

MIND THE GAP!

Speed matters in Education: Relating Technology to Human Capacities¹

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While it is clear that technology is growing in importance in contemporary society, it is *un*-clear how realistic the current debate on digitalization is. The debate seems simply to split the target-groups into hypers and victims. Understandably, the immediate corporate interests of high-tech companies and the energy sector, as well as international competition, have a strong influence on the drive and speed of this debate.² Speed is fast becoming the new paradigm for policies by decision makers and for possibilities offered by new technologies. Ironically, the speed of human processing (involving also handling of materials and tools – technological devices are also kinds of tools) and human creative behavior, are too often neglected or entirely ignored. This essay is an attempt to pinch anyone involved in the digitalization process to keep in mind that, whatever technology can offer, the end-user continues to be human. My focus is directed to the methods and motivations for new directives to enhance the use of technology in education to include a proper understanding of natural human learning capacities, including the role of creative behavior. For this objective we need to improve our general understanding of the biological characteristics fundamental to how humans perceive, act and react. These characteristics are common in all persons, and are, in addition, the features that make each single person a unique individual.

Artists that create their works themselves,³ offering their work to other persons for visual experience play a key-role in understanding these features. Real creative artists have much experience in creating artifacts that by themselves, by their visual and tactile presence, naturally appeal to a viewer, an appeal that stimulates brain processes involved in focusing attention comparable to how music affects attention. It is crucial to acknowledge that the visual experience of works of art trains the viewers' general ability to focus attention. The value of the experience of the artwork is not limited to the artwork itself and it is important to distinguish between what we are told art would be about and the biological impact of experiencing art.

This may seem irrelevant to the subject of digitalization but is actually key to all technologies that involve the human end-user. Human perception, experiences and subsequent behavior are reflective processes. Many technological devices demand quick jumps in attention, hardly allowing reflection, thus ignoring the complexities of our mind/body by focusing only on speed. The natural need for reflection is obviously also a main reason why creativity or creative behavior plays such a key role in society.

MANAGING DIGITAL TECHNOLOGIES

In sync with different purposes and with human capacities

To open the debate on technology, one may first distinguish between technologies evidently useful for doing things better, faster and on a wider scale, while improving data storage and data communication, and technologies that interact directly with humans.

¹ All thoughts and conclusions described in this essay are my own when no reference is mentioned in a footnote. My reading has been interdisciplinary and I have also gathered information by interaction with many specialists from a wide range of professions. Although I have done my best to refer to the correct sources, I apologize when I have not mentioned sources I am not familiar with and will add appropriate acknowledgements in any future edition. For further information on my thinking, see Ilgen, Fré; 'Art? No Thing! Analogies between art, science, and philosophy', edited by Craig, Megan; Pro Foundation, The Netherlands, 2004, ISBN 90 9018543 7. Ilgen, Fré; ARTIST? The Hypothesis of Bodiness, Tübingen, Wasmuth GmbH, Germany, 2014, ISBN 978 3 8030 3364 2.

² It is quite interesting how, for environmental reasons, in the 1990s the reduction of energy consumption was a mainstream topic in politics and the media. This concern melted away when the smart phone took center stage.

³ To be distinguished from artists who may design their work on a computer and have third persons or machines produce the work, or who only offer some concept which will be executed by another person, an industry or machine.

While, in the first case, speed matters obviously for economic and geopolitical reasons, in the latter speed in implementation of technology depends on the (re-)active involvement of a human being. This is important in the debate about technological upgrading and the way we as humans respond in the age where advanced technologies are increasingly important in everyday life. In the light of the common understanding of AI (artificial intelligence), the way digital products interact with humans should be critically reviewed from the perspective of human abilities. However, one must question if what is presented as AI has anything in common with human intelligence or natural human behavior. Unquestionably, very smart technological advancements evolve all the time, yet there continues to be a large gap between what is actually possible and what would be theoretically possible. This is comparable to the issue of quantum computers: though in theory such fast computers are possible, many complex problems still have prevented the realization of this technology, even though the word *quantum* is frequently (and incorrectly) applied to market technological applications.

