Offline digital – digital offline
The potential of offline digitised information for the production, distribution and appropriation of human knowledge

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Introduction

The digital revolution brought about enormous shifts, one of them in the way scientific, technical and other information is produced and disseminated. Vast amounts of such digitised information has been produced, reproduced and distributed mostly via the internet. Considerable parts of the wide range of analogue information existing before the advent of the information technologies have also been converted into digital format.

In this paper we follow Heinz von Foerster for the definition of information and knowledge. Knowledge requires a human brain, therefore it cannot be stored in media, only information can (Foerster, 2008).

Digital refers to data and information stored electronically in media usually in binary codes, digitised refers to data and information produced in or transformed into binary code, digitalised refers to models of business that leverage digitised information for business processes. In computer technology and telecommunications, online indicates a state of connectivity, and offline indicates a disconnected state.

The wealth of digitised information is however only available to users that have access to an internet connection

– these are only about half of the world's population[33].

International attention and efforts are concentrating on expanding internet services. Although there has been remarkable progress in coverage, for instance, in Sub-Saharan Africa from just 2.1% in 2005, to over 22% of individuals in 2017, an overwhelming majority of the population live without or with only weak connectivity to the net.

Their needs for information are mostly ignored, as the world's attention is concentrated on the internet. The expansion of connectivity through the net, however, requires heavy investments in infrastructure, adequate public policies and much more. The running costs, both financial and ecological, are also quite considerable with prohibitive costs for users, which further prevents expansion.

On the other hand, new technologies such as smartphones and portable memories, with high capacity for data storage are spreading much faster than the internet. This raises the question of whether technical and scientific information can be disseminated in an offline format.

In this paper we first analyze, from a historical perspective, how changes in media affected the production and transmission of knowledge and the present and future implications of the recent availability of digitised information for knowledge production. Secondly we will try to understand to what extent offline digital information can help to overcome digital inequalities and how the wealth of

[33] International Telecommunication Union, World Telecommunication/ICT Development Report and database.

information already existing in digitised format can be made available for offline users in order to contribute in a meaningful way to improve human knowledge.

Knowledge institutionalised

The digital revolution is not the first radical change in the way human societies produce, handle and apply knowledge. The Neolithic revolution which began about ten millennia ago, already brought about ground- breaking transformations – the Agrarian societies provided a fertile ground for the acquisition and transmission of information. The knowledge of hunters and gatherers was transformed slowly. New knowledge was won and tested over a long time-span, before it was stored and transmitted in myths[34], rituals and social structures.

Initiation rituals provided one of many opportunity of knowledge transmission – including the secret dimensions that were considered essential for the internal cohesion of societies organised along the ethnic matrix. (Sigrist, 1994), (Schiefer, 2002). The confined transmission lines with a grading of access to the most secret parts show that societies recognised very early the importance of knowledge. The distinction between holy and profane that is basic for ancient societies also found its expression in the division of knowledge (Eliade, 1968).

The advent of a new type of knowledge that surpassed the narrow confines of ethnic tradition and was based on logic and reasoning rather than on myth and story-telling found its expression also in new ways of transmission (Sloterdijk, 2011). The axial age provided in China, India, Persia, Judea, and Greece in the first millennium BCE new ways of thinking that, at least in part, found their institutional expression in new centres of learning (Jaspers & Jaspers, 2017). Plato's academy lasted, with some interruptions, nearly a thousand years. The influence of Aristotle, his most famous student, who structured and wrote a complete syllabus, lasted even longer and had a more profound impact on the university model. In Europe it seems to have been the first successful institution to take the tuition out of the confines of the family environment by creating an open space for instruction. Chinese institutions of higher learning are as old and have trained imperial elites for millennia (Needham, 1956a) (Needham, 1956b). They produced phenomena such as the imperial examination systems that were later adapted by elites in Western Europe and still exercise a strong influence on modern societies. A comparison of the Greek and Chinese syllabus, fundamental differences in their episteme (Foucault, 1994) notwithstanding, (Jullien, 2002), (Jullien, 2004) shows uncanny similarities (Wilhelm, 2012) (Needham, 1956a). The Greek division of disciplines survived in the trivium and quadrivium of the middle ages until modern times in Europe.

