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Technologia i edukacja, czyli rzecz o niekoherentnej symbiozie tradycji z nowoczesnością

Technology and education, or the incoherent symbiosis of tradition and modernity

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Abstract: The article discusses the complex relationship between technology and its tools, education and its objectives. It is recognized that both areas are closely interwoven since the emergence of communication between people and the need to use tools for self-development (it is indicated that this phenomenon is not reserved exclusively for homo sapiens sapiens). The coexistence of both areas – education and technology is identified as crucial for the development of civilization, while raising the issue of their impassable incoherence resulting, inter alia, for other purposes (education retains, technology changes, education transfers information from the past to the present, technology transfers knowledge from the present to the future, etc.). All this makes the seemingly seeming relationship of technology and education as synergetic areas supporting civilization development. At the same time there is a relationship between technology and education manifesting itself in permanent cultural crisis between what is old and well known (defining education) and what is new and unpredictable (the support of technological development).

Key words: technology, education, teaching, e-teaching, media, multimedia, the Internet

Streszczenie: W artykule omawia się złożoną relację między technologią i jej narzędziami a edukacją i jej celami. Uznaje się, że oba obszary ściśle się przenikają od czasu pojawienia się komunikacji między ludźmi i potrzeby wykorzystywania narzędzi do samorozwoju (wskazuje się, że zjawisko to nie jest zarezerwowane wyłącznie dla homo sapiens sapiens). Współistnienie obu obszarów – edukacji i technologii – określa się jako kluczowe dla rozwoju cywilizacji, przy czym podnosi się jednocześnie kwestię ich nieprzekraczalnej niekoherentności wynikającej m.in. z innych celów (edukacja zachowuje, technologia zmienia, edukacja transferuje informacje z przeszłości do teraźniejszości, technologia transferuje wiedzę z teraźniejszości ku przyszłości itd.). To wszystko sprawia, że oczywista z pozoru relacja technologii „i" edukacji, jako obszarów synergetycznie wspomagających rozwój cywilizacyjny, jest jednocześnie relacją między technologią „a" edukacją objawiającą się m.in. permanentnym kryzysem kultury znajdującej się pomiędzy tym, co dawne i dobrze znane (definiujące edukację), a tym, co nowe i nieprzewidywalne (wspierajcie rozwój technologiczny).

Słowa klucze: technologia, edukacja, nauczanie, e-nauczanie, media, multimedia, Internet

> *Thrown into a vast open sea with no navigation charts and all the marker buoys sunk and barely visible, we have only two choices left: we may rejoice in the breath-taking vistas of new discoveries – or we may tremble out of fear of drowning. One option not really realistic is to claim sanctuary in a safe harbour; one could bet that what seems to be a tranquil haven today will be soon modernized…*
> Zygmunt Bauman, *Globalization*

The history of the relationship, or rather the symbiosis, between technology and education dates back to the earliest beginnings of humankind. It is hard to decide at this stage what human beings were actually driven by, namely whether our primal aim was "to learn and get to know" and consequently teach others, or was it "to use an object", for example a tool, in order to achieve certain goals. However, the starting point for both of these approaches seems to be the most essential component of human psychology, that is: our unbridled curiosity and need for communication. But is it a feature typical solely of humankind? As many years of research have shown, the very same feature can also be found in non-human primates. Chimpanzees learn from one another, share their knowledge of tools and imitate each other's behaviours. Similar features can also be found in species quite far removed from humans on the evolutionary tree: for example, Egyptian Vultures (*Neophron percnopterus*), a species of bird in the accipiter family, learn how to use stones to break ostrich eggs and oyster shells and pass that knowledge to their offspring (Burni, Hoare, DiConstanzo, Benstead 2009, p. 41). It is apparent that survival in nature requires species to communicate, treat nature "as a learning space" and use "its elements as tools".

This paper discusses the relationship between education (or science) and technology, which began in the earliest stages of humankind's development and still continues in our contemporary global village. It starts by listing some of the positive aspects of this mutual relation and then presents communication disruptions which affect the relation negatively. Three examples of interactive media research carried out within the last several years will be presented to support the thesis.

