well. The problems that students mentioned included the language of instruction that was English (the mother tongue is Swahili); they found the home environment difficult for studying; there were power cuts; and tv did not offer interactivity. The researchers concluded that "It is evident that the COVID---19 pandemic has created some sort of educational anarchy with the government having no firm grip of the educational system."

The research in a Ghanaian university aimed at looking at eLearning technologies and policies. (Akayuure et al 2021) The University of Education Winneba pioneered technology enabled instructional delivery and learning in the tertiary education space in Ghana in 2012, but, according to researchers, was not able to sustain its implementation. Their study evaluated the hybrid mode instruction "matching what is been practised against what is the standards". Earlier, in 2003-2008, the UEW failed to implement a new e-learning strategy and experimented with mass technology training which resulted in massive failure in impacting on student learning and academics' practices. Not only e-learning is challenging, the researchers conclude. In the African countries the lack of adequate space for learning has always been a challenge because of the high enrollment in schools, universities have become more and more crowded because of large student populations.

In South Africa, several large studies were conducted on covid-19 closures, and overviews of policies, challenges, ethical questions, practical tools and implementations have been published. Findings brought to the fore the multiple forms of challenges experienced by students when they engaged in online learning. Moodle and WhatsApp were used as parallel mediums to engage students. Due to covid-19 the exclusion gap became wider due to economic, social, political and cultural contexts. A national survey on university students during the lockdown had low rate of response, but responses revealed that 20% of students were not able to charge their devices as needed, more than half (54%) did not have a quiet place to study, and only half (50%) indicated that they had appropriate network connection. "Some other challenges students faced during this time include problems with electricity, a lack of study space, not having adequate knowledge and skills to optimally make use of devices and new study platforms, and feeling isolated or disconnected from lecturers and peers." (Khumalo 2021)

According to the UNESCO GEM report (2021) "In South Africa, schoolchildren are between 75% and a whole school year behind where they should be, with up to 500,000 having dropped out of school altogether between March 2020 and October 2021." The report concludes about African countries:

"One message is clear: the impact on learning is expected to be long-term, especially in those countries that did not have the resources to provide equitable distance learning opportunities of good quality for all. Globally only one in three children, and one in six of the poorest children, had access to the internet as school closures began. About 40% of children in Ethiopia and Nigeria followed radio programmes but only 10% in Ethiopia and 17% in Nigeria used mobile learning apps; barely any in Burkina Faso, Malawi, Mali and Uganda. While almost all countries deployed a mix of remote learning modalities, at least 463 million children could not access any remote learning opportunities, especially in low- and lower-middle-income countries." (GEM 2022)

Actual risk areas. When considering the risk areas that are discussed above in chapter 2.2, most can be seen relevant for the schools and educational institutions in developing countries, particularly because the governmental or public capacity to protect users is weak. Moreover, there is not enough technical expertise for secure system maintenance, which has become very demanding. Skill level that is required for safe

operation in current technology infrastructure is actually very high. The problem with insufficient expertise is global but more acute in the global south.

Typical digital services that are used in African schools are free social media including Facebook + Whatsapp +Instagram, Youtube and other Google products, Snapchat, and Moodle. Schools cannot afford safer technology because of lack of funds. They have no choice but to give user data and to be dependent on the software giants for being able to use technology at all.

Moreover, schools and other educational institutions have outdated equipment and old software versions that are more vulnerable to attacks and failures. On the other hand, poor customers are not a main target for hostile activity, but unfortunately, many hostile attacks happen at random like the Maersk global collapse mentioned above. Political motivations may account for the spread of citizen monitoring technologies, and there are more risks in countries that have a fragile democracy or no democracy. Infrastructure that is provided for colonial motives leads a dependency to the donor or provider, especially China has lately increased its construction activities in Africa.

As cited above, security analysts conclude that humans are the most serious threat for data protection because of their ignorance, carelessness and trustiness. If the general knowledge of risks is lower, it will lead to less vigilance. Unfortunately, the quality of school education has been found to be poor in most African countries.

On the other hand, use of ICTs in schools is not entirely beneficial or desirable, and it may actually be harmful to students' cognitive development. A nationwide study in Finland concluded that "Frequent ICT use at school predicted students' weaker performance in all the cognitive learning outcomes, when adjusted for age, gender, parental socioeconomic status, students' ICT competence, and ICT availability at school." (Saarinen et al 2021) Whether this finding from a technologically advanced country is relevant in the global south, needs to be reflected.

3 Impact of technology on culture and communities

The efforts to transfer technology from industrialised to developing countries have been studied and analysed since the 1980s. (Hoekman et al 2004) The basic assumption is that technology is desirable and necessary, and the Technology and Innovation Report 2021 by UNCTAD "urges all developing nations to prepare for a period of deep and rapid technological change that will profoundly affect markets and societies. All countries will need to pursue science, technology and innovation policies appropriate to their development stage and economic, social and environmental conditions." (UNCTAD 2021). In reality, results of technology transfer projects have been varied, but generally less encouraging than planned for various reasons. Development funding by western countries and agencies has been defined by donors who choose what projects to fund and when, not taking recipients' actual needs into account. Despite a continuous criticism of the colonial attitude incorporated in this practice, development aid still is a top-down effort, dominated by institutions such as the World Bank and IMF that see technology adoption from an economic and pragmatic angle.

Additionally, transfer of technology usually involves private businesses who have their own interests. Therefore, it is just logical that the efforts serve receiving countries less successfully.