Because creative behavior is a natural and basic aspect of human life, creativity is an essential part of any person's ability properly to function in social or work situations. In situations where the same action is repeatedly demanded, or merely a limited amount of variations of the same action are called for, such actions can obviously be replaced or even done better by a computer, a robot or other machine. In most professions and in society in general, however, individual intelligent and therefore creative behavior cannot entirely be replaced by technology.⁴ This is one explanation for why professionals in the high-tech industries continue to fly around the globe to meet other individuals in person instead of interfacing by technological means.

KEEPING HUMANS IN THE LOOP

Natural interaction between humans and machines

Human brain processes are tremendously fast, but human (re)action involves looping processes within the brain, a necessary repetition of perception, involving more than just one particular part of the brain and involving the rest of the body as well (the brain being a part of the body). The use of one's arms and hands, for instance, is not a handicap in any desired (re)action but rather enhances those brain processes naturally involved in focusing attention. In education, it is important to make new technologies available to young people, to extend their abilities to contribute to contemporary and future society and to allow them to add value to many professions in higher education, industry and commerce. New visions for the education of coming generations in an enhanced digitalized society can only be useful when these perspectives take into consideration the natural perimeters of the student's capacity for perception, experience and learning. These natural perimeters have not, in fact, changed much over time.

A decline of the capacity to focus attention in any substantial way has been observed in the members of more recent generations, especially those who have grown up with a large amount of screen time, obviously including smartphones and tablets. This clearly must alert policy makers involved in setting new perimeters for a digital education following technological developments. Digital devices serve as valuable props for the development of young people's personality in the hybrid age, and are essential to extend capabilities in order to contribute to contemporary and future society and to prepare for a variety of professions, but these devices cannot replace those human features which are basic for the individual functioning in society.

Policy makers who wish to reform person-machine interface in the future should therefore reflect on findings from various fields of science to consider human behavior but especially to learn from neuroscience.

⁴ This is also a plausible reason why in some discourses "machine learning" and "machine intelligence" is preferred over "Artificial Intelligence". "Machine learning" clearly indicates "what a machine can learn" which is obviously not the equivalent of human learning, while it might be more sophisticated than human learning regarding a specific task (like fast communication).

As opposed to the current tech-debate among policy makers, a more widely reflected approach is required for reforming digital education.

HOW TO ADJUST EDUCATION

Policy makers direct schools to make young people work with digital devices throughout their education, replacing such activities as writing by hand. In the meantime, cognitive neuro-researchers have discovered that the use of smartphones and tablets in schools has caused new generations to grow up with a lack of substantial and longer-focus attention.⁵ Predictably, at some universities this lack of attention has been observed in undergraduates. This inability to focus for longer periods of time will prove disastrous in many businesses, research, teaching positions, as in many other professional occupations. This development should alarm anyone with a serious interest in professional education. These neuroscientific findings and general observations do not mean one should not include digital devices in education but rather make the determination of the right balance the pith of the matter.

Studies demonstrate that optimal perimeters for educating young people should include training in mind-hand control. Handwriting, for instance, has the underestimated advantage of a reduced speed that works naturally well for the brain to focus and process attention.⁶ Repetition of focusing on the same action causes the involved brain circuits to process the perceived information to such a degree that focus may become strong enough to be impregnated in long term memory; in other words, a physical action like writing by hand allows real learning, an individual's acquiring knowledge and abilities. This observation has everything to do with biology. When thinking about digitalization in education, one should find the right combination of continuing training in handwriting and other focused physical training, such as drawing or the manual creation of 3-D objects or dance, along with the use of digital devices. Debates on education and learning processes frequently include references to creativity.