Gestures, speech and simple graphic signs belong to the discoveries and inventions related to the techniques which are part of communication processes and didactic processes. The primeval educational communication processes in both human beings and other species, like the aforementioned vultures, are related to the act of noticing certain facts, phenomena or regularities in our surroundings and remembering them. In this case, our senses serve as the tool used for observation, while our mind becomes the tool whose task it is to transfer these individual "discoveries" into reproducible processes. The primeval communication tools or the primeval

informational techniques enabled us to describe these phenomena using gestures, speech or graphic signs. What is more important, those simplest and most intimate human technologies of imaging, describing and, later on, recording information have been unchanged for thousands of years and became the basis of our culture and civilization.

The primeval memorizing techniques that enabled human beings to transmit information using speech include alliteration, rhyme and rhythm. These simple techniques are still successfully used to teach languages, grammar, spelling and vocabulary. Development of new communication tools has always required breaking natural limits imposed by space and time. Speech exists "here and now". A sentence once uttered never returns in the same form, and its lifespan is very short – no longer than saying the actual words. Sentences are memorized by people or students who hear them, and any registered phrase can only reach as far as the person who memorized them. How long a message exists, and how far it can spread, is firmly constricted by the abilities of physical bodies and limitations of space and time. The most significant revolution (or, more adequately, evolution, considering the timescale and range over which it happened) in technology, and later in communication and education techniques, accompanied the invention of writing. Words written on clay tablets, stone slabs or skin became immortal. This allowed them to travel beyond the time and space of their origin. The invention of appropriate tools enabled recording, storing, moving and protecting data such as words, signs and numbers. New types of buildings appeared: libraries, in which words were collected, schools, in which words were used for educational purposes, and finally archives, which served as repositories for the most important written documents of their communities.

For people who live in the *Gutenberg Galaxy*, books and printed text seem to be rather obvious tools which have been present in human civilization for millennia. However, as far as the evolution of human communication is concerned, this technology is relatively new, similarly to how three-dimensional print technology is a new phenomenon in printing. Writing has been around "only" for about 7,000 – 8,000 years. "Modern" Phoenician writing using a modified alphabet, a relatively recent writing system, is approximately 3,000 years old. Codices (sing. codex), books made up of a number of sheets of paper usually stacked and bound by fixing one edge, has been known since the end of the first century AD. The European technology of print has been known for 550 years. Speech, in comparison, developed 35,000 – 50,000 years ago[1].

The invention of print had an immense impact on the proliferation of books and, in consequence, also in the proliferation of textbooks, which

[1] The question of how and when speech developed in humans is still being disputed and vigorously researched. E.g. Professor Shigeru Miyagawa from the Massachusetts Institute of Technology argues that speech resulted from an accidental genetic mutation approximately 80-50,000 years ago.

could now be easily produced and distributed. Print became less of commodity available only for high society, and more of a commonly accessible tool which fundamentally and irreversibly improved the range and permanence of messages. While it was possible to permanently destroy manuscripts or even burn down the Great Library of Alexandria, then the largest library in the world, destroying thousands of copies of printed text was an unfeasible proposition, as a number of twentieth century dictators learned to their chagrin. Printed books became common, durable goods and made knowledge available to a wider range of readers. Thanks to the invention of print and the ongoing improvement in printing technologies (accompanied by the development of sales and distribution systems) a number of religious, moral, social and educational revolutions could take place. Print radically lowered the prevalence of illiteracy, while the gradual increase in egalitarianism in both systemic education and self-learning were crucial for the scientific revolution which started one hundred years after print was invented and is still in progress. After reading *The Sorrows of Young Werther* by Goethe, a number of young people decided to commit suicides. The increased number of suicides provoked the eighteenth and nineteenth-century philosophers to raise questions about the destructive influence of books on young people's psyche. In time, books became even more dangerous and "revolutionary", poisoning not only minds of young people but of whole societies. The nineteenth century brought new discoveries of the kind that seemed inevitable in this sequence of events, and new communication tools and technologies were invented. These new tools used for communication were based on the use of electric signals and soon developed into milestones of our modern, twentieth-century technological civilization. The invention of telegraph, telephone, radio and television finally and irreversibly broke spatial and temporal limitations on both communicating and teaching. It took barely 150 years from the invention of the telegraph to the appearance of commonly available, fully personal computers capable of accessing the global instant communication network[2]. Don't we have the right to feel a bit lost in this technological race in which the way the data are processed, sent and recorded changes several times during the lifetime of a single generation?

