RE→ENGINEERING FUTURES

Executive Summary

FUTURE AGENDAS FOR GLOBAL EDUCATION

KEY CHANGES IN GLOBAL EDUCATION

	AROUND 2017	AROUND 2025	AROUND 2035
NEW EDUCATION LANDSCAPE (EMERGING FORMATS)	• Online learning (including MOOCs) integrated into personalized educational trajectories • Academic grades give way to achievement recognition (competency and precedent passport) • New models of investment in talent and other financial / insurance tools in education for learners & investors • Cognitive traction and student engagement become elements of assessment / self-assessment and evaluation procedures	• Rise of Billion-Student Universities leads to education market concentration (Educational Imperialism) • Artificial tutors and mentor networks • Mass market solutions allow high quality education without ever entering a school or a university • Major role of gaming environments and augmented reality • Objectification of education through biofeedback / neurointerfaces	• Game and teamwork are two predominating forms of education and social interaction • Artificial intelligence as a mentor ('Diamond Age Primer') and a partner in research • 'Live Knowledge' models and the death of 'Gutenberg Galaxy' • Education in NeuroWeb-linked groups and new pedagogy
OBSOLETE FORMATS (LARGELY RECOGNIZED AS INEFFECTIVE GIVEN THE AVAILABILITY OF FEASIBLE FORMATS IN ADVANCED COUNTRIES)	• 'Human phonograph' industrial teaching based on standard textbooks & tests (replaced by ICT based solutions) • Standardized tests (complemented & replaced by tests more focused on unique & creative abilities) • Semester grades (replaced by continuous result recording)	• Graduation diplomas (replaced by life-long competency diploma) • Academic journals (replaced by researcher communication networks), citation indexing standards & IPR management system (replaced by comprehensive digital KM ontologies) • Single-author textbooks • ASCs as a social deviation	• Comprehensive schools • Research universities • Texts (books & articles) as a predominant medium of knowledge-based communication

INTRODUCTION[1]

The coming decades will see an era of the most radical changes in education since the appearance of national education systems. And the source of these changes will not be in the educational system itself, but rather it will be driven primarily by industries: digital technologies, healthcare, and finance.

Within the next twenty years, this new global architecture of education will emerge. We will examine the seminal design of this new architecture by creating a systemic vision of the impact that innovative technologies and emerging social practices will have on educational system. This analysis reflects a wide range of experience culled from educational experiments that we have observed, took part in or initiated ourselves.

Our work is also an invitation to collaborate: it is a call to those who feel ready to take part in the creation of architecture, protocols, and practical solutions for education in the 21st century. We believe that this kind of design requires an open-source platform, that we, working together will have to assemble.

* 1. This report is a textual description of the various aspects of the 'Global Education Futures Map'. The complete map can be accessed at www.edu2035.com or downloaded and printed for offline study.

DISCUSSING A GLOBAL EDUCATION AGENDA: WHY NOW?

A majority of 'best practices' in education systems today come from OECD countries. However, these countries also find themselves at a critical juncture, a turning point — they need to re-assemble educational models due to challenges we all face. The primary challenges are:

1 | Development of digital technologies and telecommunication systems that adapt efficiently to changes in which knowledge is actually created, transmitted and stored, and related skills are developed.

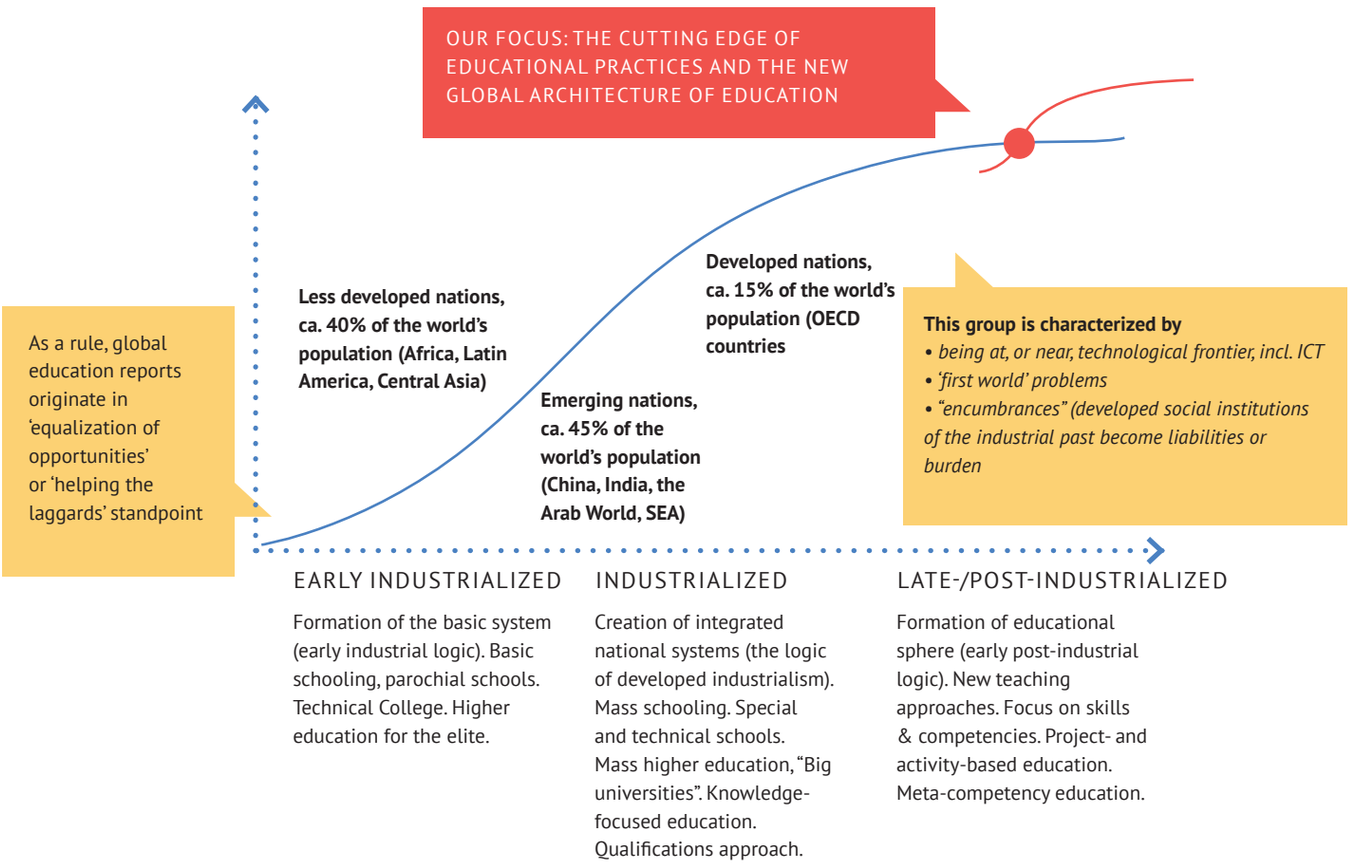
2 | Many of the new solutions in education today come in the form of technological startups that co-develop with spreading digital technologies and social innovations. Outside the education system, a new transnational market emerges, which within a couple of decades (or even sooner) could take over the traditional educational system and introduce new standards of learning and talent management.

3 | Increased economic competition in industrialized countries sets the demand for new types of skills and new forms of professional education & training. On the one hand, there is a call for higher flexibility and a broader scope of curriculum with a strong focus on universal skills (so-called '21st century skills'); on the other hand, shorter preparation cycles are required for highly-focused professional skills critically needed within industries.

4 | Education is now quite literally seen as an intangible investment asset, to which all criteria of investment markets should be applied. The way this asset is created and capitalized should become transparent and easily manageable (incl. the partial 'detachment' of talent benefits from talent owners, as in stock and credit markets).

5 | Shifting values of this consumer society imply that the educational system obtain a new type of 'human resource' to work with. On the one hand, there is a growing number of students who no longer have a high valuation for education and so we see concurrently less motivation to learn (thus comes the need for gamification and other means that help retain students' interest) on the other hand, there is a growing share of conscientious students who understand the importance of personal development, who are willing to set their own goals and are therefore reluctant to take 'package deals'.

Apart from advanced countries that face these challenges, new players in the global education market are emerging countries who are striving to compete for markets and political agendas (including the 'competition for minds') on par with developed nations. These countries rapidly and successfully establish their educational systems by copying the models of industrialized countries. However, given the fact that the advanced countries' education systems are now themselves transforming, there is a risk that emerging nations may actually buy 'unsalable goods' (recipes for industrial-age educational systems) which may become obsolete in just 10-15 years.



Advanced and developing countries need a global education 'futures map' — a map of opportunities and threats that may emerge over the next decades as new educational models unfold. None of the existing players — neither leading educational institutions, nor major employers, not even global governance organizations — have an answer to how exactly this global sphere should be configured. But it is evident that the search for solutions should focus on cutting-edge practices exhibited by leaders of new education. One of the focal points of global political and business dialogue will be the global education architecture — the system of checks and balances that would create more room for collaboration and would resolve potential conflicts and tensions between local, national and transnational levels. Our report is an invitation, a kick-off in the process of charting such a global map which, as we believe, will help create processes and institutions to support productive formation of next-generation educational systems.

THE MAIN ISSUES WE DISCUSS IN THIS REPORT:

1 | How should the new model of education be designed, and what processes will influence its organization?

2 | What are the most promising sectors of the emerging market in this new education, and what types of business projects may be most in demand? Today, many areas in education, including new educational technologies, remain as hidden opportunities,

potentially worth many billions of dollars, where first-movers will have a chance to corner this huge market[2].

3 | How will the transformation of the old ('industrial') model of education occur, and what decisions need to be taken to manage existing educational institutions more effectively and efficiently?

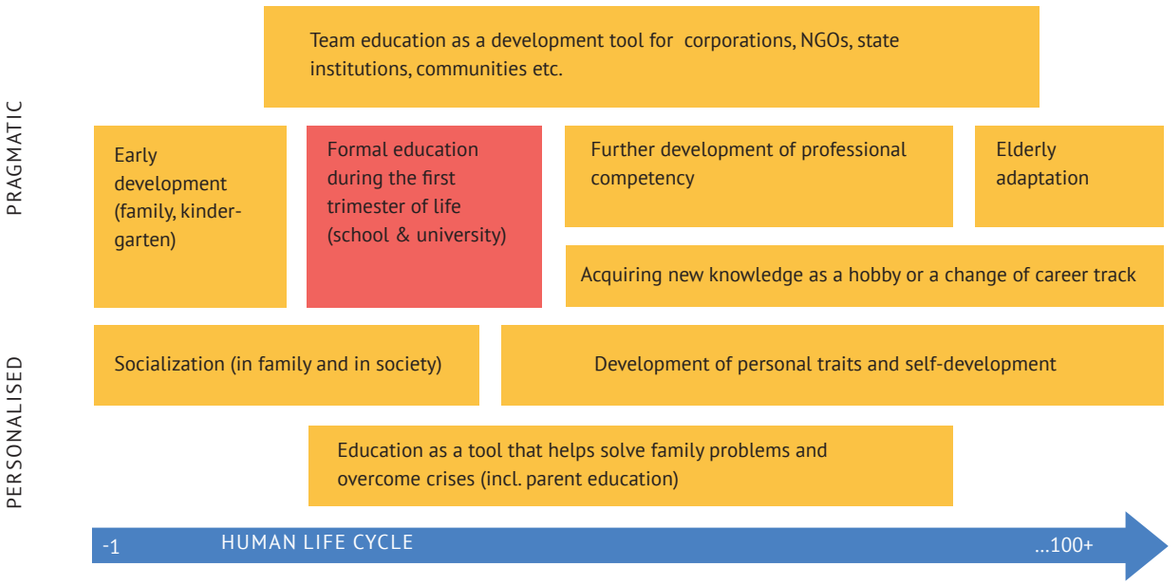
* 2. To be more precise, it is more often that second-movers, not first-movers, get the top position, if they are able to create necessary competences and learn from first-mover mistakes. This strategy is applicable in new education too.

BASIC PRINCIPLES OF MAPPING THE EDUCATION FUTURES:

- The future can be created, it depends on our efforts;
- There are many possible futures — it is not determined by the past, but depends on current decisions taken by participants and stakeholders;
- There are areas in relation to which one can make predictions, but in general, the future is not reliably predictable; we can get ready for the future or prepare the future the way we envision it to be.

HOW WE UNDERSTAND EDUCATION

In this report, we discuss education as it should be, a practical, flexible , formatted process as an institutional support to development and learning from birth to death. Obviously, formalized educational institutions represent only a fraction of this phenomenon. We believe that in the future the domain of education will expand to match the evolving domain of learning — it will encompass nurture, personal development and even psycho-therapy.
In this report, our aim is to look into the universal processes affecting education in its totality, not only the formal educational institutions.



KEY DRIVERS OF EDUCATION SYSTEM TRANSFORMATION

TRANSFORMATION DRIVERS: WHERE THE NEW EDUCATION COMES FROM

Transformations in educational sector are driven by new technologies and innovative social practices that spread through modern societies. Solutions that serve as a backbone of society (i.e. infrastructure) are particularly important. The three infrastructural domains that have the greatest impact on these transformations are:

- Communication infrastructure: the domain of information and communication technologies (ICT) that influence all processes of information storing and transmission;
- The infrastructure of production and consumption: the financial and investment sector that sets common protocols for the economy & the education;
- 'Body' infrastructure: wellness & healthcare industry that is (broadly) responsible for the development of human body and mind.

Modern technologies (especially ICT) have low cost for the end user; they are indifferent (non-sticky) to cultural differences and can quickly penetrate into the social processes (incl. education). Since both the creation and transfer of modern technologies are essentially trans-boundary, this sets up new requirements for the architecture of the educational system, which in the future should also be globally integrated.

However, ICT should not be looked at as a silver bullet that will solve any and all problems of the existing education models. For instance, even now it is clear that existing teaching models of schools and universities can be easily 'hacked' by the use of Internet: unlike real teachers, Internet search engines appear as if they 'know' everything and are ready to share it at any moment, thus encouraging intellectual passivity in students that would rely on external rather than intentionally acquired knowledge. Target outcomes of traditional education (e.g. the formation of a worldview) cannot be achieved through online education alone, so finding new ways to help students form a comprehensive and more valid worldview using the new technologies is a critical task.

THE IMPACT OF NEW TECHNOLOGIES ON EDUCATION[3]:

* 3. Technologies that may influence education are discussed across multiple technology foresight reports, and we do not include this discussion in the Executive Summary version. See trends & specific technologies in the map below.

1 | In the future, the provision of education will become even more segmented and stratified. Its quality level depending on the availability of, and the cost of access to, the holders of unique competencies — 'gurus' and relevant communities of practice.

