

Entering Global Knowledge Society: Role of Education

Ivo Slaus

ABSTRACT

We discuss the role of global education in the 21st century for a changing human being and for a rapidly changing world in order of achieving global knowledge-based society. It is shown that contemporary education has to encompass specialized, disciplinary education and paradigmatically different holistic approaches, and that the universities have a mission and a responsibility which goes far beyond the task of providing industry with efficient employees, marketable ideas or science-based solutions. Their mission is to produce mature, independent, critical and responsible personalities, who are not tools in anybody's service.

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INTRODUCTION—THE WORST OF TIMES, THE BEST OF TIMES

Charles Dickens opens his novel 'The Tale of Two Cities' describing the times encompassing the French Revolution by the following sentence: 'It was the best of times, it was the worst of times, it was the age of wisdom and it was the age of foolishness, it was the spring of hope, it was the winter of despair...' It sounds familiar. It should. Our times could very well be described by the same sentence—even more so.

Last hundred years witnessed enormous progress described by many socioeconomic and political indicators: significant increase in GDP/capita: about a factor of five, appreciable increase in life expectancy: by more than a factor of two, there are more democratic and free countries than ever: in 2002, 2.5 billion people lived in free countries compared to 1.6 in 1981 and 89 countries were considered free and democratic compared to only 43 in 1972, colonialism ended, as did the Cold War, 39% of world population (115 sovereign states) live in zones free of weapons of mass destruction (WMD). One could almost claim that the quality of life is better than ever. Certainly human capital has self-augmented during last centuries^{1,2} accompanied by major scientific breakthroughs.

Yet the world is already several years in a deep economic crisis. April 2013 Ipsos-Publicis poll conducted in UK, Germany, France, Italy, Spain and Poland showed that 75% consider that the crisis will be worse in 2014 than it is now,

and in Spain and Italy over 70% consider that the reforms have a negative effect. Presently, the combined wealth of one thousand richest persons is twice than of poorest 2.5 billion people. This large wealth inequality causes increasing crime rate, increasing child mortality and decreasing life expectancy and deterioration of most of social indicators.³ Plutarch claimed that the imbalance between the rich and the poor is the most fatal ailment of all societies. Plato argued that the common good required that the ratio between the rich and the poor be 5:1, and JP Morgan thought that bosses should have not more than 20 times the salary of their workers. Now the ratio is thousand times bigger.^{4,5} Natural resources are overused, biodiversity is alarmingly destroyed, nitrogen and phosphorous cycles are threatened and climate has changed due to human beings.⁶ Ecological footprint is over 30% larger than the Earth's capacity and it is rapidly increasing. In 2025, one-third of world population will be threatened with lack of water. During the last 20 years there were 30 new infectious diseases, and humankind is becoming resistant to antibiotics. There are more countries with nuclear weapons than ever before and many nuclear weapons are still on hair-trigger alert. Military arsenals are enriched with high tech non-WMD, autonomous weapons systems: killer robots, laser weapons, prompt-strike non-WMD force and cyber weapons. Comprehensive Test Ban Treaty is still not ratified. The use of WMD in inter- and intrastate conflicts and in terrorists' acts is a serious threat to humankind. During the last century state terrorism–democide⁷ killed three times as many men, women and children (over 230 millions) as wars (about 80 millions). Natural capital, human capital and social capital—particularly trust are being destroyed! Doomsday clock on the front page of the Bulletin of the Atomic Scientists put in 1947 the humankind at 7 minutes before midnight. Following the end of the Cold War in 1990 it was at 17 minutes before midnight and now it is at 5 minutes before midnight.

Contemporary world is global,⁸⁻¹⁵ very fast changing and interdependent characterized by instabilities and uncertainties. It is scientific human endeavor that generated and generates such a world. Uncertainties characterizing our material world are well understood through Heisenberg uncertainty principle. Yet, uncertainties, black swans, wild cards, challenges and opportunities facing our socioeconomic and political world are not understood and they often paralyze and misdirect human and social activities. Surprises are a basic feature of the future, and

mark all scenario: optimistic (Ray Kurzweil), pessimistic (hell scenario of Bill Joy), prevail (of Jaron ZepeL Lanier), the limits to growth of the Club of Rome and the business-as-usual scenario. There is a profound difference between scenario and predictions in physical sciences related to rational/irrational characteristics of humans and to the very nature of time.