The education system is a natural beneficiary of the technological revolution in communication because every teaching process is strictly related to the process of communication. The development of media and information technology led to the creation of a whole new discipline of digital media-based education, or education technology, whose main areas of interest are: (1) the choice of didactic tools (means, techniques and technologies) which would be appropriate for teaching a specific subject (such as biology, art) or a specific type of course (in the classroom, at home, etc.);

[2] It is generally assumed that "computers for the masses" had their world premiere in 1984, when Apple presented the first Macintosh personal computer.

(2) the meaning, direction and quality of education performed with information technology-based tools in the context of the dynamic evolution of this process; (3) research in the field of didactic efficiency of all types of media in various types and areas of education.

The recorded history of modern media use in education goes back to Johann Amos Comenius who developed a naturalistic approach to education and demonstrated its practical execution in the textbook *Orbis Pictus* in 1658. However, as my earlier comments have shown, one should seek the precursors of naturalistic teaching, of illustrating and exemplification, much earlier. In *Pampaedia* Comenius himself considers Plato a precursor: "Plato advocated that children should be taken to war, and that they should be spectators at battles so that their presence as onlookers should make their fathers fight more bravely on their behalf, so that children would learn to emulate the bravery of their fathers." One of the most important stages in the evolution of didactic aids was the development of print (which allowed printing photographs, for example). However, the accessories increasing teaching possibilities or the capabilities of the textbook (in the form of additional teaching resources) also include "obvious" objects, such as crayons, paints, modeling clay or even the most basic blackboard. Although these aids have been known for many years, the twentieth century introduced a large group of new, elaborate (technical) didactic means, linked directly to the media, their transmitters, and information technology.

Closing the historic introduction, one could submit here the following thesis: every communicative process, both inter- and intra-personal, and all communicative behaviours taking place in the social sphere are simultaneously placed in the didactic sphere. Every technique of communication, local or global, beginning with a gesture and ending with online voice broadcasting, is also a technique subjected to learning or teaching. Every communicative technology is simultaneously educational. The link between the two is unbreakable. Our every behaviour, reaction, gesture, word or even our way of articulation is a lesson. According to Chomsky, we discover and experience reality so long as we know the language (the code) in which this reality is described. If we follow Wittgenstein's reasoning, however, the barriers of the world which we discover and experience are the barriers of the language which we use. Taking this into consideration, one could state that teaching and learning (including "world reading") depends on all the means of communication available to a person (or to an accipitrine bird), starting with the senses and ending with cyberspace. The transition from direct communication to the kind of communication that uses tools is the first human communicational (and educational) revolution whose remnants, such as computers and the Internet, are visible to this day. And we will continue to be the communicative "cousins" of the Egyptian vultures who break shells and eggs with stones until the time of

the second revolution, after which man will stop using tools of any kind in the process of communication.

One of the most essential functions of any educational system is equipping the student (this includes oneself in the process of self-education) and the teacher with a language system (including techniques, technologies and tools) and communicative expertise which will allow both objects of the educational process to perceive and understand reality in a coherent way and recognize existing relations, conditioning, barriers and norms. And here occurs the first, one could say the most general, philosophical problem regarding the relationship between technology and education. Their unresolvable incoherence. According to Francis Herbert Bradley the test of truth lies in coherence. However, the relationship between technology and education is in principle incoherent, which I will shortly attempt to demonstrate, whereas the relation which I described above as a relation of education and technology linked together should ultimately be approached in a separate manner as education versus technology.

