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REVIEW ARTICLE

Revolution 4.0, Skills, Education, and Guidance

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Abstract

We are witnessing the birth of the fourth industrial revolution, which is blurring the boundaries between the physical, digital, and biological spheres. It is transforming productive, economic, and commercial relations, to the point of radically changing the way we live, work, and relate to each other. It is not only changing what and how we do things, but also who we are. Numerous studies agree that the new scenario will require new competences not only of a technical and methodological nature but also and above all of a participatory and personal nature. Those "cross-sectional competences," widely generalizable and transferable, required in different contexts and different activities, and which are apprehended through different experiences. Education is the most powerful tool that can be used to respond to the unavoidable need to update and improve the competences of an ever-growing number of people and, additionally, all throughout their lives. An education that fosters learning or unlearning in order to relearn in the VUCA world. In this world, the guiding intervention that favors the clarification of personal possibilities with meaning is essential, so that every human being can become who they are, without being trapped in cognitive, procedural, and attitudinal patterns of the past.

Keywords:
fourth industrial revolution, competences for life, university education, vocational counseling

Revolución 4.0, Competencias, Educación y Orientación

Resumen

Asistimos al nacimiento de la cuarta revolución industrial, que está borrando los límites entre las esferas físicas, digitales y biológicas. Está transformando las relaciones productivas, económicas y comerciales, hasta modificar radicalmente nuestra forma de vivir, de trabajar y de relacionarnos. No solo está cambiando el qué y cómo hacer las cosas, sino también quiénes somos. Múltiples investigaciones coinciden en que el nuevo escenario requerirá nuevas competencias no solo de carácter técnico y metodológico, sino también y sobre todo de participativas y personales. Esas "competencias transversales", ampliamente generalizables y transferibles, requeridas en distintos contextos y diferentes actividades, que se aprehenden

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a través de diversas experiencias. La educación es el arma más poderosa, que se puede usar, para responder a la necesidad ineludible de actualizar y mejorar las competencias de cada vez mayor número de personas y además a lo largo de sus vidas. Una educación que fomente el aprender o el desaprender para volver a aprender en la sociedad VUCA. En ella es imprescindible la intervención orientadora que favorece el esclarecimiento de posibilidades personales con sentido, para que todo ser humano llegue a ser el que es, sin quedarse atrapado en patrones cognitivos, procedimentales y actitudinales del pasado.

Palabras clave:
Cuarta revolución industrial, competencias para la vida, educación universitaria, orientación profesional.

Revolução 4.0, competências, educação e orientação

Resumo

Assistimos ao nascimento da quarta revolução industrial, que está apagando os limites entre as esferas físicas, digitais e biológicas. Está transformando as relações produtivas, econômicas e comerciais, até modificar radicalmente nossa forma de viver, de trabalhar e de nos relacionarmos. Não só está mudando o quê e como fazer as coisas, mas também quem somos. Múltiplas pesquisas coincidem em que o novo cenário vai requerer novas competências não só de caráter técnico e metodológico, mas também e, principalmente, participativas e pessoais. Essas "competências transversais", amplamente generalizáveis e transferíveis, requeridas em diferentes contextos e atividades, adquiridas através de diversas experiências. A educação é a arma mais poderosa que pode ser utilizada para responder à necessidade ineludível de atualizar e melhorar as competências de um número cada vez maior de pessoas e ao longo de suas vidas. Uma educação que fomente o aprender ou o desaprender para voltar a aprender na sociedade VUCA. Nela é imprescindível a intervenção orientadora que favorece o esclarecimento de possibilidades pessoais com sentido, para que todo ser humano chegue a ser o que é, sem ficar atrapado em padrões cognitivos, procedimentais e atitudinais do passado.

Palavras-chave:
Quarta revolução industrial, competências para a vida, educação universitária, orientação profissional

Introduction

We are living in a time of major transformations, which are shaking the foundations of our social, economic, ecological and cultural well-being. (See Figure 1) It is an increasingly disruptive period, which leaves us no other option than to move from "ego-systems to economic ecosystems" and to "Lead from an emerging future" (Scharmer & Käufer, 2015).

Nowadays, the words of Leo Tolstoy, "everyone thinks of changing the world, but no one thinks of changing himself" become especially important, and we frequently consider that doing what we propose to is impossible. However, this society—where we contribute to collectively generate results that nobody wants—could hardly change without changing the awareness level that we apply into our actions. Developing such ability is what can allow us to create a future with greater possibilities.