Human beings change continuously as the results of biological and cultural evolutions. Human beings do change the world they live in, indeed so much that it has been suggested^{16,17} that the current geological epoch be named Anthropocene epoch. There is evidence that human biological evolution has accelerated 100-fold during the last 5,000 to 10,000 years,¹⁸ so that people today are genetically more different from those of 5,000 years ago, than the difference has been at earlier 5,000 years intervals. The driving forces of this acceleration are human activities. Domestication of animals is closely connected to the success of the mutation causing the capacity to digest lactose, which occurred over the last 3,000 years. Genes controlling the glucose metabolism in the brain are identified as those that most recently evolved, possibly being essential for the human brain growth to the size twice that of our nearest cousin¹⁹—chimpanzee, and possibly suggesting why humans do and chimpanzees do not have diabetes. Just as in the past people whose ancestors lived in cities infected by smallpox and people living in the area infected by malaria have developed resistance, so humans will change to cope with new diseases. Humans and even human ancestors affected the functioning of the Earth system: couple of million years ago our ancestor—*Homo erectus*—‘invented’ fire and initiated the late Pleistocene megafauna extinction. Agricultural development 10,000 years ago definitely changed the demography thereby influencing the Earth system. Agrarian societies used 3 to 4 times more energy than hunter-gatherer society. Industrial societies use 4 to 5 times more energy than agricultural. From 1800 till 2000 the world population increased over 6 times, the world energy use over 40 times. Over the past 50 years humans have changed the world’s ecosystem more rapidly and extensively than in any other period: the earth is in its sixth great extinction period with rate of species loss growing rapidly, the atmospheric concentration of greenhouse gasses has increased resulting in global climate change. Humankind is now and will remain a major geological force for many millennia.

The process caused by interplay between cultural and biological evolutions is slow compared to intertwining between humans and machines²⁰ and of synthetic biology.²¹ Kurzweil suggested²⁰ that in 2020 nanomachines will be

routinely used in medicine—entering the bloodstream to feed cells and to extract waste. Virtual reality will not be distinguishable from real reality. Ten years later mind uploading will be possible, and in 2040 human body 3.0 could alter its shape and organs can be replaced by superior cyber implants. Synthetic biology is defined as the design and construction of new biological parts, devices and systems that do not exist in the natural world. Synthetic biology is attempting to extend the limited set of molecules in DNA: A, T, G and C. EraGen Biosciences in the USA produces and sells oligos built from four natural bases and two artificial ones: K and X. Around 66 commercial firms on five continents specialize in synthesizing gene- and genome-length pieces of double-stranded DNA.

J Huxley, Nobel laureate and first director general of UNESCO, wrote ‘As a result of millions years of evolution, the universe is becoming conscious of itself, able to understand something of its past and its possible future.... Evolution on this planet is a history of the realization of ever new possibilities.. through the new knowledge.... it has defined man’s responsibility and destiny—to be an agent for the rest of the world in the job of realizing its inherent potentialities as fully as possible.’ It is as if man had been suddenly appointed managing director of the biggest business of all, the business of evolution... What is more, he can’t refuse the job... That is man’s inescapable destiny.²² Current humanity needs not be the endpoint of evolution. Present technologies, as genetic engineering and information communication technology (ICT), and anticipated future ones, as nanotechnology, artificial intelligence, space colonization and creation of super intelligent machines can alter the human condition leading to human enhancement: trans- (and post-) humans. The concept was introduced in 1957 by J Huxley and developed during the last 2 decades.