Academic institutions for the training of elites go back at least two and half millennia. They produced a model of an institution that is at least partially closed and distinct from its environment, usually in competition with rival institutions. As a general rule an academy has proper infrastructures, a specialised teaching staff, paying students, age grading, a combination of collective and individual learning, a distinct syllabus, exams and certification, and written forms of information storage[35]. In most cases it also has an international dimension, be it through its teaching staff, student body or the origin

[34] For an interesting interpretation of the Gilgamesh epos, the oldest known myth representing the original conflict between hunter and agriculturalist, from an economist's perspective see: (Sedlacek & Havel, 2011).

[35] For a short history of ancient libraries as precursors of modern online and offline libraries see the study about "Radical Tactics of the Offline Library" (Warwick, 2014). Warwick's seminal and critical analysis gives an overview from a historical perspective over a wide range of problems touching the offline-online topics of modern libraries.

of its teaching material. As in the pre-Neolithic and Neolithic ages, the transmission of accumulated knowledge always used to be imbued with the transmission of values and social norms[36].

In a global perspective, the modern university as an institution of higher education seems to be the most successful model for providing scientific training for elites, although there have always been other institutions, such as religious orders, military academies, and specialised institutions for public administration, to name just a few types. The rapid expansion of universities, from about 600 in 1945 to more than 10 000 at present is due to the growing need of rapidly industrialising societies to produce technical-functional elites to manage their economies and societies.

European universities have trained national and colonial elites for five centuries, modern European research universities that integrated research and teaching within an autonomous space free of political state intervention, were conceived about two centuries ago (Humboldt, 1999), (Newman & Turner, 1996).

Their transformation into industrial-type, digitalised, scalable knowledge factories in Eurasia spans two decades. The "Bologna process" created a common space for Higher Education, with supposedly standardised levels of qualification and mutual recognition of diplomas between 48 countries. Basic tenets of this transformation are the economisation of education (Krautz, 2014), with stress on cost reduction and quality improvement through industrial quality management and certification processes (Münch, 2009). The standardisation and certification of mass-produced technical-functional elites answers a need for globalising labour market where industrialisation requires highly qualified[37], exchangeable employees or "free subcontractors" (Liessmann, 2014).

The medium is the medium

Profound changes in the socialisation of human knowledge coincided essentially with the revolutions in the transmission media. The Platonic academy passed from oral, rhapsodic transmission of myths to (hand) written texts and drawings. Manuscripts always played an important role, and still do. They were, however, superseded in quality and quantity by printed matter, first invented in China, and later, independently, in Europe. The invention of the printing press with movable types (Gutenberg) provided texts, printed pictures and graphs which were much more accessible due to new distribution systems. With these new delivery systems, such as print shops, bookshops, university and public libraries and similar institutions, information on printed matter broke out of the narrow confines of religious orders and the courts of the nobility.

Printed texts, such as books and journals, as well as digitised electronic media have influenced how societies through their human brains – the primary social organs (Hüther, 2010) - produce, distribute, receive and appropriate information.

The new form of knowledge and its transmission combined the teaching by specialists with the written code as exemplified by the alphabet or standardised ideograms. It also produced a new style of knowledge acquisition as exemplified by the Greek askesis and the Confucian discipline in the east.

[36] The ancient ideal of kalokagathía survived in several transmigrations in the education systems of Europe until the 20th century. So did the universal human values developed by the original cosmopolites. Cf.: (Sloterdijk, 2011).

[37] For a profound critique of the level of qualification produced by the Bologna process see: (Liessmann, 2014) who continues the critique of Adorno on modern higher education (Adorno, 2006).

Handwritten as well as printed information can only be used after an intensive training. It takes at least five years of preparation to read a simple text, and 12 to 15 years to be able to read scientific texts.