2 | The relative cost of automated solutions (such as online courses and training software) will decrease compared to 'live' education, at the same time its efficiency will increase, due to the accumulated learning of new education providers. The major share of learning will therefore occur through automated solutions: at the early stages these will be hybrid online/offline formats, like in blended learning or flipped schools, whereas later fully automated personal mentor systems will be able to compete on par with schools and universities.

3 | Face-to-face live education & training will be considered a 'premium' service and, in most cases, will be organized not as lengthy & gradual, but as short & intense. Live education will refrain from forms such as teaching & training through standardized texts and exercises, and will instead focus the development of complex interdisciplinary skills such as creative & critical thinking or communication skills, and mastering body-and-mind states that enhance resourcefulness, productivity & creativity — i.e. focus on things that are distinctively human and difficult or impossible to mechanize. Live education, especially for adults, should and will be organized 'horizontally', largely through knowledge exchange, co-learning, and co-creation. Moral education, focused on higher values that help uncover and actualize human potential, should become an important part of such live education.

4 | Performance assessment systems in education will develop further to allow continuous assessment in a gaming-like dynamics (as it is done in massive multiplayer online role-play gaming). For many users, education will transform into a 'personal quest to boost a character', wherein a student develops herself according to a recommended scenario. The 'quest for achievement or trophy' logic will be embedded into augmented reality systems that would award (with gaming bonuses, tokens, badges etc.) real-life professional conduct, healthy lifestyle, citizenship skills.

5 | A shift occurs from the senior-to-junior (hierarchical) evaluation & feedback (e.g. teachers assessing pupils, bosses evaluating their subordinates) and towards multi-source (circular) evaluation & feedback. This provides a substantially more comprehensive picture about the current traits of the student and her/his 'development zones'. Teachers, curricula and learning environments should also become the subject of regular circular evaluation, allowing a much faster and more productive tuning of the components of educational process.

6 | The assessment of achievements gradually evolves into a competence profile, a system that would record current state and development of individual's knowledge & skills across different domains of professional & social life, and would accompany individuals throughout their life. Results of formal & informal education, extracurricular & citizen activity, professional activity, hobbies, sport achievements and personality developments could all be represented in this single profile, updated throughout lifetime from early childhood and until death, providing a comprehensive representation of individual skillsets, abilities, achievements, and reputation.

7 | Assessment and evaluation processes will go beyond educational systems and will become integrated into the universal systems of personalized achievement and reputation management. Levels of achievement and reputation will also moderate access to knowledge and resources in education and in society overall (e.g. personal competence profile could be a much more reliable source of information regarding the borrower than a credit history).

8 | In addition to evaluating the results, it is possible to assess the learning progress through the use of objective physiological parameters, using real time biometry and neurointerfaces. On the teacher side, there are already tools available that help identify individual learning styles (cognitive traction), the speed of learning for different type of assignments, student's engagement in learning, etc. On the learner side, similar tools allow to provide the objective feedback whether the learning process is sufficiently interesting, intensive, accessible and engaging. These metrics would allow to build courses and programs where the majority of students could achieve a 'flow state', a state of maximal immersion in the learning process, in which learning would occur effortlessly and would be intrinsically rewarding.

MACRO-FACTORS INFLUENCING THE TRANSFORMATION OF EDUCATION

1. *Rebuilding global economy through technological innovation and greening*

A fundamental process in the global economy today is the gradual reorganization of technological foundations of major industrialized nations. In particular, in the wake of 2008 crisis, many OECD countries responded with re-industrialization, aimed to revive industrial production practices and increase employment in industrial sectors. However, these newly established industries are built around the different set of technologies, compared to industries previously displaced in 1990s and early 2000s by restructuring and outsourcing. Two major trends that shape these new industrial practices are intellectualization (i.e. proliferation of automated solutions that replace routine manual and intellectual labor) and greening (i.e. increased application of green technologies including the reduction of waste, reuse and recycling, etc.). Another important trend is that production may become hyper-local: with 100% connectivity and widely spread modern production technologies (e.g. 3D printing, energy micro-generation, robotics and biotech), manufac-

turing will occur on the level of local communities or even individual households, and trading will primarily concentrate on exchange of designs and blueprints.

Given this transformation, one of the most important competencies of future workers & citizens will be the 'lean & green' thinking: the simultaneous cost-reducing, quality improving & 'greening' technologies and practices[4]. 'Eco-thinking', a responsible attitude towards nature, bridges with 'global thinking' whereby individuals take responsibility not only for environmental but also for social and cultural consequences of their actions. This will gradually lead towards the introduction of 'ecology of mind' (responsible thinking & action, the term suggested by G.Bateson) as one of backbone disciplines in the future curricula, along with critical & creative thinking.

* 4. The application of lean methodology in mass-production industries has challenged the conventional wisdom that quality improvement and cost reduction cannot be achieved at the same time. Similarly, lean & green thinking challenges the conventional wisdom that green solutions cannot be cost-efficient.

Although some aspects of this new economy can already be observed, the proliferation of new technologies and practices will occur gradually over the next several decades. Speed of proliferation will be driven by the cycle of replacement of the old infrastructure with the new one (including the energy and extracting sectors), and by the rate of acquisition of new consumer values and habits. A key stage of transition is the fast moving 'launching wave' of technological startups in OECD countries and emerging economies that bring lean & green solutions to consumer & production markets. Education can play a vital role in boosting this start-up culture. This is occurring now as the venture industry generally applies the model of startup acceleration that is essentially an educational process (involving project-based learning, mentoring & training business skills).

The development of the new economy will also require the formation of new financial architecture — in particular, a more reliable valuation of creative and unique activities. Non-monetary exchange models will use time and reputation as basic exchange values. Such models have already been successfully applied in education to stimulate the 'webs of learning' (in particular, Brazilian SABER system allows junior students to pay senior students for their tutoring and mentoring with vouchers, that senior students may further use to reduce the university tuition fees). Reputation can become another form of capital — it already can have objective representation within social networks, and several startups are developing possible models of digital reputation that would reflect individual status within online communities. In the future, such online reputation models will merge with offline reputation indicators, and integrated models of reputation models will be form, that will have a significant impact how (and with whom) we learn or build our careers. We also expect that in few years first online exchanges will appear that will allow reputation and time capital to be used to pay for the variety of educational online services.

2. *Shift in employment patterns and lifestyles*

The transformation of economy structure inevitably changes the structure of employment. In coming years, automation of manual and intellectual routine labor will lead to substantial job reduction — which may increase social tension unless displaced workers can acquire new skills and enter job markets in new sectors. Education may serve as a social buffer that helps this shift — and educational institutions should proactively prepare for the coming transformation. In addition to more traditional forms, re-training can also be done in virtual worlds that could be customized or specially developed for the purpose.

Hyper-localization of production 'folds down' complex production chains into desktop devices (3D printers, biotech micro-plants, chemical micro-reactors etc.) controlled by end users. This will allow the end users to embody their ideas directly into products, which will

lead to the revival of DIY-culture or the new 'craftsmanship'. Production will be accomplished by network-like communities of craftsmen, a dynamic mosaic of small groups of artisans with unique specializations, united by shared practices, standards and values. The new craftsmanship will rethink the division of labor: the specialization in the domain of material production will be of little importance (instead, we could think of some of these craftsmen as one-man-shops that will produce a wide variety of products), yet there will be a deep specialization of intellectual and creative labor based on the unique and authentic character of products offered by their manufacturers. The main barrier to the spread of the new craftsmanship is a nearly-lost culture of material production 'for yourself', so it is for education to help revive it and tip the balance in favor of DIY practices. New craftsmen can emerge within the strata of the 'new aged', people over 65 who (due to improving medical technologies) get a chance to live a second active life up to 100-120 years. In the longer-term perspective, the development of DIY-culture can help destroy the 'tyranny of experts', professionals who protect their jobs by keeping barriers on knowledge and expertise sharing. It will contribute to the genuine democratization of technology and, consequently, to the transition to a society with dominance of networks (not hierarchies) in relationships, coordination, and learning.

Another important shift occurs due to the mass-scale satisfaction of basic needs in the consumer society (or, moving up levels of Maslow's pyramid of needs). As a result, new generations recognize the ultimate importance of creative self-actualization — it is no longer the prerogative of the elite, but a value for the majority. We can assume that the deep meaning of 'affluent economies' is not to enslave people though consumption but to help social healing, moving them from consumerism (basic need satisfaction) and towards self-actualization (higher need satisfaction). Individuals seeking self-actualization are naturally among the key consumers of personalized education.

3. *Shift in patterns of family organization & childhood*

Decline of the 'traditional family' model and the explosion of new experimental family forms over last decades occur due to the fact that modern urban infrastructure encourages autonomy, allows the breaking of family ties (as new partners can be easily found) and questions the need for co-existence (as surviving or raising children can be done in single-parent and other family forms). Today families are in search of identity and existential meaning — and it is for education to help families find new meanings of 'being together'. In the next few years, we expect a growing & widening popularity of the 'family university' model, where, based on their shared vision of the future, family members can acquire family-demanded skills or educate each other. Some programs in these universities can cover courses on effective parenting across the child's lifetime, from early childhood or even pregnancy and well into adolescence, and provide mentorship and community support for parents. Another important role of such universities could be to facilitate the transfer of inter-generational experience of the family: its history and experiences of its older members, its footprint in reality and digital worlds, as well as the reintegration of generations within a family (from grandparents to grandchildren) through co-work or co-play. Finally, education can help re-establish 'family teams' building their identity around the family's social mission (e.g. restarting the professional dynasty or a family business).

It is not only up to adults but also to children to initiate changes within their families. Today we are at a turning point, when children in developed countries have an opportunity

to apply their 'childish' curiosity and interest to 'serious' activities that generate substantial economic returns (e.g. young designers or programmers that can earn millions before age of 10). As a result, some children can become financially & socially independent at an early age and can take decisions concerning their employment, independent residence, active participation in the affairs of the family, etc. The new education can provide some students with an opportunity to reach not only intellectual, but also emotional and social maturity much earlier than today (e.g. age 12-13 as was the case a hundred years ago and not 17-21) — while some others may want to delay until much later. The modern urban model of 'automatic initiation upon reaching the proper age' can be replaced with a new model of 'initiation upon passing a pre-determined level of personal achievement and maturity' — and later by the competence profile that can open doors to the ever expanding range of opportunities depending on proven capability. In other words, as lifelong learning models become ubiquitous, and as early adolescence models become wide spread, social age will completely replace physical age as the measure of 'adultness'.

The spread of new technologies in child and family education has its downside, too. Media stories discuss the problem of 'tablet children', the new 'Mowglis' raised by computers — the threat that modern children overusing tablets and smartphones (instead of playing with toys, their mothers or their peers) from a very early age would lose some important cognitive skills & abilities that they could not develop with limited tablet interfaces. However, this is likely a temporary problem: the next generation of technologies will unify all educational, developmental and entertaining solutions surrounding a child (her own room, playing area in the kindergarten, or entertainment center in the mall) into integrated learning environments where long-term gaming scenarios will combine physical, virtual and augmented realities in a natural way and will provide 'seamless' experiences of educational scenarios. However, in the long term we can expect other serious, yet underestimated, problems, that will jeopardize the formation of complex mental structures in children and younger adults — in particular:

- 'new dyslexia': many complex cognitive activities (e.g. proper use of language such as the correct spelling and punctuation; skills of complex information retrieval through remembering and analyzing; proper use of technical environments through device programming or configuring, etc.) will be done by automated services and advisory services — and 'intuitive interfaces' will 'dumb down' the majority of population that will lose relevant skills & abilities;

- 'flexible' morality and worldview: when virtual worlds with arbitrarily constructed physical and ethical laws become the main developmental & educational environment for the majority of children and adults (which, as we believe, is a highly realistic scenario for education beyond 2020), and the basic motivations are driven by gaming achievements, a generation is soon formed with highly volatile and distorted value system, that may likely be incompatible with needs & goals of their real families, future employers, and society overall.

These threats (and many others that could be listed alongside) indicate a fundamental challenge that the new education faces even today. New technology solutions rarely take into consideration specific goals and functions related to the development of individuals and communities. So far, they have not produced any major disastrous effects on human

cognitive abilities (or at least these effects have not been too dramatic to risk the functioning of our society) — but it should be seen as a responsibility of hardware, software and virtual world designers to avert these effects in the future. Of course, the software developers community requires support from educators and cognitive scientists in respect to standards that would help effective & safe work with children. This means, inter alia, that more sophisticated standards & regulations on the design of multiple-age user interfaces (such as tablets or smartphones that some parents give to their children at the age as early as six months, while psychologists believe that may be unsuitable before the age of two years). Ideally, all software architectures should consider how educational & developmental goals are achieved in their solutions: that is, a universal 'developmental paradigm' in software design.

SCENARIO FACTORS

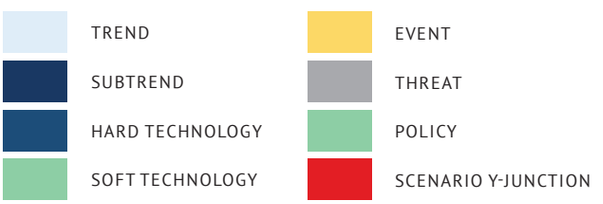
Among the most important high-uncertainty and high-impact factors that can influence the new education is the scenario of Internet proliferation. National governments of many large countries search for ways of controlling and limiting the spread of global content across their domestic networks (so-called 'splinternet' scenario). From the point of view of many traditionalist countries, free access to global educational content poses a possible threat to their intellectual and spiritual security. Therefore, it is likely that such countries will introduce censorship regimes aimed directly at regulation of educational content delivered via the Internet. In particular, governments of some countries (such as China, UAE, and Russia) may impose restrictions and licensing for massive open online courses (MOOCs), virtual worlds with educational components, educational simulators and other educational content.