This best and worst of times is a result of human creativity, curiosity, persistence, love and diligence, as well as of human mistakes, hatred, prejudices, and stupidity, and of inertia of social structures, methodologies and technologies humans developed and built. Human being is *homo faber*, *homo ludens* and *homo politicus*. Humans are eusocial animals. Social groups and social interactions play important roles in the evolution of humans generating co-operation, empathy and love, and competition, animosity and fighting. These basic values are inscribed in our genes. In their quest for survival and reproductions animals behave against other members of their species in the same way as game players. In 1973 John Maynard Smith and also W Hamilton applied game theory to the evolution of animal strategies and introduced the central concept—evolutionary stable strategy. Animals not only compete but often share a

resource if that is beneficiary and if the cost of fighting is too high. Explanation of the evolution of this unexpected behavior is based on the special problem in the game theory—the prisoner’s dilemma. A winning strategy for repeated prisoner’s dilemma games is tit-for-tat: co-operate and never be the first to defect, retaliate only after your partner has defected, forgive and co-operate after retaliating just once. Through such reciprocal altruism natural selection generated various human characteristics, e.g. generosity, gratitude, sense of owing, empathy and trust.²³⁻²⁷ Human beings have social instincts: predisposition to learn how to co-operate, to discriminate the trustworthy from the treacherous, to earn good reputation, to exchange goods and information and to divide labor. We owe our success as a species to a large extent to our social instincts and they are responsible for the rapid expansion of our brain and our inventiveness. Human societies and minds evolved together, reinforcing each other. Altruism is an example of a win-win game. In all major cultures one basic moral law dominates: ‘Thou shalt love thy neighbor as thyself.’—golden rule. Now, ‘my neighbors’ are all human beings? C Darwin wrote ‘As man advances in civilization, and small tribes are united into larger communities, the simplest reason would tell each individual that he ought to extend his social instincts and sympathies to all the members of the same nation, though personally unknown to him. This point being once reached, there is only an artificial barrier to prevent his sympathies extending to men of all nations and races.’²⁸ As never before, the future of each one of us depends on the good of all.²⁹ In our own selfish interest we have to get involved in the betterment of global conditions. Learning and educating are inherent features of human evolution and HG Wells was correct in saying: ‘Human history becomes more and more a race between education and catastrophe.’ underlining Aristotle’s opening sentence in his *Metaphysics* ‘All men by their nature have a desire to know!’

EDUCATION AND THE KNOWLEDGE-BASED SOCIETY

Spoiling youth has been considered one of three most deplorable sins in ancient China. Bertrand Russell optimistically said in his Nobel Prize acceptance speech: ‘The main thing needed to make the world happy is intelligence. This is an optimistic conclusion, because intelligence can be fostered by known means of education.’ However, in 1937 S Freud wrote that ‘psychoanalysis is the third impossible profession following two much older: bringing up the children and governing of nations.’³⁰ Education is broader than ‘bringing-up the children’ and even more impossible. Who should be educated and how,

and for what goal? In a global world the answer to the first question is clearly everybody—all human beings. Since, knowledge now increases exponentially with a doubling time of 5 to 10 years, education cannot be time limited, but it has to be lifelong. The Millennium Development Goals state that by the year 2015 everybody should be educated. Will we achieve this goal?³¹ What it means to be educated? Is it just literacy, and what literacy includes, e.g. computer literacy, science literacy? Task Force for Education for the 21st century, chaired by J Delors, concluded its report ‘Learning—the Treasure Within’³² with ‘Education should contribute to every person’s complete development—mind and body, intelligence, sensitivity, esthetic appreciation and spirituality.’ Therefore, Delors’ Commission answers our second question: the goal of education and to some extent outlines its content and scope, though we will return to it later on. Education encompasses teaching and learning of knowledge, acquiring skills and values as well as mental, moral and esthetic development of human beings. Right to education is one of the basic human rights as declared by the United Nations (UN) Universal Declaration of Human Rights. Since 1957 the Article 2 of the First Protocol of the European Convention on Human Rights obliges all signatory parties to guarantee the right of education, and The UN Covenant on Economic, Social and Cultural Rights of 1966 guarantees the right to education under its Article 13.

Contemporary education is education of a person that is changing and for the world that rapidly changes. It is very different from what it was centuries and even decades ago. In 2003 Orio Giarini and Mircea Malitza published a Report to The Club of Rome ‘Double Helix of Learning and Work’³³ stressing the unity of education and work: work is also education, and education is work. Humans are social animals and in addition to learning and working, which can be individual activities, it is necessary to extend this double helix adding realization of human rights and duties—governance of human societies, condensing into: Triple Helix of Education, Employment and Governance.