CREATIVITY

One of the least understood features of natural human behavior

But: what is human creativity? Avoiding mere philosophical debate on defining human intelligence, one may nonetheless define creativity and the focus of attention as key notions in a human-centered debate about digital transformation. Creativity is the process of finding new solutions, which are mostly variations of known, established solutions and is not limited to, nor the equivalent of, fine arts but is a core feature of human behavior.⁷

Unfortunately, the ongoing tech-debate focuses mainly on the advantages of technological devices, not on technologies as perceived and experienced from the perspective of the end-user. The designs of wireless remote controls in consumer electronics of the 1990s with too many buttons are a classic example, teaching that ignoring behavior and preferences of the consumer makes corporations lose their market shares to corporations with an advanced interest in human semantics. A technology, to become successful, must offer space for stimulating human creativity and natural focus of attention, instead of obstructing both.

⁵ In the media and on the internet one can find an abundance of information on the impact on learning and social behavior of uncontrolled or excessive exposure to and focus on smartphones, tablets and computers (including on disrupted development of speech, sleep and anxiety disorders). There is, obviously, also information disregarding or even denying dangers to society, an impulse motivated by the industries that benefit from a growing market. Although policy makers certainly have to support the interests of such industries, the proven problems should motivate them to set priorities and limits.

⁶ The culture of handwriting by itself is not the topic here, but how the speed and character of mind-hand control matches learning capacity.

⁷ This is not a new thought and loops back to earlier considerations about paradigm shifts, originally proposed by Thomas Kuhn in 1962. Progress, for instance in science, can only happen by breaking away from a current consensus.

Acknowledging natural, human behavior not only helps people but it also supports sales' improvement for tech-companies.

In the tech-education-debate some experts focus on *homo ludens* (the playful human) — a model that underscores the importance of elements of play in a culture and society. Although humans are fascinated by gaming, it requests less focus than creativity, which requires substantial and deep attention significantly different from attention in gaming. The brain's incredible speed in absorbing information, is helpful in gaming, but this activity only summons a focus of attention that does not linger enough to contribute to actual learning. For learning and creativity, information must be processed in a sequence of repeated observations that loop within the brain. This process demands a different level of concentration than a game allows.

A holistic education must enhance creativity in a person, not by putting pressure on the student to reach a pre-defined result, as is the case in gaming, but by focusing on fragments of the subject, gradually building towards the generally described objective or task. Creativity requires reduced speed. Many artists know that creativity is a process of finding and reflection, not of searching with a fixed goal. At least since the Renaissance, artists are aware that they think with their hands (*nelle mani*⁸), not only with their minds. Additionally, creativity is known to be stimulated by pragmatic perimeters, for instance, set by the limited range of physical properties of the human body, or by the conditions of certain circumstances in the real world. Of course, experience, knowledge and training additionally play crucial roles for artists, like for any person.

In the later 1980s, when personal computers were introduced at universities for architecture, obliging students to only work with CAD-programs, the professors soon discovered that the students had not developed any sense for space in their designs. Understanding the dilemma, the staff decided to hire an art professor to teach the students free-hand sketching from life. This is an exercise which stimulates the brain to focus on spatiality. In drawing from life, eyes-hand-mind control, and the involved slow speed, allow the brain to process various features of three-dimensionality; staring at a computer image does not encourage the development of these skills.

FOCUS OF ATTENTION

The key factor for education

Focus of attention is a relatively young field in cognitive neuroscience.⁹ Here, too, we may distinguish between different but overlapping and dialectical (mutually influencing) ways of focusing of attention: one may be described as biological by nature, the other as psychological. The biological factors involved in the focus of attention deserve to be taken seriously, because the impact of biological processes on our behavior is, although not the only influence, still much larger than most people and certainly most policy makers are aware of. Biological processes within our bodies, caused by the complex ways our mind/bodies respond to and interact with our immediate environment, come into play in everyday behavior (otherwise a person, for instance, could never walk up or down stairs) and obviously in handling any technological device. As early as the 1990s high-tech developers liked to talk with and study creative persons such as artists, designers and architects, to understand their creative processes in order to improve human interface technology.¹⁰

⁸ "Nelle mani" is a term originally coined in Italian Renaissance, referring to the way that experienced artists allow their hands to lead what they do in painting or sculpture. For an extensive discussion and historical summary of main interests in the relationship mind and body, see Ilgen, Fré ARTIST? The Hypothesis of Bodiness.

