21st Century Higher Education:
Quick Scan of Foresight and Forward Looks on Higher Education in the ICT Age

Discussion Paper

Victor van Rij

Draft 1: February 2015

Contents

1 Introduction

This report was commissioned by the UNESCO Institute for Information Technologies in Education (UNESCO IITE) and is meant as input for the discussion on the future role of Information and Communication Technologies (ICT) in higher education (HE) during the kick-off meeting for the UNESCO project "Access, Equity and Quality: Envisioning the Future of Higher Education in a Digital Age" to be held in Paris on March 25-26, 2015. Main objectives of the project are as follows:

1. Capturing the ongoing trends in the impact of digital technologies on society and on higher education based on the analysis of ICT-related innovations
2. Extrapolation of current/emerging trends/challenges into the future; development of a descriptive vision of the future, identification of the strategies, which might ensure that learning at universities will adequately employ the potential of ICT to widen access to high quality education
3. Engaging a broad range of stakeholders in structured evidence-based dialogue about long-term implications of ICT-related innovations in higher education
4. Drawing up recommendations for policy and decision-makers in higher education on innovative ways to leverage cutting-edge technologies in order to stay competitive and prepare students for successful careers throughout life.

The main objective of the report was to systemize the diverse approaches, arguments, conclusions and recommendation resulting from different foresight exercises and debates and to search for potential gaps in the knowledge and thinking about the future in order to optimize educational policies and practices related to ICT in HE. The report summarizes the trends which affect the future of the ICT-HE relationship, and disruptions that can be found in foresight and future studies. This paper is intended to identify long-term trends that have impact on society, economy and governance with regards to the UNESCO priorities in the field of education.

"The UNESCO Position Paper on Education Post-2015" set the imperative goals - equitable, quality education and lifelong learning for all by 2030 (UNESCO, 2015). It is believed that ICT can contribute instrumentally to this goal by ***broadening access to learning opportunities at different levels and varied educational contexts****, by* ***improving the quality of knowledge acquisition, knowledge deepening, and knowledge creation, and the development of 21st century skills*** and by ***equalizing learning opportunities in favor of economically and/or demographically disadvantaged populations***. According to the Position Paper, *the changing requirements in the type and level of knowledge, skills and competencies for today's knowledge-based economies and the insufficient opportunities to access higher levels of learning, including for the acquisition of knowledge and skills on ICT ('e-literacy'), especially in developing/low income countries, are resulting in a knowledge divide, with major economic and employment consequences in today's mainly technology-driven world*. The Position Paper emphasizes one of the imperatives of education for the post-2015 agenda: *Flexible lifelong and life-wide learning opportunities should be provided through formal, non-formal and informal pathways, including by harnessing the potential of ICTs to create a new culture of learning*.

This study is mainly based on literature review. It summarizes the conclusions and considerations produced by a wide variety of foresight activities and the works of future thinkers and think tanks that

are considered to be relevant to envision the future development of the relationship between ICT and higher education. The future development of this relationship is intertwined with the societal, economic and governmental developments and can only be understood in this wider context. Therefore this study does not only focus on the future instrumental role of ICT for higher education, but also on the dynamic co-evolution of learning and teaching with future societal, economic and governmental developments that are interacting with ICT developments.

The most representative achievements were considered in the following domains and themes:

1. ICT in relation to societal development (Knowledge Society, Digital and Networked Society) and in relation to economic development (Knowledge Economy),
2. The future of learning
3. The future of work and future skills with focus on higher education level
4. The future of higher education
5. The future of ICT in higher education

The report includes an introduction, a brief overview of main foresight techniques and the reflections on the future of ICT in higher education through the prism of social and economic changes and the future of learning, the future of universities and the future of skills. The report contains an Annex with a summary of the main trends discovered in examined reports on foresight exercises.

2 Foresight and forward looking planning of HE

Along with the experience and knowledge about the past, decision-makers use future projections and/or visions to make decisions for the future. They can do this intuitively but also with the help of the so-called forward looking methods such as forecasting and foresight, which rationalize the future projections and vision building in a systematic and transparent way.

2.1 Forecasting

Planning and quantitative analysis are very commonly used to prepare important decisions especially if they are concerned with large-scale investments. Usually the analysis is based on statistical data, which are projected into the future. Nowadays this projection is done with more or less sophisticated models or the use of scenarios where policy measures are tested with the use of quantified input and output parameters. In educational policy this may be quantitative indicators of expenditures, the number and qualification of teachers, the number of students in certain age groups, the outcomes of PISA scores, the number of degrees at different levels and so on. These approaches were used in the reports by OECD (2013) and UNESCO ("Trends in Global Higher Education: Tracking an Academic Revolution" prepared for the UNESCO 2009 World Conference on Higher Education (Altbach et al., 2009)). National forecasting is usually done by urban planners and planning agencies of governments, while enterprises usually leave this kind of activities to strategic and/or marketing divisions.

2.2 Foresight

Foresight is less focused on forecasting but may use the results of forecasting to feed its processes. In general foresight tries not only to quantify important aspects, but also to stimulate the thinking and debating the future (using all available knowledge but also imagination) to activate relevant stakeholders to let them shape their future to their will within the existing constraints that might be imposed by the past. Foresight therefore is often considered as a process rather than a product. This process is primarily based on participative methods and implemented through knowledge sharing and the fostering of creativity.

These methods bring together relevant stakeholders and experts to think and debate the future and to create common lead visions or to develop more qualitative scenarios, which sometimes are translated into more quantitative models. Good examples are the "Beyond Current Horizons exercise" of the UK Department of Schools Children and Family (Facer, 2009) and the "Future of Learning" exercise conducted by the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre of the European Commission (Redecker et al., 2011).

To gather information or to visualize the outcomes, the process of foresight may employ different techniques: the construction of scenarios, horizon scanning, vision building, roadmapping, back casting, Delphi survey, weak signal search, wild card approach, citizen or expert panels, etc. An overview of these techniques can be found in numerous handbooks, for example, "UNIDO Technology Foresight Manual" (UNIDO, 2005), "The Handbook of Technology Foresight" (Georghiou et al., 2008), "The Guidance

Document of the UK Government: Futures toolkit for policy-makers and analysts" (HM Government, 2014), "A Practical Guide to Regional Foresight (FOREN, 2001), etc.

Let us consider the two methods that are supposed to be used in this project in more detail.

2.3 Horizon scanning

Horizon scanning within foresight focuses on the scanning of different "strong" storylines about the future, which include plausible impact-rich developments, that are created by experts or stakeholders individually or group wise in permanent or temporarily think tanks. The storylines may be supported by strong scientific evidence but may also be supported by strong emotional aspects and beliefs. The mapping of these narratives and storylines provides an overview of potential leading trends, thoughts, imaginations and potential future events, as well as of more personal or subjective visions of particular stakeholders that may shape the future either as self-fulfilling or self-denying prophecies (Rij, 2013). Scanning is used in strategic decision making in business management (which originally focused more on present trends).

This paper may be considered as a small-scale horizon scan assembling the lines of thought about the future relation between ICT and HE as derived from a set of articles and storylines from experts, think tanks and foresight exercise reports.

To interpret the meaning of the different lines of thought and storylines it is important to distinguish between the "normative" arguments which primarily focus on the (un)desirable futures for the stakeholders (or authors) and "Explorative arguments" that focus on probabilities (quantitative) or likeliness of futures, trying to avoid subjective judgments.

2.4 Scenarios

The scenario method is one of the most common and known methods of foresight. The objective of the scenario method is to create a thinking space of the future which uses the drivers with the highest impact and uncertainty as coordinates, usually this is done with two main drivers, which creates a two-dimensional space with two (dialectic) axes and 4 quadrants (which in classical scenario building often means that economic growth is taken as one axis and liberal or socialistic policy as the other axis). The plausible direction of other variables (as trends and policy measures) is then estimated within this space (either quantitatively or qualitatively). The scenarios are built on the direction and interrelation of the plausible trends and policy measures and the behaviour of different actors within the quadrants. The scenarios usually are transformed in storylines (or story boards), which try to connect the trends, measures and actors in a narrative shape to illustrate possible futures.

Scenarios are neither predictions about the future nor utopian or dystopian visions (although some exercises have a tendency to produce those). They are more like simulations of plausible future situations or contexts. Scenarios are used both as an exploratory method and as a tool for decision-making, mainly to help reveal and invent aspects of the present that would otherwise be obscured by existing images of the future (Miller, 2003). However when people are given four or more storylines they

usually follow the mode of preferences and choices between these lines. Scenario experts should make it clear to decision-makers that they should not choose between the scenarios, but reflect on the effect of present-day decisions in different contexts that are shaped by scenarios. The premise here is that the main drivers, which are used as axes for the scenario spaces, are beyond the reach of the will of the decision-makers.

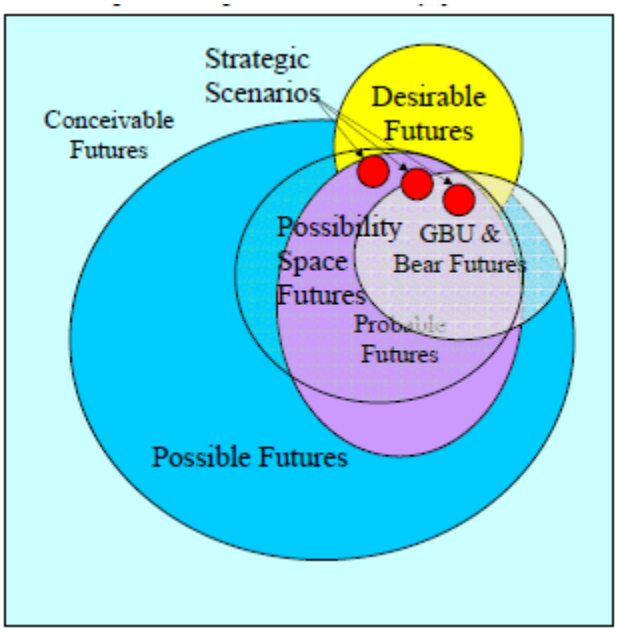


Fig. 1. Strategic Scenarios and Possibility Space Futures. Source: Miller (2003), p. 8.

2.5 Explorative and normative approaches

Foresight practitioners often make the distinction between normative and explorative approaches, but this distinction is misleading in many ways (Georghiou et al., p. 68) because it is actually impossible to avoid subjectivity and normative elements in any foresight activity, it is very important to realize which "hidden" norms and interests are behind statements, storylines and visions on the future. While it makes no sense to do foresight solely on the basis of normative grounds without having an idea on foreseeable elements of the future that are beyond our will (like path dependencies, laws of nature and wild cards).

For this reason we would like to explain the normative aspects of this exercise. The normative aspects are related to the UNESCO objectives in line with goal 4 of the post-2015 agenda:

- access to the highest achievable level of education for all world citizens according to their aspiration and capacity
- education of the highest quality everywhere
- equal accessibility for people with equal capacities.

Unfortunately very few of the exercises we studied explained the background or normative points of view of the authors.

In view of importance of normative aspects we should recognize that the ways we look at the future and how we use our knowledge to deliberately influence our future differ not only over time in history but also amongst cultures (and confessions).

Though it is a difficult task to charter the relevant foresight and contributions to the future debate globally, we nevertheless attempted to charter as much as possible to explore the main issues that should be debated to shape the future relationship of ICT with higher education in different parts of the world in compliance with the UNESCO objectives. Main difficulty lies in the fact that the majority of foresight exercises are coming from developed countries, the interest groups also reside in these countries. As a consequence, there is a risk this report might be dominated by western views on the future developments – this will need special attention for users of this paper and for further work that will be based on this paper.

It is clear that the participative foresight is primarily concentrated in western (oriented) countries. In other countries, we can find forward looking activities, but these are usually focused on more classical quantitative approaches.

3 Thoughts about the Future of ICT and Higher Education

3.1 ICT in Relation to Societal and Economic Development

3.1.1 ICT and Automation Revolutionizing Human Communication and Knowledge Creation

The report of a high-level workshop held in Brussels in 2010 within the EC-funded blue sky project "Far horizon" concludes: *The development of ICT in the last decades doubtlessly ranks amongst the major revolutions in our ability to communicate and to manage information. Former major revolutions in the sphere of human communication include the development of speech in prehistoric times, the development of symbols and writing and later the invention of printing. Each of these revolutions has had a tremendous impact not only on the way we lived, worked for our living and produced, but also on how and what we learned***".** The report states further that it is not only necessary *to incorporate the full array of ICT in all curricula to prepare students on the ICT skills they need in work and civil life but also to stimulate the use of ICT to discover, create and innovate*. By fostering the use of *ICT during education this way, it is expected that the economy may be boosted by new generations and that future generations may bring better answers to present and future challenges of society* (Rij & Warrington, 2011).

The assumption here is that ICT competencies of the population pay themselves back by optimizing the catalytic effect that ICT has on many businesses and tasks in society creating new business and increasing labour productivity but also learning, innovating and performing research with an enormous higher efficiency and increasing accuracy to bring innovation and solutions for our grand and small societal challenges.