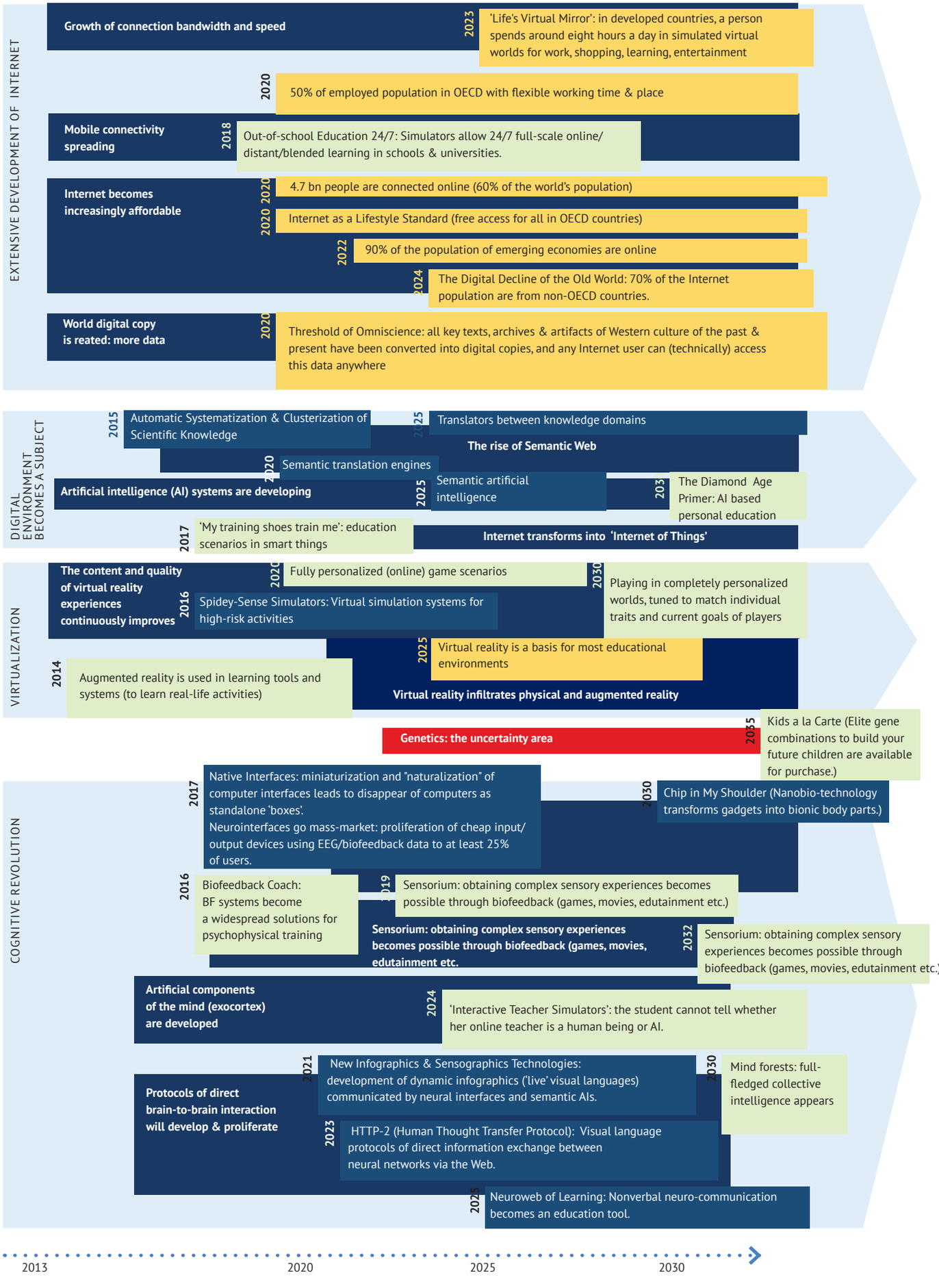
Another important uncertainty factor is the role of Asian cultures in the transformation of education. Besides the widely debated themes of rapid economic development and urbanization in Asia — we should consider an inevitable change of the world cultural landscape due to Asian cultural interventions (which will move from 'Eastern flavour' into mainstream), and further the re-shuffling of economic, social and cultural tendencies through practices developed by modern urban Asian population (from fashion to science & new consumer products). In addition, Asian countries — especially China, which is expected to become the world's largest economy by 2025 — aim to provide the world with alternative global development goals that are not West-driven (including the revival of the international space race and the discussion of new values for the consumer society). Finally, Asian schools of thought, both traditional and modern, may offer better models of human development (e.g. Chinese, Indian and Arabic traditions have a profound understanding of life-long learning stages, objectives and methods, especially for adult education), and we can expect that future educational models will incorporate these approaches.

One more important factor to consider is the future model of the state, including the rise of new types of players. Open government initiatives, spread of digital democracy tools, as well as the transfer of state functions to private providers indicate that governments will likely shift many of their existing functions onto the private and non-government sectors, and the civic / national identity will become the main focus of their management. 'Virtual states' may emerge, guided by specific values and rules for their web-based populations, as well as 'franchise states', organized as networks of distributed yet interconnected enclaves with shared rules of life. Structures like these may become customers of

the new education, looking for educational solutions that help form their distributed elites (with greater loyalty towards their communities than towards their countries). At the same time, states are extremely stable social institutions that have survived for millennia — and the first breeze of change will not blow them away. The transformation of public infrastructure and replacement of government functions will take at least several decades, since a generation of people has to grow for whom the idea of the disappearance of states and their replacement by other mechanisms of coordination will not be too foreign.

Legend, pages 17 & 19




EXTENSIVE DEVELOPMENT OF INTERNET
Growth of connection bandwidth and speed
2023
'Life's Virtual Mirror': in developed countries, a person spends around eight hours a day in simulated virtual worlds for work, shopping, learning, entertainment
2020
50% of employed population in OECD with flexible working time & place
Mobile connectivity spreading
2018
Out-of-school Education 24/7: Simulators allow 24/7 full-scale online/ distant/blended learning in schools & universities.
Internet becomes increasingly affordable
2020 2020
4.7 bn people are connected online (60% of the world's population)
2020
Internet as a Lifestyle Standard (free access for all in OECD countries)
2022
90% of the population of emerging economies are online
2024
The Digital Decline of the Old World: 70% of the Internet population are from non-OECD countries.
World digital copy is reated: more data
2020
Threshold of Omniscience: all key texts, archives & artifacts of Western culture of the past & present have been converted into digital copies, and any Internet user can (technically) access this data anywhere
DIGITAL ENVIRONMENT BECOMES A SUBJECT
2015
Automatic Systematization & Clusterization of Scientific Knowledge
2025
Translators between knowledge domains
The rise of Semantic Web
2020
Semantic translation engines
Artificial intelligence (AI) systems are developing
2025
Semantic artificial intelligence
203
The Diamond Age Primer: AI based personal education
2017
'My training shoes train me': education scenarios in smart things
Internet transforms into 'Internet of Things'
VIRTUALIZATION
The content and quality of virtual reality experiences continuously improves
2020
Fully personalized (online) game scenarios
2030
Playing in completely personalized worlds, tuned to match individual traits and current goals of players
2016
Spidey-Sense Simulators: Virtual simulation systems for high-risk activities
2025
Virtual reality is a basis for most educational environments
2014
Augmented reality is used in learning tools and systems (to learn real-life activities)
Virtual reality infiltrates physical and augmented reality
Genetics: the uncertainty area
2035
Kids a la Carte (Elite gene combinations to build your future children are available for purchase.)
COGNITIVE REVOLUTION
2017
Native Interfaces: miniaturization and "naturalization" of computer interfaces leads to disappear of computers as standalone 'boxes'.
Neurointerfaces go mass-market: proliferation of cheap input/ output devices using EEG/biofeedback data to at least 25% of users.
2030
Chip in My Shoulder (Nanobio-technology transforms gadgets into bionic body parts.)
2016
Biofeedback Coach: BF systems become a widespread solutions for psychophysical training
2019
Sensorium: obtaining complex sensory experiences becomes possible through biofeedback (games, movies, edutainment etc.)
Sensorium: obtaining complex sensory experiences becomes possible through biofeedback (games, movies, edutainment etc.
2032
Sensorium: obtaining complex sensory experiences becomes possible through biofeedback (games, movies, edutainment etc.)
Artificial components of the mind (exocortex) are developed
2024
'Interactive Teacher Simulators': the student cannot tell whether her online teacher is a human being or AI.
2021
New Infographics & Sensographics Technologies: development of dynamic infographics ('live' visual languages) communicated by neural interfaces and semantic AIs.
2030
Mind forests: full-fledged collective intelligence appears
Protocols of direct brain-to-brain interaction will develop & proliferate
2023
HTTP-2 (Human Thought Transfer Protocol): Visual language protocols of direct information exchange between neural networks via the Web.
2025
Neuroweb of Learning: Nonverbal neuro-communication becomes an education tool.
2013
2020
2025
2030

NEW EDUCATIONAL SOLUTIONS BASED ON NEW TECHNOLOGIES

	CORE EDUCATIONAL PROCESSES	TRADITIONAL SOLUTIONS	NEW SOLUTIONS
1	PASSING DOWN A STANDARD EXPERIENCE OR PRACTICE FROM TEACHER OR EXPERT		
1.1	Teaching or learning of verbal knowledge	Lecture or textbook	Online multimedia libraries, massive online courses etc.
1.2	Teaching of nonverbal knowledge through communication with its holder	Lecture or personal tutorial	Virtual tutors (artificial intelligence, AI), wearable devices for biofeedback learning
1.3	Teaching of nonverbal knowledge through skill training	Personal tutorial & mentorship or apprenticeship	Wearable devices or virtual simulators
2	INDEPENDENT ACQUISITION OF EXPERIENCE, INDIVIDUALLY OR IN A GROUP		
2.1	Quest or challenge	Sports competitions, adventure camping etc.	Gaming environments and 'sensoriums', urban quests using augmented reality etc.
2.2	Research or experiment	Work in a laboratory, discussions in a research group	Distributed, distance and virtual labs and research teams, also with AIs as a team members
2.3	Creative (individual or team) project	Group work (planning, discussions, experiments, etc.)	Distributed group work in social networks, work in virtual environments (incl. gaming)
3	ASSESSMENT AND RECORDING OF ACHIEVEMENTS		
3.1	Selecting students for the course / program	Entrance exam, interview	Gene testing; forecast of education and career trajectory based on achievement profile and comparative big data analysis
3.2	Interim evaluation of achievements and feedback	Interim task evaluation	Comprehensive continuous monitoring (incl. gaming-based behavior monitoring inside augmented reality / Internet of things games)
3.3	Final examination	Final work (diploma or chef d'œuvre)	Personal competence profile, personal virtual portfolio, virtual environment game, creation and stress testing of a virtual world / digital model
4	MOTIVATION FOR EDUCATION		
4.1	Competitive motivation	Contests or competitions	Gamification: competitive gaming models
4.2	Achievement motivation	Evaluation & grading systems	Gamification, reputational & financial capital management systems
4.3	Social pressure	Admonitions or threats from teachers, parents, etc.	Preventive management of educational results (systems for achievement prediction)
4.4	Pleasure from the educational process	Teacher's personal charisma, use of entertaining components (e.g. movies)	Adjustable gaming models, Biofeedback systems (tracking the intensity of experiences in the learning process)

NEW WAVES OF TECHNOLOGICAL INNOVATIONS
2014 Start in Web. Online startup accelerators and team fairs.
2015 Green & Lean. Eco-thinking in production & urban life becomes one of the core subjects in schools & universities
System engineering (incl. CDIO) at the core of professional lifelong learning in technologies
2020 Multi-Bio-DIY-Cooker. Domestic appliances (e.g. 3D printer) allow to produce wide range of food and pharma products at home.
2030 NBIC convergence dominates product markets
NEW MODELS OF BUSINESS ORGANIZATION AND COORDINATION
2025 Era of Self-organization. Hybrid / network structures become dominant in advanced economies
2035 'Ideology Collapse' (real economies mix of 'planned-liberal-capital-anarcho-communism')
SHIFT IN EMPLOYMENT PATTERNS AND LIFESTYLES
2015 On the Sidelines! A significant share of population start losing their professions to automation and are unable to adapt to changing conditions.
The New Spare
2018 Gerbil on a Treadmill. Involving socially marginalized people into employment & personal development through alternate reality games.
2014 Web-based Sandboxes. DIY and science clubs for school kids and students go online.
Fab Labs become mass educational solution for OECD universities.
DIY-models Exchanges. Emergence of online platforms to trade and exchange blueprints for 3D-printing.
2020 Bio-DIY-Labs. Mobile labs producing biomedical products.
Spread of DIY culture
2023 WorkPlay. Online and virtual gamers are engaged on the mass-scale to help solve real-life tasks.
From gaming generation to Homo Ludens: gaming becomes life norm
2018 Gaming Achievement Logic Used in Education for real-time monitoring of individual current educational trajectory and learning achievements.
2030 Attempt Culture. Game culture becomes an integral element of work and everyday urban life.
2014 Education becomes a means of overcoming personal existential crises - midlife crisis, ageing crisis etc.
Increasing demand for authenticity & self-actualization
NEW FINANCIAL ARCHITECTURE & REPUTATION ECONOMY
2013 Development of Independent Digital Currencies. Amid the crisis of national economies, independent digital currencies become real alternatives to national currencies.
Search for new models of global financial architecture
2025 Collapse of Bismarckian Pension Systems. Due to economic complications, OECD countries are forced to adopt post-Soviet pension model (minimum subsistence level for the majority of pensioners).
2014 States Strike Back. States lead fight with transnational corporations: campaigns for "deoffshorization", transaction transparency, increased financial control, control over digital financial communication.
Development of the Reputation Economics
2014 Reputation Assessment Models. Ways to assess person's 'reputation capital' to be used in various contexts.
2017 Exchanges of Reputation Capital. Exchanges converting reputation currencies to pay for online education and other personal services.
New Sincerity. New norms of social interaction due to increased transparency of personal life, abilities, activities & interests (growing digital footprint and big data analysis).
2025 Reclaim Yourself! Personal digital footprint becomes personal property
SHIFT IN PATTERNS OF FAMILY ORGANIZATION & CHILDHOOD
Modern families in search for identity
2020 Family Universities. Lifelong learning for families: images of family future, family competencies & family teams
2013 Mixed-Age Education. Peer- and cross-age tutoring (in & between families) is a means of family reintegration.
2020 School in the Womb. Prenatal study programs: acquisition of knowledge and skils in the womb.
New family education: competent parents and cross-generational integration
New childhood model: Early maturing kids
2018 Mickey-Mouse-Club-Law. Introduction of legislation regulating early-age intellectual labor (10+).
2025 A Captain at Fifteen. Mixed-age education substitutes physical age for social.
2021 T-9 Dislexia. The culture of written text changes dramatically or begins to die out due to reliance on and heavy use of predictive texting.
'New Mowglis': A generation of children raised by computers
2030 Generation with Shaky Values, whose members grew in gaming environments (augmented reality with game-achievement logic) has contorted or unstable values
2013
2020
2035