⁹ For a summary of research on the focus of attention see: Posner, Michael I., editor, "Cognitive Neuroscience of Attention", second edition, New York, London, The Guilford Press, 2012, ISBN 978 1 60918 985 3. Michael Posner is a leading expert in the cognitive neuroscientific research of attention, known for his seminal work on visual selective attention.

¹⁰ See, for instance; Candy, Linda; Edmonds, Ernest, "Explorations in Art and Technology", Berlin/Heidelberg, Springer Verlag, 2002, ISBN 1-85233-545-9, including essays by corporate and academic computer-scientists and artists. For

The psychological focus of attention is influenced by one's personal history, and this includes a person's family background, culture, society and education. It must be noted that the majority of research on the focus of attention is done in controlled, even confined laboratory settings, excluding many features of natural behavior and perception. Still, the obtained knowledge is useful for understanding focus of attention and might help to improve technological applications. A large part of the research about attention is naturally about vision and the involvement and influence of eye movements on the shifts of attention. Attention is also stirred by other senses, such as sound, smell, or feeling heat, cold, drafts or touch. Events in our field of vision may trigger eye motions but do not necessarily influence our attention on a one-to-one level. This phenomenon is the cause of many car accidents. A driver may have his eyes open and his eyes may move in response to all that is happening on the road, but when he is too absorbed in thought, or is distracted in any substantial way (like by using a cell phone), he may not consciously notice dangerous situations.

It is of course possible that a mature artist, or scientist, or economist, or CEO, may think that when he or she brings a higher amount of attention to bear on those features important to his or her profession, then attention for other things diminishes. Some capacities are delegated from the brain to other parts of the body. Trained, repetitive physical actions involved in attention are stored as motor reflexes. Examples include walking stairs, the professional use of tools, or quasi-tools in sports, like in golf, tennis, hockey. Technology can replace or enhance certain components of human behavior but it cannot replace the basics of being human. A neat example, as mentioned earlier, is that even leading specialists in advanced technologies need to fly around the globe for their profession, regardless of cutting edge communication technologies: they prefer personal encounters to video-conferencing.

LESSONS FROM THE ART WORLD

Applied to digitalization of education

Though obviously more complex, here I would like to select and emphasize two kinds of focus of attention: the focus of attention in learning, training, assembling knowledge and creative abilities, and the focus of attention on a fixed mission. In other words, the first is the focus of attention of target-groups, the second is the focus of decision-makers.

While this subject is relevant for the discussion on digitization and digitalization, the following remarks may demonstrate the gap between policy-makers' good intentions and the views of their target-groups. This gap turns on differences in focus of attention. Most persons who decide to visit a museum have a pre-set focus to enjoy a nice day looking at many things to distract their main focus away from their everyday concerns (job, family, finances, politics). The curators of that museum have an entirely different focus, mainly aimed at creating exhibitions with subjects intended for lecturing the public and aiming for their own peer recognition (with regard to their possible next jobs). The art world repeatedly demonstrates that such differences in basic focus collide. Art professionals who wish to be of contemporary relevance, are convinced that their exhibitions should include new technologies as typical main interests of our time. Though it is correct people use technologies at work and at home, the implementation of such kinds of technology in museum exhibitions is a misjudgment, since it does not correlate with the reasons why people visit a museum or gallery. It is no surprise the attendance for museums of contemporary art is globally declining while for museums showing art from history until Modernism is increasing.