Perhaps the greatest crisis in our time is the thinking model, how we address problems. Facing future challenges requires seeing the world from new perspectives. To connect with the emerging opportunities and making them real, we need an open mind, an open heart, and an open will (Scharmer, 2017).

This vision openness will be essential to address everything related to the work future (Rifkin, 2010; WEF, 2016), by anticipating that the technological disruption (Parker, 2015) will interact with other socio-economic, geopolitical and demographic factors, creating a great upheaval in the labor market. Everything indicates that in the future the destruction of occupations will be greater than our society's ability to generate new

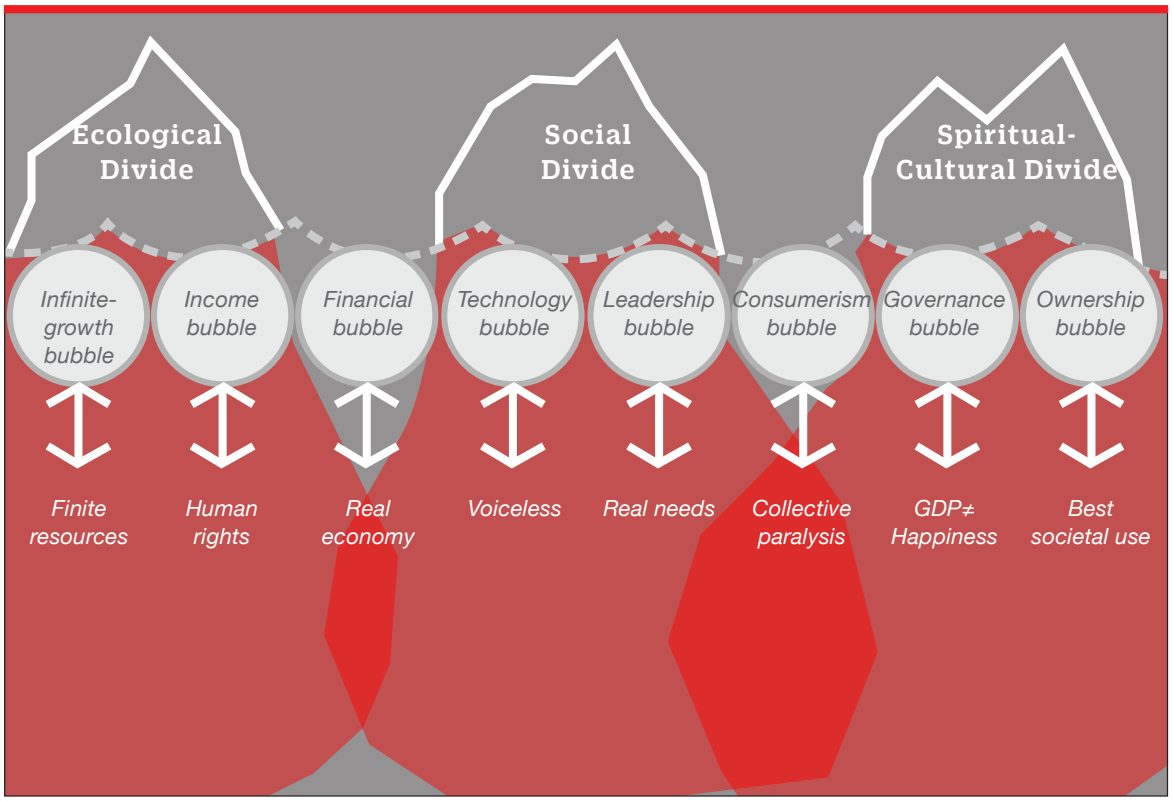

Figure 1. *Iceberg Model: a surface of symptoms and structural disconnects (bubbles) below it. Taken from LEADING FROM THE EMERGING FUTURE. From Ego-System to Eco-System Economies, by C. O. Scharmer & K. Käufer, 2015, p.17. Copyright 2015 Editorial Eleftheria, Barcelona, Spain.*

ones. And along with the anticipated unemployment rates, filling certain job positions will be a challenge. Several of the skills that companies will require in the following decade are not yet considered as essential (ManpowerGroup, 2017; Randstad, 2018) and a big part of the current "to know" and "to know how" demanded from professionals needs to be supplemented with "to know how to be" (Echeverría, 2001, 2002, 2010, 2016a). Many companies will find that keeping the most talented workers is a priority and in most of them the impact of technology will shorten the usefulness of the workers' skills, who will need to update them throughout their lifetimes.

