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GUTENBERG OR VON NEUMANN? LITERACY AND EXTENDED COMMUNICATION IN TWO MERGING GALAXIES

„There have been three revolutions in the history of human thought, and we are on the threshold of a fourth.” This statement from *Steven Harnad* (1991) refers to a revolution foreseen as the consequence of using internet. *Harnad* counts the emergence of printing press as the third revolution and his vision on a dramatic change forecasted in the year of publication coincides with the first steps of using World Wide Web in public institutions including universities and research facilities. Indeed, it was true for the last decade of the twentieth century that „the forth revolution has not yet taken place”. Now, three decades later, we are living in a world that underwent a very fast phase transition around the millennium so that we face the post-Gutenberg Galaxy with extreme challenges. The changes we experience every day evokes hundreds of questions. Only a portion of them will be raised with a focus on the interaction of literacy, learning and digital technologies. The first question is whether printed books are still important. Do they disappear or change only. How prints survive and co-exist in the digital world? Does the use of digital devices influence our literacy? Is literacy the only human activity the fast-changing digital world has an impact on? How our daily communication with humans and smart devices changes? Do we fail or going to merge the two Galaxies to their best in order to serve extended communication and human values? The answers given below are of partial and represent a cognitive approach.

The original information age – emergence of the Gutenberg Galaxy

Gutenberg is known in the developed world as the father of print, although the Chinese have used printing by a thousand years before him. Then how it comes that *Johannes Gutenberg* is one of the most celebrated inventors in history? The answer is rather simple; the printing press, using moveable prints, less characters and better technology than the Chinese became a widespread technology and allowed *Gutenberg* himself as well as millions of others to set knowledge, news and stories down on paper. However, the most important change in history introduced by *Gutenberg's* printing press is the impact via spreading literature to the masses for the first time in an efficient, durable way, and this contributed to the emergence of the „original information age”, the Renaissance.

Gutenberg's first large-scale printing was a set of two hundred illustrated Latin Bibles in 1455 and every copy had been pre-sold. Standard works of science with an access to by more people than ever stimulated and spread new ideas fast and in large scale. Literacy, very low among the general population in Europe, improved immensely even before public education was introduced as the cost of books steadily dropped and book fairs were organized in the major cities. Printing books became a commercial success – unfortunately not for *Gutenberg* who died with little money and glory – and around half million books had entered circulation by 1500, ranging from classical Greek texts to *Columbus' account* of the New World. News and books travelled faster across Europe and the cheap, mass-produced books were available for the lower class with several implications, especially in science, religion, and society.

Gutenberg's method has then hardly undergone any change for three hundred years. News and books travelled to areas unknown before and printing has spread across Europe. Literacy became available for the general public and at the turn of the 18th and 19th century children started to learn to read in public schools

and books became the major source of knowledge and information. In Hungary the first institution for primary school teachers' education started in 1870 and new reading instruction methods were developed in the following years. Reading as cultural invention became available for all and could be acquired by most of the children. It is nearly hundred years ago when teachers got aware of the fact that children of normal intellectual development faced serious difficulties in reading and advanced text comprehension. Since then the disorder of neuro-developmental origin called dyslexia has heavily been studied by several disciplines. During the last two decades a significant amount of data revealed that reading and writing are performed by complex networks of the human brain shaped by an intensive use of script. Moreover, the level of reading achieved in the foundational phase plays an important role in the pupils' academic success and building up the effective neural networks serving reading and comprehension has a crucial period that is the first four years of schooling. Emergence of the *Gutenberg* Galaxy provided a unique opportunity for saving memories of centuries in print and enabling a valuable contribution to a cultural progress not seen before. The change from speech to script became and still is a challenge for the human brain not evolved for reading the most valuable effort that contributes to human development.

Changes introduced by mass-produced books had several implications, especially in science, religion, and society. Moreover, printing has changed the structure of labor market in Europe, with printers rising as new artisans, proofreading and lay-outing as new occupation, as well as the rise of the book industry and libraries available for the general public. The *Gutenberg* Galaxy is alive in the 21st century as it is shown by the existence of thousands of proofreaders, layout artists, and printing service providers working in the book industry. The legacy of *Gutenberg* and his printing press lives on. Then why we are so much worried about the survival of print? Do we think that print is endangered by the digital media? Do we know how the emerging digital world influenced reading? Does literacy change with using digital devices? Do our cognitive processes change as the digital world overruns our everyday life? Only print is at stake or our communication undergoes significant changes?