At the 2015 Venice Biennale, for instance, the majority of exhibitions showed digitalized videos displayed on large screens in darkened spaces. Many visitors quickly went in and immediately out, often with

instance, Ilgen, Fré, "The Illusion and Simulation of Complex Motion", reporting on an artist who explores motion in painting and sculpture in virtual space while playing with virtual reality devices. The revised version of this book, including 15 additional contributions by artists, will be published by Springer Nature Series. Springer Series on Cultural Computing, 2018.

some irritation. After all, visitors traveling far to Venice with the purpose of enjoying the sun, the city and the Biennial, are hardly inclined to be captured for long in such darkened spaces. While from an art professional's point of view there was nothing wrong with this choice of artworks, it clearly collided with their target audiences' focus of attention. Equally, at the opposite side of the spectrum, when one decides going to a cinema, one focuses on the enjoyment of sitting in a darkened space, immersed in the large screen projection and sound: now imagine how would that viewer feel if not a movie were displayed but a painting, or a person on the stage reading aloud from a book? For the Biennial's own statistics, every visitor that went through the entrance door was counted—a normative way of surveying attendance and delivering proof of a successful exhibition.

Video art and other digital art have their reasons for being, but clearly do not work in all circumstances, and one understandably sees a steady decline of such (digital) technologies in exhibitions. All professionals in the art world are challenged to understand their target audiences, to improve their understanding of the naturalness of focus of attention of exhibition visitors and to learn from neurobiology why the traditional art media continue to be successful in terms of natural visual appeal.¹¹ With justification, one should pose questions about purpose, time and place that have much to do with focus and attention, and therefore are basic for setting perimeters for each new technology.

BASIC HUMAN CAPACITIES

In art as well as in education

In general, many feel that coming generations will be different, better informed, are smarter, certainly when it comes to handling new technologies. While some of this will be true, this exaggeration must be set against the acknowledged fact that the human brain biologically does not offer reasons to assume that next generations of people will be very different. The brain has vast but limited possibilities. In very simple terms, the brain's capacities can be imagined as a table loaded with many objects. If one object is enlarged, taking up more space, some other objects will fall off the table. A person may accomplish specialization: collecting, building and maintaining vast knowledge on some specialized subject, but this comes with a price. Extreme specialization on, for instance, highly abstract thinking may lead to deviant social behavior.

The basic features and capacities of the human organism have not fundamentally changed since early homo sapiens, meaning, for instance, that artists have a very large choice of artistic expressions but still must remain within constraints set by the limits of their bodies.¹² Art is strictly linked to our natural perceptual preferences, not merely those of the mind but also those which involve the whole body, and therefore remains close to the natural, human behavior and needs. It is fascinating that people throughout human history need creative expressions as virtual intermediary for interacting with the world. Though it is beyond the scope of this essay to explore this observation in depth, for stimulating more thought on creativity (and technology) it is useful to remark here that artistic expression revolves around a limited range of variations. Sameness can be found on the level of visual appeal, tactility and compositional preferences, differences are expressed in verbal explanations following local (cultural) and individual preferences.¹³

¹¹ The traditional media are painting, drawing and sculpture, while one obviously can add manually made graphic arts like etching, lino cut, wood cut, lithography.

¹² We all have two arms and hands which offer a large range of movements, but still with limitations. It is fascinating that exactly these limitations set the perimeters for the cohesion and analogies between creative expressions in art, which, again by these limitations, appeal naturally by analogy to any other person. This provides an important reason why traditional painting and sculpture through natural appeal spark and stimulate focus of attention. Also, the matter of natural limitations is an important reason why creative expressions in which the human body is not involved, may attract some attention but do not appeal to the same degree. This observation is not limited to fine art but also applies to music.

¹³ Such sameness is by approximation, otherwise we could not distinguish between a work by Michelangelo, a Bernini or a Rodin.