ICT revolutionizes our societies and economies by an enormous enhancement of human cognitive and communicative capacities. It changes not only the way we can produce, store, retrieve, analyse and make sense of more and more big and small data, but it changes also our capacities to communicate in textual, audio-visual or graphical and simulating way over the world and to next generations. ICT (starting with audiovisual broadcasting and the rise of computers) induced a major revolution in human communication, that can be compared to those that began millions of years ago with the evolution of human speech (thousands of years ago), the creation of meaningful pictures (tens of thousands years ago), symbols and writing (thousands of years ago), book printing (hundreds of years ago). All these revolutions took place in relatively short periods of time in our human evolution and transformed not only the societies and economies in a drastic way but also the things people had to learn to be prosperous or even to survive in these transformed societies and economies. In most cases learning the "new ways of communication" was a matter of necessity for all, although reading and writing has long been the privilege for elite.

It is therefore expected that ICT-competence, as well as what we could refer to as ICT fluency, are becoming necessary conditions not only for acquiring a good job and prosperity, but also for survival in our ICT transformed society with ICT creationism and consumerism. This development also includes the risk that this revolution causes an increasing gap between those who can fluently use ICT and those who cannot even afford access to ICT. This requires attention of all actors that have substantial influence on the future global, national and local development.

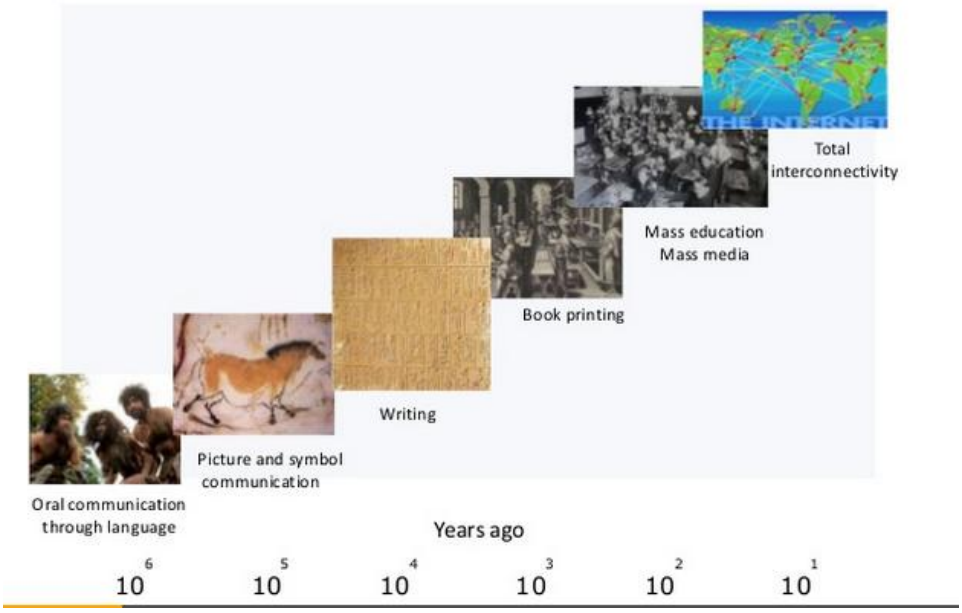


Fig. 2. Communicative revolutions in human society. Source: Rij & Warrington, 2011, p. 3.

3.1.2 Knowledge and Information Society and Knowledge and Digital Economy

The concept of knowledge society developed in the 1960s in academic circles and was strongly connected to the growing importance of the knowledge factor for the economy (Machlup, 1962) and for strategic corporate decision-making (Lane, 1966). The concept of knowledge society coincides with the emergence of the concept of knowledge worker (Drucker, 1999) as an important factor for economic development. The ICT development was in its childhood, colour television started its rise in households and mainframe computers, with capacities many times lower than that of an IPhone, took the space of a small apartment.

The concept of “knowledge society and knowledge economy” sets knowledge as core value and as factor of production. It is seen as a next phase of economic and societal development that follows after the”industrial (or manufacturing) economy”, which was preceded by “agricultural economy and society” that in its turn was preceded by “hunters/gatherers societies”.

The major shift between the “industrial society” and the “knowledge society” is the disappearance of physical labour as the major production factor (due to automation of labour) and the upcoming importance of knowledge work which translated into an upcoming importance of knowledge related services. Due to the growing importance of ICT in knowledge generation and distribution in the 1990s, the discussion shifted more to the envisioned role of ICT which lead to the concept of “Networked Society” and “Information Society” (Castells, 1996). These concepts illuminate an extra dimension of the concept of knowledge society stressing the power changes that are related to the control of the continuously (in speed and wideness) increasing flows of information, the knowledge management, the networking and communication infrastructures and the automation. Castells explores the consequences of growing importance of knowledge, information and networking in the industrialized world and

describes amongst others the causes for the shift of manufacturing activities from the industrialized world to the BRICS countries in the past decades.

The concept of information society clarifies the economic difference with the industrial society in a stronger way than the concept of knowledge society. In industrial society capital focuses on the replacement of physical labour by industrial machinery, with a consequential growth of services as well as service related employment, while in the information society capital focuses on replacing knowledge labour by information and communicating machines (Soete, personal communication), which should bring new activities and employment. Some authors believe that the model of information society applies not only to the developed world but also to the developing world that is considered to leap frog to information societies and thus develop faster to wealth and prosperity.

UNESCO promotes the concept of knowledge society (UNESCO, 2005) while stressing the cultural aspects of knowledge which is embedded and (re)shaped in local communities.

The authors of the report "Renewing the Knowledge Societies Vision for Peace and Sustainable Development" (Mansell & Tremblay, 2013) state that many deliberations about development seem to have "*a fascination with technology as "the" solution to development problems"* and stress the importance "*not to ignore the complex and unpredictable ways in which technological innovation is coupled with other changes in all areas of society which need to be taken into account"*.

In the same report it is concluded that "*A central lesson from decades of research on the economics of technological innovation, and especially innovations in ICTs, is that it is possible to "leapfrog" generations of technology, for example, to wireless networks without extensive fixed line networks. But it is not possible or desirable to "leapfrog" towards a universal knowledge society …. because it does not take into account the many non-technical arrangements that must be in place for earlier generations of technology to be bypassed or for new technologies to be assimilated into people's working and everyday lives*".

It is further stated that information and knowledge are not a synonym, because knowledge suggests interpretation by human beings. What matters in development is "*participation in change, enabling people's choices, values, preferences and voices to be expressed, heard and taken into account. A renewed vision of knowledge societies must not take the impacts of digital technology for granted. It must be built on the basis of participative processes enabling people's choices, values, preferences and voices to be expressed, heard and taken into account to shape equitable, just and sustainable knowledge societies".*

The report further stresses that it is important to *understand human development as "a process of enlarging people's choices",* and creating *"an enabling environment for people to enjoy long, healthy and creative lives", it is essential that progress is made in promoting freedom of expression, freedom of information, universal access to information and knowledge, quality education for all, and respect for linguistic and cultural diversity. These aspects of knowledge societies are just as important as the accumulation of commodities and financial wealth.*

3.1.3 Learning Society

Another concept that is closely related to the concepts of Knowledge Society is the concept of the Learning Society that focuses on the learning character of the Knowledge Society and Knowledge Economy. The concept of learning society was introduced by Hutchins (1968), later refined by Husen (1974) and Jarvis (2006). It is used in a descriptive way, pointing to the omnipresence of learning in formal and informal setting, as well as in a normative way, stressing the importance of stimulation and fostering of the learning spaces for citizens during their entire life in a continuously and rapidly changing world. The main assumption is that societies of the future will be self-reflecting learning societies, which according to CISCO (2010), should:

- *Engender a culture of learning throughout life.*
- *Aim to develop motivated, engaged learners who are prepared to conquer the unforeseen challenge of tomorrow as well as those of today.*
- *Take learning to the learner, seeing learning as an activity, not a place.*
- *Believe that learning is for all, that no one should be excluded.*
- *Recognize that people learn differently, and strives to meet those needs.*
- *Cultivate and embrace new learning providers, from the public, private, and NGO sectors.*
- *Develop new relationships and new networks between learners, providers (new and old), funders, and innovators.*
- *Provide the universal infrastructure they need to succeed—still physical but increasingly virtual.*
- *Support systems of continuous innovation and feedback to develop knowledge of what works in which circumstances.*

According to Popescu (2011), learning societies enable individuals to learn throughout their life, from cradle to grave. A learning society is a mix of different learning environments, encompassing: formal learning (in schools, training institutions, universities), non-formal learning (e.g. structured on-the-job training), and informal learning (skills learned from family or community members).

3.1.4 Conclusion

All the above concepts give descriptions of observed ongoing developments with large future impact (Castells, 1996) and/or normative prescriptions on desirable futures (CISCO, 2010). The descriptions claim a revolutionary change of the Western societies and economies from the industrial “standardizing” age, where “institutionalized formalized learning”, “manufacturing” and “physical labour” was dominant, towards societies and economies that find their earning power in “Knowledge”, continuous “Learning”, “Connections” and “Mental labour” for which ICT as well as learning are seen as the major tools or even as key drivers.

ICT has developed its potential with an enormous speed and is connecting people all over the world and tremendously enhancing our cognitive skills with already visible huge changes in our societies and economy. This development is still ongoing and is leading to an increased interconnectivity not only between people, but also between people and sensory networks and machines (the Internet of Things and people) the consequence of this is on one hand an enormous increase of productivity in almost

every aspect of life and on the other hand an enormous variety of still unknown applications and activities that suddenly come within human reach (which we only could have dreamt of).

Also for societies that are mainly dependent on their industrialized or agricultural economy this development is eminent but may evolve in another way.

Whether the concepts are descriptive or normative, they all force us to rethink what and how we should learn, but also how "earning" will be generated in knowledge and learning societies, what kind of work will evolve and what kind of skills will be needed to live in future societies. This rethinking will lead to different outcomes in different countries and should be done in participatory processes in each country.

During the launch in 2005 of the UNESCO report "Toward Knowledge Societies", the then acting DG of UNESCO, Koïchiro Matsuura, explained that ***knowledge societies contribute to the well-being of individuals and communities, and encompass social, ethical and political dimensions***. The report urged governments to expand quality education for all, increase community access to information and communication technology, and improve cross-border scientific knowledge-sharing, in an effort to narrow the digital and "knowledge" divides between the North and South and move towards a "smart" form of sustainable human development. At that very moment only 11 percent of the world's population had access to the internet and 90 percent of those connected, lived in industrialized countries.

3.2 Future of Learning

In recent years many thoughts have been given to the topic of the future of learning, which not only encompasses but also relates the future of education with the future of learning in other settings than in educational contexts and institutions. Many stress that in the "learning society" people will need or will learn their entire life in formal, non-formal and informal contexts (Popescu, 2011). It is stressed that the questions 'what', 'how', 'when', 'where' and 'why' related to learning are changing in a very fast way over time. An important factor in this is the increasing importance of the growing availability of ICT in many parts of the world, which creates learning opportunities beyond any expectation but also alters our learning needs. Many authors and foresight outcomes point to the fact that many institutions and many teachers are not aware enough or even if they are aware are not capable to utilize the new changing learning opportunities. This is valid for primary and secondary education and higher education as well.

An intriguing question concerns the "what" and "why" in relation to the fast development of ICT applications. If we for instance take the increasing accuracy of translations by Google (which have a written but also oral input and output) we may wonder if, in the decades to come, we still need to translate ourselves at all. An interesting phenomena here is that Google has introduced the possibility for people to add improvements of translations, which creates a powerful machine (memory) based translation system that is continuously adapted (or even educated) by an enormous amount of human (experts) on the world. This way the internet becomes a central acting partner in our translations and interpretations. Similarly the spellchecker in text editors has already taken an important role in assisting correct spelling. Obviously, due to this development a completely different approach should be used to teach and learn foreign languages in the future. Similar questions can be asked for many other domains, including the highest level of education.

It is also clear that the "why" and "how"" are enormously influenced by the rapid expansion of ICT and internet allowing us to search and find information very quickly. Knowledge and insight can be gained in an ever expanding worldwide library not only through e-books but also using (scientific) articles, documents, discussion lines, databases, texts, images, sounds, games, simulations and documentary and artistic videos. Furthermore, this allows us to enter the networks of peers and professionals and to discuss any topic with people around the world (Wheeler, 2015), thus creating a "rhizome" learning environment. On top of this the internet is expanding with an immense growing amount of applications (from the cloud) that allow learners to (co)-create new contents – in different shapes on the internet, to control devices at a distance or to use and interpret online "big" data from expanding internet connected database and sensory networks in space, the natural and social economic environment and the microcosm which together shapes "The Internet of things" (Holler et al., 2014; Fell, 2014).

Many authors and foresight exercises therefore conclude that learning has to focus on the "learning to learn" using the continuous expanding possibilities of new technologies rather than consuming prepared "lessons" of knowledge that may become obsolete within years or decades..

Miller et al. (2010) formulated these ideas in the first volume of the Promethean Thinking Deeper Research series (Miller et al., 2010) as follows:

"To learn is to be human and to be human is to learn. This is not new.

What does change is the what, how, when, where and why of learning. It is the context for learning that changes. So in the world today, unlike the past, what we learn extends well beyond limited sets of already defined knowhow, as in how to till the soil, mend torn clothes or recite the times tables.

Equally changed is how we learn, transmission of knowledge now covers a wider range than the traditional conduits of parent to child, older sibling to younger sibling or master to apprentice.

When we learn is different too, the skills we need for a lifetime can no longer be condensed into a few years, or even a decade or two, at the start of a lifespan.

And where we learn has diversified away from one special place such as a school or university or workplace, to become ambient, happening all around us.