The digital age – emergence of the von Neumann Galaxy

The starting point of the emergence of the *Gutenberg* Galaxy is the date of the first large-scale printing and that is the publication year of the illustrated Latin Bibles. The question is whether we can find a precise starting point of the digital age. For this we should agree on the largest impact invention that might give rise to the digital age. However, one may ask whether any special invention of a clear starting point had such a strong impact on information transfer as the print press had on literacy. From this point of view is rather probable that the digital age is more a time frame in history than a particular year of introduction of a new technology. Therefore, we better define the starting point as time period when digital technology became prevalent and of common use throughout the world. Based on this definition the digital age might begin with the widespread use of the Internet. However, if the digital age is defined as the information age, or computer age we find a different historical point, the time when computing and the prolific use of technology in almost all aspects of human activity began. The genuine invention where everything what is digital started is computing therefore the digital age might start in 1945 and the new Galaxy can be named after its founding father, *John (János) von Neumann*. Two computers, the first designed in 1945 by *Neumann* as well as the magnetic drum recommended for new generation computers led to commercial success rather early though not yet for general public use. The stochastic computing theory published by *von Neumann* in 1953 (see in *Bródy* and *Vámos*, 1995) could be implemented only in an advanced phase of computing e.g. in the 1960s. The seventies and eighties witnessed a faster spread of computers, and this means that the evolution of a digital world took decades, though not very much longer than the spread of printed books by the end of the 15th century.

Computers, internet, smart devices and various technologies including digital media became parts of our daily life and led to the current era whereby individual, social, economic, cultural and political activities are more dependent on information and communication technologies than ever before. We believe that these technologies do not substitute reading and writing as the main source of human communication is language in its spoken and written form. However, we may expect a qualitative change produced via merging processes. All these may lead to further challenges for the human mind and require further shaping of the processing networks of the human brain. For this we should mention a multidisciplinary approach called cognitive info-communication (see *Baranyi and Csapó, 2012*) having a systematic view on cognitive processes and the human brain co-evolving with the info-communication devices. The co-evolution means that the human mind may function over distances and the capabilities of the human brain can be extended through these devices and interact with any cognitive system artificial in nature. Here not only the galaxies merge as most of the cognitive capabilities undergo merging and extension so that artificial and natural cognitive systems may work together. The changes we see in the digital era may mean the start of a new revolution of the human mind. The mode of communication changes when the information transfer occurs between two humans having similar cognitive capabilities or between humans and artificial systems of different cognitive sets. Furthermore, the world of smart devices is at intensive use and influences our life to a large extent. How do we get then adapted to the fast changes? Did the *Neumann Galaxy* reach a new path? If yes, do we define well what digital means? Do we give a strong support to our children in getting familiar with this new world and being aware of its benefits and dangers? How our schools cope with these changes and how can they benefit from changes and transformations in the digital era?

Children of the Neumann Galaxy

It is a common experience of caretakers that children get interested at a very early age in gadgets that do something when touched, turned, pushed or stroked. Every smart device is a „toy” of high predictability and of strong effect on drawing children’s attention to due to the early developed motivation called agency that prefers actions with effect. Digital devices do not only draw attention and keep it sustained, they reward the action made and the performance achieved instead of evaluating it. Smart devices have a magic effect as their use is self-explaining and can be acquired by implicit learning. Here our main question is whether we make use the inherent features of smart devices at schools for active learning and differential instructions at school. Computer assisted programs, smart phone applications, serious games and many other possibilities are available, although their introduction depends at least on the age and grade of the pupils as well as on the subject studied.