Work includes monetarized, nonmonetarized and even nonmonetarizable activities—all socially and economically important. We use the word employment rather than work with two purposes. First, to stress that though some traditional employment, e.g. in agriculture dropped from 85% to about 35% from 1800 till 2010, the number of jobs increased from 0.9 billions in 1950 to 2.7 billions in 2000, while world population increased from 2.5 to about 7 billions, i.e. percentage increase of jobs is larger! There is a job scarcity of 200,000 MDs and 800,000 nurses in the USA, and 50% of firms in developing countries face skill

shortages. Similarly many other countries display mismatch between needed jobs and available skills. Second, education itself is a major job-intensive activity, since the education process that lasted about 20 years has to be extended to lifelong process and has to include everybody.

By education we mean a social endeavor and obligation of assuring learning, education, research and creative activity satisfying human curiosity and esthetic feelings, and assuring collective human security. Society has to guarantee education, otherwise—as stressed by Wells—it is self-destructing! It also means an endeavor encompassing everybody and through their entire lives, i.e. lifelong learning. It is society's responsibility to stimulate and guarantee such an all-encompassing lifelong endeavor.

Employment, governance and education are intertwined and interdependent. It is impossible to claim that the country is ruled by the will of the people, indeed that laws are embodying the concerns for individuals and the global world, and maintaining and developing existing cultures, if citizens are not adequately educated and meaningfully employed. Indeed, current percentages of about 70% stating that their country is not ruled by the will of the people and low employment rates clearly demonstrate that the triple helix of governance, employment and education requires improvements and has to be addressed integrally.

The term knowledge society was used first in 1969 by Peter Drucker³⁴ and its present meaning emerged in the 1990s. In 2000, EU leaders launched the Lisbon Agenda to turn the EU into 'the world's most competitive knowledge-based economy' by the year 2010, and by 2025 into a 'sustainable knowledge-based society'. The key elements of the agenda are: research and development (R&D), lifelong education, ICT, liberalization to create a single market and entrepreneurial culture, and jobs-led growth leading to improved social cohesion. A knowledge society identifies, produces, processes, transforms, disseminates and uses information and knowledge for human development.³⁵ It provides ways to humanize globalization. The fundamental feature of the knowledge society is the knowledge-development link. Knowledge includes science, humanities and technologies, research and development (R&D), inventions and innovations, education—all forming the culture of knowledge. Breakthrough discoveries increase the Pareto maximum (level when all win-win games are exhausted). They can be generated by curiosity-driven research, but also by applied research, as the discovery of the Big Bang demonstrates. On the other hand, the curiosity-driven research led to the discovery of electromagnetic induction and the X-rays—the two most applied inventions. Universities, public research institutes and industrial

institutes are cradles of scientific and technological breakthroughs. Knowledge is the main resource in a knowledge-based society, permeating everyday life, culture, policy- and decision-making. Knowledge-based society is constantly changing and maintaining a long-term and global perspective. The current system of R&D is far from being satisfactory. Nevertheless, it is definitely the best social system that exists as various studies and opinion polls indicate that science is the humanity's greatest success. Planning R&D, commercialization, governance regulation of the R&D and penetration of science into politics are all necessary endeavors to develop the knowledge-based society, but so far full of mistakes: from Lysenko affair and German science to the war on science.

Knowledge differs from all other resources in being not only inexhaustible, but increased by sharing. Knowledge is becoming the main source of political power. These features show that knowledge-based society is considered the most efficient method to achieve goals formulated through various political processes. In that sense all societies throughout the history could be termed knowledge-based, since all used most of the knowledge available at that time to achieve their respective goals. In 2013 EU, and all countries of the world, are very far from realizing the goal of being a knowledge-based society. Knowledge-based society degenerated into a political slogan with empty content. We define knowledge-based society as the society centered on human beings, where the goal is to increase human³⁶ and social capital and assure sustainable development maintaining natural capital. The State of Human Development states 'People are the real wealth of nation. The basic aim is to enlarge human freedom and choices so that people live full and creative lives. This must benefit everybody equitably.'³⁷