Even the reasons why we learn have changed – it is not only to survive or get a job but to enjoy, to better know one's self and the world of freedom and diversity encountered a new everyday"

3.2.1 The Challenges of Learning in the 21st Century – Promethean Thinking Deeper Research series

The second Volume of this Promethean Thinking Deeper Research series states that learning is at the brink of an enormous gain of productivity, if we use the opportunities that are provided by the new technologies. The concepts of open and closed learning (Bergheim et al., 2011) are used. "Open learning" refers to learning *"when the outcome is unknown. This is learning as a journey, a series of experiences and experiments, with knowable starting points but only emergent, novelty filled end-points"*. Closed learning refers to learning "*when the knowledge to be acquired is defined in advance – the goal is clear and so too, in many circumstances, the resources and rules for getting there"*.

Due to the openendedness of the challenges of our societies the authors expect that open learning becomes more and more eminent, while educational policies at the moment are still focused on the improvement of the closed learning, they plea for a better use of the open learning space to promote the learning to learn in the ICT-enhanced learning environment and to create conditions for the cross fertilization of the open and closed learning spaces. This will not only increase the productivity of learning in the open learning space, but also that of the closed learning space.

3.2.2 EC Initiative "Future of Learning: New Ways to Learn New Skills for Future Jobs" (2009-2010)

In 2009, the European Commission Joint Research Centre Institute for Prospective Technological Studies in Seville started a large-scale foresight exercise to address the "Future of Learning". The aim of this exercise, which is visualized in Fig. 3, was to build a vision for education and training policy that will adequately prepare learners for life in the future society, which envisages which competences will be relevant and how these will be acquired in 2020-2030. The exercise was focused on all educational levels and explored the role of new technologies as ICT. It was based on and extended the work done in 2006-2008 on "Future Learning Spaces" (Punie & Cabrero, 2006; Punie & Ala-Mutka, 2007; Miller et al., 2008). For this exercise hundreds of teachers, learners, practitioners, experts and policymakers were interviewed and engaged in debates about their expectations and visions on the future.

The final report of the exercise emphasizes the shift from classical learning to personalized learning as well as the context of learning towards home and working life. It also emphasizes the added and enabling value of ICT for education: *ICT will change what, how, where and when people learn. Due to the ubiquity of technology and its power to facilitate highly dynamic, adaptable and engaging virtual learning environments, personalized lifelong learning opportunities will become feasible. ICT will enable teachers to better respond to diversity and heterogeneity in the classroom and to adapt learning material and objectives to individual students' learning needs. ICT will furthermore support lifelong learning opportunities that smoothly integrate into people's lives and allow them to adapt their training objectives, schedule and pace to individual needs and preferences"* (Redecker et al., 2011).

To realize the potential of ICT the report addresses educational and training institutions and encourages *"to promote tailor-made collaborative learning opportunities that are adaptable, challenging, relevant and enjoyable*, and to foster *open access and basic digital skills need"*. While policy-makers "*need to ensure that all citizens will be able to benefit from the opportunities offered and that more vulnerable groups are equipped with the necessary skills to participate in learning activities that are more and more technology based"'*. Finally it concludes that *"E&T institutions will need to be provided with the necessary ICT infrastructure and tools to become e-mature. Teachers and trainers need to receive targeted training, enabling them to align pedagogy and technology to the benefit of their learners. Guidance is needed for educators, learners and parents alike on how to best use technology"*

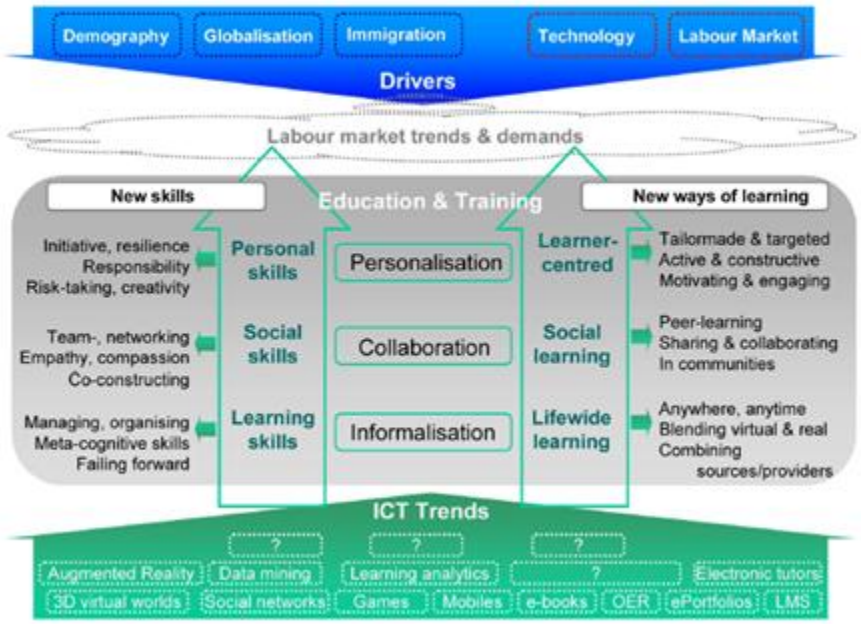


Fig. 3. Conceptual map of the future of learning. Source: Redecker et al., 2011, p. 9.

3.2.3 The learning internet, learning machines, the Internet of Things

According to the "Promethean Thinking Deeper Group" (Miller, 2010), learning is considered to be a human activity for human purposes. We should emphasize that due to the enormous increase of "machine memory" and "calculating speed" computers acquire more and more capabilities to learn as well. In robotics and in the creation of expert systems we can see that systems are designed to use human "corrective" input to improve their functioning, which can be considered as learning. The fact that this learning can be stored and transmitted to all other computers within seconds and minutes makes this learning very powerful.

The futurist Kurzweil foresees rapid growth of Artificial Intelligence, which will soon exceed the capacities of humans and their learning capacities. In the book "Singularity is Near" Kurzweil (2005) states: *the education of Artificial Intelligences will be much faster than that of unenhanced humans. The twenty-year time span required to provide a basic education to biological humans could be compressed into a matter of weeks or less. Also, because non biological intelligence can share its patterns of learning and knowledge, only one AI has to master each particular skill. As I pointed out, we trained one set of research computers to understand speech, but then the hundreds of thousands of people who acquired our speech-recognition software had to load only the already trained patterns into their computers.*

The fact that Artificial Intelligence will exceed the Intelligence of Humans may seem trivial but will have an enormous impact on human learning needs which even can be demonstrated with more recent examples where machines take away the learning need or at least may diminish our skills. To put it simply children need to learn calculus at primary and secondary school but if they do not practice the calculus skills because of their reliance on pocket calculators and computers their skills may erode, The more intellectual skills are supported or taken over by computers the less important is the role they play in human memory.

Some researchers suggest that the contact with machines may even impede the development of our social skills (Uhlsa, 2014), others suggest that the use of navigation devices may impede the development of the human capability to navigate. Near perfect written and spoken translations of texts in different languages by internet applications may make our attempts to learn other languages futile, but will also enhance our computer-assisted capacity to communicate with people in many other language areas.

Another aspect that we should have in mind is the development of the cloud and the Internet of Things which expands the human capacities in an enormous way and should therefore be seen as an important component of our future learning space with enabling but also many ethical and governmental challenges (Kranenburg & Dobson, 2008).

3.2.4 Conclusion

ICT and internet will change the "where, when and how" people learn but also the "what" they learn in societies that have sufficient access to ICT and especially internet. In the near future the answering the question "who needs to learn what" will be strongly influenced by the increasing learning capacities of machines and what they will learn. The enormous learning space that is created by internet and ICT, including the Internet of Things, requests a different approach to education and to focus on the "learning to learn with the available and developing technologies" especially in the open spaces. ICT and the Internet of people and things create an optimized environment for personalized learning. The increasing speed of technological change should continuously be taken into account in curriculum development and by teachers as well as by learners.

A matter of concern, therefore, is the way ICT and further automation will interfere into what we need to learn. On one hand we need to learn to "master" and "control" the machines but on the other hand the machines will take away our need to memorize everything and to practice certain "intellectual" skills, which may cause humans to become completely dependent on them and finally even to lose control on their own creation. Next to this the Internet of Things creates enormous potential but also enormous threats for privacy and security with which we need to learn to cope.

3.3 The Future of Work and Skills

3.3.1 21st Century Skills, ICT Literacy and Fluency as Learning Priorities

The discussions on the concepts of "Knowledge Society", "Knowledge Economy" and the "Learning Society" lead to a quest, to the kind of skills that would be needed in these Future Societies. The answer is a multitude of partly overlapping and partly complementary "normative" lists of 21st century skills, all of which express high expectations towards the future-generations as competitive entrepreneurs, powerful, creative and communicative problem-solvers resolving the present and future major global challenges.

In most of the lists of 21st century skills and ICT-related skills are mentioned but usually hidden among more abstract overarching descriptions of skills. It is not always clear what these skills imply and moreover not even on which graduation level they should be achieved by students. The Hannover

Research Institute (Hannover Research, 2011) compared the skill lists that were conceptualized by several organizations and networks:

- Partnership for 21st Century Skills (PS21)
- Tony Wagner's Global Achievement Gap Seven Survival Skills
- enGauge
- Iowa Essential Concepts and Skills – 21st Century Skills
- Connecticut Department of Education's 21st Century Skills
- Assessment and Teaching of 21st Century Skills (ATC21S)

Table 1. Crosswalk of 21st century skills (Hannover Research, 2011, p. 4)

Ranking	Skill	Partnership for 21st Century Skills	Seven Survival Skills	enGauge	Iowa Essential Concepts and Skills	Connecticut Dept. of Ed	ATC21S
1st	Collaboration and teamwork	x	x	x	x	x	x
	Creativity, imagination	x	x	x	x	x	x
	Critical thinking	x	x	x	x	x	x
	Problem solving	x	x	x	x	x	x
2nd	Flexibility and adaptability	x	x	x	x	x	
	Global and cultural awareness	x		x	x	x	x
	Information literacy	x		x	x	x	x
	Leadership	x	x	x	x	x	
3rd	Civic literacy and citizenship	x			x	x	x
	Oral and written communication skills		x		x	x	x
	Social responsibility and ethics			x	x	x	x
	Technology literacy	x		x	x		x
	Initiative	x	x	x	x		
4th	Curiosity and inquisitiveness		x	x	x		
	Financial literacy	x			x	x	
	Health and wellness	x			x	x	
	Media literacy	x				x	x
	Productivity	x			x	x	
5th	Accountability				x	x	
	Entrepreneurialism	x	x				
	Information analysis		x		x		
6th	Basic literacy			x			
	Contextual learning					x	
	Environmental literacy	x					
	Interpersonal skills					x	
	Metacognition						x
	Visualization skills			x			

Note: Skills are ranked based on the frequency that they are found on the six skills lists examined in this report.

ICT falls in this table under the category of technological literacy and information analysis (or literacy), however, visualization skills may also be related. The EnGauge report "21st Century Skills, Literacy in the Digital Age" (EnGauge, 2003) gives more elaborate descriptions of these literacy clusters for the graduate level:

Technological Literacy

- *Demonstrate a sound conceptual understanding of the nature of technology systems and view themselves as proficient users of these systems.*
- *Understand and model positive, ethical use of technology in both social and personal contexts.*
- *Use a variety of technology tools in effective ways to increase creative productivity.*
- *Use communication tools to reach out to the world beyond the classroom and communicate ideas in powerful ways.*
- *Use technology effectively to access, evaluate, process and synthesize information from a variety of sources.*
- *Use technology to identify and solve complex problems in real-world contexts.*

Information (Media) Literacy:

Before Accessing Information

- *Determine what is known and what is needed for problem solving.*
- *Identify different sources of information, including text, people, video, audio, and databases.*
- *Prioritize sources based on credibility and relevance.*

When Accessing Information

- *Identify and retrieve relevant information from sources; use technology to enhance searching.*
- *Revise information-gathering strategies that prove to be ineffective.*
- *Understand how information retrieved does or does not address original problem.*
- *Evaluate information in terms of credibility and social, economic, political, legal, and ethical issues that may impact it; use technology to facilitate evaluation.*

After Information Is Extracted

- *Use retrieved information to accomplish a specific purpose.*
- *Present information clearly and persuasively using a range of technology tools and media.*
- *Evaluate the processes and products of these activities, including resulting social consequences.*

Visual Literacy:

Have Working Knowledge of Visuals Produced or Displayed through Electronic Media

- *Understand basic elements of visual design, technique, and media.*
- *Are aware of emotional, psychological, physiological, and cognitive influences in perceptions of visuals.*
- *Comprehend representational, explanatory, abstract, and symbolic images. Apply Knowledge of Visuals in Electronic Media*
- *Are informed viewers, critics, and consumers of visual information.*
- *Are knowledgeable designers, composers, and producers of visual information.*
- *Are effective visual communicators.*
- *Are expressive, innovative visual thinkers and successful problem solvers.*

The question that remains is which part of these ICT skills should be learned at what level during primary and secondary education and which part should be learned in higher education institutions.