One of the typical areas of combination of script and digital technologies via extended communication is the blended learning. The roots of blended learning are in online learning although a fundamental shift in instruction is associated with the new approach different from just using computers and technology. It is also true that until recently most of the schools haven’t used technology to provide students with a true blend of instructions. Moreover, blended learning is often misunderstood as it is not only defined by the methods used. The very complex learning and instructions are defined by content as instructional materials including lectures, assignments, and readings and by mode as methods of providing information via discussion boards, textbooks, videos. A blended classroom provides a success-oriented environment where knowledge and skill acquisition and use require extended communication in two merging galaxies.

The extended mind

The new technologies may change how our mind functions. The extended mind thesis (EMT) of *Clark and Chalmers* (1998) claims that cognitive processes may reach beyond the boundaries of the individuals to include the physical and socio-cultural environment. Empirical research in robotics, artificial life, connectionism, developmental psychology, and economics use the term of extended cognition in a broad sense. However, minds can be thought of as complex systems emerging from dynamic couplings of brain, body, and world. This coupling can be seen well in most of the studies in the field of learning sciences. The digital world has an impact almost on all aspects of our life and may change the way as well as the effect of learning and instruction. As it is seen on Figure 1. learning, teaching and skill formation are targeted by the digital environment including an increasing number of smart devices.

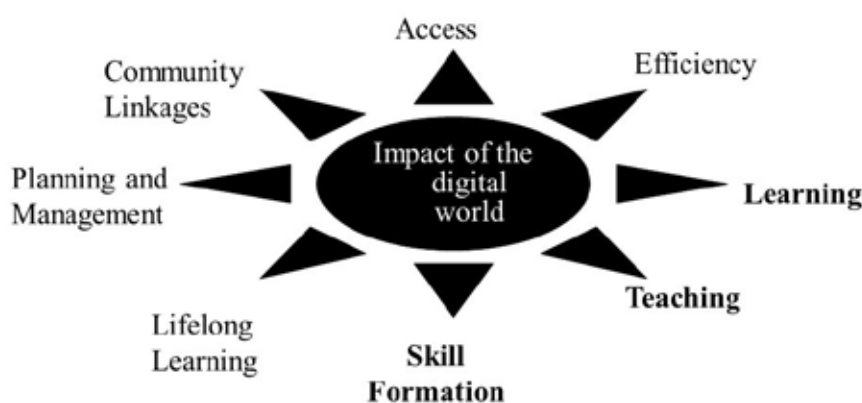


Figure 1: The impact of digital environment of human activities

Indeed, the digital world provides learning through experience and the statements of pedagogies on constructivism and game-based learning are confirmed by the fact that children learn best by doing or by being (*Aldrich*, 2005). The serious games recommended for schools are designed for educational purposes follow pedagogical principles and use state of the art graphics. They may educate and entertain through uniquely realistic recreation of a time period that no longer exists or locations that are difficult to reach. They may also provide three-dimensional (3D) models in form of augmented reality that helps to understand difficult theoretical concepts through applications. The interaction with a 3D model provides a more natural view than browsing through 2D.

Learning and instruction are the beneficiary areas of using the new technologies. The secret of the new technologies is in their interactive and collaborative nature as well as in the impact of three fundamental features on learning: immersion, imagination and interaction. These all improve participation and retention. Learning becomes rewarded by new technologies and this transforms the traditional concept of incentives in the learning process. Serious games follow these principles when they are designed for rewarding achievement so that they engage the human brain and keep learners questing for more. They have an impact on students' desire to study and failures are generally ignored. This is the opposite of standard education where success is often neutral, and failure is punished. One may also ask whether virtual reality has a place in school. It seems that it is not needed for teaching and learning. At the same time the application of augmented reality is increasing as it can be used better and in more areas as many new generation school books provide figures to see in 3D by using smart phones.

We do not know yet how far and how fast the digital era extends to. What we know, however, that we should give the opportunity to our children to use the new technologies for learning, as well as our task is to make clear how dangerous this new extended world can be. The state-of-the-art knowledge introduced and structured age-appropriate in the curriculum as well the support of acquiring 21st century skills and competencies are the prerequisites of lifelong learning. Our children should learn in time how to use the internet, the social media, how to protect their own personal data and how to recognize what source of information is reliable or false. The *Neumann* Galaxy is still full of unexpected changes to come and the new media may change several aspects of the *Gutenberg* Galaxy that will exist if humans use language for communication.

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