Content and Scope of Educational Systems

Throughout history education changed. It started with a fairly general education encompassing a large body of general knowledge and it has shrunk to narrow specialties. This reflects the development of science. Science progressed when it moved from attempting to provide answers to general basic questions to ask and answer specific questions, e.g. from a famous Thales' question 'How and from what the world is made?' to questions that appeared simpler, e.g.: 'How does an object fall?' Progress in science and technology throughout last centuries was a realization of problem solving within narrow disciplines. This endeavor enriched all scientific disciplines and created many new disciplines, e.g. nuclear medicine, and numerous interdisciplines, e.g. bioarcheology. Such activities will

continue and there is no end in sight for any scientific discipline. For instance, though it seems that the entire physical world is based on quantum physics, problems of dark matter and dark energy as well as existence of multiverses only shows that our knowledge is limited. However, our very existence presently requires that we address questions that transcend disciplinary domains. Problems and threats facing humankind are interdependent and rapidly changing requiring addressing almost simultaneously almost all of them. A dynamic holistic approach is necessary. Therefore, contemporary education has to encompass specialized, disciplinary education and paradigmatically different holistic approaches. It seems an almost impossible and even contradictory task. However, history of science can be a useful guidance. It shows several paradigmatic changes like Copernican revolution and more significantly quantum physics and theory of relativity, through which we learned that common sense concepts of time, space and determinism have only limited validity and we learned the extent of their domain of validity. Scientific research is mainly at the border of unknown and often requires methodologies and technologies that are unknown and have to be developed. Therefore, teaching and learning how to approach paradigmatically unknown subjects is part of the scientific approach.

Education has to assure deep and broad knowledge. Most curricula aim to include as much of the existing relevant knowledge. This is impossible since knowledge is exponentially increasing. It could be argued that whatever can be googled, can be omitted, namely that education should reduce to minimum information, and it should concentrate on creativity and research. Whoever engaged in any research knows that often a large collection of information is necessary to think creatively and therefore, it is necessary to train our brain to be capable of maintaining and appropriately using relevant information. Learning by heart large segments of Ulysses or Faust is a useful part of education, as is remembering huge collection of physical data. Education has to focus primarily on how to research, how to ask questions, to stimulate participants to propose new, out-of-the-box ideas, often sounding crazy. Education has to stimulate paradigmatic changes, to think the unthinkable. Most important is that education is intellectually stimulating, fun, pleasure. One is left with a mission impossible, or at least with a problem of tailoring education to an individual. Being a teacher is a very demanding job, but is also very rewarding.

‘University (actually the entire educational system) has a mission and a responsibility which goes far beyond the task of providing industry with efficient employees,

marketable ideas or science-based solutions... The mission is to produce mature, independent, critical and responsible personalities, who are not tools in the service of church, state, and party, business or trade unions. The scholars (actually all educated persons) are treated with respect if they maintain their dignity and uphold their own standards against those of the world at large in those cases where the conflict emerges, and soon are treated with contempt if they accept the rule of the outside world.’³⁸

Recommendation by the Delors’ Commission is expressed by Frank Zappa’s song: ‘Information is not knowledge, knowledge is not wisdom, wisdom is not truth and truth is not beauty.’ Education has to lead to beauty, which seems to be much more dominant than evolution requires.

EDUCATION, EMPLOYMENT AND RETIREMENT

Present retirement system has been introduced at the end of the 19th century. To reduce the influence of social-democrats Chancellor Bismarck introduced in 1889 to 1891 the retirement—first for state employees over 70, requiring that the cost for retirements is shared 50:50 by the employers and employees. The age limit has been set at 65 in 1913 and in 1957 the pay-as-you-go system has been introduced. The first retirement plan in the USA has been offered in 1875 by the private firm American Express Company, and in 1880 railroads became the first major industry to provide a pension plan. In 1935 the USA Congress introduced the social security system. At the end of the 19th century the life expectancy throughout Europe and North America has been less than 50, and fixing the retirement age at 65 implied that very few persons would actually have to receive retirement benefits. If countries would accept the spirit of the Bismarckian prescription, rather than the actual number, it would follow that the present retirement age should be around 90.