Education was, is and will be in continuous incongruence between what has been (in culture, science and art) and what is here and now. While information technology consistently and naturally changes and develops (and it has to according to the well-known Moore's law)[3], education is and will be in a natural state of delay toward modernity which manifests itself as its permanent crisis. The world rushes forward, whereas the principle of education is to impart to students an image stopped at a given moment[4]. What is interesting, this crisis of coherence and inability to adapt (including technological maladjustment) is as old as education itself. The oldest known written texts (the Tărtăria tablets and the Dispilio tablet) are about 7000 years old. The oldest proof of an upbringing and education crisis could be credited to the cuneiform writing on a clay tablet from about 5000 years ago found in the city of Ur. It reads: "Never in history has the youth been so badly raised, and never has the world descended so low". It is worth quoting Maria Kwiatkowska-Ratajczak from the Educational Innovations Lab at the Adam Mickiewicz University in Poznań who said that the permanent fluctuation between synchrony and diachrony is an intrinsic characteristic of education: "Education is (…) on the one hand a factor in recreating culture in future generations, but on the other hand, it should also be a factor of change" (Kwiatkowska-Ratajczak 2003, p. 86). This means a constant tension between what is permanent and unchanging, and has become frozen within culture and what constitutes change. It is a continual dilemma between something that has become too old and should be removed and something which has just become an important and permanent element of

[3] This is also a prosaic source of financial problems for every director in charge of an educational institution: how can one effectively spend a large sum of money on modernising the technological infrastructure knowing that tomorrow the very same infrastructure will be at least outdated.

[4] This process can be easily observed by looking at all the discussions about reading lists recommended to primary school students.

the world. From this perspective, education trying to "catch up" with the world has to undergo a reform. Nowadays, because of technology expanding in all areas of life, developments occur on such a scale and so dynamically that changes and variability are valued more than stability, and it has become much more difficult for education to shape culture.

Education (and centralized school in particular) is and will be in constant opposition to information technology, a fact easily noticed in echoes of discussions from the 1990s about the negative effects of media and multimedia on children and young people. Concerned education specialists, pedagogues, psychologists and media experts talked about addiction to media (this time the concerns were not written on clay tablets but printed), communicative apathy and a rise in aggressive behaviour among young people. Their voices forced questions about how in this world of technological gadgets, multimedia and virtual reality should we define the main formative aims of school and how should we think about technology in order to utilize its advantages on a much broader level while avoiding its dangers. These questions, formed in the 1990s, are still valid; and the discussion about the negative effects of media on children has returned once again after the publication of Mark Prensky's results from 2001 concerning changes in the brain in response to exposition to strong communicative stimuli (Prensky 2001). Prensky's propositions were confirmed in 2007 thanks to studies conducted by Garry Small and Gigi Vorgan of the University of California, Los Angeles (Small, Vorgan 2008).

Moving on to the analytical part, I would like to focus on the educational effectiveness of the particular tools in three different studies concerning three different variations of education and three strategies of introducing new information technologies in the field of teaching and learning. The first study is quite recent (from 2014) and pertains to an educational phenomenon which is quite common today – teaching a foreign language (English in this case) via an online video tool. The author of the study, dr Marta Koszko from the Department of Ecocommunication (part of the Faculty of ModernLanguages and Literature) of the Adam Mickiewicz University in Poznań, analysed the levels of verbal and non-verbal communication occurring while teaching online through Skype.