It is furthermore clear that there is a large gap between the thinking around the "21st century skills" and the implementation of the fruits of this thinking in national educational policies. In the GRALE 2012 report (UIL, 2012) the rethinking of the concept of literacy starts with the conclusion that *'Literacy' is usually understood as the ability to read and to write to which 'Numeracy' (as mediated by written material, not oral numeracy) is often added as a complement or component of literacy." Furthermore,* the report states *increasingly, there is also mention of language skills, as most people live in multilingual contexts or have a migrant background and need to use oral and written communication in different languages.*

The report reflects a little on this narrow definition by stating *that literacy in many cultures also connotes the concept of "learned and civilized"* but the further rethinking on the concept of Literacy in the report does not lead to further reflection on the "future learning needs in a Knowledge Society" - let alone the skills to use ICT and or retrieve information and communicate effectively on internet.

This is in sharp contrast to the findings of the EC future of learning exercise (Redecker et al., 2011): *Technology has catapulted us into a knowledge-based global society. It is clear that success in this society will require significantly different skills than in the past (CEO Forum, 2001; International ICT Literacy Panel, 2002). However, policymakers and educators have not yet clearly defined what it means to be "educated" in a Digital Age. The irony of a call for 21st century skills in this era of high stakes testing based on conventional metrics is not lost on teachers. To fully realize the educational opportunities that 21st century skills can bring to students, education leaders must formally incorporate them into the mainstream of school curriculum, instruction, and assessment.*

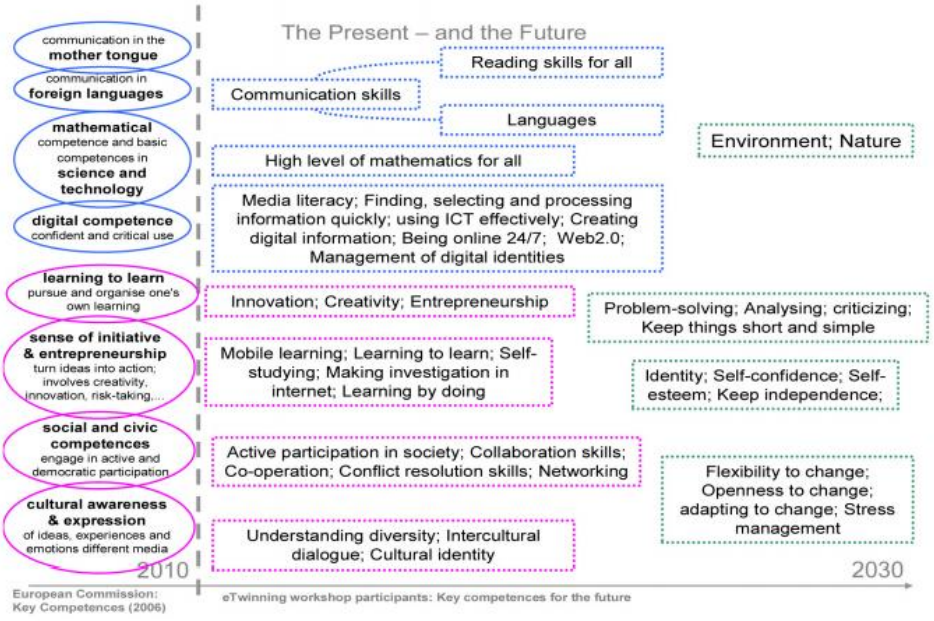


Fig. 4. Visualisation of the results of the future of learning exercise. Source: Redecker et al., 2002, p. 33.

This scheme justifies the conclusions that many future skills are fully related to the use and understanding of ICT and internet.

This conclusion can also be derived from the vision of the Partnership for the 21st Century Skills (USA) (Partnership for 21st Century Skills, 2008) where a plea is made for the integration of ICT skills as one of the pillars (or main components) of higher school curriculum to enhance the problem solving capacity of graduate students, this vision is visualized underneath:

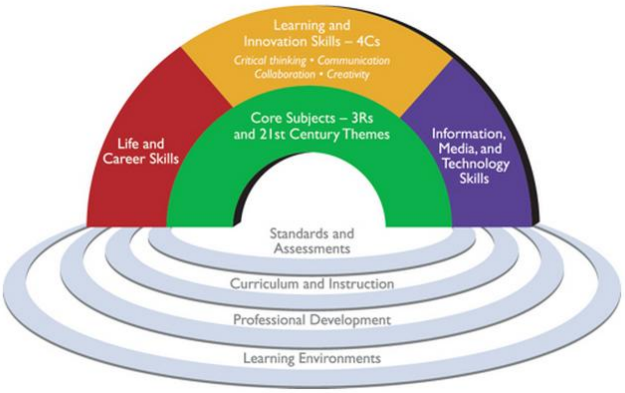


Fig. 5. 21st century student outcomes and support systems. Source: Partnership for 21st Century Skills, 2008, p. 13.

3.3.2 Employment

In many of the future storylines on the Knowledge Society, Information Society and Learning Society we can see a great optimism and expectation towards economic development and improvement of living standards under the assumption that employment demand will follow or even increase in such a way that elderly in European countries and other countries with ageing populations need to retire later. The final report of the Future of Learning exercise (Redecker et al., 2011) contains a Cedefop projection of growing supply throughout Europe, in which the lower skilled supply is gradually replaced by a growing supply of higher skilled and middle skilled workers.

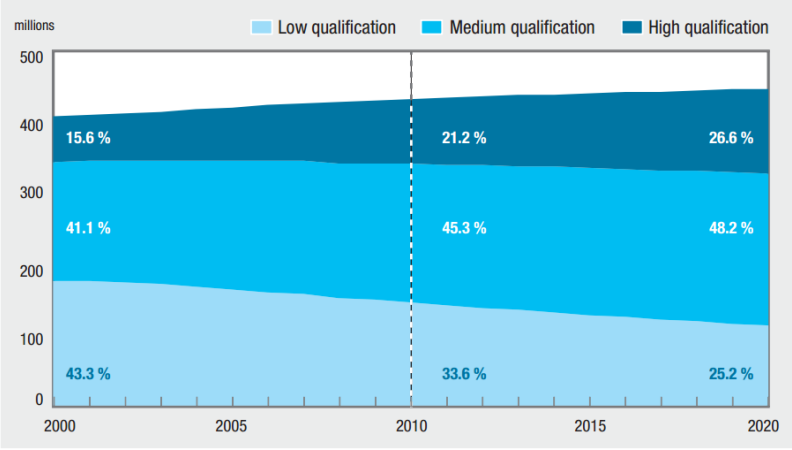
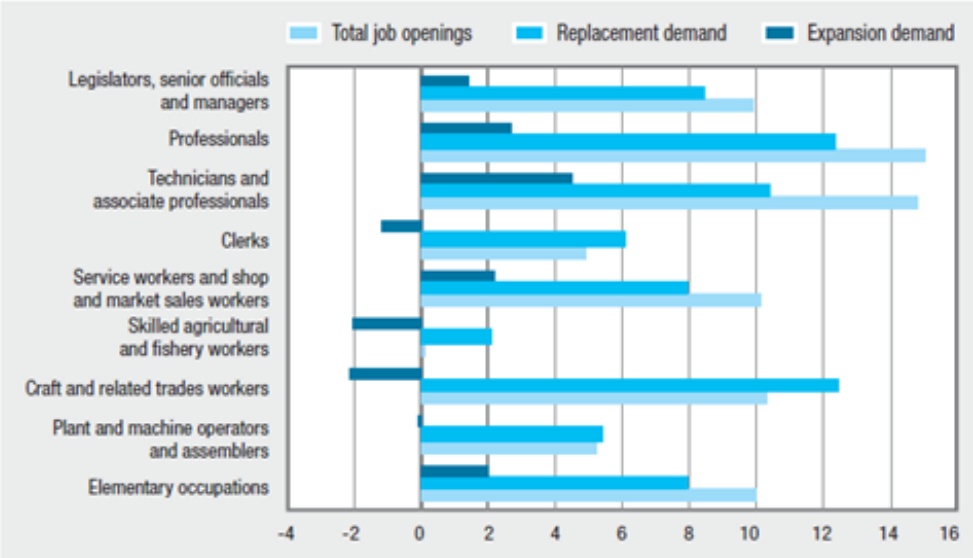


Fig. 6. Forecasting of job and skills demand development in Europe. Source: Cedefop, 2010, p. 41.

The report provides an analysis of the way in which the demand in different professions may change over time. The result was a quite optimistic view for high-skilled professions as legislators, senior officials and managers, professionals, technicians, service shop and sales workers and a pessimistic view for clerks, craftsmen and skilled agricultural and fishery workers.



NB: Numbers in employment (NA-based estimates); job openings are the sum of expansion and replacement demand.
Source: Cedefop (IER estimates based on E3ME, EDM0D and RDM0D).

Fig. 7. Forecasting of shifts in skills demand in Europe (EU-27) in 2010-20 by occupation group. Source: Cedefop, 2010, p. 59.

In general, the expectation in Europe was that higher and medium skilled demand will grow and compensate for a declining demand in lower skilled jobs, which complies with the line of thinking postulating the upcoming knowledge society.

A study of Wang (2011) for Taiwan concludes that "*the transformation (towards the Knowledge Society) changed and shaped the structure of the labour market to benefit workers who have higher information skills, are more professional, and have higher levels of knowledge and education, while an increasing number of white-collar and service workers began earning comparatively low wages"*. He concludes that *"the demand for blue-collar and lower skill workers severely declined. Nevertheless, the total labour demand of information-manufacturing and information-intensive services is far less than that of traditional labour-intensive manufacturing, further exacerbating Taiwan's increasing unemployment problem."*

Frey and Osborne (2013) use a slightly different approach as compared to that used by Cedefop to give a prognostic view on the way computerization will interfere with the American future labour market. They come to the conclusion that around 47 percent of total US employment is at high risk to be fully or partly automated. They state "*most workers in transportation and logistics occupations, together with the bulk of office and administrative support workers, and labour in production occupations, are at risk. These findings are consistent with recent technological developments documented in the literature. More surprisingly, we find that a substantial share of employment in service occupations where most US job*

growth has occurred over the past decades (Autor and Dorn, 2013), are highly susceptible to computerization".

Looking at the development of employment of tertiary educated employees in Europe since the year of the Cedefop prognosis, it becomes clear that the prognoses were too optimistic due to an overall decline of employment especially for younger people, which at the moment is most severe in the South of Europe where the unemployment for tertiary educated employees is increasing enormously (see the chart below).

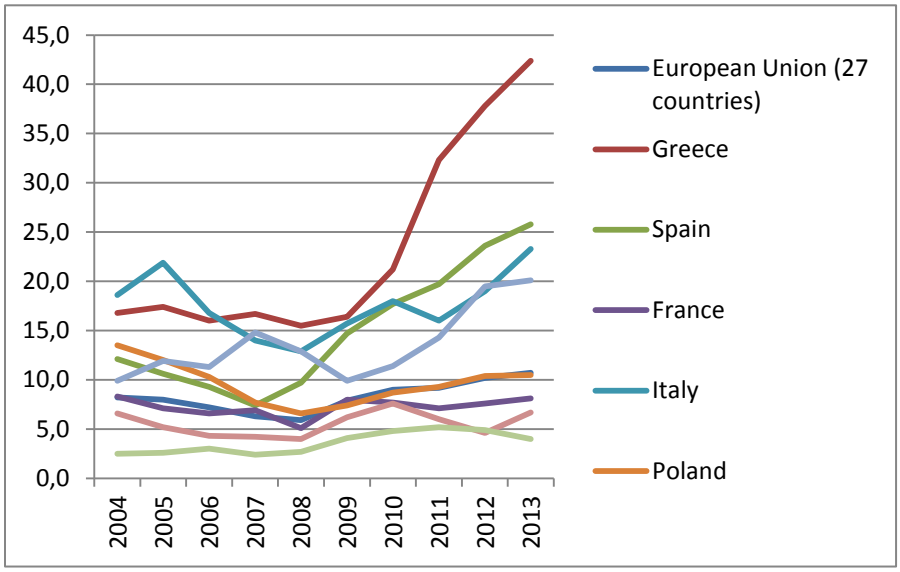


Fig. 8. Unemployment of 25-29 year old with tertiary education in a sample of European countries (percentage of age groups). Source: Eurostat, 2015.

At the same time the situation for lower skilled employees is even further deteriorating.

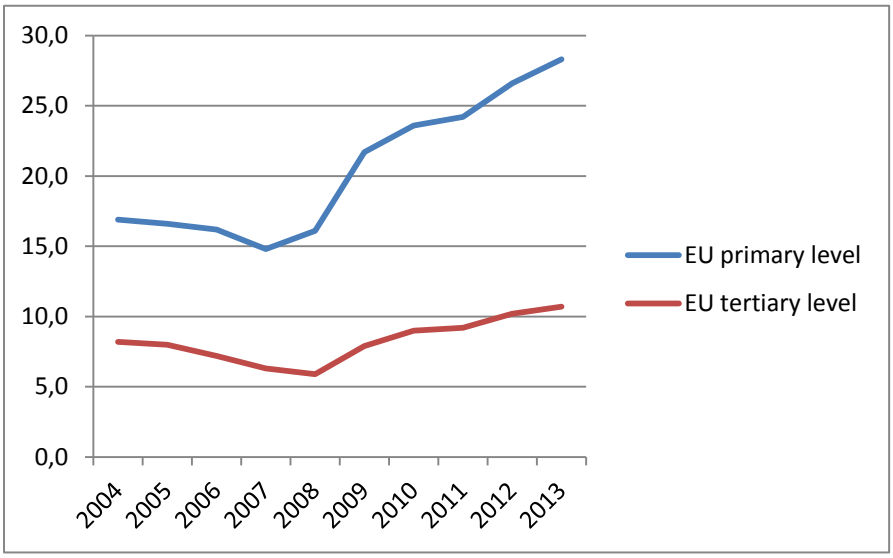


Fig. 9. Comparison of unemployment of 25-29 year old with primary and with tertiary education in the same sample European countries (percentage of age groups). Source: Eurostat, 2015.