Writing, however, enabled the information to become portable. Where before either the teacher had to travel to his students – a well-documented fact in Greece as well as in China – or the more common phenomenon that the students travelled to their teachers, now accumulating information could be stored and pass through time and space.

With the advent of the 20th century new technologies allowed the recording of still as well as of moving images. This and the recording, storage and distribution of sounds changed the whole game, because the consumption of these new media does not require previous training. The analogue or digital recording and transmission of sounds became available to illiterate or semiliterate people, be in in the form of radio, telephone or of cassettes being sent by mail. The same applies to pictures and films.

This does not, however, dispense with the necessity for a basic "technological alphabetisation" to improve the capacities for the adequate use of the new technologies. In practice the operational knowledge, based on the "social life of information" (Brown & Duguid, 2000) for the use of modern devices such as smart phones spreads by ways of peer-to-peer learning processes, which are informal but very effective[38].

The fruitful use of information – production, consumption, interpretation and processing – in short, the transformation of information into knowledge, naturally requires the capacity to relate it to a mental reference grid.

The internet trap

Modern scientists' fascination with the internet – where money, investments, business models, communication, political control, as well as their lifeworlds (Held & Husserl, 1986) converge - has largely obscured the potential of offline digitised information for the storage and circulation of information and the appropriation of knowledge. This mirrors only a small slice of the real-life forces that shape the internet – it is certainly not the use by scholars that powers the dynamics of the digital world, although at times their inward-looking approach seems to induce into this make-believe.

For the connected user the production, digitisation, storage, distribution and consumption of information seem intricately woven into the phenomenon internet (Palmer, 2005). It was certainly the rapid digitisation of information (often under misnomer "human knowledge") that fired the expansion of the internet, based on digitalised business models. Although the technological base was originally military, it was the commodification for the mass market that provided the economic incentives to mass produce ever cheaper components. This created the dynamics that have now reached a tipping point for generalised access. Although the first systematic use of the internet was by and for scientists, scientific information nowadays is only a small part of information circulating. It is however absolutely crucial for modern science as well as for the functioning of industrialised and industrialising societies. It also plays an essential role for higher education in all fields.

The cheap access and international networking capabilities created and boosted the production, systematisation, and dissemination of scientific information, on a plethora of dedicated platforms. It

[38] For instance, the practical knowledge to use mobile phones to effect and receive payments in the MPESA systems spread easily through the population of Kenya.

was a precondition for the rise of original phenomena such as the Wikipedia[39]. The Wikipedia in fact profoundly changed the way in which information is produced, validated, circulated and consumed. Where before valid information was restricted to specialised institutions and a qualified elite, the Wikipedia was open for everybody interested in sharing knowledge. The validation is effectuated through strict internal quality control mechanisms, although critical voices about its level abound (Lanier, 2018). The "Creative Commons" approach solved some of the problems stemming from copyright and intellectual property questions (Warwick, 2014). Numerous wiki-platforms expand greatly the area of production and consumption of more specialised information.

Bridging the digital divide

The lifeworlds of large parts of the human population have undergone profound and wide-reaching transformations by expansion of the internet. Yet great parts of the world are still offline or have only occasional and weak access to the net. This has been analyzed as digital inequality (Robinson et al., 2015). In 2018, roughly more than half of the world population had internet access. In Sub-Saharan Africa, the data available indicate that the percentage of population using internet in 2017 is around 22%[40] although there are considerable differences among countries: In Cabo Verde for instance the percentage of users reaches almost 60% and in Guinea-Bissau, another lusophone country, the percentage is estimated at less than 4%[41]. Furthermore, internet access for many users may still not really be functional.

A series of technological developments are now changing the conditions for access to scientific (and other) information for people without internet access. Smartphones, tablets and computers are becoming cheaper, so that many people in dire economic conditions gain access to them[42]. Ever cheaper (off-grid solar) electricity technology provides the energy to power these devices for poorer populations outside urban centres and industrialised regions. The expansion of access to digitised information originally provided for and through the internet through a convergence and increasing interoperability (Suleman, 2010) produce the conditions for a revolution in horizontal and vertical transmission (Warwick, 2014).