THE INFLUENCE OF SOCIAL MACRO TRENDS

	MACRO TREND	NEW EDUCATIONAL CONTENT (CURRICULUM COMPONENTS OR PRINCIPLES OF PROGRAM DESIGN)	NEW EDUCATIONAL FORMATS (TEACHING, ASSESSMENT, MOTIVATION ETC.)
1	New wave of technological innovations & global greening of cities and industries	• Skills & knowledge for emerging industries • Systems thinking (also: systems engineering) • In the more distant future: ecology of the mind (as system of principles guiding educational program design for managers & businesspeople, engineers, and social workers)	• Startup accelerators with educational component as a vehicle for economic modernization
2	Shift in models of business organization and industry management	• Skills & knowledge for new models of business management (e.g. distributed community-based production) • Meta-competencies for modelling & manipulating ontologies	• Webs of learning / communities of practice as the key educational environment (also: corporate universities reloaded)
3	Shift in employment patterns and lifestyles	• DIY competencies (return of the do-it-yourself & craftsmanship culture) • Re-training / re-education programs for the 'new aged' • Programs aimed to facilitate & support personal self-actualization	• Domination of gaming formats • Virtual worlds to help buffer the social tension through retraining of new unemployed • New talent investment models
4	New financial architecture & reputation economy	N/A	• Reputation capital as a (cross-institutional) model of assessment • Models of reciprocal teaching & learning (supported by non-monetary exchanges) • Transparency principle in educational process organization, tracking of intermediary results and recording of achievements
5	Shift in patterns of family organization & childhood	• Rehabilitation education for the 'new dislexics' • Skills for competent parenting • Programs to help discover family shared values	• 'Child-friendly cities' • 'Gateways' to provide professional education for early-maturing children • Cross-generational universities

THE INFLUENCE OF SCENARIO FACTORS

SCENARIO FAC-TORКЛЮЧЕВЫЕ KEY	SCENARIO UNCERTAINTIES	INFLUENCE UPON THE EVOLUTION OF EDUCATIONAL SYSTEMS
RATE OF GLOBALIZA-TION	• Will globalization continue at the same pace as before? • Can global economy go down, or be replaced by a set of macro-regions (each with their own economic & political standards)? • Is there a chance that Internet global standards will be overruled by macro-regional or national standards (leading to Internet 'balkanization')?	• Speed of global standards proliferation in education • Speed of educational innovations proliferation, incl. standardized global solutions (also in the case of 'nationalization or 'balkanization' of the Internet / 'Splinternet' scenario)
NEW ROLE OF ASIA	• Will Asian economies be able to provide new meaning of globalization - given their ascent to the global leadership position? • What will be the role of Asian cultures in the first half of 21 century — to what extent will they overcome the European cultural dominance and set their own standards? • Will Asian schools of thought be able to provide new & important content for new models of education? (e.g. non-Aristotelian models of thinking)	• Asian educational innovations: new content & forms of education based on Asian national traditions (esp. India, China, Muslim countries) in cultural & scientific domains • Alternative globalization models (incl. different value system • s underlying such models), and their impact on the speed and depth of educational innova-tions proliferation • New forms & models of thinking based on original Asian intellectual traditions
ROLE OF RELIGIONS AND SPIRITUALITY	• Will there be a revival of religions, a post-secular world with religious values dominate over economic & secular values? • Will religions & ancient spiritual traditions be able to provide new & important content for new models of education?	• The speed of educational innovations proliferation • New content requirements (religious movements as new education customers); possibility to borrow content from religious practices (incl. 'secularized' practices of self-regulation and development)
FUTURE OF STATES	• Will states get stronger or weaker compared to transnational business players and non-government network structures? • Will states become more or less autocratic, especially in advanced countries? • Will new states / governments emerge, will experiments in social design continue, and to what extent?	• New requirements for educational architecture depending on the model of national or international governance (incl. demand for education as a way to built new national identity) • The rate of changes determined by the ability by non-government constituents to take over functions of the state (incl. basic and higher education provision)

NEW EDUCATION: STORIES FROM THE FUTURE

1. GLOBALIZATION OF EDUCATION: ENTER THE MOOCS

For the last 30 or 40 years, the world has seen 'normal' globalization of education. It included programs of academic exchange, increased mobility of students and professors, formation of international academic job markets, international unification of standards (e.g. Bologna process), competitive testing of students (e.g. PISA & TIMSS), global school and university rankings (e.g. QS or THEWU rankings etc.) and other elements. The speed of the proliferation of international standards in education was about the same as any other processes of economic and financial globalization.

Through last decade, the growth of online education has launched a completely new process of globalization, which has become explicit with the development of massive open online courses (MOOCs) provided by leading international universities. Unlike earlier online learning projects, MOOC-based education has a number of sustainable competitive advantages — the course content is in high demand, the learning process yields good results, it becomes possible to develop new approaches in online pedagogy (and thus create additional competitive advantage through new competence), MOOCs provide access to the offline education opportunities of leading universities, employers can pick out talents from all over the world, etc.

In particular, MOOC-based platforms may provide potential employers with unique information that is extremely difficult to gather in offline education. For example, they can easily document competencies and qualities which a student has exhibited during (and not in the end of) the learning process (e.g. how regular was the work, whether the student was able to meet deadlines, whether she was willing to co-operate with others, etc.). These personal learning patterns can inform a potential employer whether a particular student is suitable for a specific position / project — and can help find potential candidates more efficiently.

Early enthusiasm regarding MOOCs (incl. their ability to replace live teaching) was very high, and now a certain disillusionment settles in (typical for this stage of innovation adoption). The evident advantage of MOOCs is its efficient online teaching methodology and provision of content from best global providers, while among its disadvantages is the

inefficiency of student motivation system (most MOOCs are able to retain at most 5-10% of students enrolled), insufficient recognition of MOOC certificates by job markets, and lack of complex educational programs (at this point, MOOCs are stand-alone courses). We certainly understand multiple limitations of MOOCs, but we also believe that the majority of their problems will be overcome within next 3 to 5 years (most likely, this will require another one or two 'pivots' of MOOC business model), and that the promise of MOOC platform leaders (e.g. edX) to teach one billion students before the end of 2010s will be achieved (unless operators of these platforms shoot themselves in the leg by being indecisive in creation and promotion of new educational models). A typical higher education model of the next decade may become a 'flipped' university wherein teaching is done online via MOOC platforms, and lab works, study projects and discussions are held live within the university itself.

By becoming full scale educational programs, leading MOOC platforms will create particular precedent in education: they establish easily accessible trans-boundary qualification and competency models that will have an immediate impact on national educational systems all around the world. It has been wise of top global universities (such as Stanford, MIT, Harvard and others) to spearhead the process of MOOC creation, and to establish their leadership in this new growing domain. Apart from dramatically increasing their contact base and brand recognition, they also form a unique expertise in online education that creates the 'competence gap' with second-mover universities. Unlike the conventional forms of online education, MOOC platforms create an entry barrier associated with the complexity of technology, quality of content and unique patterns of educational statistics. In fact, building an online platform that could educate a billion people is a mammoth task that is in no way simpler than constructing a sophisticated engineering object such as a nuclear power plant or a space station. We believe, therefore, that there will be a few (not more than 5 to 10) major alliances of the world's leading providers of online education that will educate the majority of online students. In addition to international projects by US, British and European providers, several countries with alternative global agenda will try to set up their own national platforms (possibly, with the help from their governments). At the very least, it will be China, India, Russia and one of the Arab countries.

The emergence of educational mega-providers competing for the entire global educational market will inevitably pose two important questions:

1 | 'Billon-student universities' will take position of 'education imperialists', and an inevitable tension will be created between top-tier universities (and their host countries) and the rest of the world.

2 | 2. The problem of 'great talent vacuum-cleaner' in the global labor market: when job placement services and international employers will begin to recognize the results of MOOC-based study programs, a notable drainage of the most valuable human resources from emerging economies into advanced economies can begin (of course, brain drain is nothing new, but 'talent vacuum cleaners' can accelerate this process and bring it to a completely new level, targeting 'best of the best').

In early 2020s some of the national governments in developing countries can respond to these threats in a non-systematic manner, trying to retain their 'educational sovereignty'. The prospects of such potential conflicts may require a preventive response — a discussion can begin on the future configuration of global education architecture, the governance system for global educational standards and talent markets (including their online dimension). Such architecture can apply at least one of the following models:

- WETO or World Education & Talent Organization (similar to World Trading Organization), a translational alliance that ensures equal opportunities for educational service providers and talent mobility for alliance country members, as well as guarantees adherence to the uniform international standards.

- 'Kyoto Protocol' in Education (similar to Kyoto Protocol on greenhouse gas emissions), a transnational agreement that sets out rules of compensation between nations for investment into talent education & training.

Discussions to start such governance structures will inevitably be painful, as there are many 'skeletons in the closet' in the existing organization of education & talent markets. But it is far better to tackle the issues of educational sovereignty at an early stage, rather than to wait until it becomes a cause of international conflicts or a factor in building new geopolitical alliances.

2. PERSONALIZATION: FROM BUSINESS DRIVE TO SELF-DIRECTED EDUCATION

Since the ancient times, education was organized as a process of personal interaction between the teacher and the student. During the industrial age, however, education was redesigned for the purpose of 'mass-production' of 'human material'. Today, information & communication technologies allow to bring personalized approach at the heart of educational process — and, due to ICT low cost, this can be done on the mass-scale. The variety of personalized education forms should be based on life-long competence models that reflect the unique set of skills & knowledge developed through various educational, professional and social experiences. In particular, as many of new skills are acquired in the workplace (and it therefore assumes some of the functions of educational institutions), the personalized life-long education trajectory is best described as an 'education&career track', where education provides opportunities for career advancement, and career experiences become prerequisites for further education. Furthermore, both professional education and career development are only few of the ways in which an individual competences are developed: the complete competence profile should reflect skills and abilities that are developed and used across all domains of life, be it education, work, volunteering, play, hobby, networking, or sex. Moreover, the personalization of education will only become sustainable when all main areas of human life, from play to sex, are naturally and seamlessly integrated into the process of building personal competence profiles.

The radical redesign of the existing educational infrastructure towards personalization will benefit not only students but also businesses seeking to attract best talents. A range

of instruments already serves their purpose — from personal portfolios and reference lists, to corporate competence profiles and electronic university diploma. The main problem is to restore the ownership of this data for students and to detach it from specific organizational providers such as educational institutions, employers, or industry unions. Personalized life-long competence profiles become the next step in the development of education and labor market infrastructure, that would allow to understand the contribution of specific courses and programs to the set of competences, and benefits (e.g. career shifts) obtained thereof.

Besides that, a new and extremely important trend in education is the emerging opportunity of direct talent investment (e.g. a recent crowdinvesting platform Upstart allows to invest up to US$ 200,000 into a talented young person who then shares a small share of their income over 5 or 10 years). This model has for a long time been employed in athlete and actor job markets, but it can soon become a mass solution as big data models of competence profiles would allow to estimate the most beneficial educational & career tracks. The beginning of 2020s may see the emergence of first 'man-llionaires' — owners of investment portfolios, made solely of talented people investments, that worth more than one billion dollars. Later, the same model of direct talent investment could be applied by pension funds — in fact, it can be described as a modified version of Bismarckian pension system where highly performing youth would work in the interest of retired investors.

The rising demand for personalized education from employers and investors will spur the development of personal education management systems (and respective market infrastructure). In particular, we expect the standardization of descriptors defining the contribution of specific courses and other educational products (e.g. games & simulators) to the competence profile (much like 'nutritional facts' on food products packaging). We also expect that within next 2-3 years a fully functional search engine for educational online services will appear, most likely as a search option within major search engines such as Google, Baidu, or Yandex. In addition to that, it is highly probable that specialized educational content aggregators will offer 'branded' educational tracks: a path to create a target competence profile, e.g. an average profile of a skilled industry professional or a profile of a 'hero' such as an industry leader (e.g. Bill Gates or Jack Welch). These 'branded' tracks will gradually develop into 24/7 (artificial intelligence) virtual instructors that could make flexible adjustments to the educational trajectory to adapt it to the current results, objectives, and body-and-mind state of the student.

Development of personalized education tools will open a wealth of opportunities for 'concise' students that are ready to manage their own educational goals. The growing demand for authenticity, the search for a unique life path guided by deeper personal interests and the need for self-actualization, becomes a significant social phenomenon. The 'live' education will steadily migrate toward formats that help discover this authenticity, therefore restoring 'teaching' to its original meaning. Some of the approaches within personal development or psychotherapy will become the integral part of lifelong education, supporting individual transformation or facilitating the passage of age crises. The process of the life-long self-development — in fact, a process that supports life itself — becomes a cord on which the various educational formats and solutions of the future will be strung.

3. CO-OPERATION: FROM 'TEAM HUNT' TO COMMUNITY-CENTERED LEARNING

Competitive economies of the future rely not on gifted individual heroes that can manage problems single-handedly, but on teams capable of performing complex functional tasks or projects. Two largest customer groups that form the demand for team-based education are businesses and government institutions. They require teams that are able to work efficiently under given conditions and that would ensure consistent progress of organizations they work for.

One of the forms of team education is producing theme as a 'by-product' of core business activity, such as advisory services (e.g. McKinsey, Big Four etc.). Education does not have to be the core function of an educational institution — instead, any organization (e.g. a business incubator, a consulting firm, a research laboratory, a service club, etc.) can become an education provider if educational solutions support its core activity and increase its chance to succeed. An organization can build a business model wherein the knowledge and skills obtained through education become the source of value that customers appreciate (and have persistent demand for), and wherein the strong knowledge management in the workplace (including education, training, learning-by-doing, embedded learning etc.) becomes the key factor of its competitive advantage.

Communities of practice become another new and important education milieu. The key feature of a community of practice as a collaborative learning environment is the 'division of educational labor' within the community. Practices (e.g. specific business or social activities) are at the core of the community, and every practice can be implemented as a stream of projects performed by various, often independent, teams. A new community member learns in practice by joining one of these teams, and performs his or her function based on existing and desired skills & knowledge. Communities of practice provide opportunities to learn through practice, opportunities for horizontal learning (exchange of knowledge & experiences) and weak vertical learning (development & maintenance of standards & certification), as opposed to strong vertical learning structures such as schools and universities (where knowledge is transmitted from teachers to students). In this respect, communities act as 'collective gurus' or collaborative learning spaces where valuable experience of their every member can be used for their mutual development. An arrival of the Internet has caused the qualitative shift in the development of communities of practice, as they are no longer limited by local communities and can unite practitioners from all over the world, while Web 2.0 tools help organize the process of new membership incorporation without the face-to-face contact.

The most effective learning within communities is achieved through the 'horizontal' transfer of information whereby experienced members of the community take the position of instructors or mentors. It is usually the mentor that helps new members master the key aspects of the practice, and therefore mentors are 'guides' into practice. We believe that, as economic organization and coordination transforms from hierarchies into networks, mentorship models will become increasingly widespread. Full-scale realization of 'mentorship webs' would require the system of competence profiles (and 'path of hero' educational trajectories) that can set the frame of reference for mentors and their students.