Most of developed countries have low fertility rates (much less than the 2.1 required to maintain the population), education extends to well over 25 and first jobs are very demanding considerably reducing the time interval likely for women to become pregnant, life expectancy is well over 70 and many businesses still maintain a practice of early retirement (typically between 55 and 60) to allegedly make room for younger, better educated and definitely cheaper, workers.³⁹ All of this makes the system of pensions, as it is today, not sustainable. It will collapse—simply the ratio of retirees and employed persons is drastically increasing from acceptable 0.25 to about 1. Progress in science and technology has resulted not only in a much longer and constantly increasing life expectancy, but also so that

disabled person can work and can be creative. It is not surprising that many retirees work after they retire.^{40,41} This is the realization of the fourth pillar of the retirement system advanced by the Geneva association. Three conventional pillars are: first, the compulsory pay-as-you-go retirement, second, the supplementary and often capital-funded company pension, and the third are individual savings. Only the fourth pillar—part-time, flexible employment after retirement is robust enough to withstand various perturbations. It has been pointed out that older workers, specifically retirees have not only more experience, but are also more loyal, have high motivation and can learn, albeit in a different way than their younger colleagues but nevertheless quite fast and efficiently.⁴²⁻⁴⁶ The human capital of older workers is often not used and therefore, it deteriorates. The Geneva Association in collaboration with University of Lünenburg has launched in 2005 a project ‘Silver workers’ to understand the postretirement work.⁴⁷ Based on the study of retired Germans aged 60 to 85 they concluded that 75% of retirees would work even without pay, indicating that the work itself provides various intangible benefits, 84.6% are prepared to go on business trips, and 68.6% have participated in advanced training since retirement. These findings clearly demonstrate a variety of benefits stemming from part-time, flexible postretirement employment.

Instead of a rigid structure of education followed by employment and then retirement we propose early employment guaranteeing continuous lifelong education. Throughout our life we should learn, work, play and contemplate. We argue for raising the current minimum mandatory level of education to a first independent research project (typically age of 18-20). This will enhance the learning capacities and employability of new job seekers, and increase job growth in education and education-related fields. It is essential that the lengthening of mandatory education is done by increasing the quality of education. The increasing demand for knowledge and skills requires a continuation of education and training even after people find employment. Actually, a system where institutions (firms, factories, etc.) where a person will work should provide fellowships, then internships, and education once a person is employed in that institution (firm, etc.) would be a fairly good integration of education and employment. Lifelong education including everybody is necessary to sustain rapid economic development. Full employment is necessary! This means that the need for education-related jobs increases by more than factor of 10. The demand for more educators is best met by reemploying an appreciable fraction of retirees, many of them to be re-educated or at

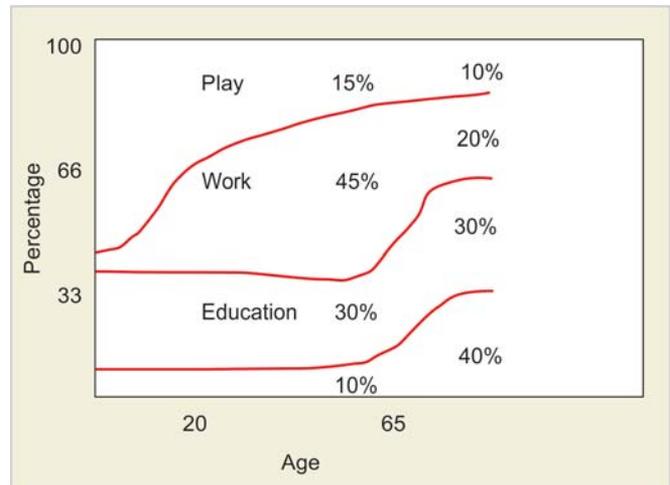


Fig. 1: A new model of education, employment and no retirement

least requiring additional education. Percentage of persons engaged in lifelong education is quite small. The EU15 average in 2000 was barely 8.4%, with largest for Sweden (22%) and the UK (21%), and smallest for France (3%) and Greece (1%).