The dynamics produced by the advances in the digitisation are significant and manifold: physical requirements are reduced – a whole library fits into a pocket and a whole university syllabus fits onto a smart phone. This is important for regions of the world where logistic chains for books and other printed matter are weak or non- existent. Books require adequate storage space and certain physical conditions, not always easily found in tropical climes and precarious living conditions. Electric light for reading is taken for granted by most people, but still far from universal. Digital information is much cheaper to acquire; logistic chains through which books or journals are produced, shipped, delivered and stored are as unnecessary as are libraries in zones without the necessary concentration of demand. The reproduction of a book requires both a publisher and a printing shop; a photocopier will do for smaller volumes. This infrastructure is not available everywhere, fairly expensive and difficult to maintain. On

[39] The Wikipedia has by now produced a growing family of specialised wikis for different kind of users: for kids, for students, for health personnel, etc.

[40] World Bank Data based on data from the International Telecommunication Union, World Telecommunication/ICT Development Report and database. Although the quality of this type of data maybe doubtful, they can give us a rough indication.

[41] See: https://www.internetworldstats.com/stats.htm

[42] There are numerous movements to produce dedicated hardware at minimum cost: the Raspberri Pi series of card-sized specifically developed computers to aid education may serve as one of many examples.

the other hand digitised information is easy to copy without cost. This naturally raises questions about intellectual property and copyrights. The problems posed by these questions can, however, be overcome by educational institutions. The tendency of "freeing" information as propagated by the Open Access movement and practised by others, such as Google Books, and a plethora of other movements, will probably gain more and more influence.

The actual access to information is also vastly different – the electronic search function and the offline Wikipedia may serve as examples.

This suggests a rethinking of the "digital divide" which is no longer synonymous with internet access. Is there still a divide or rather a frontier zone where different forms of access overlap?

From the Babylonian Confusion to the descent of the Holy Spirit

Meaningful traditional knowledge has always been confined to the language boundaries of societies[43]. Only with the change of the medium and the codification of information these boundaries have been overcome.

Historically, the training of imperial elites usually implied the acquisition of common ruling languages. The production and access to scientific knowledge required linguistic competence. This was a tiresome and costly process that occupied a good part of their education systems. Imperial elites usually became fluent in at least one or two acquired written languages. For the Han this was Mandarin, for the Hellenes Greek, for the Roman Empire Latin and Greek, for the Europe of the Middle Ages Latin and Greek, for the Internet age up to now, English. Although currently Mandarin is gaining ground, at least in scientific publications, it is too early to say if this will translate into a rivalry with English as the dominant internet language.

The advent of translation software[44] has now reached a level where many functional and scientific texts can be easily and cheaply translated from and into many languages[45]. Even though the final quality of translated texts is not yet perfect, they are getting better and are mostly clear and understandable. These machine translation processes require digitised texts and are internet-bound, their equally digitised results, however, are not.

The Wikipedia[46] is a good example of this: although machine translations of articles are still frowned upon by the editors, they are gaining more and more ground.

[43] This does not imply that societies are monoglot. In rural Africa, for instance, Agrarian Societies are not limited to one language. Many people speak quite a few languages, and for official events specialised interpreters may be called in (Schiefer, 2002).

[44] See for example: https://translate.google.com/ or the newer site that provides much higher quality translations: https://www.deepl.com/en/translator.

[45] A parallel development can be seen in the progress from the original "machine languages" needed to interact with computers, to the software, both operation systems and applications, which are more and more converging to produce user interfaces that transcend cultural and linguistic boundaries.

[46] It is to be expected that smaller versions of the Wikipedia such as the Portuguese edition which currently has a volume of about 14 GB will grow faster than the English version which has a volume of about 78 GB. Translation engines will accelerate the adaptation and exchange across language barriers.