The critical factor for the existence of communities of practice is their ability to estab-

lish and maintain the shared meanings and goals for community members. Collective design of the vision (e.g. foresight) acts as an anticipatory function of the community, a factor of its collective intelligence. The organizational competence of collective future-thinking (and supporting tools for collaboration such as wiki-foresight environments) becomes an essential component of any sustainable and evolving communities of practice.

As web-based communities of practice continue to develop, the role of vertical transmission of knowledge (from experts / teachers to profanes / students) will decrease significantly. Of course there will remain world class guru that broadcast their expertise through MOOCs — but apart from that, the majority of knowledge holders will be 'collective gurus'. In 'collective gurus', every community member can be both the teacher and the student, a possessor of invaluable knowledge and the one who wants to embrace it. Transfer of knowledge becomes a supporting (and a secondary) educational process, whereas practices of here-and-now collaboration between senior & junior community members will become essential to education.

Communities of practice will develop their own 'community universities' to conduct educational & training programs for community members. In the core of such programs lies the occupational standard designed (and regularly updated) by the leading community practitioners. We already witness the emergence of such educational formats as MOOC student self-organized study groups. The rise of community universities may lead to the revival of the medieval university model — a self-organized corporation of students who would jointly order their education and would migrate (even physically) between their professors and mentors. This model assumes that the joint ownership is held, and governance is accomplished, by students (and not by their professors) who determine their own learning needs and objectives. Within next 20 to 25 years, 'community universities' may become a mass solution that would rival traditional universities or would even begin to replace them.

4. GAMIFICATION: FROM EDUCATION GAMES TO THE TOTALITY OF GAMING

The industrial age has removed the play from all domains of life but leisure and sport, and education, even pre-schooling, to this day remains an extremely 'serious' affair. In recent years, however, the high efficiency of games has been recognized as a vehicle to boost human learning & creativity, and gamification began to penetrate education, social communications, R&D and other 'serious' spheres.

Educational services for children is one of the areas where the game has never been undervalued. However, a profound transformation in this area is underway, primarily driven by three trends:

- First, it is understood that any children products should also be designed as educational products that also (typically) have a game component.

- Second, children products undergo rapid mediatization whereby up to 90% of revenues in the industry are generated by lengthy multi-character stories (whether these are 'Marvel universe' comic book heroes, or transmedia characters of My Little Pony or

Winx). These media characters set out behavioral norms and values for children, and create their own subcultures. A remarkable innovation in this respect is demonstrated by the Russian animated series Kikoriki (or Smeshariki in Russian — literally, 'funny ball creatures'), where the plot is built not as a fundamental conflict of the good & evil, the protagonist and antagonist (the model traced from ancient Greece and into Hollywood) — but around conflicts resulting from differences in worldviews of otherwise equally 'positive' heroes. This helps children to understand that conflicts often come from the diversity and can be efficiently resolved through communication.

- Third, the most successful products are built as transmedia developing games that mature with the child (by presenting different developmental tasks and challenges for different ages). In the future, childhood-long games (that combine toys, shows, augmented reality and other media) will become one of the dominant formats of children education.

The growing market of developmental gaming environments can soon become a real competitor of school education, especially for primary and middle schools. This will compel schools to enrich their educational environments & curricula with gaming elements, in order to make them more interesting yet retaining their educational functionality. Through the application of augmented reality gaming, schools will be able to complement the educational process with educational multiplayer games that involve teams of kids of multiple ages working on a variety of tasks and projects — whereby education will go unnoticed, with learning occurring through in-game problem solving. In this respect, the school will no longer be a place for 'industrial model', a place where 'human phonograph' teachers use standardized texts & tests to 'process' batches of students — but a place where the main educational format is the long & unfolding game that integrates educational components (development of specific skills & knowledge) into its rules, roles and scenarios, with personalized & team education performed in form of playing character tasks & quests.

Game achievements should also be recognized in the same way as educational & professional achievements. Gaming has already become an activity that involves millions of kids and adults, and many players spend hundreds and thousands of hours perfecting skills they can often use in their professional & daily life (e.g. skills of negotiation, resource planning, strategy building etc.). These achievements should be reflected in personal CVs and portfolios, as the game level in a massive multi-player game may be of equal importance with an average university grade (as an indication of skill or personal quality). In addition, multi-player games can be used to test some of these skills or to perform educational projects and final exams, especially in MOOCs where face-to-face contact is impossible and a massive group of students needs to be assessed simultaneously. Experiments in this area are already taking place, and we expect them to go massive in next five to ten years.

Game format is one of the most effective ways to organize team work, encourage creativity and overcome groupthink — which allows a substantial reorganization of 'serious' activities such as industrial production or research. Among the first solutions in this area are the simulators and virtual worlds that help improve professional skills, and gamified software solutions for collaborative development, ideas crowdsourcing, operator work etc.

The demand for productive creativity in advanced countries will drive the emergence

of clubs that we call 'adult-gartens' (as inspired by M.Resnick's 'lifelong kindergartens'). These will be places for adults to 'fling off' their social roles and responsibilities and to recover the state of a playing child, to play any interesting game, to try out any creative work, to fail without condemnation from others. Such 'adult-gartens' can be used for educational and therapeutic purposes on their own, as well as applied by 'serious' businesses (such as a hi-tech company or a business incubator) as a tool to spur creativity for teams & individuals within their organizations.

Besides that, gamification can be efficiently used to redesign the penitentiary system. Among one of the problems of existing penal systems is that, on one hand, they are a social burden and a necessary evil of the society that isolates malefactors from the rest of the population — on the other hand, they rarely improve individual behavior and often serve as 'breeding grounds' for criminality. However, application of maturing virtual simulations can allow (within the coming decade) to create realistic virtual worlds, 'virtual jails' that help delinquents correct their dysfunctional behavior and acquire socially acceptable ways of conduct — for instance, re-living the criminal action from different positions (of a violator, of a victim, of a police officer who searches for an offender, etc.) and then mastering the proper way of acting. Such educational solutions could become a more humane way to rehabilitate criminals — and similar solutions can be applied to help re-qualify 'accidentally alienated' citizens, e.g. those dismissed from jobs due to skill mismatch. We believe that, since early 2020s, virtual reality worlds will be used as temporary holding places for unemployed and as a cheap alternative for vocational education & training. Also, virtual worlds that help replace dysfunctional behavioral patterns with functional ones can be used to deal with traumatic experiences and improve lives of 'clinically normal' people that suffer from dependencies, bad habits or fears. 'Psychodrama worlds' where people play together and live life stories of each other could gain wide popularity as an alternative to group therapy by mid-2020s, not only (and not so much) as a clinical psychotherapy, but as part of standard educational trajectory for the majority of population.

ΓThe gamification of education is in fact in an active phase — as well as the gamification of many other 'serious' areas of economy & society. We witness the advent of the era of total game. The process of gamification penetrates more aspects of human life - not only entertainment, education or work, but also healthcare, government regulation and social interactions. And any gamified practice has an educational dimension, because the game clearly defines desirable and undesirable behaviors through rewarding mechanisms (cf. assessment and self-assessment in education), and also provides mechanisms for skill development and self-improvement. Any domain of human activities can in principle be represented as a 'long game' in which an individual perfects grows through perfection of skills from lowest to highest levels. Our foresight anticipates that, around mid-2030s, playing and gaming may become the predominant type of human activity that would take a considerable share of citizen time in developed countries. This will not be the game to furnish or support 'serious' activities — rather, all 'serious' activities will be gradually integrated into the game.

5. SCIENCE: FROM BIGDATA TO LIVE KNOWLEDGE MODELS

The key driver in transformation of modern science is its pragmatization: the definition of hypotheses and design of experiments should be determined by the greatest cogni-

tive 'bang for the buck' (as defined by C.S. Peirce). However, it is impossible to maintain constant or increasing returns indefinitely: like any other domain of human activities, science faces diminishing returns on investments (that includes the variety of science cognitive instruments, both intangible and tangible, such as theoretical concepts, research methods, laboratory facilities, skilled researchers and their communities, etc.). This situation has several implications:

- In traditional disciplines, the cost of research to acquire new knowledge gradually increases..

- Inevitable 'diminishing returns' from traditional research paradigms demand to search for alternative models of reality description, which can most easily be found in 'empty' spaces between academic disciplines — hence the explosive growth of interdisciplinary research that creates even more disciplines. For those researchers who remain within their traditional disciplines, the main competitive advantage is an extremely deep knowledge inside their narrow field of study (hence the increasing 'division of labor' within the researcher community).

- The exponential growth of explicit knowledge — not only due to increased investments into research, but also due to its use as a metrics of researcher performance — has been compounded by the problem of 'knowledge decay' (the more facts are accumulated and relevant theories are created, the more of the past knowledge may be proven wrong). An increased risk of research quality plunge, along with the spread of plagiarism, increases the cost of the quality control systems.

Science, as the industrial-age system of knowledge acquisition, systematization and application, may soon reach the limits of its productive development. This may occur is not due to science own inability to advance itself, but rather due to the unwillingness of the society to provide resources for such advancement. Besides, one of the major internal problems of science is the growing disconnection of researcher groups due to increased narrowness of research, a sort of modern 'Tower of Babel' curse, whereby even scholars within related fields of a single discipline typically do not know about each other's research and do not understand specific issues and terminology (this problem was foreseen by S.Lem as early as 1963, and he described it as 'breaking of the scientific frontline'). As a result, science may begin to collapse under the weight of its own knowledge that rapidly turns into non-knowledge (that is, a knowledge that is not applied nor even understood). This situation calls for knowledge that can be created as knowledge-in-practice, by practitioners who immediately apply this knowledge.

Improvement of efficiency and reorganization of scientific processes in next years will be mainly associated with the use of ICT, which will partially compensate the diminishing returns of science with 'network' effects (which have the 'increasing returns' property, according to B.Arthur). In particular:

1 | The lower returns from existing scientific paradigms require that the new language of complex system description — in particular, the transition from analytical to algorithmic descriptions & models, including 'reusable' simulation models (e.g. digital models of organs & living systems in quantitative biology).

2 | Transition to science big data and transformation of researchers into 'moderators' of interactions between data collection systems and 'big data' quantitative modelling systems.

3 | Research cost reduction through network effects, including the use of 'virtual' laboratories (complex 'reusable' simulations with access granted to any interested group), remote laboratory access for 'big science' objects, and applications using 'collective intelligence' (crowdsourcing for R&D). As a part of this process, it is likely that an open experiment market will emerge, supported by reputation & recommendation system, allowing the exchange of research resources of 'big science' facilities, laboratory equipment, research teams capabilities, and talents of interested amateur scientists.

4 | Reorganization of publications system. Transition to full-fledged hypertext structures (including ones that integrate 'raw' research data and analytic models); reorganization of scientific publications to the format of 'threaded discussions' allowing to track down individual contributions; dissemination of computational models as an independent form of presentation of scientific results, as well as the development of indexing tools for this form (we expect that a search engine for scientific computational models will soon be created, similar to existing search engines for articles and databases).

The main challenge for modern science is to maintain 'scientific frontline' integrity by renewing systemic theoretical generalizations. 'The scientific worldview' as it was taught in schools and universities since the early 20th century, the consistent outline of laws of the material & social world grounded in secular premises, begins to crumble — simply because we now know too much, and would know even more, and no human mind would be able to keep the integrity of this knowledge. However, there is no way back to pre-scientific world view — the technological environment created by humans is already too complex, and it requires adequate science and technologies to be maintained and developed. To overcome the 'Tower of Bable' curse we as a humanity have created ourselves, it is necessary to reogranize the institutions of cognition and knowledge management — but the progress in this area will depend the ability to create semantic Internet and supporting artificial intelligence solutions that will structure human knowledge, and scientific knowledge in particular. As semantic solutions become available, this will lead to the following consequences:

- emergence of structured 'science maps', solutions that help cluster meanings of specific research pieces, bridge the gaps between theses meanings, and 'stitch' them together into unified semantic fields (we observe early cases of such 'maps' already);

- semantic artificial intelligence working with these 'maps' (or even building them) may become a co-author in wiki-like semi-automatic creation & updating of scientific theories and worldviews;

- activities of (typically, distributed) research project teams are followed and supported at all stages of their work (from problem setting to presentation of final results) by artificial semantic agents that will determine the prospects of each project and the place of its results in large 'maps' of scientific knowledge;

- as results of scientific work become completely digitized, and the work of research teams is supported and tracked by semantic systems, traditional forms of scientific result communication, such as scholarly articles or monographs, become redundant. This effectively heralds the death of 'the Gutenberg Era'. What will count is not the 'text copy' but the 'digital copy' of knowledge — most likely, sophisticated digital models or information processing algorithms.

Thus, the vacant position of 'new Aristotle' — a genius that stitches the 'breaking of the scientific frontline' — is most likely to be taken by the collective hybrid intelligence of research communities supported by semantic artificial intelligence. The next step after the 'big data science' will be the design of 'machines that process meanings' — artificial agents that create various models of data processing in the context of their economic and cultural applications. The new standard of knowledge management will be 'live' models of knowledge built around (and for) communities of practice, models continuously updated by semantic artificial intelligence to include the latest data collected about the material and human world.

6. NEUROWEB: DISRUPTING TECHNOLOGIES FOR 'NEW EDUCATION'

All existing educational technologies, whether lectures, or textbooks, or multimedia online courses etc., are mediators between holders of knowledge or skill and those who want to learn it. The dream of science fiction, the immediate acquisition of knowledge (e.g. direct download into nervous system), may become real even during our lifetime, in the next fifteen to twenty years, due to the development and dissemination of existing and feasible cognitive technologies. Obviously, such technologies would require to revise the education model more substantially than any other technology mentioned in this Report.

In this chapter we consider these technologies and their implications, that may be perceived today as an 'engineering sci-fi' — much alike the flight to the Moon was perceived at the dawn of the rocket era, achievable, but requiring more than one significant technological leap. Available opportunities in this area are technological solutions that directly work with our body and our nervous system, including:

a. *Various applications of neurointerfaces which influence the development of this area in coming years:*

- Medical applications: neural implants (e.g. cohlear implants, artificial eyes etc.), neuroprosthetics and non-invasive solutions for rehabilitation purposes;

- Military and industrial applications: remote & distributed control of military and industrial robots; exoskeletons; non-verbal communication interfaces in combat, control and co-development;

- Entertainment: game character controls, specialized neurosports.

б. *Body interfaces: conversion of movement patterns into control commands (from video recordings such as Kinect to electromyography), bio-monitor wearables (e.g. bracelets with accelerometers, heart rate monitors, etc.), biofeedback systems (BFB).*

в. *Psychopharmacology: drugs enhancing quality of nervous system work with no side effects (e.g. nootropics), as well as drugs for productive altered states of consciousness (e.g. deconcentration of attention for dispatchers & operators, as in experiments of O.Bakhtiyarov).*

There is a number of practical applications of these solutions for education and personal development:

- 'Brain fitness' systems (both software solutions and biofeedback wearables) that help to develop cognitive skills and overcome age-related dysfunctions of the nervous system (e.g. Alzheimer's and Parkinson's diseases).