In other parts of the world we can see that youth employment is under pressure, especially in the Middle East and North Africa but also in the developed world.

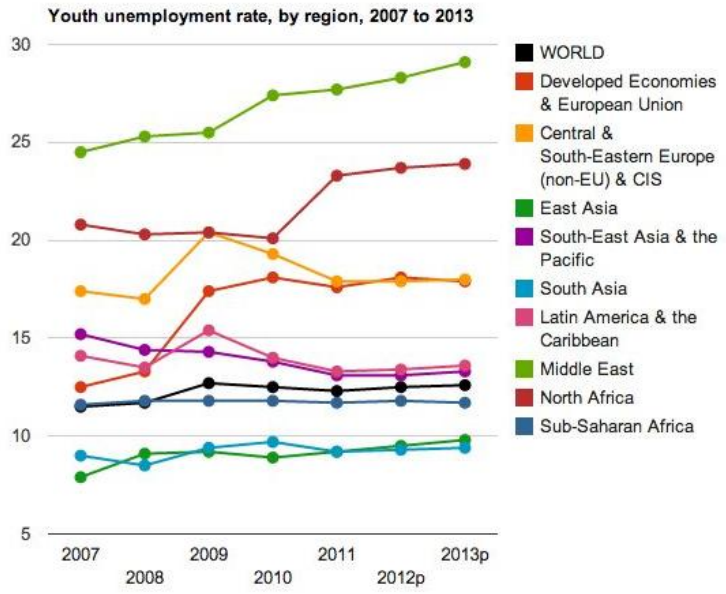


Fig. 10. Worldwide prognoses show and increase in youth unemployment worldwide. Source: ILO.

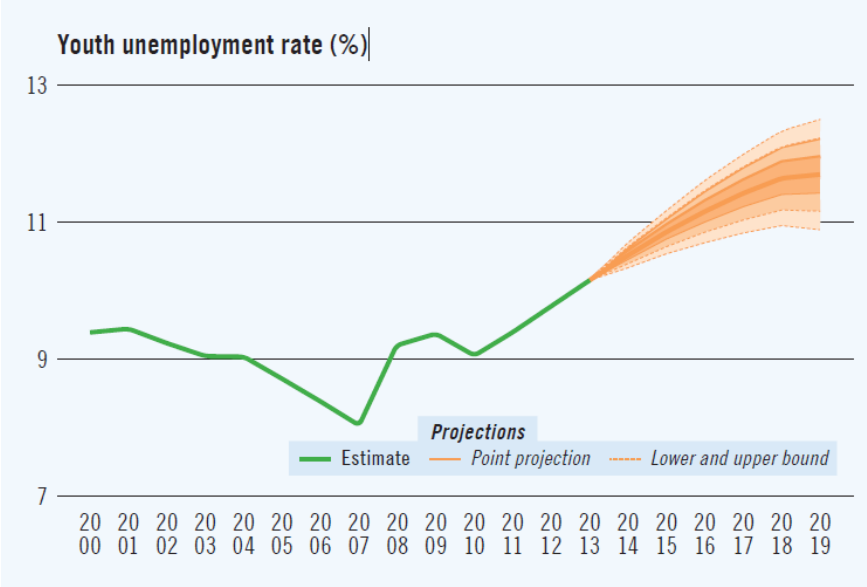


Fig. 11. Youth unemployment till 2019. Source: ILO.

3.3.3 The future of work

While it is clear that employment in some parts of the developed and developing world is under pressure since the economic crisis of 2008, it also seems to be clear that, due to computerization, many jobs will disappear all over the world. The present slow recovery as well as the increasing tendency towards short-term labour contracts may in some sense be signals for a quite instable future development of

employment, which can only be stabilized, if new jobs or work will be created, which would diminish the threat of unemployment.

As stated above, many “futurists” and foresight projects seem to be quite optimistic, pointing to the fact that all former technology revolutions lead to what is referred at as creative destruction (Schumpeter, 1950). It first causes an enormous crisis in employment and welfare leading to serious power shifts between the main owners of new and old productivity, and eventually ends in a restoration with full adoption of the new technology, new business and new forms of employment and new socio-economic relationships. Perez describes five subcycles of technological innovation that occurred in the last centuries and that follow more or less similar patterns: the industrial revolution; steam and railways; steel, electricity and heavy engineering; oil, cars and mass production - and information technology and telecommunications. All of these cycles are characterized by large technological revolutions that coincided by considerable investment and restructurization that often lead to periods of financial crisis, unemployment, conflicts and power shifts to successful new investors and entrepreneurs, followed by more or less stable periodss, with increasing demand for new “shapes” of employment.

Perez warns that, though we can learn from the past, we cannot predict how new cycles will evolve. The question is therefore what kind of work or human activity will be created when the Knowledge/Information or Learning Society will fully evolve from the ashes of the industrial and service-oriented Society. For many the answer to these questions lays in a search for activities that most probably might not be automated nor computerized. Most reports than mention professions, which require very high cognitive levels or which require direct human contact, social interaction or creativity. Akrich & Miller sketched their expectations in 2006 (see Fig. 12).

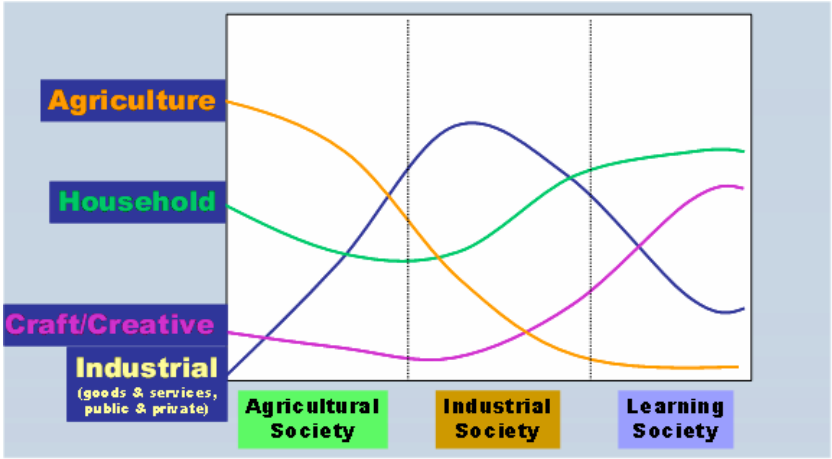


Fig. 12. Source: Akrich & Miller, 2006, p. 48.

Their expectation suggests that future work mainly will be more individualized creativity and craftsmanship while other mass produced commodities and services will be almost for free.

There would be also space for some low skilled jobs that are too expensive or difficult to automate so there would be a gap between very low and very high skilled.

Other authors point out that many of great societal challenges as climate change, pollution, scarce resources and ageing all demand research, development and innovation, which requires well-educated

workforce (ReFuture.me). Next to this futurists are sketching horizons where human intellect combined with artificial Intelligence will lead us to new frontiers as space travel and expanding our longevity even to cyborgs and eternal life (Kurzweil, 2005). It is however very difficult and even worrying to foresee how these activities by a worldwide intellectual taskforce will not lead to overproduction and redundancy as well as how these activities will lead to earning. Moreover a burning question is how distribution of consumption rights can be organized in a society where production of food, goods and services are fully automated and owned by a very small group of people that can freely move their capital across borders (Piketty, 2014). In developed countries, this distribution is ensured by tax income and social insurance schemes to generate work in and for the public sector and to give benefits to people who do not work. The tax income is generated by taxes on labour from workers in the private and public sector and from profits and sales incomes of private producers and salesman (companies). Automation and ICT may not only diminish the number of workers in the private sector but also in the public sectors which on the long run will diminish employment and finally the earning capacity of states by downwards spiral effects on the public budgets, while a large part of the private capital is free floating (and may finally also soar).

The report on Youth Unemployment the Institute for the Future (2014) outlines these challenges and comes up with four scenarios that are summarized in the following table.

Table 2. Four scenarios for the future of youth employment (Institute for the Future, 2014, p. 3)

 GROWTH: The Flexing Economy	 COLLAPSE: The Growing Gap	 CONSTRAINT: Desk Inside	 TRANSFORMATION: The Amplified Individual
Labor market favors high-skill employees in certain growth sectors. Job market is highly fluid with abundant new opportunities. Worker skills must be constantly upgraded. Education expands from institutions into online and community spaces. Alternative credentialing grows and is increasingly accepted.	Growing automation reduces knowledge work and minimum-wage jobs. More college students graduate but find their degrees unmarketable. Permanent underclass of detached individuals grows. Governance faces a crisis and is unable to address needs in a systematic way. Informal economy and alternative currencies grow.	With few new growth opportunities, firms focus on cutting costs. Algorithms coordinate teams; efficient teams command a premium. Online labor networks supplement highly efficient employees. Flat organizational structures supported by coordination software replace traditional hierarchy.	Coordination costs drop significantly. Capital for businesses from crowdfunding, banks, and VCs flows freely. Highly entrepreneurial flexible firms and mindsets proliferate. Power balance shifts from large organizations to individuals.

The report “The Future of Work, Jobs and Skills in 2030” (UK Commission for Work and Skills, 2014) predicts the development of market-based and employer-focused education. The report maps the main trends foreseen for the coming decades by designing four scenarios with characteristics similar to those of the Institute for the Future.

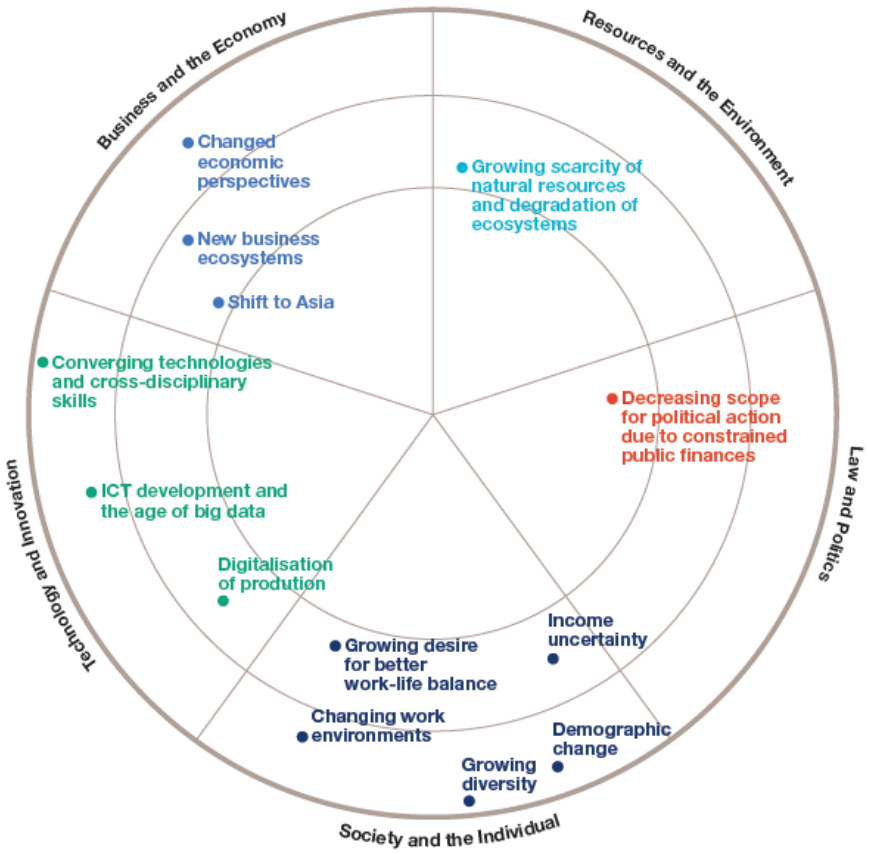


Fig. 13. Main trends for the future of jobs and skills for 2030. Source: UK Commission for Work and Skills, 2014, p. 8.