Figure 1 shows a new model of education, employment and no retirement.⁴⁸ Retirement is often necessary for disabled and persons with long illnesses. However, progress of science and technology is significantly reducing human inabilities as is demonstrated by one of the greatest living cosmologist S Hawking. Creativity is not necessarily decreased by illness: L van Beethoven was deaf when he composed the ninth symphony. Claude Monet, Marry Cassat and Edgar Degas had cataracts and their eyesight worsened so much that it seems they painted from memory. Pierre Renoir suffered painful rheumatic arthritis. All of them continued their creative work.

BEYOND THE CAMPUS

Universities and academies are considered among the most conservative structures prompting W Wilson to say, when he was president of Princeton University, that it is easier to move the cemetery, than to change the curriculum. Nevertheless, universities, academies and research institutes are the cradle of all scientific breakthroughs producing paradigmatic changes. Therefore, any change has to be done carefully!

Though universities are still inert, contemporary system of higher education did change appreciably. The Open University, the first UK University to offer distance learning to entrants with no prior qualifications, is the country largest university with more than 200,000 students. It routinely tops the country's national student satisfaction survey. For-profit institutions are also growing. A number of organizations generate revenue based on services supporting open-source

software. ICT introduced massive open on line courses (MOOCs). We list some.⁴⁹

Udacity, a private educational organization founded by S Thrun (Udacity derives from audacious for you, the student). It is the outgrowth of free computer science classes offered in 2011 through Stanford University. As of April 2012 Udacity has 24 active courses, and hope to enrol half a million students. Udacity is funded by venture capital firm and from Thrun's personal money.

edX-MOOC platform founded by MIT and Harvard to offer online university-level courses in a wide range of disciplines. The two institutions have each contributed \$30 million to the nonprofit project launched in 2012 and builds on MITx, a project started in 2011. Neither MIT nor Harvard students may take the online courses for credit. Courses are used to enrich their learning experience. The project will be used also for distance education.

Coursera is an educational technology company initiated by Stanford professors. The contract between Coursera and participating universities contains brainstorming to generate revenue, including certification fees, introducing students to potential employers and recruiters, tutoring and sponsorship.

Khan Academy is a non-for-profit organization with the goal of changing education for the better by providing a free world class education for anyone anywhere.

The Council of Australian University Directors of Information Technology (CAUDIT), EDUCAUSE (the Association for Information Technology in Higher Education based in North America), the UK Joint Information Systems Committee (JISC) and the Netherlands SURF Foundation undertook a collaborative visioning of the future of higher education to explore important issues.

It is absolutely necessary that the higher education system changes since the number of students will considerably increase: from about 5 to 10% of a narrow age cohort to 50 to 80% of all people. The students' age will span from adolescence to quite old age. Regardless of their prior education and degrees at the time of enrolment in a new program knowledge of students will be very different. During the past 40 years the number of students pursuing the tertiary education skyrocketed from 30 to 150 millions. It is expected that by 2025, 60% of the USA population will hold high-quality college degree. The UK Government has set a deadline (already now!) for 50% of all 18 to 30 years old to participate in higher education.

ICT, ubiquitous networks and new models mean that higher education institution will need to focus less on ownership than on access. Book may be accessed online without a need to own a physical copy. Application, such

as e-mail, can be accessed 'in the cloud' without needing to own the software or a computer. Educational resources may be from a freely accessible repository whose material is owned by no one—yet by everyone. Collaboration becomes essential in education and research. Wikipedia is a good example. ICT has become a dominant 'game changer'. 'Cloud computing' assures not only cost saving, but necessary flexibility. An institution can quickly respond to requests for new services because they can simply locate and purchase from the cloud without having to build in-house systems and assure their operation. Cloud computing is highly scalable and forces providers to increase and assure standardization and interoperability and efficiency. Open educational resources (OER) including textbooks, lesson plans, journal articles, audio-video, exams, digital images, entire courses, etc. are available under an intellectual property licence such as creative commons, that allows their use for teaching and research.⁵⁰

Not everything can be 'from the cloud'. It is necessary to establish and maintain institutions as, e.g. CERN is, and hopefully SESAME will be. These institutions are both a role model and have considerable political and social impacts. It would be appropriate that such institutions are established throughout the world forming a network of global institutions superimposed on many networks, actually a full spread of higher education institutions and research institutes, as well as academies.