Artworks are figurative or abstract, may be described as beautiful or ugly, but these features all are less important than their visual appeal and thus, like music, offer the brain a stimulus to temporarily find some biological relief important for the brain to stay healthy. This is not a matter of culture, nor of criticism on what technology can offer, but a matter of how human beings function. This is a crucial lesson to be learned in any thinking about education.

When one realizes that art professionals do not consider the natural side of experiencing art,¹⁴ it becomes clear why the drive for endless disruptions of supposed traditions in art has led art professionals astray, away from the basic interests of their target audiences. The processes of naturally experiencing art (for a large part a biological process) explain why, for instance, new technologies, including digital and AI-manufactured art, can never appeal beyond the degree of any screen-saver or decoration.¹⁵ Artworks that are not manually made do not have the capacity for holding anyone's attention long enough to affect long term memory, while classical media as painting and sculpture do. This is one of the reasons for the growing gap between the art that professionals continue to promote in their institutions and the art that people like to include in their own environment, their homes.¹⁶

An important lesson for any developer of technology and for any policy-maker regarding education is not to be blinded by new technological development in and of itself, but to check the usefulness of such developments in direct comparison to people's natural behavior.

CONCLUSIONS

In the immediate context of this book "Re-designing Institutions - Concepts for the Connected Society", for technology or the implementation of technology to be most effective, it is key for policy makers to focus on speed for economic or geopolitical reasons. But it will be just as important for a future of human beings in a hybrid age to recognize the various human capabilities by which people can naturally handle and apply the speed of technologies.

Even in the early days of the first—mechanized—industrial production, maximizing the speed and efficiency of value-added chains was seen to be the only logical decision from an economic perspective. Workers were assumed to be extensions of the machines, merely adapting and hanging on. This attitude

¹⁴ It is revealing that in all debates about technology and art in all the many discussions, from the innovation of tools, the subjects of artworks, the process of making art as technological process, up to the psychological understanding of how people verbalize their art experiences, there is little reference to the biological processes within our mind/body evoked by the artwork. It is possible that the real purpose of experiencing art may be different from what it seems to be at first glance, involving just the senses. The natural chain reaction in our organism perhaps is what art actually is for. Comparably, we may discuss culinary culture by analyzing the structure and ways of the preparation and presentation of food, or the enjoyment of the glamour of a star restaurant, but we would miss the real natural need to eat (energy) and to socialize with others (self-reflection). The restaurant that does not take into account the limits and abilities of the human palate is bound to fail.

¹⁵ Exceptions always exist. In digital art, for instance, the complex works by Manfred Mohr offer the viewer visual appeal equal to that of painting. In photography, the exceptional visual tactility of Lynn Stern's photos is naturally visually appealing, reminiscent of grainy Old Master's aquatint gravures.

¹⁶ The capacity of holding one's attention refers to the way our eyes, without any conscious decision, can be attracted by something we look at, for instance evoked by the visual features of an artwork. When the artwork offers the right visual stimuli, the eyes may roam over the work repeatedly and the focus of the brain follows suit, focusing our attention. This biological process does not deny the influence of art historical knowledge or fame of an artwork or the artist, but across the board plays a more crucial role than is acknowledged by art professionals and is key to understanding how and why people may consider artworks appropriate for their private environment. The involved process of focused attention, causing a relaxing experience, a diversion of the main focus of the brain (on problems of everyday, job, politics) and thus a sense of wellbeing, is likely the actual experience of works of art, not so much what the artwork represents. This kind of focus of attention diverting the brain, is known to be basic for developing solutions and creating new ideas.

towards the relationship between technologies and human workers disrupted profitable production, causing many mistakes in production circles as well as unhealthy conditions for workers.

Digitalization has the potential to improve business efficiencies, e-governmental services, and education to foster advancements of a society. This can be successful when policy makers learn to understand the functioning of the human being and the natural behavioral constraints as set by biology. One has to search for a useful synthesis of human demands and human abilities with technological progress.