Seek, and ye shall find.

Finding information for all purposes has been revolutionised by the advent of the "search engine". These engines became widely known as features of personal computers, before they enabled and conquered the internet[47]. In earlier times finding information was based on acquired knowledge. In traditional societies, knowledge was stored in people's memories. In a later phase, people were supposed to know their texts, a knowledge that took decades to master and called for expensive and cumbersome systems, such as library catalogues, bibliographies, indices, etc. The advent of online libraries has not reduced complexities. There are now calls for Digital Librarians (Sreenivasulu, 2013) as well as approaches to evaluate their value, use and impact (Hughes, 2012).

Nowadays, search engines are also available offline, for personal computers, tablets and smartphones. They are easy to handle and effective. They greatly facilitate the access to offline digital information. The miniaturisation and cost reduction of storage media that provide de material basis for digital libraries are impressive. They require, however, some expertise in order to be effective, which cannot always be taken for granted, if the knowledge of the average user may serve as an example. Technical advances have greatly facilitated the building and use of offline digital libraries[48]. 15 years ago the building of a digital library was still the domain of informatics experts (I.H. Witten et al., 1999) (Ian H. Witten, 2002).

The extra mile – through walls and through the bush

The potential of offline access to digitised information encompasses a diverse and wide range of situations and opportunities[49]. From confined spaces where internet access is blocked artificially, such as prisons, schools, totalitarian countries and the like, to the vast regions of the planet where internet is either non-existent, not functional or too expensive to be accessible for many[50].

Technology transfer, confluent streams and changing business models

In fact the technical advances in various fields are creating the conditions for new dynamics that will have a profound influence on the lifeworlds of people with no or non-functional internet access.

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[47] Google now dominates 93% of online searches and its parent company Alphabet occupies third place on Forbes ranking list. https://forbes.uol.com.br/listas/2018/05/forbes-divulga-as-marcas-mais-valiosas-do-mundo-em-2018/

[48] On the other hand, in Lusophone African countries there seem to be no offline digital libraries – with the exception of the usual rather limited personal libraries stored on the devices of scholars and intellectuals. The knowledge about offline Wikis does not seem to be very common. At least we have not been able to trace any hints.

[49] Through the KIWIX platform a whole array of Wikipedia products is now available offline. Although this was originally planned for prisons and educational facilities, is has proved to be extremely practical for access in "remote" areas as well as in highly developed regions, because of its easy, cheap and very fast access – anytime, anywhere. (https://www.kiwix.org/en/home/).

[50] Even in countries where mobile payment systems have penetrated most regions, such as for example Kenya, these are based on telephone networks and not on the internet which is still patchy. Kenya's MPESA payment system is a good example for the positive network effect. Once a network reaches a certain density it becomes necessary for most actors to join in.

As an example: in wide regions of Sub-Saharan Africa the confluence of the availability of smartphones, off grid solar panels, digital storage media and the like provide the technical bases for the distribution and use of digitised information.

This technology transfer happens on the simplest level, though, through the marketing and acquisition of end users' objects. With very few exceptions there is no relevant technology transfer of production capacities, such as factories or even repair shops. While highly sophisticated objects proliferate, there is only negligible investment in the countries' overall technological development.

The availability of digitised information as well as the advances of machine translation capabilities and the advances in offline search engines have now reached a tipping point where internet based developments allow to transcend the internet. The more and more intuitive use of smartphones, tablets and personal computers facilitates the access. The generalised use of icons in communication provides an easy alternative to written texts as did the standardisation of interfaces over a wide range of applications. Touch screens already simplify the use of devices which do not require keyboards anymore. The speech functions of smartphones allow even illiterate users to access their devices: e.g. they can simply ask a question and listen to the answers.

Different business models based on the self-organising market-based distribution systems for advanced equipment, centred on end-user devices, are currently penetrating areas until now cut off from modern technology and provide the bases for satisfying the demand of know-how as well as for scientific information. The confluence of these advances results in a new quality.