Absorbed in the fourth industrial revolution, employers cannot continue being just passive consumers of competent employees; politicians must lead deep changes in the educational system and the job market regulation; and the citizens must involve in learning processes throughout all their lives (Raina, 2016). "It is not longer enough for individuals to collect early in their lives a set of knowledge that they could use later without restrictions. More than anything, they must be able to *take advantage of and use* during their lives each opportunity for *updating, going in depth, and enriching* that initial knowledge and for *adapting* to an ever–changing world" (Delors, 1996, p. 95. [Italics are from the authors]).

That is, "Learning for a world in constant change" (Thomas & Seely Brown, 2009), absorbed in the "Liquid Modernity" (Bauman, 2003), which places us before "The paradox of choice" (Schwart, 2004), towards which the VUCA (volatile, uncertain, complex and ambiguous) society of the 21st century constantly pushes us. A "modernity" characterized by the transition from a "solid" (stable, repetitive) society towards a "liquid" one (flexible, unpredictable), whose social structures do not last the time necessary to become fixed and do not

serve as reference frameworks for human activity. This "continuous flow" brings along changes in the way of learning, organizing, communicating, managing information, and relating to others. And as the amount of alternatives increases, the choice becomes more difficult. Therefrom the "paradox of choice" that the present society faces.

Revolution 4.0

The first revolution (1784) used water and steam energy to mechanize production. The second one (1870) used electricity to create mass-production and generate the division of labor. The third one (1969) uses information technology to automate production. Since the beginning of the 21st century we are witnessing the birth of the fourth one, based on the digital revolution, characterizedby the merge of technologies, which is blurring the boundaries of the physical, digital and biological spheres.

We find ourselves again facing a change in times, preceded by a deregulated globalization that has challenged the sovereignty of most governments (Sampedro, 2013), and after the hangover of a decade of financial crisis (Tooze, 2018; Vidal, 2018) with institutional, economic, social and work consequences that are yet to be overcome by the West (Madina, 2018).

According to the indicated in the 2016 Davos summit: "The Fourth Industrial Revolution, which includes developments in slightly disjointed fields such as artificial intelligence and machine-learning, robotics, nanotechnology, 3-D printing, genetics, and biotechnology, will cause widespread disruption not only to business models but also to labor markets over the next five years, with enormous change predicted in the skill sets needed to thrive in the new landscape". (WEF, 2016a, p. 5).

This revolution is very different from the ones experienced by humanity in the past. It stands out due to its complexity, speed, magnitude, depth and impact of transformations (Standford, 2014; Stone et al., 2016). It is not only changing what we do and how we do it, but also who we are. The productive, economic and commercial relations are changing until dramatically modify our ways of living, working and relating (Maison, 2016).

We do not know for sure what the future will bring, but we know that we must answer in a comprehensive and integrated manner. "All of us should ask ourselves what we can do now to improve the chances of reaping the benefits and avoiding the risks" (Hawking, Russell, Tegmark & Wilczek, 2014), similar to Mary Shelley's reaction before the first revolution in her famous work *Frankenstein or the Modern Prometheus"*(1816). Just as in this romantic drama about the prometheus-like will of human being, the risk of science devoid of the boundaries of reason and of human live dependence on technology arises again (Hariri, 2016, 2018a) and it can impact on people essence and some of their main activities, such as the ones briefly mentioned below.

"The incredible innovations caused by the fourth industrial revolution—from biotechnology to artificial intelligence—are redefining what it means to be human" (Schwab, 2016b. p. 17). The impact that these would have on us as individuals will affect our identity in its deepest in various aspects of our lives, such as, longevity (Gratton & Scott, 2017), health (Robledo 2017), sense of privacy (Toscano, 2017), cognitive processes (Gazzaley & Rosen, 2018), the way we relate to others (Stalman, 2018), the time we use for work and leisure (Dufour, 2015), the development of our professional careers (Kaye, Williams & Cowart, 2017), etc. These changes and other similar will demand a continuous adaptation to people, which may lead to a increasing degree of polarization between those who accept it and those who fight it. The "winners of this ontological inequality" (Schwab, 2016b) will be able to benefit from improvements caused by this revolution, as for instance, genetic engineering, but this is not the case for the "loosers". We could add to this potential division, the problems caused by, for instance, the generational gap between those who were born and grew in a digital world and those who had to adapt to it at an advanced age (Ortega & Vilanova, 2017).