Technology and science are introduced as being pure and beneficial, and independent of the users or their societies and cultures, which is a belief that is largely shared in the international community. However, technologies are always developed for the needs of a certain society. Some international actors and NGOs have begun promote this kind of view. The Association for Progressive Communications, based in South Africa, declares that its mission is "to create a just and sustainable world by harnessing the collective power of activists, organisations, excluded groups, communities and social movements, to challenge existing power structures and ensure that the internet is developed and governed as a global public good." (https://www.apc.org/en/about)

Scientific knowledge is socially constructed . (Knorr-Cetina 1999) Western science is a product of European societies and its development is tied to their colonial history (Harding 2016). Western science is essentially number-centred and follows the logic of money and economic gain. Western economics sees a society based on value of money, individualism and human innate greed. Most other societies are based on communal values and collective responsibilities (Coltelli 1990, Bloch 1998). Nevertheless, research into different indigenous scientific ontologies and epistemologies is rare, and very little has been written on decolonial mathematics, decolonial ICT or computing and decolonial technology studies.

All modern technology is based on mathematics, and even though basic mathematical principles remain the same, the meaning and importance of numbers varies greatly between societies (Crump 1990). Rice-cultivating and other wet-agriculture societies assign numbers "magical" power (Hindu, Chinese, Balinese, Maya), and they are used in all decision-making concerning life-choices. Similarly, western science has a strong preference for number-based quantitative research.

Knowledge is defined by the society: what is knowledge and how it is acquired and stored. Bloch (1998) analysed the knowledge categories of Zafimaniry who are village people in Madagascar. Among them, literacy was not common, and they spoke Malagasy and claimed not to know French, which was the colonial language and language of the administration. In their view, knowledge of a person is connected to her status and age, and it belongs to one of three kinds: young people know about wild things; married people have a house and their knowledge is linked to household and agriculture; elders have a traditional and historical knowledge which is not pragmatic but connected to the ancestry of the village and moral code (wisdom). For them school knowledge resembles knowledge of elders: it has no practical value but comes from an authority which is never questioned. It is not considered to be a source of information about the empirical world.

Western psychology is the study of individual self whereas many non-western societies see a person as part of the group, closely connected to nature, the environment and the spiritual world. (Lee et al 1999) Psychology studies have largely been conducted with US American university students who are a very unusual group in global view (Henrich et al 2010). Despite this, psychology has drawn generalisations on

human nature based on the exceptional population in the studies. Because most software that is used in modern applications is developed in the US by this same group of people, it fits best for North American users and their preferences. The field of usability studies and user-centred design relies on the findings of western psychology, as well. Systems are tested with users from affluent countries who have cognitive patterns that are acquired in the western educational system. Consequently, efficient use is best possible when users have a similar background as designers. When users need to adopt western ways of thinking, it could be considered cultural colonialism.

One essential cognitive function is categorisation, which is applied in all digital systems. Categorisation principles are culture-dependent and context-dependent. As a typical western field of science, anthropology invented culture by classification, naming, and writing down. It tried to understand other cultures and their ways of thinking through reification (Coltelli 1990). Bloch (1998) believes that anthropology has been limited by those methods of naming and describing using language, and he emphasises that human cognition contains more than just verbal expression and thinking with words. Presumably, if educational systems are developed to the ways of thinking in other cultures, they cannot be based on western descriptions and categories but need to be developed with the intended users. Nevertheless, categorisation as such is not only connected to western thinking: in Japan categorising is omnipresent, but with different principles. The Japanese language has more than 350 different counters for numbers which classify objects and living things according to their properties such as long, small, animate, etc. (Suzuki & Koichi 2018)

Comprehension of texts like user instructions is defined by the context, and the background of the user. Whitten & Graesser (2003) have analysed comprehension of text in problem-solving, particularly following user instructions of simple devices. They define aspects of comprehension mechanism to be code, process and skill. There are five levels of text representation: 1) the surface code, 2) the textbase, 3) the referential situation model (mental model of what the text is about), 4) the communication level and 5) the discourse genre (style, is this textbook, manual, literary text). In order for communication to succeed, the user needs to understand the language code and have a correct mental model of the use. This is an enormous challenge for the transfer of technology.

What will be the impact of western-developed information systems to the thinking and worldviews of people in the south? Systems carry new cognitive patterns with them, as well as values and beliefs. According to Wilson's (2010) theory of cognitive retooling, cognitive tools are culturally transmitted through education, and the use of cognitive tools shapes neuro-cognitive architecture. Presumably advanced and modern technologies have a high prestige and therefore they are powerful in replacing indigenous beliefs leading to cultural colonialism.

4 Conclusions

Digitalisation and e-learning concerns are obviously different in poor countries than affluent countries. In the global south, the concerns are multifaceted and include

economical, technological, political, social, ethical and epistemological questions. The existing weak infrastructures raise the question how desirable digitalisation actually is. A large share of students in the world is without internet connections, which makes closing the digital gap a very long term effort.

Global south has very little choice of what to use and how, and the developing countries are therefore unable to develop their education in appropriate ways. Much research would be needed to find out how they could achieve some kind of independence from the global technology giants. Technological optimism is still prevalent in many policies where digitalisation is considered to be the magical solution to the problems in education. Concluding from the case studies in Africa that are presented in this paper, it seems obvious that national policies and strategic plans do not yield desired outcomes. Very often digital services fail to deliver usable solutions. Instead, local efforts that are based on realistic assumptions and knowledge of the available capacity and competencies can produce functional solutions on a small scale. However, the complexity of modern systems and the wide extent of hazards in the use would need to be addressed by a strong support from technical and educational experts. Similar goals are also set by some NGOs such as the APC that advocates local initiative and ownership, and decentralised action. (APC 2021)

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