Table 3. Summary of scenarios (UK Commission for Work and Skills, 2014, p. 17)

	Scenario 1: Forced Flexibility	Scenario 2: The Great Divide	Scenario 3: Skills Activism	Scenario 4: Innovation Adaptation
Economic conditions	Moderate economic growth in the context of a volatile world economy	Sturdy UK recovery fuelled by hightech and innovative business	Slow recovery following prolonged crisis	Stagnant economy within a turbulent international environment
Social conditions	Widening income gap, low-skilled workers are the most vulnerable	Two-tiered society with deep division between the economic 'haves' and 'have-nots'	Automation of professional work has hit medium to upper income groups hard	Decrease in income inequality as financial sector struggles to compete internationally
Labour market context	Hourglass-shaped – ferocious competition for low-skilled positions and a hollowing out of the middle of the workforce	Competitive and attractive marketplace for high-skilled jobs, poor opportunities for the low-skilled	Significant disruption to medium and highly skilled work. Jobs are mainly project-based with high turnover	Growing virtual workforces as a strategy for productivity in a low growth environment. Increased work intensity

	Scenario 1: Forced Flexibility	Scenario 2: The Great Divide	Scenario 3: Skills Activism	Scenario 4: Innovation Adaptation
Policy context	Easing of employment regulation and focus on job quantity rather than quality. Reduced public funding available for training and skills due to fiscal constraints	Liberal immigration policies and labour regulation create a supportive environment for business. Minimal public funding available for training and skills	Extensive government-driven skills programme and investment to facilitate re-skilling, supportive employment regulation strengthens employee position	Commitment to skills development despite deficit reduction, government drive to re-engineer training and skills content and delivery to best fit need
Uptake of innovation	Focus on incremental innovation in UK businesses, across almost all UK sectors	Radical Innovation in life and material sciences driving economic growth	Disruptive IT automation restructures professional tasks	Wide integration of cost-efficient ICT technologies to enable business survival
Education and training contex	Greater commercial focus and responsiveness to employer needs, although fees are higher	Highly competitive and efficient, but also expensive which reduces access	Reform of system and expansion of access to all socio-economic backgrounds	Significant increase in online provision as a cost-effective option

3.3.4 Conclusion

The debates regarding the 21st century future skills lead to a variety of lists that stress the importance of critical thinking, entrepreneurship, creativity and other problem-solving skills with implicit or explicit reference to required ICT skills. Discussions around these skills show high aspirations towards future generations and education while at the same time the future of work and economic activity becomes less and less clear. Recent developments in youth unemployment, in particular, for graduates of tertiary education institutions in the developed countries, show that the knowledge economy does not automatically create the expected knowledge working class by itself – by educating people to the tertiary level. Therefore we should be cautious with the high expectations that are connected to the concept of the Knowledge Economy and the Knowledge Society.

If no measures are taken the capital liberalization that has initialized its rise may hinder its further development by distracting too much of profit and result in unemployment. Solution may lay in a redistribution of income and a new balance of leisure to work with income, redistributing the work and the income generated amongst employed and unemployed, but also in developing new activities that focus on “common” activities to deal with the grand challenges of our societies (as, for instance, stated in the Millennium project) based on democratic decisions and on the futuristic frontiers of our human existence (Kurzweil, 2005).

Higher education and proper used ICT are essential to accomplish this.

3.4 The Future of Higher Education

3.4.1 Ernst and Young Perspective

Higher education faces many changes in its environment, which makes the topic of its future a hot topic that recently has been discussed by many fora, national think tanks and international interest groups and media.

Many of these discussions in the developed world focus on the strategic choices that universities will have to make in a competitive world that faces more and more competitors from the upcoming economies, but which also creates a growing world market for higher education. The ongoing privatization of education in many countries forces universities to search for strategies and activities to increase their income while at the same time many funding schedules have the tendency to direct universities to relevance to societal purposes and challenges. The scheme of a recent exercise of Ernst and Young (Ernst & Young, Australia, 2012) for Australian universities gives a set of main drivers that are representative for many higher education systems in the developed countries.

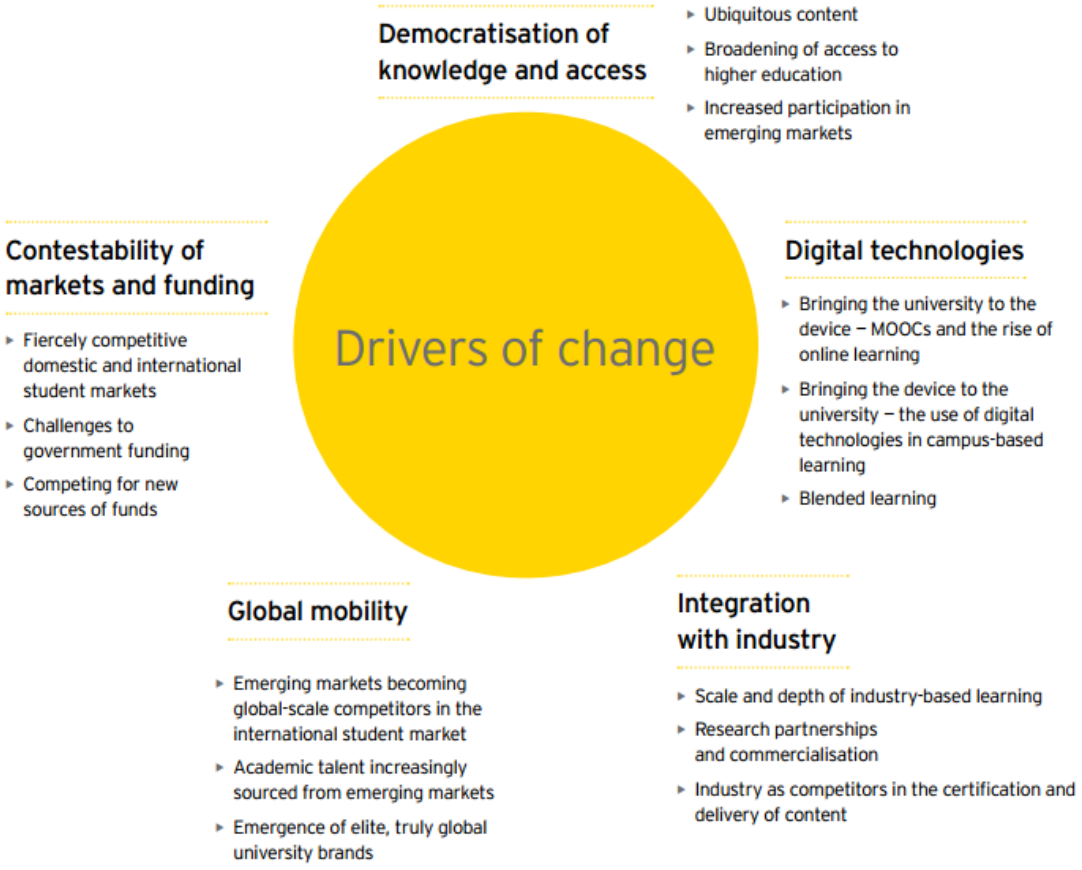


Fig. 14. Source: Ernst& Young, Australia, 2012, p. 6.

3.4.2 Perspective of the Committee on Research Universities (NRC) and the British Council

The report “Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security” published by the Committee on Research Universities of the Board on Higher Education and Workforce; Policy and Global

Affairs of US National Research Council (NRC, 2012) analyses similar challenges for the US universities, coming to recommendations regarding the state funding of the research universities as well as measures to improve the transfer of knowledge to industry.

The British Council (2012) is concerned by the transformation of the system of higher education institutions. In the report "The shape of things to come", The Council focuses on the international positioning of British universities taking into account the geopolitical economic shifts (in particular, in South East Asia where upcoming economies acquire more independency in the development of international tertiary education) and the fast technological changes (which opens up tertiary education to open distance learning). The report analyses mainly the higher education market chances for British universities, but also mentions the changes in the educational degree market initiated by the US - with the MOOC initiatives.

The Rathenau Institute (Netherlands) chooses a scenario approach to clarify the strategic space for Dutch Universities in a world where the rate of privatization of higher education is unclear and where also the dependence of the competitiveness of research and HE educational markets is unclear (Rathenau Institute, 2014).

3.4.3 An avalanche is coming

In the report "An Avalanche is Coming, Higher Education and the Revolution Ahead" of the Institute for Public Policy Research (Barber et al., 2013) the authors start with the main question whether *a university education is a good preparation for working life and citizenship in the 21st century or, more precisely, whether it will continue to be seen as good value, given the remorseless rise in the cost of a university education over recent decades. For students, the question is immediate and challenging given the growing anxiety around the world about youth unemployment, even among college graduates*. *For policymakers, all kinds of new challenges are raised: how to promote meritocracy; how to regulate a sector that used to be national and is increasingly becoming global; how to ensure universities of the right sort combine with great cities to fuel innovation and economic growth; and how to break the rigid link – at least in people's perceptions – between cost and quality*.

For university leaders, the questions are considered to be more profound. According to the authors standing still is no option, but to set out the right strategies many questions rise as: *Does the curriculum need complete overhaul? What are the right models of teaching and learning now that the traditional lecture seems obsolete? Which students should be targeted? What global allowances will be necessary? And so on.*

They conclude that universities cannot remain traditional multipurpose institutions with a combination of "classical" degrees and a modestly effective research programme, because all of the traditional tasks (research, degrees, city prosperity, students, governance and administration and curriculum, teaching and learning and assessment) are under threat by more specialized new competitors. The authors advise universities to unbundle their activities and to find the specific niches and market segments that fit them and to rebundle what is necessary for this. The authors propose the following five models:

- The elite university
- The mass university (broad offer for the middle class)

- The niche university (content specialization)
- The local university (specializing on the local challenges)
- The lifelong learning university

3.4.4 Horizon scanning "What Will the Higher Education Look Like in 2020"

In the horizon scanning 2013 of the Observatory on Borderless Higher Education (Lawton et al., 2013) similar revolutionary conclusions are drawn for the UK higher education especially regarding the unbundling of activities. The first conclusion in the report is that *although the accelerating pace of change in the world is taken for granted, it does not follow that the rate of change in human relations will be as fast. Technology does not have a free hand in driving change. Change is driven, and held back, by people, institutions and countries with political and economic interests.*

The horizon scanning report follows the conclusions of the British Council regarding the mobility market and foresees a strong impact of MOOCs and of the online learning on the universities bringing in new players and alliances, as well as resistance of students (who prefer blended learning) and the unions (who, according to the authors, are against any automation process).

For further future developments it concludes that the economic liberalization" is *the behind-the-scenes driver of HE internationalisation. Even in the absence of a GATS, there is no reason to suppose that it will be reversed or even have slowed by 2020. That is good because none of the world-changing work between international partners that requires trade in knowledge, skills and ideas could happen in a less open world. The downside is that greater liberalisation is consistent with the commercialisation and privatisation of higher education and this also leads to an increasing acceptance of its commodification. This is driven by governments that everywhere see higher education in instrumental terms: as an instrument of national economic development or international competitiveness or entry into the knowledge economy or a commercialiser of innovation – take your pick. There is of course resistance to this from within the academy in many countries, and the idea of higher education as an intrinsic public good still hangs on. But for those who run universities, they are by default businesses that operate in a competitive world. To fail to do this effectively means the same for universities as for any other business.*

This "economic liberalization" is overwhelming present in a recent special issue of the Financial Times with the title "The Future of Universities" (Financial Times, 2014): t*he western model of state-funded university education is a luxury",* which *"emerging markets, with limited resources, cannot afford."*

3.4.5 Conclusion

Universities in the developed countries are aware of the fact that the world is changing in a way that urges them to revise their position and function. One of the strongest drivers for this is the liberalization, which as a political and economic force presents a dilemma in ethical terms. This liberalization created the context for the rapid expansion of cross-border activities in higher education but it has also facilitated the conceptualization of HE as a tradable commodity and the consequential demand for further privatization of higher education. This is consistent with governmental mandates when HE is only seen in instrumental terms but diminishes its conceptualization as a public good to create a "Knowledge Society" instead of solely a "Knowledge Economy".

Another aspect that urges universities to revise their role and function is the fast changing technology that starts to create a kind of "automation" process for mass education and for research, which not only will reduce "production" costs but also allows many other players to come into the market, which basically may undermine many of the stable pillars on which 19th and 20th century universities were built on (e.g. the monopoly on degrees, the recognition of the highest expertise, etc.).

The development of ever increasing numbers of online courses and possibilities to learn autonomously from the internet will challenge the world of formalized degrees and campus universities.

Despite the fact that universities are privileged by the fact that they provide a social environment (by campus life) as well as a research and engineering environment where real objects can be studied and developed, it is clear that many of their more theoretical courses may be given by online distance learning , while part of more practical courses may be replaced by simulations and gaming. Although the worries of universities in the developed countries occupy a lot of the discussion space on the internet they may be seen as luxury problems compared to the problems of developing countries that are building up tertiary education systems to comply with a growing need for engineers and scientist to build up their industrial and knowledge economies and where the automation of education is welcomed as an opportunity to speed up the process.

While little is published on the forward looking activities of the developing countries, the report and analyses of the British Council show us that at least in South East Asia there is a tendency to find a their own solutions to the problems in their the tertiary education and its automation.

3.5 The Future of ICT in Higher education

This chapter provides a summary of some reports and activities that focus especially on the future of ICT in relation to Higher Education (Barber et al., 20113; Osborne & Hennessy, 2003).

3.5.1 UNESCO IITE policy briefs

The brief "Technologies in Higher Education: Mapping the Terrain" published by the UNESCO IITE (UNESCO IITE, 2015) provides an overview of the major ICT related developments which influenced higher education. The brief is based on the summary of a series of topic focused policy briefs that were produced by the IITE in 2010-2014.

The relationship of ICT with higher education is partly seen from the instrumental perspective and partly from the substantive perspective. The instrumental perspective translates in the pedagogic and catalytic rationale (realizing educational change to better learning processes) and in the cost-effectiveness rationale (cost reduction), while the substantive perspective translates into the social and vocational rationale, bringing in the use of ICT as learning objective in curricula (needed for societal and professional functioning), connected to this is the rationale of the ICT industry which needs ICT professionals and has of course an interest to educated ICT users.