Koszko demonstrated that this form of education is communicatively poorer than a traditional one and presented the most important differences in a tabular layout. The study did not question whether the analysed form of education is as effective as the methods and techniques of traditional language teaching (as Koszko stated, it was not what interested her). One cannot rule out the notion that this educative form is indeed highly effective (as proved by the many students willing to follow it); however, it is worth considering the differences between the skills of a student who partakes in lessons in a profiled didactic space (e.g. in a classroom), and the communicative ability of a student in contact with a two-dimensional computer

screen. In this case, the question which seems relevant is: can a principally limited and somewhat obstructive technique of communication be a complementary didactic tool allowing academic results as good as those achieved though "traditional" methods? It is an open question, similarly to the question of the place of this type of education in the whole process of language teaching.

The focus of Koszko's study was to observe the basic communicative skills one gains while studying a foreign language. The focal point of the second study was reading and understanding texts on a higher, symbolical level. The experiment, conducted by the author of this paper in 2008 in secondary schools in Poznań, looked at the interpretation of the symbolic cultural text of a film in two environments: in school and in the virtual space at home. In both variations, secondary school students who were discussing George Orwell's *1984* at the time were asked to also analyse an additional cultural context provided by Leni Riefenstahl's film *Olympia*. One group of students were to read the book at home and later watch the film in class with their teacher providing additional comments and explanations. Another group, upon finishing the book, received a DVD with a specially composed multimedia lesson including Riefenstahl's film and rich, varied comments as well as interactive exercises.

As their final assignment, both groups were asked to write a paper titled "From ideas to ideology – using examples from cultural texts, describe the mechanism employed by totalitarian regimes to turn ideas into ideologies". The teachers were instructed to place special emphasis on the relationship between ancient culture (and its ideas) and the Third Reich (and its ideology) presented in the film. The goal was to help students understand the mechanism of propaganda used by Riefenstahl and make it easier for them to write their homework.

The study assumed that *Olympia's* expressiveness and visual qualities should considerably increase the appearance of Nazi-related contexts and result in attempts to explain the propaganda mechanism using the relationship between ancient culture and the Third Reich presented in the movie. The frequency of appearance of certain references to *Olympia* and to Nazism in general was selected as an important quantitative measurement of the effectiveness of media (in the school group) and multimedia (in the home group). Also evaluated and considered equally important to the quantitative aspect, was the quality of references used by students. However, since any subjective evaluation of quality is susceptible to bias, the study focused on the most distinctive elements of each student paper with the goal of gauging how students approached the subject, if and how they made the connection with Leni Riefenstahl's movie and, therefore, how effective were the media. Particular attention was given to the forms in which *Olympia* served as a context for explaining the mechanism of turning ideas into ideologies. Papers were divided into three categories based

on whether they invoked the context of Nazism at all and whether they did it directly or in an extended fashion. To ensure more precise results, three separate "school" groups and "home" groups were evaluated.

Table 1: percentage of papers containing references to Nazism and Olympia **(quantitative results)**

	A1	**B1**	**C1**
School groups	85%	79%	89%
	A2	**B2**	**C2**
Home groups	68%	17%	15%

The comparison of paper quality between the "school" and "home" groups leads to the conclusion that the communication challenge posed by the computer media variant proved much too difficult and therefore unintelligible for students working with it on their own. Information technology serves its role incredibly well in historical science or STEM disciplines, which have been taught using more naturalistic methods for thousands of years, but attempts at using it to improve communication abilities have been consistently plagued by the following issue: as the difficulty of communication and interpretation increases and the message becomes more intricate, didactic effectiveness of IT based solutions decreases, particularly where their capacity is limited by design or they are employed as the only teaching tool (Wobalis 2011, pp. 120-140).

Multimedia, with their huge capacity for visualisation, mesh particularly well with natural sciences, but there are reasons to believe that difficulties exist even in that area. The final study (or rather the results of a series of studies) which will be presented in this paper is the oldest of the three. It was performed in the 1990s by a group of researchers from the Faculty of Chemistry at the Adam Mickiewicz University in Poznań led by professors Hanna Gulińska and Andrzej Burewicz. The department's team developed (and partially published) several dozen types of multimedia teaching aids and spent hundreds (if not thousands) of hours testing the usefulness of these aids at all levels of education. Their tests unequivocally confirmed that multimedia visualisation techniques are effective chemistry teaching tools. Based on their research the Poznań team created in 2000 the first, and so far the only, multimedia-based school textbook. It was published by a respected publishing house and introduced to schools under the title *Multimedialny Podręcznik Chemii dla Gimnazjum* [en. *The Multimedia Chemistry Textbook for Middle Schools*]. The conclusions from Hanna Gulińska's many years of research into the use of multimedia in

chemistry education are summarised in her book *Strategia multimedialnego kształcenia chemicznego* [en. *A strategy for multimedia-based chemistry education*].