This raises a series of questions: What are and will be the distribution mechanisms for offline digital information? Are there self-reinforcing loops? Which market mechanisms may grow from the technological dynamics?[51] To what uses can digitised information be put offline? How will the new availability of ever cheaper technology affect knowledge production, circulation and acquisition of information? What will be the effects of offline digital information in spaces where the internet is heavily policed by the state or where the internet companies collect ever more user data?

Will the scientific open access movement[52] that tries to guarantee free (online) access to scientific information financed by public funding include offline access? Will it be able to overcome the massive resistance of interest groups that defend the proprietary models of selling information? Or the business models of companies that dominate the internet?

A profound rethinking of the way education systems handle information seems urgent.

The effects on education systems cannot yet be fully gauged. Many institutions of higher education, especially in areas with weak internet access, are still struggling to understand the implications of the technological revolution that is taking place in their surroundings. Will their business model which is based on conditional access to information (libraries, online access, etc.) hold? How will the more generalised access to digitised information influence research and teaching? Will they be able to open their systems in such a way that they help to spread scientific and other information online and offline to the general public? Can they broaden their recruitment base by facilitating information access to

[51] The new dynamics that will power "the internet of things" is already attracting huge investments and attention. With the growing importance of this new connectivity offline data bases will appear to be technically even more obsolescent.

[52] The scientific open access movement is only one branch of a big tree that includes free operation systems and free software – but most of effort seems to be dedicated to free online distribution and access. For a good summary of Open Access see: https://en.wikipedia.org/wiki/Open_access.

prospective students? Can they change their role in society from elite training institutions to becoming general providers of quality information for a wider public?

Will their proprietary model of information management be able to adapt to an environment where information flows more freely? Under a more generalised open access, can the information management be separated from the teaching and learning (transformation of information into human knowledge) and certification processes?[53]

Will universities and other institutions be able to become true innovators and reach areas that are still offline?

Institutions setting knowledge free

Universities and other institutions of (higher) education could play a significant role in granting online and offline access to information that has been accumulated and transmitted through many generations, not just to their teaching staff and students, but also to a more varied interested public.

Their role can be manifold: they are able to produce, collect, select, structure, translate, transform, validate, legalise and distribute information well beyond their actual remit inside their closed systems.

Universities even in remote places usually have privileged access to information; they also have the knowledge and the manpower to produce scientific information through research. They can collect and select relevant information through the internet and many other channels, such as the personal networks of their teaching staff, who mostly hold at least some digital information. They can structure information according to their teaching needs. They could, per instance, structure the relevant information for the access exams and distribute it freely to everybody interested. This could greatly enhance the pool for new recruits and broaden and thus improve their student base by facilitating the preparation of candidates now excluded because they experience difficulties in accessing relevant materials to prepare for the exams.

Internally, universities (and other institutions) could structure the study materials for their courses and provide their complete syllabus offline digital to the entrants. As all courses and other educational programmes are already structured, if not always in the best way, this would be a fairly simple exercise which could greatly improve the quality of courses and level the playing field for students with more limited access to libraries and other sources of information. It would also greatly assist teaching staff and level out regional disparities in the quality of courses.

They could likewise translate the relevant texts into languages accessible to their students (and teaching staff). This is easy to do with the new translations engines available at low cost.

They could similarly transform relevant information into adequate forms, such as teaching material, student handbooks, research material and the like, and through all these combined processes validate information[54].

[53] For the online world, some of the biggest universities (more than 130 partner institutions) already offer free access to their courses, (MOOC) through online platforms (edx.org). Only certification has to be paid. These courses which are rapidly gaining large audiences, are however limited to users with functional online access.

[54] The COREECON project may serve as a good online example for providing complete teaching and study material for economics – maybe it could be put to use in offline distribution? (https://www.core-econ.org/).

As institutions of higher education enjoy privileged access to the use and dissemination of scientific literature their role could also be to legalise the use of the information; in this way the thorny questions surrounding copyrights and intellectual property could be solved[55].