The report addresses the following eight main topics:

- ICT enabled personalized learning, with changing approaches to assessment

- ICT enabling open learning that under proper condition may reduce costs
- ICT enables inclusion
- ICT enables the creation of technology platforms and the use of social media and mobile learning, which support interaction and cooperation between teacher and learners (and other relevant actors) in different kind of configurations and for different purposes
- ICT enables the creation and exchange of (open) educational resources
- ICT enables MOOCS
- ICT enables learning analytics
- The teachers play a central role to integrate ICT in education

3.5.2 The Future of Higher Education: Beyond the Campus

The Educause report "The Future of Higher Education: Beyond the Campus" (Educause, 2010) based on the analysis of drivers of change and enablers of the future identifies emerging themes and distinguishes the underlying technologies. The report emphasizes the cost saving aspects for the educational institutions of new ICT developments as cloud computing in combination with mobile devices and open educational resources, but also stresses the importance of identity management and analytics for managerial reasons, ending up with the value of collaboration tools for preparing students on their future in the working environment.

3.5.3 NMC Horizon Report: 2014 Higher Education

The NMC Horizon reports result from expert panel discussions. In particular, the NMC Horizon Report: 2014 Higher Education (Johnson et al., 2014) is based on a three-month expert panel discussion that took place in 2013. It is a part of the "The New Media Consortium Horizon Project" launched in 2002. This comprehensive research venture on a regular basis identifies and describes emerging technologies, which are likely to have a large impact over a period of five years in education around the globe. The panel for the 2014 Report was composed of 53 technology experts from 13 countries on 6 continents. The input was provided by a modified Delphi survey over the earlier NMC horizon reports, amongst 850 internationally recognized experts and practitioners. The Horizon report 2014 incorporates the consensus view of the panel on the technologies, which to their view will have a significant impact on the practice of higher education around the globe in the coming five years and discusses some of them in more detail. The report also identifies a set of trends and challenges for the higher education system in the coming decade.

The following key trends are revealed:

- The growing ubiquity of social media as Facebook, Twitter, YouTube, etc.
- The integration of online, hybrid and collaborative learning, which merges home learning and institutional learning
- Rise of data-driven learning and assessment, which allows optimizing learning processes
- Shift from students as consumers to students as creators using state of the art ICT tools, which is particularly suited to train ICT competencies
- Agile approaches to change developing entrepreneurship amongst teachers and students

As significant challenges the report mentions:

- Low digital fluency of faculty
- Evolution of online leaning
- Relative lack of rewards for teaching
- Competition from new models of education amongst which the rise of MOOCs
- Scaling teaching innovations
- Expanding access
- Keeping education relevant

From the full list of tracked Technologies (see table below), the report discusses the following qualitative oriented technologies in more in depth:

- Flipped classroom
- Learning analytics
- 3D printing
- Games and gamification
- Quantified self
- Virtual assistants

Table 3. Key emerging technologies (Larson et al., 2014, p. 35)

Consumer Technologies
> 3D Video
> Electronic Publishing
> Mobile Apps
> Quantified Self
> Tablet Computing
> Telepresence
> Wearable Technology

Digital Strategies
> BYOD
> Flipped Classroom
> Games and Gamification
> Location Intelligence
> Makerspaces
> Preservation/Conservation Technologies

Internet Technologies
> Cloud Computing
> The Internet of Things
> Real-Time Translation
> Semantic Applications
> Single Sign-On
> Syndication Tool

Learning Technologies
> Badges/Microcredit
> Learning Analytics
> Massive Open Online Courses
> Mobile Learning
> Online Learning
> Open Content
> Open Licensing
> Personal Learning Environments
> Virtual and Remote Laboratories

Key Emerging Technologies

Social Media Technologies
> Collaborative Environments
> Collective Intelligence
> Crowdfunding
> Crowdsourcing
> Digital Identity
> Social Networks
> Tacit Intelligence

Visualization Technologies
> 3D Printing/Rapid Prototyping
> Augmented Reality
> Information Visualization
> Visual Data Analysis
> Volumetric and Holographic Displays

Enabling Technologies
> Affective Computing
> Cellular Networks
> Electrovibration
> Flexible Displays
> Geolocation
> Location-Based Services
> Machine Learning
> Mobile Broadband
> Natural User Interfaces
> Near Field Communication
> Next-Generation Batteries
> Open Hardware
> Speech-to-Speech Translation
> Statistical Machine Translation
> Virtual Assistants
> Wireless Power

3.5.4 Singularity is near and a global educational agenda

A longer and more normative approach is given by Kurzweil in his book "Singularity is Near" (2005). The author states that "*Most education in the world today, including in the wealthier communities, is not much changed from the model offered by the monastic schools of fourteenth-century Europe. Schools*

remain highly centralized institutions built upon the scarce resources of buildings and teachers. The quality of education also varies enormously, depending on the wealth of the local community (the American tradition of funding education from property taxes clearly exacerbates this inequality), thus contributing to the have/have not divide".

He continues with the statement that he expects that all educational institutions *"will ultimately move toward a decentralized educational system in which every person will have ready access to the highest-quality knowledge and instruction."* He connects this to the observation that we are now in the early stages of this transformation, pointing to *"the availability of vast knowledge on the Web, useful search engines, high-quality open Web courseware, and increasingly effective computer-assisted instruction"* which all *"' are providing widespread and inexpensive access to education."* while *" Most major universities now provide extensive courses online, many of which are free."* which all *have already had a major impact on education around the world. Kurzweil predicts that "By the end of the decade it will be feasible for underdeveloped regions of the world to provide very inexpensive access to high-quality instruction for all grade levels from preschool to doctoral studies. Access to education will no longer be restricted by the lack of availability of trained teachers in each town and village."* Finally he predicts that:

"As computer-assisted instruction (CAI) becomes more intelligent the ability to individualize the learning experience for each student will greatly improve. New generations of educational software are capable of modeling the strengths and weaknesses of each student and developing strategies to focus on the problem area of each learner". In the global Education Future Agenda (Afanasyev et al., 2014) similar ideas are put forward and extended by pointing to the developing virtual learning environments and the development of the coginitive revolution leading to direct brain-to-computer interfaces and even genetic modification.

This is in line with Kurzweil's ideas on singularity which actually describe the era in which humans and machines will merge and in which "*our intelligence will become increasingly non biological and trillions of times more powerful than it is today—the dawning of a new civilization that will enable us to transcend our biological limitations and amplify our creativity. In this new world, there will be no clear distinction between human and machine, real reality and virtual reality. We will be able to assume different bodies and take on a range of personae at will. In practical terms, human aging and illness will be reversed; pollution will be stopped; world hunger and poverty will be solved. Nanotechnology will make it possible to create virtually any physical product using inexpensive information processes and will ultimately turn even death into a soluble problem."*

3.5.5 Conclusion

The relationship of ICT with higher education can be partly seen from the instrumental perspective and partly from the substantive perspective. The instrumental perspective translates into the pedagogic and catalytic rationale (realizing educational change to better learning processes) and in the cost – effectiveness rationale (cost reduction) while the substantive perspective translates into the social and vocational rationale bringing in the "fluent high skilled use of ICT" as learning objective in curricula (needed for societal and professional functioning).

It is clear that many technologies will enable higher education teachers to improve and enrich their teaching method, and to track the performance of students, but also that the technologies will enable learners to learn autonomously from the increasing variety of sources the internet and cloud providers.

Next to this teachers will be enabled to offer their courses to a much wider audience than ever before by placing them in open sources either on complete open media as YouTube or on more qualified media as MOOCs transcending the borders of their institutions and countries. It is however also clear that curricula have to learn students to use ICT and the internet in their future work either as entrepreneur, researcher or professional and always as citizens with higher-education degree, which means that higher education students have "to learn to learn" from the internet (of people and of things) with ever expanding technological possibilities, and that this is one of the most important objectives of education. In order to make this feasible all parties involved, including policy-makers and education practitioners should thoroughly rethink the role of ICT in education and not just the ICT-assisted improvement of the educational process.

4 Trends with impact on the ICT HE relationships

The forecasting but also the foresight activities examined all revealed inevitable developments, drivers and trends and sometimes "possible" events that are influential on the relationship of ICT and HE. A compilation of these trends is given in Annex 1: Trends. The compilation is based on the literature used for this report and some additional literature that focused on worldwide trends (published by OECD, World Bank, UNESCO, UNHDP).

5 Conclusions

5.1 Knowledge Society and Economy Perspective

All the above concepts provide an overview of ongoing developments with large future impact (Castells, 2009) and/or normative prescriptions on desirable futures (CISCO, 2010). The descriptions claim a revolutionary change of the Western societies and economies from the industrial "standardizing" age, where "institutionalized formalized learning", "manufacturing" and "physical labour" was dominant, towards societies and economies that find their earning power in "knowledge", continuous "learning", "connections" and "mental labour" for which ICT as well as learning are seen as the major tools or even key drivers.

ICT has developed its potential with an enormous speed and is connecting people all over the world and enhancing our cognitive skills with already visible huge changes in our societies and economy. This development is still ongoing and is leading to an increased interconnectivity not only between people, but also between people and sensory networks and machines (the Internet of Things and people). The consequence of this is on one hand an enormous increase of productivity in almost every aspect of life and on the other hand an enormous variety of still unknown applications and activities that suddenly come within human reach.

For societies that are mainly dependent on their industrialized or agricultural economy this development is eminent but may evolve in another way.

Whether the concepts are descriptive or normative, they all force us to rethink what and how we should learn but also how "earning" will be generated in knowledge and learning societies, what kind of work will evolve and what kind of skills will be needed to live in future societies. This rethinking will lead to different outcomes in different countries and should be done in participatory processes in each country.

5.2 Future Learning Perspective

ICT and internet will change the "where, when and how" people learn but also the "what" is learnt in the societies that have sufficient access to ICT and especially internet. In the near future the answers on "who needs to learn what" will be strongly influenced by the increasing learning capacities of machines and what they will learn. The enormous learning space that is created by internet and ICT, including the Internet of Things asks for a different approach to education and to focus on the" learning to learn with the available and developing technologies" especially in the open spaces. ICT and the Internet of People and Things create an optimized environment for personalized learning. The increasing speed of technological change should continuously be taken into account in curriculum development and by teachers as well as by learners.

A matter of concern therefore, is the way ICT and further automation will interfere to what we need to learn. On one hand we need to learn to "master" and "control" the machines but on the other hand the machines will take away our need to memorize everything and to practice certain "intellectual" skills, which may cause humans to become completely dependent on the machines and finally even to lose control on their own creation. Next to this the Internet of Things creates enormous potential but also enormous threats for privacy and security with which we should learn to cope.

5.3 Future Work and Skills Perspective

The debates regarding the 21st century future skills lead to a variety of lists that stress the importance of critical thinking, entrepreneurship, creativity and other problem solving skills with implicit or explicit reference to required ICT skills. Discussions around these skills show high aspirations towards future generations and education while at the same time the future of work and economic activity becomes less and less clear. Recent developments in youth unemployment also of tertiary educated youth in the developed countries show that the knowledge economy does not automatically create the expected knowledge working class by itself – nor by educating people to the tertiary level. Therefore we should be cautious with the high expectations that are connected to the concept of Knowledge Economy and Knowledge Society.

If no measures are taken, the capital liberalization that initialized the rise of Knowledge Economy may hinder its further development by distracting too much of profit and resulting in unemployment. Solution may lay in a redistribution of income and a new balance of leisure to work with income, redistributing the income generated by capital and by labour and scarce work amongst employed and

unemployed, but also in developing new activities that focus on "common"' activities to deal with the grand challenges of our societies (as, for instance, outlined in the Millennium project) based on democratic decisions and on the futuristic frontiers of our human existence (Kurzweil, 2005). Higher education and properly used ICT are essential to accomplish this.

5.4 Universities Perspective

Universities in the developed countries try to find their way to respond to changes occurring in the world, their mission and functions. Liberalization is one of the strongest drivers for this. The liberalization created the context for the rapid expansion of cross-border activities in higher education but it has also facilitated the conceptualization of HE as a tradable commodity and the consequential demand for further privatization of higher education. This is consistent with governmental mandates when HE is only seen in instrumental terms but diminishes its conceptualization as a public good to create a "knowledge society" instead of solely a "knowledge economy".

Another aspects that urges universities to revise their role and function is the fast changing technology that starts to create a kind of "automation" process for mass education and research, which not only will reduce "production" costs but also will allow many other players to come into the market, which basically may undermine many of the stable pillars on which 19th and 20th century universities were built (the monopoly on degrees, the recognition of the highest expertise and so on).

The intensive development of new online courses and possibilities to learn autonomously from the internet will challenge the world of formalized degrees. Today most universities provide not only a social environment on campus, but also conduct research and engineering, in these environments real objects can be studied and developed, which by online distance learning only can be simulated.

Although the concerns of universities in the developed countries occupy a lot of the discussion space on the internet, they would seem exaggerated if they would be compared with the problems of developing countries that are building up their tertiary education systems to comply with a growing need for engineers and scientist to build up their industrial and knowledge economies and where the automation of education is welcomed as an opportunity to speed up this process.

While little is published on the forward looking activities of the developing countries, the report and analyses of the British Council show us that at least in South East Asia there is a tendency to shape the tertiary education and its automation more independent from the Developed world.

5.5 ICT for Higher Education Perspective

The relationship between ICT and higher education can be partly seen from the instrumental perspective and partly from the substantive perspective. The instrumental perspective translates into the pedagogic and catalytic rationale (realizing educational change to better learning processes) and in the cost – effectiveness rationale (cost reduction) while the substantive perspective translates into the social and

vocational rationale bringing in the “fluent high skilled use of ICT” as learning objective in curricula (needed for societal and professional functioning).