- Productive state-of-mind training (e.g. highly focused state or ability to relax in stressful environments), attention management (which becomes a critically important due to information overload and ADHD syndrome), and working with subliminal signals & sensations.

- Objectification of evaluation and assessment of educational process and its outcomes. This may be one of the most important applications of cognitive technologies for the future education model. Objective assessment allows to track student's cognitive engagement in learning in order to make prompt adjustments of the educational process, and to monitor how well a student has learned this or that material or skill. (If the interaction time between the student and the neurointerface / databases is sufficient, it becomes possible to create a personal brain map and use it to track activity in the areas of the brain responsible for various types of knowledge and skills, i.e. to record the specific impact of education & training on the brain structure).

- Options of psychopharmacological support to the learning process (including the potential of personalized medicine that will provided personalized drugs based on gene testing to improve body & mind abilities).

Further development of cognitive technologies will lead to the emergence of a new communicative environment in next 10-15 years. This communication media, NeuroWeb, will use the protocols of brain- brain interface (for instance, HTTP-2 — the 'Human Thought Transfer Protocol'). First instances of this technology will be highly utilitarian (i.e. driven by practical demand in the narrow application field), e.g.:

- battlefield communication environments between frontline combat soldiers, military robot operators, and remote coordinators;

- environments for operational management of complex industrial facilities or urban infrastructure (teams of operators supported by artificial intelligence);

- environments for complex engineering projects (from aircraft to smartphones design) with distributed teams working on early stage generative design.

Such and similar environments will become the foundation for the first 'neural collectives', teams using post-verbal neurocommuncation protocols for efficient group work. These groups will be able to solve non-trivial problems in uncertain environments and under time pressure (thus requiring intense interaction between individual human minds and supporting virtual and real artificial agents). To operate, they will use digital coworking environments and 'live knowledge' models supported by artificial intelligence, and frequently will employ non-anthropomorphic robots that will serve as 'limbs' of the 'collective body'. The majority of such groups will form their own exocortex, artificial components of the mind that would interact 'seamlessly' with minds of team members (through the mechanisms of ultrafast learning and direct download into neural system). Accordingly, these teams will act as a whole, a collective subject formed by participating individuals.

Various military and civilian applications would allow to create massive communication environments that will ultimately become the next generation of the Internet, or NeuroWeb, wherein services for learning, social networking, creative activities and 'neural collective' management will quickly emerge, as well as the multitude of media and entertainment applications[5]. The main difference between the existing Internet and the future Neuroweb is that the latter will use a unique language to connect 'maps' of individual neural systems — and this will allow communication to occur faster and more precisely, it will allow to 'express the inexpressible', to upload knowledge directly from one brain to another, to create complex and highly realistic sensations, and to share not only verbal or audiovisual messages, but also experiences and emotions.

* 5 Obviously, adult entertainment industry will be among the primary drivers in content & traffic generation, as it was in the history of World Wide Web in 1990s.

Today there are two main obstacles hindering the development of the NeuroWeb:

- degree of neurointerface resolution that would allow to capture the state of individual neurons or groups of neurons (this is only possible with invasive, or implanted, interfaces, whereas the 'resolution' of non-invasive interfaces is extremely low, however only few people would agree to let an electronic chip be implanted into their brain[6]);

* 6 However, there are some recent emerging alternatives that may essentially work from inside the brain but will not require brain surgery, such as the 'neural dust'

- as every brain is unique, a full personal map of the mind must be drawn (and constantly updated) for every user in order to access features of Neuroweb. This will require machines that will have several orders of magnitude more computational power than can be offered by existing silicon-based computer processors (here, the potential of emerging quantum computing is seen as most promising).

If these problems are successfully resolved, it is highly probable that NeuroWeb will emerge using the underlying protocols of Internet, and it will rapidly start to attract more and more users.

The emergence of NeuroWeb will create a problem of 'Global Psychodivide', a divide of society into those who are ready to enter the new communication environment and to face its benefits and side effects — and those who will resist it. There will be at least two barriers to enter: first, it is the general ability to learn how to use the new communication protocols, and second, the willingness to do so. Unlike the digital divide of 1990s, the

reason for ability to cross the 'psychodivide' will be primarily mental, not economic. The digital divide was mainly caused by differences in access to ICT tools and solutions, and only to a small degree by differences in thinking, whereas in case of NeuroWeb the reverse will be true.

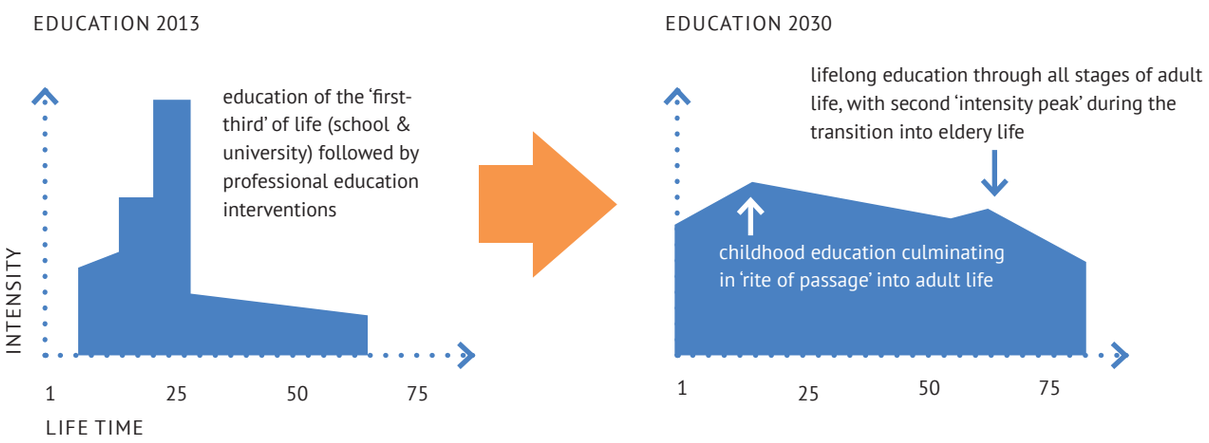
Should NeuroWeb become the reality, it will mean the end of teaching & learning as we know it, and the emergence of new forms of education & training that will be created specifically for 'neural collectives' and superfast network learning. It is clear that the concept of learning itself will be embowered by the concept of co-development.

The scenario of Neuroweb emergence is highly probable (as many technologically advanced nations consider neuroscience among their scientific priorities), however, it is still many years ahead. Since we assume that this Report can be used in practice of decision makers, we have to remain practical, and more attention should be paid to short-to-medium perspective opportunities, that are available now or may become available in the nearest future.

IMAGINING EDUCATION 2030

1. THE PLACE OF EDUCATION IN THE HUMAN CYCLE OF LIFE

The use of educational solutions described above will change the place of education in people's everyday lives — its position both in full human life cycle and in shorter periodic (daily, monthly, yearly) cycles. Education of today is like a 'pre-race warm-up': it prepares students for the competitive adult life by isolating them in specialized educational institutions. Later, some individuals get additional education through refreshing courses, but overall intensity of such education is not very high — and for the majority, after the retirement education stops completely. Unlike that, education of the future will accompany individuals through their entire lives — from before they are born ('school in the womb') and essentially until their death. This does not mean that education will claim a lion share of their time and effort — as the educational dimension of 'non-educational' activities (e.g. project work, sports or gaming) is acknowledged, an individual will constantly be 'inside education'. There is at least one peak when educational intensity will be at its maximum — the period of transition from child to adult, which may be institutionalized as a 'rite of passage' or a 'maturity exam'. (It is probable that the second climax of education will be around the time when professional career is finished and a transition to the 'last third' of life occurs: since the duration of life and the quality of old age both increase, the eldery life may become a separate stage of self-realization that will require additional educational preparation).



Education transcends beyond the age and institutional limits, 'dissolving' within the society and becoming a lifelong 'companion' from birth to death. Concise and self-directed education is not anymore the choice of the tiny number of autodidacts — but a widespread phenomenon integrated into our everyday life as routinely as personal hygiene or fitness.

2. 'THE LEARNER'S PATH' IN THE NEW EDUCATION MODEL

Lifelong education model defines the fundamental components of the new educational structure. These components will be same or similar for preschoolers and schoolchildren, for young people starting a career, for mature people engaged in self-development, and for elderly people changing their line of work.

The core of this universal design is the individual development trajectory, which may become the 'education&career track' during the high school, university and post-university years — but essentially accompanies everyone through their entire lives. This individual trajectory is determined by the educational goals which can be set in several ways, depending on motivation and maturity of the student:

- the most mature students (both in personal and social aspects), capable of self-directed learning (i.e. autodidacts) can independently set developmental goals and create their own trajectory to reach them;

- another option (most likely, chosen by the majority in the near future) is to build a personal track based on the 'hero's path', modelled after personal trajectories of profession leaders or other prominent figures;

- some students will work with mentors who will use their own experience to help build students' educational trajectories;

- 'enforced goals': education 'commissioned' by the 'supervisors', e.g. by parents for their children or by employers for their employees, will also remain as part of the picture.

Based on the goals specified, an integral education & training program is formed, which comprises the following:

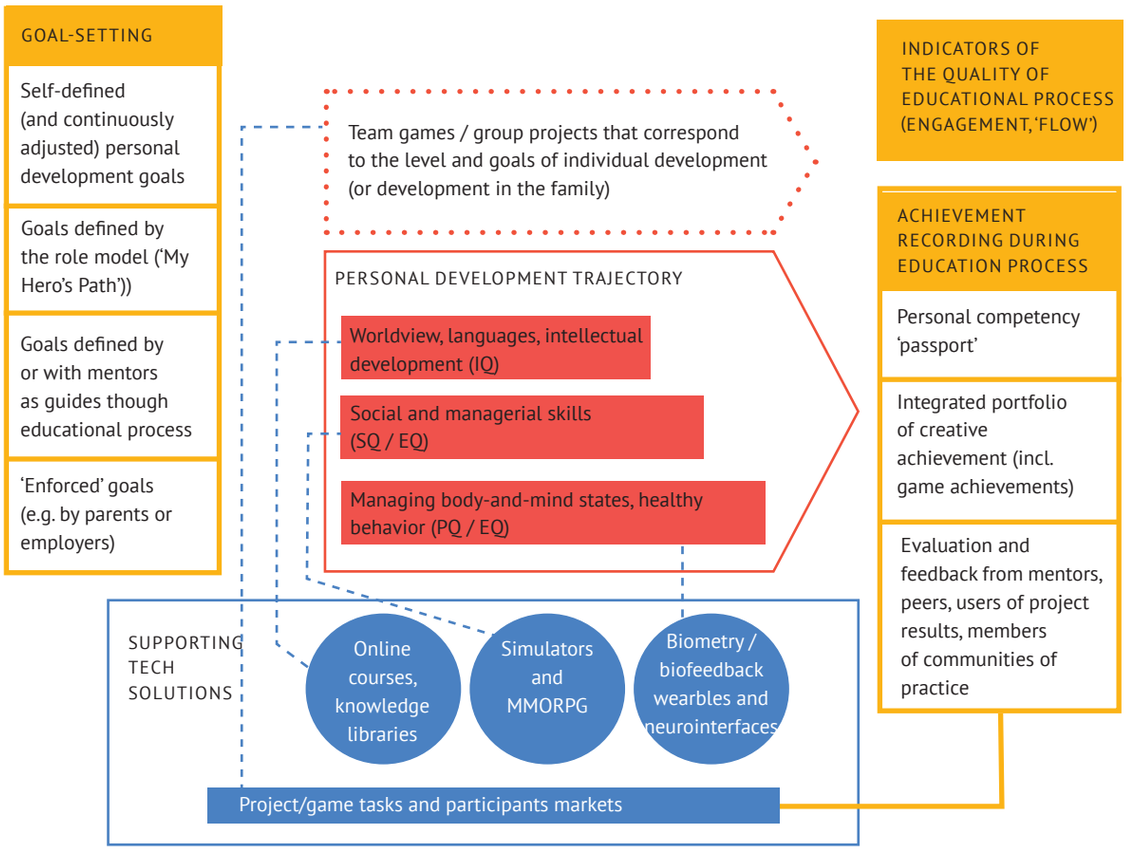
- intellectual development track: acquiring the worldview, learning of languages, developing logical and critical thinking, and later in life working with subject-specific knowledge, special thinking skills (e.g. design thinking, TRIZ etc.).

- social and managerial skills development track: collaboration, co-creation, leadership, etc.)

- body-and-mind development track that will not only include sports or skills of health self-care, but also skills of body-and-mind control.

These tracks will not go 'parallel' to each other but rather be tangled tightly, allowing to master knowledge-in-practice by solving applied problems and overcoming various chal-

lenges (e.g. learning in gaming environments would simultaneously develops intellectual, managerial and psychophysiological skills).



The technological environment is an active partner of the student, supporting various components of her / his educational trajectory:

- MOOC-style online courses and knowledge libraries support intellectual development;
- team work simulators and educational multi-player gaming environments (e.g. based on massive multi-user online role-playing game universes) help develop social and managerial skills;
- psychophysiological state simulators using biofeedback and neurointerfaces support body-and-mind development;
- apart from that, technologies track and record student's performance and achievements throughout the learning process.

The educational process can be highly personalized, but a major share of learning will occur collectively, through work or play with other students in communities, families and organizations. Therefore, it is necessary to match or align personal educational goal with opportunities that exist collaborative learning environments. One of the important tools that will connect students with collaborative learning environments (e.g. role-playing

games or project-based organizations) will be the 'education opportunities market', where various educational opportunities (in form of projects or activities that help advance team or organization) can be offered in exchange for an increase in the experience and reputation of the student.