Their role, however, does not have to be limited to act within the narrow boundaries of the closed systems. They could significantly expand their role to provide relevant scientific, technical and otherwise information to other institutions and to the wider public in general.

The content could be packaged according to specific needs and be distributed adequately. What hinders universities in areas with limited internet access to provide their student when registering with complete syllabuses of the courses in digitised formats on digital media? They could even provide them with a solar kit to provide the energy for their digital devices.

Specialized information packages, such as handbooks for mechanics, farmers, or woodworkers could benefit other professional groups. Here development actors of all types through their development projects which reach out to populations which are mostly excluded from internet access, could play a significant role by producing and distributing relevant digital information in most of their areas of intervention. The medical Wikipedia may serve as an example. It could become a standard equipment on the smartphones of all medical personnel, but also of teachers and others. Teachers of secondary and primary schools would certainly gain from specific information packages, as could for instance (rural) development and similar actors.

These institutions can also set up specific dedicated information delivery points where information can be copied. This does neither require specific technical installations, nor new distribution systems as existing infrastructures such as schools, shops, markets, etc. can be used. Existing distribution systems for goods and merchandise can also be used – it is to be seen if and what market forces will shape dissemination mechanisms. Social networks can also be used to distribute information which than can then travel to regions with no or low internet connectivity. It is to be expected that direct peer-to-peer offline data exchange of relevant scientific, technical and otherwise useful information will take off in an informal way as it already does for entertainment, such as the sharing videos and music.

There are also vast opportunities opening up for private enterprise within and outside of the formal economies that characterise many of the countries in the developing world. As digitised information can be reproduced error-free[56] without much initial investment and at reduced cost, there is a very low threshold for start-ups.

These should be able to provide services for all kinds of institutions as well as for end users of digital information.

The genie is out of the bottle – hopefully it only poses a threat to the business model of selling and controlling scientific information and not to science and knowledge production itself. Experience shows, that when new technologies can be put to bad uses, they will[57]. But there is always hope that their power can be put to good use, too.

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[55] The freely available scientific information on platforms such as academia.edu, researchgate.net or ssoar.info should pose no problems. A cooperation with relevant online editors could resolve the access problems to copyrighted materials. Other solutions have been proposed also (Warwick, 2014) but will probably not fit into institutional settings.

[56] This was not a given when manuscripts were still laboriously copied by hand; even typesetting of text was expensive and far from error- free.

[57] For one critical voice see: Jaron Lanier, who in his book "Ten Arguments for Deleting Your Social Media Accounts Right Now" puts the digitalised business model firmly as a cause for the negative dimension of the big internet

Concluding remarks

There is a huge need for scientific and technical information in areas that are not covered by the internet. The rapidly growing technological bases for the use of digitised information now reaches populations so far excluded from the digital world. Ever cheaper devices required for the use of information in digital format now become available also for people whose limited purchasing power allows them to acquire relevant devices such as smartphones or tablet and off grid solar energy systems.

The fall in costs for storage, transmission and use of digital information is an enduring phenomenon and will most likely continue. This helps to transform the real information needs into a growing demand for digitised information. This opens new opportunities on many levels for numerous actors.

For one, education systems in regions of the world that are mostly excluded from internet access can use digitised information offline. New models will have to be developed and propagated on all levels from primary to tertiary education.

Public and private administrations in regions not covered by the internet could also greatly benefit from a systemic access to offline digital information. So could private companies and professionals as well as people simply interested in information for different purposes – not least for self-study.

This also provides opportunities for entrepreneurial initiatives which can find markets for digital information outside the internet. As the initial investments are very low this also provides opportunities for start-ups in the poorer regions of the world.

New fields open also for all actors in international development cooperation, for international and national agencies as well as for non-governmental and civil society organisations which so far have mostly ignored the opportunities and potential which digitised offline information provides.

And last but not least, scientific research is required to define the potential in more detail, to develop models and to accompany the new developments.

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