It is clear that many technologies will enable higher education teachers to improve and enrich their teaching methods, and to track the performance of students, but also that the technologies will enable learners to learn autonomously from the increasing variety of sources on the internet and from cloud providers. Next teachers will be enabled to offer their courses to a much wider audience than ever before by placing them on open sources either on complete open media as YouTube or on more qualified media as MOOCs transcending the borders of their institutions and countries. It is however also clear that curricula have to learn students to use ICT and the internet in their future work either as entrepreneur, researcher or professional and always as higher educated citizen, which means that higher education students have “to learn to learn” from the internet (of people and of things) with ever expanding technological possibilities, and that this is one of the most important objectives of education. This can be achieved only if all parties involved, including policy-makers and education practitioners thoroughly rethink the role of ICT in future higher education and not just the ICT- assisted improvement of the educational process.

6 References

1. Aceto, S., Borotis, S., Devine, J. & Fischer, T. (2013). Mapping and Analysing Prospective Technologies for Learning. Results from a consultation with European stakeholders and roadmaps for policy action. JRC Scientific and Policy Reports. Ed. by Panagiotis Kampylis & Yves Punie. Seville: European Commission-Joint Research Centre, IPTS.
2. Afanasyev, M., Luksha, P., Peskov, D., Luksha, C., Makarova, T., Schoukine, T. (2014) Future Agendas for Global Education Executive Summary. Re-Engineering Futures.
3. Aicholzer, G. Scenarios of eGovernment in 2010 and implications for strategy design. Electronic Journal of e-Government. 2005. Volume 2, issue 1 (1-10).
4. Akrich, M., & Miller, R. (2006). The Future of Key Actors in the European Research Area: Synthesis Paper. Contribution to the DG Research Expert Group on The Future of Key Actors, Paris, May 2006.
5. Altbach, P.G., Reisberg, L., Rumbley, L.E. (2009). Trends in Global Higher Education: Tracking an Academic Revolution. A Report Prepared for the UNESCO 2009 World Conference on Higher Education. UNESCO, 2009.
6. Barber, M., Donnelly, K., and Rizvi, S. (2013). An avalanche is coming: Higher education and the revolution ahead. Institute for Public Policy Research, 2013.
7. Bergheim, S., Miller, R., Tuomi, I. (2011). Learning Productivity: It is Time for a Breakthrough, Promethean Thinking Deeper Research Paper No. 2. Promethean Education Strategy Group, 2011.
8. British Council (2013). The shape of things to come. The evolution of transnational education: data, definitions, opportunities and impacts analysis.
9. Castells, M. (1996). The Rise of the Network Society (The Information Age: Economy, Society and Culture, Volume 1). Massachusetts, Blackwell publishers Oxford, Cambridge/Massachusetts.
10. Cedefop (2010). Skills supply and demand in Europe. Medium-term forecast up to 2020. Luxembourg: Publications Office of the European Union, 2010.
11. CISCO (2010). The Learning Society. WhitePaper.
12. Coiffait, L. (ed.) (2014) Blue Skies: New thinking about the future of higher education. A collection of short articles by leading commentators, UK 2014 edition. London: Pearson.
13. Drucker, P.F. (1999). Knowledge-Worker Productivity: The Biggest Challenge. California Management Review, Winter 1999, Vol. 41, No. 2. Reprint Series.
14. Educause (2010). The Future of Higher Education: Beyond the Campus.
15. Elahi, S., & Jeremy de Beer, J. (2013). Knowledge & Innovation in Africa: Scenarios for the Future. With Kawooya, D., Oguamanam, C., Rizk, N. and the Open A.I.R. Network. ISBN: 978-1-55250-577-9. Published by Open A.I.R, 2013.
16. EnGauge (2003). 21st Century Skills for 21st Century Learners: Literacy in the Digital Age.
17. Ernst & Young, Australia (2012). University of the Future. A thousand year old Industry on the crisp of profound change.
18. Facer, K. (2009). Educational, social and technological futures: a report from the Beyond Current Horizons Programme. London: UK Department for Schools, Children and Family.
19. Fell, M. (2014). Roadmap for the Emerging Internet of Things - Its Impact, Architecture and Future Governance.

20. Financial Times (2014). The Future of the University. Financial Times, 7 October 2014; supported by Banco Santander.
21. FOREN (2001). A Practical Guide for Regional Foresight. FOREN Network (Foresight for Regional Development), European Commission, STRATA Programme.
22. Frey, C.B., & Osborne, M.A. (2013). The Future of Employment: How Susceptible are Jobs to Computerisation.
23. Fullan, M., & Donnelly, K. (2013). Alive in the Swamp: Assessing Digital Innovations in Education. NESTA.
24. Gaebel, M., Kupriyanova, V., Morais, R., and Colucci, E. (2014). E-Learning in European Higher Education Institutions: Results of a Mapping Survey. European University Association.
25. Georghiou, L., Harper, J.C., Keenan, M., Miles, I., and Popper, R. (2008). Handbook of Technology Foresight. Concepts and practice. PRIME Series on Research and Innovation Policy. Edwar Elgar Publishing, 2008.
26. Hannover Research (2011). Crosswalk of 21st Century Skills.
27. HM Government (2014). The Futures Toolkit: Tools for strategic futures for policy-makers and analysts. Horizon Scanning Programme, Cabinet Office and Government Office for Science (UK).
28. Holler, J., Tsiatsis, V., Mulligan, C., Avesand, S., Karnouskos, S., and Boyle, D. (2014). From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition. Elsevier Academic Press - E-book ISBN 9780080994017.
29. Husen, T. (1974). The Learning Society Revisited. Pergamon, 1986.
30. Hutchins, R.M. (1968). The Learning Society. Chicago: The University of Chicago Press, USA, 1968.
31. IBM (2009). Education for a Smarter Planet: The Future of Learning.
32. ILO (2015). World employment and social outlook. Trends 2015. International Labour Organization, 2015.
33. Institute for the Future (2014). The Future Exploring the Future of Youth Employment: Four Scenarios Exploring the Future of Youth Employment.
34. Jarvis, P. (2006). Beyond the learning society: globalisation and the moral imperative for reflective social change. International Journal of Lifelong Education. Volume 25, Issue 3, 2006. Special Issue: Lifelong education: beyond the learning society. Pp. 201-211. DOI:10.1080/02601370600697011
35. Johnson, L., Adams Becker, S., Estrada, V., and Freeman, A. (2014). NMC Horizon Report: 2014 Higher Education Edition. Austin, Texas US: The New Media Consortium.
36. Kranenburg, R. van, & Dobson, S. (2008). The Internet of Things: A critique of ambient technology and the all-seeing network of RFID. Institute of Network Cultures, 2008.
37. Kurzweil, R. (2005). The Singularity is Near: When Humans Transcend Biology. Viking Press; ISBN: 0670033847.
38. Lane, R. (1966). The Decline of Politics and Ideology in a Knowledgeable Society. American Sociological Review. Vol. 31, No. 5, October.
39. Lawton, W., Ahmed, M., Angulo, T., Axel-Berg, A., Burrows, A., and Katsomitros, A. (2013). Horizon Scanning 2013: what will higher education look like in 2020?
40. Machlup, F. (1962). The Production and Distribution of Knowledge in the United States. Princeton: Princeton University Press.

41. Mansell, R. (2012). ICTs, discourse and knowledge societies: implications for policy and practice. In: Frau-Meigs, D., Nicey, J., Palmer, M., Pohle, J., and Tupper, P. (eds.) From Nwico to WSIS: 30 Years of Communication Geopolitics: Actors and Flows, Structures and Divides. ECREA series. Intellect, Bristol. ISBN 9781841505862.
42. Mansell, R., & Tremblay, G. (2013). Renewing the Knowledge Societies Vision for Peace and Sustainable Development. Report prepared for the WSIS+10 Review for the Communication and Information Sector, UNESCO and for presentation in the "Knowledge Societies, Stakeholder Accountability for Sustainable Development" Panel at the UNESCO WSIS+10 Conference, Paris, 25-27 February 2013.
43. Miller, R. (2003). The Future of the Tertiary Education Sector: Scenarios for a Learning Society. Prepared for the OECD/Japanese Seminar on the Future of Universities, Tokyo, December 11-12, 2003. OECD-CERI.
44. Miller, R., Looney, J., and Wynn, J. (2010). Thinking Strategically About Education and Technology: Making Learning Happen Today for Tomorrow's World. Thinking Deeper Research Paper No.1 - Parts 1 & 2. Promethean Education Strategy Group, 2010.
45. Miller, R., Shapiro, H., and Hilding-Hamann, K.E. (2008). School's Over: Learning Spaces in Europe in 2020: An Imagining Exercise on the Future of Learning. Seville: IPTS, 2008.
46. NRC (2012). Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security. National Research Council of the National Academies Washington, the National Academies Press, 2012.
47. OECD (2013). Trends Shaping Education 2013. OECD Publishing.
48. Osborne, J., & Hennessy, S. (2003). Report 6: Literature Review in Science Education and the Role of ICT: Promise, Problems and Future Directions. FUTURELAB SERIES.
49. Partnership for 21st Century Skills (2008). Framework for the 21st Century Learning.
50. Perez, C. (2003). Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages. Cheltenham, UK: Edward Elgar. ISBN-10: 1843763311.
51. Piketty, T. (2014). Capital in the Twenty-First Century. Massachusetts: The Belknap Press of Harvard University Press, 2014.
52. Popescu, A.I. (2011). The learning society as a key for development. Proceedings of the 7th Administration and Public Management International Conference.
53. Punie, Y. & Ala-Mutka, K. (2007). Future Learning Spaces: new ways of learning and new digital skills to learn. Digital Kompetanse, 2007, Vol. 2, Issue 4, pp. 210–225.
54. Punie, Y. & Cabrero, M., (2006). The Future of ICT and Learning in the Knowledge Society. Report on a Joint DG JRC/IPTS-DG EAC Workshop held in Sevilla, 20-21 October 2005, DG JRC-IPTS, European Communities, March 2006, EUR 22218 EN.
55. Rathenau Institute (2014). Future Knowledge: 4 scenarios for the Future of Dutch Universities. The Hague.
56. Redecker, C., Leis, V., Leendertse, M., Punie, Y., Gijsbers, G., Kirschner, P., Stoyanov, S., Hoogveld, B. (2011). The Future of Learning: Preparing for Change. Seville: IPTS, 2011.
57. ReFuture.me (2014). Re-Engineering Futures: Future Agendas for Global Education.

58. Rij, V. van (2013). New Emerging Issues and Wild Cards as Future Shakers and Shapers. In: Recent Developments in Foresight Methodologies. Eds. Maria Giaoutzi & Bartolomeo Sapio. Springer. ISBN: 978-1-4614-5214-0 (Print) 978-1-4614-5215-7 (Online).
59. Rij, V. van, & Warrington, B. (2011). Teaching and Learning for an ICT revolutionized society, EC – FAR Horizon project. Manchester: University of Manchester, 2011.
60. Schumpeter, J.A. (1950). Capitalism, Socialism, and Democracy. 3d ed. 1942. New York: Harper and Brothers, 1950.
61. Soete, L. (2005). Innovation, Technology and Productivity: Why Europe Lags Behind the United States and Why Various European Economies Differ in Innovation and Productivity. In: Castells, Manuel and Cardoso, Gustavo, eds., The Network Society: From Knowledge to Policy. Washington, DC: Johns Hopkins Center for Transatlantic Relations, 2005.
62. Soete, L. (2006). A Knowledge Economy Paradigm and Its Consequence. UNU - MESRTCIT Working Paper Series, No. 001. Maastricht: Maastricht Economic and social Research and training centre on Innovation and Technology.
63. Thornburg, D. (1997). 2020 Visions for the Future of Education.
64. Uhlsa, Y.T., Michikyan, M., Morris, J., Garcia, D., Small, G.W., and Zgourou, E. (2014). Five days at outdoor education camp without screens improves preteen skills with nonverbal emotion cues. In: Computers in Human Behavior. Elsevier, 2014. Vol. 39.
65. UIL (2012). Second Global Report on Adult Learning and Education: Rethinking Literacy.
66. UK Commission for Work and Skills (2014). The Future of Work, Jobs and Skills in 2030. Evidence Report 84.
67. UNESCO (2005). Towards Knowledge Societies. Paris: UNESCO, 2005.
68. UNESCO (2014). Shaping the Future We Want. UN decade of Education for Sustainable Development (2005-2014). Final report.
69. UNESCO (2015). Position Paper on Education Post-2015.
70. UNESCO IITE (2015). Technologies in Higher Education: Mapping the Terrain. Compiled by Neil Butcher.
71. UNIDO (2005). UNIDO Technology Foresight Manual. Vol. 1-2.
72. UNITE (2014) Living and Learning in 2034. A higher education futures project. University Alliance and UNITE.
73. Wang, W.-C. (2011). Transformations of employment and occupation patterns in Taiwan's transition to an information society. Chinese Journal of Communication: Vol. 4, Issue 4, 2011.
74. Wheeler, S. (2015). Learning with 'e's: Educational Theory and Practice in the Digital Age. ISBN 978-1-84590-939-0.
75. Wilson, R. (2009). The future of work and implications for education. In: Beyond Current Horizons. Warwick, 2009.