Results of education, or achievements, can be recorded in various forms:

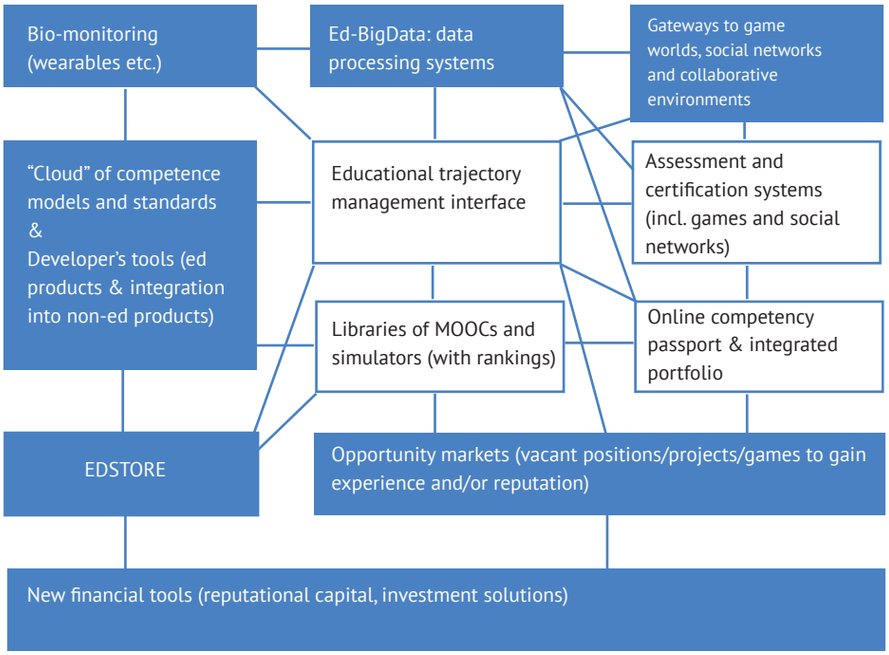
- incremental change in the competence profile during training, gaming or real problem solving (including changes in meta-competencies that reflect personal 'learning style' and learning abilities);
- personal portfolio: real and virtual artifacts created in the process of learning;
- reputation indicators (e.g. as 360-degree assessment provided by peers, mentors, product customers, members of communities of practice, game NPCs or even bystanders). These indicators help create a more appropriate and precise competence profile (since competences are assessed through performance), and also contribute to the reputational capital (that may give access to additional educational opportunities).

Besides that, the quality of education process itself can be evaluated, or self-evaluated, allowing intelligent educational systems to create educational experiences that will be extremely engaging in order to attain a high degree of skills development or sufficient depth of knowledge.

3. TECHNOLOGICAL PLATFORM FOR NEW EDUCATION

New education model will only be successful if supported by a cloud of inter-dependent technological solutions that will have all functionalities of the 'industrial' educational system, yet cheaper and more efficiently. Every learner in the new education will be surrounded by a 'supply side' infrastructure that enables the work of educational institutions and independent providers. The core of this infrastructure will be comprised of four elements:

- educational trajectory management interface: a system that will allow student (and their s human or virtual mentors) to set their educational goals, to create or modify their planned educational programs, as well as to track their progress within these programs;
- libraries or (semantic) search engines that allow to choose specific online courses (e.g. MOOCs) or entire programs, as well as educational simulators;
- web-based assessment and certification systems that allow to receive an external confirmation of knowledge, skills, and abilities;
- achievement recording tools, e.g. integrated electronic portfolio, online competency passport including real-time performance recording, etc.



Additional components of educational infrastructure:

- biomonitoring systems describing student's biological / medical / psychological profile and collecting current metrics from and biomonitors and neurointerfaces in order to provide real-time feedback during the educational process, to train attention management skill and control over mind-and-body states, etc.

- gateways that help integrate educational processes into non-education services, such as multi-player games, social networks and collaborative environments for creative project work. In particular, there is no need to invest in creation of specialized educational gaming universes - existing virtual worlds (e.g. MMORPG universes) can be complemented by educational trajectories and achievement recording systems, turning them into learning environments.

- educational opportunity markets that help exchange collaborative learning opportunities;

- EdStore-like educational content stores, most likely built upon educational content search engines or educational trajectory management systems;

- specialized developer environments and tools for online course and simulator development, as well as for integration of educational components into non-education solutions, including:

  • 'cloud' of competence models and educational / professional standards,
  • developmer tools for educational trajectories and educational programs,
  • tools that help integration of educational components into gaming environments;

- Ed-BigData analytical modules processing vast amounts of data generated by users of online courses, simulators and other new education formats, including:

  • data mining systems that help identify (a) most efficient educational and career trajectories, (b) impact of specific educational solutions upon user competencies, (c) level of demand for various types of educational content and formats, (d) patterns of student behavior such as 'learning style' etc. (proliferation of such data-mining systems in digital learning launches the new age of evidence-based education that will become the core of new pedagogy science);
  • recommendation services that help adjust personal educational trajectories;
  • supporting analytics for developers of educational products for various target audiences and different types of educational content.

The list of necessary technologies is by no means exhaustive, yet the full-scale new education will require infrastructural solutions that will have functionalities described above in one form or another.

4. NEW FINANCIAL INSTRUMENTS

Introduction of new investment instruments that help finance education is one of the essential components of a more flexible educational model. In addition to the traditional types of financing (e.g. education loans) we expect the following forms to emerge:

a. Direct talent investment. For investments in education to be transparent and manageable, both the process and the outcomes of education must be documentable and measurable. Hence there is demand from talents and their investors for (a) competence passports, (b) analysis of the contribution of specific educational products to the development of skills & competencies, (c) educational trajectory as a program designed to increase the probability of successful investment (based on data mining of similar investments), (d) transition to integrated 'education&career' trajectories. From investor's point of view, such tools would allow to estimate risks of individual talent investments and to build balanced portfolios composed of many students and/or professionals.

b. The insurance model, assuming that 'being competent' is similar to 'being healthy' (competence implying sufficient efficiency and adaptability in the modern society, including competitive employability). Various insurance plans for education may include:

- 'subscription for education' or 'ad-hoc education' plan, applied when education & training is used to remedy the revealed incompetence (much like visiting a doctor during acute phase of a disease);

- 'insurance against ignorance' plan (which could also complement the direct talent investment) in which the insurance benefit is paid out when education outcomes do not meet the customer's expectations (e.g. an increased skill or an expected movement up the career ladder).

c. Mutual benefit society', a model that can be developed in the context of 'horizontal' education (including online education), when communities of practice create mutual funds to order educational services that match current needs of their members.

d Another (rather amusing) model that could be used in some educational services is an 'educational casino', in which an additional monetary incentive is created for students through betting on their ability to study a subject or form a skill (alike online betting on losing weight).

e. The reputational capital exchange model, in which reputation becomes an indicator of accumulated personal skills and traits, and it can be spent to develop additional skills through exchange with their possessors. In long-term perspective, this could become one of the mainstream models that will help the proliferation of 'horizontal' education models.

5. NEW COMPETENCIES FOR NEW EDUCATION

Technologization of educational processes implies that robots and software solutions will take over many of the processes currently performed by human educators. Does this mean that the new education will become predominantly unmanned, and that the change of educational paradigm will lead to mass layoffs of teachers and professors?

We believe that this is absolutely a misguided idea. Education is, and will always remain, a sphere where people work with people. However, people should not turn themselves into machines that read standard lessons or mark tests — on the contrary, by 'rendering unto technology things that are technological', people can focus on truly human tasks: creativity, communication, and self-development. These tasks will require a greater number of specialists that will be able to create and support new educational formats — in fact, as changes in economic organization gain momentum (including the introduction of elements of post-scarcity economy), the domain of education may become one of the largest employment sectors in the economy. However, the core competencies of these specialists will differ from those of the majority of existing educators: 'human phonograph' teachers will be replaced by a generation of 'new education' teachers that employ project-based, community-based and game-based learning. Also, special products that support educational processes in non-educational spheres (e.g. entertainment) will also be created, and people that create and maintain them will essentially become a part of this new education.

NEW EDUCATIONAL ACTIVITIES	SPECIALISTS THAT APPLY NEW SOLUTIONS	SPECIALISTS THAT DEVELOP NEW SOLUTIONS
'Blended' learning through online & offline educational modules	• tutors • 'blended' educational program directors	• online and blended pedagogy experts • educational content authors online and blended learning platform developers
Project–based learning and on-job training	• project work facilitators / moderators / directors • project mentors (within business, government & non-government sector) • supervisors / coordinators of internship & apprenticeship programs, coordinators for business & school / university relations	• designers of project-based educational programs • developers of teamwork collaborative environments
Game-based learning	• live non-player characters • chief & assistant game masters (in charge of playing) • game-based teaching faculty that help integrate games into educational process	• gamification experts that help embed games into non-gaming activities • game design masters that develop game scenarios and game mechanics • virtual & augmented reality gaming solution developers • game-based education methodologists
Wearable-based learning	• mind fitness experts • instructors that help integrate wearables into educational process	• developers of training programs and supporting software for productive mind-and-body states • new educational hardware designers (based on biofeedback wearables etc.)
Education and career tracks management	• personal mentors • experts on marketing of 'branded' educational trajectories • quality control experts for education & career trajectories (role alike 'movie critics')	• educational trajectory designers • big data system developers for trajectory / success factors analytics • education & career 'heroes' (alike 'movie stars') • personal trajectory management platform developers
Assessment & evaluation	• independent evaluators & evaluation observers • independent auditors of assessment systems	• assessment / reputation system designers (incl. reputation capital models) • behavior monitoring system designers (incl. game-based monitoring)

RECOMENDATIONS FOR KEY STAKEHOLDERS

IMPLICATIONS FOR THE VENTURE CAPITAL INDUSTRY: ED-TECH STARTUPS

Education technological startups are new players that in the next 10 years will reshape the education market and will introduce completely new rules for it. There are vast opportunities and, in fact, empty market niches for the new education that include:

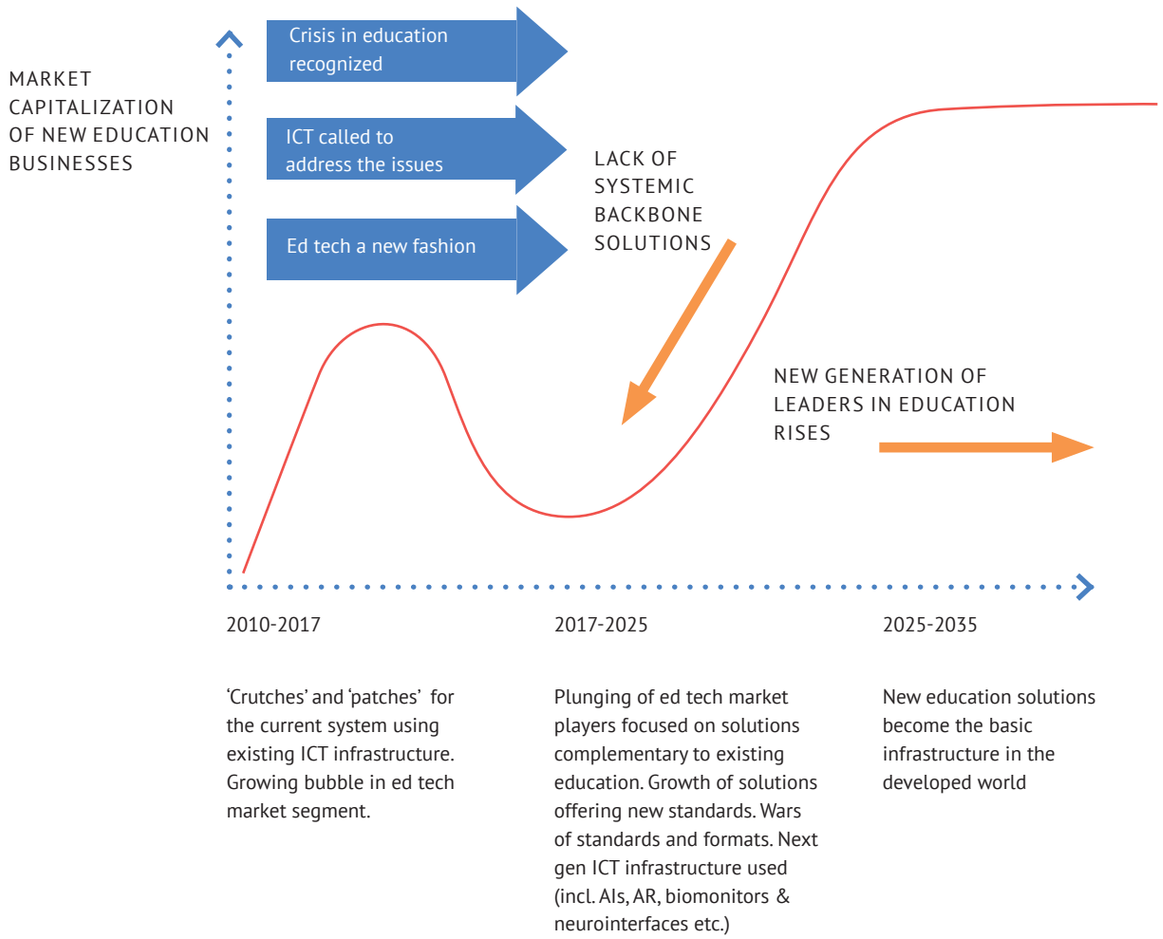
- backbone solutions which create a technological infrastructure of the new education;
- new financial and investment instruments for the developing education sphere;
- educational solutions for consumer groups that are either underestimated or altogether neglected by traditional educational systems: early-maturing children, progressive families, the 'New Old', etc.;
- new gaming solutions and virtual worlds aiming for the development of personal and team skills;
- various neuro-technological solutions for education.

Some examples of prospective solutions in these areas may include:

SPHERE OF APPLICATION	EXAMPLES OF SOLUTIONS
BACKBONE ICT SOLUTIONS	• competency, achievement and reputation tracking systems • education content search engine and/or EdStore • Ed-BigData solutions • education software developer tools • education trajectory design & management (including artificial tutors) • mentor networks • opportunity and talent exchange markets
NEW FINANCIAL INSTRUMENTS	• direct investment into education & career trajectories of talented individuals • insurance instruments for talents and their investors • reputation capital instruments, incl. reputation-based educational service exchange • instruments for betting on education & training outcomes
EDUCATIONAL SERVICES FOR UNDERESTIMATED CONSUMER GROUPS	• professional training programs for early maturing children • support of career track relaunch for 'New Old' (people 65+ in active physical & mental form) • 'family universities' for family life-long learning and integration
VIRTUAL WORLDS FOR GAMES AND EDUCATION	•simulators for prolonged team training • simulators for alienated people & delinquents • games with augmented reality in corporate & urban environment • simulators of risky & hazardous situations 'playing with values': simulators that facilitate the children's moral development • 'psychodrama worlds
BRAIN FITNESS AND OBJECTIFICATION	• state-of-mind training tools (incl. wearables) & attention management schools • measurement of engagement & learning attained • sensoriums: virtual environments that help recreate sensory experiences and emotions

Drawing an analogy with the Internet industry, today we are at the stage of 'Internet launch' (the phenomena that were seen between 1994 and 1996). Opportunities are vast: it is the time when new Googles and Amazons can be created. However, only a handful of companies truly have the vision and systemic solutions that can establish the backbone of the new education system. Like in many hi-tech sectors, the early enthusiasm evaporates, and the market moves into the 'trough of disillusionment'. Most ed tech startups will not stand to their promise - as a result, by the end of 2010s we may see a collapse of the ed-tech market bubble. This scenario may shock the public that can start calling the new education a failure. These discussions will also be encouraged by conservative educators and regulators who may see new education as a risk (in fact, voices against MOOC platforms indicate that this battle has already started). However, the frequently occurring 'double hump' effect in innovative sectors is well known to the venture industry: an intermediary decline after the early growth, following by the new wave of more robust growth. We believe that the new education solutions will go into the mass-market only in 2020s,

while 2010s will be the time of experiments and learning that will determine the future leaders of education markets.