Is spite of unequivocally positive didactic effects and enthusiastic reception of multimedia teaching applications, a perceptive reader will notice among Gulińska's results several reports consistent with comments offered 10 years later by Small and Vorgan. Gulińska writes: "It became apparent (in the course of this research) that media-based communication suffers from certain disruptions" and later: "Use of multimedia applications can cause undesired behaviours in learners (…). These include attention deficit and hyperactivity symptoms (characterised by low focus, impaired ability to analyse and synthesise data, impaired planning ability and increased emotional instability) and various inhibitions (among them difficulties in understanding incoming information, slower thinking and communication). Also present are behaviours typically associated with computer use, among them, especially in cases of individual use, insubordination resulting in an overwhelming urge to browse everything currently stored on the computer's hard drive and, in extreme situations, even copying certain files without informing the person in charge" (Gulińska 1997, pp. 292-293). In another passage, while describing the effect of multimedia tools on the retention of material, Gulińska points out an interesting phenomenon: instead of the actual content, some students remember only that they played or worked on a computer.

The author of this paper followed that trail and in 2002 performed his own tests of the multimedia chemistry textbook for middle schools on a group of children from a school in Swarzędz. The students worked with a multimedia lesson involving three-dimensional, spatial animations of chemical molecules and reactions. The children watched rotating carbon atoms, a sulphuric acid molecule model, and a several-minutes-long animation showing nuclear fission of uranium. The 3D animations were designed to work with special glasses (included with the book) which allowed students to see the video content as if it appeared several centimetres in front of their computer screens. Each animation was also paired with an appropriate voiceover track explaining the chemical phenomena in real time.

Today, in the age of 3D cinemas and television sets, this sort of imagery is no longer impressive, but in 2002 it was incredibly interesting to observe the children's reactions to three-dimensional animations. The students were delighted and animated. They reacted in a very lively fashion and commented on the animations. Some tried to catch the rotating molecules. Interviews performed immediately after class showed that the children remembered the looks (structure, colours) and movement of molecules almost perfectly, but could not name them properly. In most cases the voiceover commentary was either forgotten, drowned in the noise of lively reactions and conversations, or did not register at all. The teacher

was asked to not repeat the material or spend additional time on exercises which may have helped students retain the material. Interviews performed a longer time after the experiment showed that most children at that point remembered only that they put on weird, colourful glasses in class and watched something spectacular rotate in front of a computer screen.

Conclusions

Used skilfully for teaching purposes, multimedia technologies can achieve brilliant results. They allow people to develop skills and knowledge, to have fun and learn, while at the same time helping users retain information and allowing complex experiments or tests to be performed form the comfort of one's armchair. The aim of this paper was not, of course, to question the undeniable results of repeated studies. The effectiveness of information technology in teaching natural sciences is the subject of the aforementioned *Strategia multimedialnego kształcenia chemicznego*, while in humanities the same topic is covered by *Ekranowy czytelnik* [en. *The Screen Reader*] by Aniela Książek-Szczepanikowa, as well as *Multimedia w nauczaniu polonistycznym* [en. *Multimedia as a tool for teaching the Polish language*] by the author of this paper. Technology and education have always shared a connection and this is not going to change. One could say they are stuck with each other. It is important, however, to remember the reservations presented in this paper, and to ensure that the only thing that students gain from interacting with the torrent of ever-evolving gadgets will not be a memory of "some cool stuff twirling in some program".

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