CONCLUSION

The aim is to assure healthy, educated, creative, free and active human beings cooperating (co-operating and competing) in a harmonious and sustainable developing society. Within such a society humankind can successfully cope with all threats and problems and take advantages of all opportunities. Education plays an essential role and new, innovative, out-of-the-box, even crazy ideas how to develop education to meet the contemporary needs are blooming, and many more are needed. It is very appropriate that the World Academy of Art and Science (WAAS) initiated a systematic discussion on education, notably on higher education.

We list some challenges and opportunities faced by contemporary education:

- Education encompasses from pre-Kindergarten to lifelong education for everybody in a rapidly changing world and therefore, it is a major economic, social and political endeavor. It is simultaneously the responsibility of society, of sovereign states and of families and individuals. This multi-trillion dollars enterprise has to involve public and private schools on all levels. Mixture

of public and private enriches the entire educational system, but general guidance has to be present, guaranteeing differences, flexibility and constantly advancing quality.

- Public and private education are aimed toward excellent education, but they also involve some additional different value systems. It is necessary to assure competition but also co-operation between them. Since, education is a very costly endeavor benefiting societies and individuals, it is necessary that its cost is covered by both society and individuals without jeopardizing the existence and dignity of individuals. Currently, in the USA student debt represent the largest source of public debt and it exceeds now 1 trillion dollars. Disconnected employment from education resulted in a system which is almost worse than slavery. System of vouchers, of fellowships, of internship and initial guaranteed employment are worthwhile options to be discussed.
- Science and technology and also education changes human beings and education has to be tailored to this changing human being. Education has to have a feedback developing mechanism implying that education itself constantly evolves guaranteeing advancement of quality of education.
- Challenges and opportunities in our rapidly changing world demand fast actions producing paradigmatic changes. Education has to encompass knowledge, appreciation, methods and stimulus to assure paradigmatic changes and nevertheless, it has to maintain incremental improvements within specific disciplines. Global dimensions are badly missing in all our schools, and there is no appreciation of local/global: glocal aspects.
- Research and creativity are necessary at all levels of education. Best teachers of creativity and of research activity are those who are creative themselves. This requirement may lead to elimination of distinction between research and 'community type' higher education systems.
- Structure of education has to allow easy transition recognizing that humans develop at various speeds: late bloomers and early developers, particularly talented, born leaders and followers. Each level of education has to be awarded with an internationally recognized degree.
- Education and employment have to be strongly interconnected assuring that at the age of about 18 to 20 years a person is employed and continues to study, to research and to be creative. Society—sovereign states, firms, factories, universities, etc. and individuals—through values and structures assure this strong

employment/education link. Education after this first employment can be called higher education. Since, the longest segment of life humans are involved in higher education, it is necessary to devote special attention to higher lifelong education.

- Most significant changes will be in higher education. First, the number of persons involved in higher education will change by many orders of magnitude. The ICT plays the most dramatic role in higher education and MOOCs can soon become the dominant mode of higher education.
- It is important to discuss various hybrid modes and Ian Donald School system provides interesting case studies. Hybrid models could be composed of MOOCs and 'summer' schools with experimental, laboratory and/or clinical studies.
- It is frequently said that we currently face leadership deficit. Contemporary leaders should be educated for a global, rapidly changing world. President Ivanov of Macedonia initiated a very worthwhile project School for Young Leaders and that experience can be incorporated in a development of global education.

This conference and several consequent conferences will enrich our understanding of education and particularly of higher education and guide us in improving them.

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ABOUT THE AUTHOR

Ivo Šlaus

World Academy of Art and Science and Dag Hammarskjöld University College for International Relations and Diplomacy, Zagreb, Croatia

Correspondence Address: Institut Rudjer Boskovic Bijenicka 54 10000 Zagreb, Croatia, Phone: +385-14680202, +385-915864442 e-mail: slaus@irb.hr