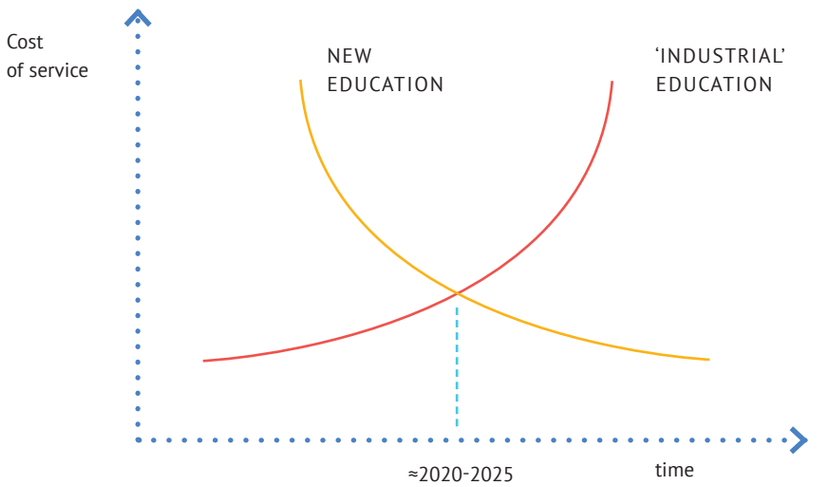
IMPLICATIONS FOR EDUCATION INSTITUTION ADMINISTRATORS

1. Industrial education model: providing the 'base load'

The existing educational system may be in need of the radical reorganization — however, it remains operable and therefore will be reorganized gradually and from inside. There are certain similarities between the transforming education and the changing energy sector where the age of 'smart grids' is coming. Similar to large and highly concentrated industrial energy production systems, the 20th century education was built as a hierarchically structured system of mass production of profesionals concentrated in large schools and universities. Similar to energy 'smart grids' that allow horizontal interactions of massive small energy providers and users, the 21st century education will be built as a distributed system that allows the horizontal interactions and exchange of knowledge & skills within and between communities. For the next generation (up to 20-25 years), however, we will still need many 'standard' professionals that maintain and gradually upgrade existing industries and technologies. The 'industrial' educational institutions will continue to provide the 'base load' (alike in energy sector, where large producers of energy such as

coal & nuclear plants provide the 'larger part' of electric energy on the constant basis) for at least the next couple of decades, as new education solutions will slowly build the infrastructure that would allow them to operate systemically, consistently, and with comparable quality.

However, the industrial model of education (schools & universities) will continue to lose the monopoly of education providers. By the mid-2020s alternative educational solutions in OECD countries will allow to get adequate basic & professional education (with comparable cost & quality) without ever entering a school or a university. And, similar to energy sector, the cost of services in the new education will gradually go down (as mass market solutions and new infrastructure are developed), while the cost of traditional education will continue to grow (due to increasing customer expectations and talent competition). The proliferation of 'new education' solutions will primarily depend on their ability to provide higher quality & lower cost services in areas where the state invests (e.g. socialization & social adaptation including languages & professional education for children & immigrates, national security including patriotic education & inter-cultural education, etc.). We believe that before or around the first half of the 2020s we will witness the wave of switching in the state-financed education from traditional providers to independent 'new education' providers (MOOCs, simulators etc.)..



Traditional educational institutions will have to realize that their 'cushy time' is over, and the wave of changes is coming. The resistance in traditional teaching & academic community is high, but the reluctance of the faculty to adopt new methods and practices may jeopardize the future of the institutions altogether. Forethoughtful schools and universities will not oppose the new education but will use it to their advantage.

2. Segmentation of educational system and possible strategies within segments

Within next 10-15 years institutions of the existing educational system (schools & universities) will segment into several groups by their level of adaptation to changing environment and solutions available in the new education:

a. Leaders (top national and international schools and universities) will adopt practices of the new education and will use them actively in their educational process, including:

- focus on building and retaining the unique competitive advantage: the culture and competencies of the institution, and access to direct mentorship with leading specialists in the field;
- personal (asynchronous) educational trajectory for every student (including the design of potential career);
- flexible assessment that helps retain motivation and create capability for self-directed learning;
- 'culture of experimentation' that provides opportunities (including time and other resources) for individual and collective experiments in the fields of education, science, arts, social activities);
- end-to-end digital environment to support learning processes and development of educational programs;
- flexible architecture of educational facilities that allows the variety of educational activities (including innovative formats) for individuals and groups;
- a strong community inside and around education providers (strong ties with local community, businesses, government etc.);
- collaborative learning formats that involve industrial practitioners and student families.

Top universities in the USA have already implemented many of these elements, and this will help them retain their leading positions. However, institutions of emerging economies that implement these practices will also be able to join the race for global leadership.

b. The mass market segment (the majority of schools and universities in developed countries) will combine solutions of traditional and new pedagogy. The strategy of mass-market solutions will partly imitate the leaders:

- unique competitive advantage of these institutions will be their niche focus — either on local needs (school or university becoming the center of community social life) or the needs of a specific industry or sector;
- pseudo-personalized trajectories (selected from the range of 'branded' trajectories);
- 'blended' education that involves a fair share of online courses, online games and simulators (the 'flipped' classroom model);

- the dominant form of live education is mentor-supported teamwork on creative projects;

- the use of web-based social networks to support the educational process with external competencies;

- partnership programs with other institutions that increase student mobility for multi-country & multi-cultural experiences and ability to work in different contexts.

c. Finally, the 'tail' of educational market will include:

c1. Organizations in professional education that providing quick & targeted skill training: a combination of 'shared use' educational facilities and a cluster of training program providers.

c2. Institutions primarily or exclusively focused on social care & security (e.g. schools in poor areas). The strategy of such institutions will often include:

- facilities architecture and IT environment that ensure the safety and security of students;

- education is predominantly digital (including learning in virtual worlds) yet conducted in classes (in order to decrease cost of access and increase student motivation);

- intervention of supervisors is focused on assistance in understanding harder problems and solving personal issues;

- special programs for social adaptation and re-socialization of at-risk students, including programs developed in partnership with social movements and local communities.

3. EDUCATIONAL SPACE

a. Educational architecture. The digital education transforms but does not eliminate the live education. Accordingly, examples of educational space that supports new education models are needed — and they can already be found. They are not university campuses but campuses of leading IT companies: Google, Facebook, Amazon etc. We think that education has much to learn from the IT sector, and the workspace organization is among the things to be learnt first of all.

b. Education in its urban (or rural) environment. Education can no longer ignore John Dewey's call to eliminate the boundaries between school and society. Some leading universities have already become the 'world change agents' with global ambitions — but there cannot (and should not) be too many of them. The majority of schools and universities should focus on their local communities to become engines of the development process for their cities and regions.

IMPLICATIONS FOR REGULATORS

In countries that seek to upgrade their educational systems to the top-class level, especially in emerging economies, the proactive position of regulators plays the essential role. We believe that the main objective of regulators is to create conditions that allow the emergence of new education rather than try to reform the existing educational system. The depth of changes required in 'industrial' education may be so significant that it could be easier to leave it than to repair it. The most advantageous strategy in the modern education could be to launch 'greenfield' startups rather than to reorganize existing 'brownfield' institutions.
Accordingly, the potential elements of forward-looking educational policies may include:

a. Policies regarding 'industrial model' education (existing basic, secondary and tertiary education system):

a1. Maintain sufficient funding to retain the quality of basic education that takes into consideration the necessary modifications and upgrades of the curriculum to match the changing technological and social reality (including the knowledge of native and foreign languages, mathematics, programming, natural science worldview, as well as 21 century skills).

a2. Target investments for:

- achieving leadership of institutions that can become a part of the world's education elite;
- launch breakthrough projects to improve secondary and professional education through application of ed hi-tech (alike the model of ARPA-ED);
- reorganization of part of national universities into drivers of regional growth and development.

a3. One of the main missions of the industrial education system in the coming years will be to help rebuilding economy with new green & smart technologies. Schools and universities therefore should be incentivized to:

- initiate and maintain the dialogue between the educational and the industrial sectors in order to close the skill gap and address the future skill needs of the economy;
- remove barriers that impede adaptation to the industry requirements in professional education;
- create programs to support self-employment (including entrepreneurship education, mentoring of startups and non-profit projects, providing incentives and infrastructure for student founders etc.)

a4. For national education regulators, is essential to work out their own position towards the leading international MOOC platforms. Although such platforms may be seen as a risk for national education providers, banning them will not be a far-sighted decision. However, the unlimited and uncontrolled access to these platforms may also have negative implications for national educational institutions and labor markets. The best thing the regulators can do is to develop the terms of win-win partnerships between leading MOOC platforms and national educational systems, and later to integrate such partnerships with national programs that support education of talented students in top global universities.

b. Policies regarding 'new' education (ed tech startups, alternative educational providers including entertainment & toy industry etc.):

b1. Regulators can encourage the new education development by helping to establish 'Ed Tech incubators' that bring together educators, engineers, and entrepreneurs for joint work on ed tech startup projects. Regulators can also provide financial and fiscal incentives to ed tech startups (through tax allowances and creation of specialized 'ed tech' venture funds in public-private partnership format).

b2. Education can influence the current physical and mental health and the future behavior of individuals. Therefore, standards and requirements for physical, mental and social safety of innovative educational products must be developed. The positive experience of juvenile industry in the US prompts that the best working solution to establish such requirements is through professional associations (Juvenile Products Manufacturers Association in case of the US, Canada, and Mexico) that host dialogues between designers, manufacturers, consumers, and independent experts in psychology and pedagogy.

c. General educational policies.

c1. Equal rights for all providers of educational services to access key resources: students, government funding and tax liabilities, etc.

c2. Creation of national infrastructure that allows to record individual life-long achievements and support individual educational trajectory — this will give consumers more flexibility to choose between 'traditional' and 'new' education providers.

c3. Focused initiatives that help integrate existing 'traditional' educational practices with practices that rise in 'new' education (e.g. application of online learning and MOOCs, gaming technologies, online simulators etc.)

c4. The quality of educational innovations increases if educational product producers are able to work with customers outside their region or their country — therefore, support to educational services export is required (incl. export of ed tech solutions).

c5. Creation of opportunities for scientific and practical experimentation in educational sphere (including targeted grants for development and commercialization of new educational technologies).

d. Transboundary / international policies.

d1. Promotion of inexpensive education technologies in developing countries. Concurring with the leaders of 'Hole in the Wall' and 'One Laptop Per Child' projects, we assume that educational divide between developing countries (including less developed nations) and advanced nations could be bridged through extensive implementation of ICT-supported educational solutions.

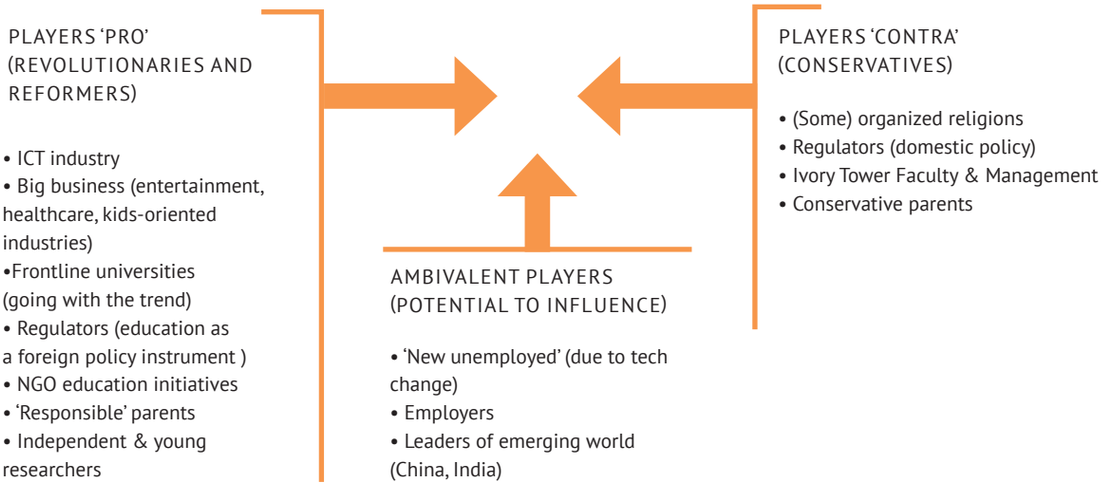
d2. Identification and global replication of educational practice from developing and less developed countries (e.g. 'learning from extremes' model), as these locations become new laboratories for educational innovation where the most socially and economically demanded solutions are being born.

d3. Creation of global professional certification systems and global simulators for skill testing in partnership with international professional organizations and leading MOOC platforms.

d4. Formation of uniform rules of global talent flow: World Education & Talent Organization, 'Kyoto Protocol' in Education or other potential designs of global education architecture.

CONCLUSION

Publications on the future of education sometimes depict the process of its transformation as a battle between two principles, sort of the 'good' and the 'evil': the 'new' education, supported by most advanced technologies and aimed at the radical social transformation, and the 'industrial' education, designed to maintain the status quo of educational institutions and the society that it is part of.



However, there are not two but three principles involved in this battle, and each of them is absolutely constructive in its nature and aims for the good:

- Social conservation is the principle of the past that sees education as a process of accumulation and passing down collective / social memory, a way to retain social norms and patterns.

- Social pragmatism is the principle of the present that sees education as a tool to help solve current & pressing social issues. Pragmatism is definitely a source of transformation and progress (and often has played this role in the history of education).

- Social progressivism is the principle of the future that sees education as a 'break-through zone' for the society.

Any real process in education is a combination of these principles. By following only one of these principles in education curriculum, format and policy design (e.g. that education should be practice-oriented), one risks losing the very essence of the educational process as a link between the past, present and future.

When one discuss the future of education, it is necessary to have some staples, some points of reference that allow to make forecasts and provide potential designs — it is why we refer to technological and institutional trends so much. However, we, people, are driven not only by the technological and social pressures. The main source of our progress is the expressed personal disagreement with the present state of affairs. Our common goal should be to keep this tension, to integrate the dividing processes, not to be lulled by pseudo-consensuses, to continue the dialogue between irreconcilable positions.
It is only in this way that we can overcome the systemic crises of civilization and make a leap forward. The future of education cannot be predicted, but it can be created together, through our common effort.

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