These tensions are already visible in the relations between teenagers and the mobile technologies; for them, on-line interactions have replaced face-to-face conversations. *For many young people, life now happens on phones. Everything else is backdrop* (Kuper, 2015) and it is foreseeable that for an entire generation of young people listening, making eye contact, or understanding

body language is difficult, as they are immersed in social networks. Their individual and collective relations with technology—and also the ones of some adults—can negatively impact on their social skills and empathy capacity.

The fact that they in particular—but also an increasing number of adults—remain constantly connected, can deprive them of such a valuable asset as time, to rest, reflect, and enter into deep conversations (Esquirol, 2015, 2018) without being assisted by technology or social networks. The longer we stay connected to the web, the shallower our cognitive skills become, and we loss control over our ability to focus, as the web is designed as a machine that splits our attention (Carr, 2011). As Turkle demonstrates (2011, 2015), after studying the digital culture for more than thirty years, we live inside a technological universe where we are always communicating, but where we sacrifice conversation to be just connected. In such an accelerated time, full of distractive elements and always moving, nothing is best that going slow, paying attention, and stopping to reflect (Iyer, 2015), as "a wealth of information creates a poverty of attention" (Herbert Simon).

In addition, as Michael Sandel states "we seem increasingly willing to change privacy for coexistence with many of the devices we often use" (Segran, 2015). One of the biggest challenges, posed by the Internet, is the issue of privacy in an increasingly transparent world. "It could represent a unique weapon of freedom and democratization and, at the same time, an incentive for indiscriminate and almost inscrutable mass surveillance of considerable scope" (Schwab, 2016b, p. 85). "Thanks to *big data*, artificial intelligence, and the automated learning, for the first time in history getting to know people better that themselves, "hacking" human beings, and making decisions on their behalf is starting to be possible. We are beginning to have the knowledge required to understand what is going on inside their brains (Hariri, 2018b, par. 16).

Just as Mary Shelley had the remarkable nightmare about a monster created by human science, and Turkle (2011, 2015) has shown the risk of sacrificing conversation for simple connection, some "Silicon Valley rebels" (Torres, 2018) are willing to stop the excess of the big technological companies. After realizing that the platforms are strategically designed to generate addiction and about the damages that ill-used technology is causing to humanity, eight former workers from the most powerful companies in the industry launched in early 2018 the *Center for Humane Technology*[1]. The main purpose of this non-profit organization is to introduce ethics in technology design. It aims at warning users about the detrimental effects of technology and to put pressure on the United States Government to make the industry regulations stricter.

As one of the project founders explains in a TED talk: "Technology is not neutral and consequences are evident" (Harris, 2017). "The business model is based on increasing the number of users and the connections and interactions among them in order to increase the data base" (Torres, 2018, par. 7), another founder states—Sandy Parakilas—former person in charge of operations in Facebook. And for other of these "rebels", Lynn Fox, who has 25 years of experience in the industry. "The lack of control over social networks have severe consequences, such as the increasing cases of depression among teenagers or the spreading of eating disorders" (Torres, 2018, par. 5).

And if these are some of the detrimental effects caused by the omnipresent technology in our individual lives, the impact—both negative and positive—of Revolution 4.0 in our work activity is just as important (González-Páramo, 2017; Lasalle, 2018; WEF 2016b). Pessimists consider that this great transformation is going to cause high unemployment rates, while optimists state that the employees affected by it will be able to fill new job positions. Most likely, the real result will be something in the middle, as history has shown us before (Dans, 2017). Some job positions will be destroyed, and replaced by new ones with different types of activities (EUROFOUND, 2015, 2018b, 2018c), performed by other professional profiles, and probably in different places (EUROFOUND and ILO, 2017).

In effect, in the World Economic Forum summit in Davos (2016), it was stated that before 2020, seven million job positions could be destroyed,

1 http://humanetech.com/

with only two million new jobs to compensate for this loss. That is, between 2015 and 2020 probably five million people will become unemployed (WEF, 2016a, p.13-16). In addition, in some of the wealthy countries, the short-length and low income contracts are very popular, in spite of the low unemployment rates registered (Doncel, 2018)However, more or equally shocking that the job position destruction will be their transformation. According to the Think Tank Bruegel[2], almost half of the jobs is in risk of disappearing in the next two decades and currently, 30% of the functions required by the job market in the future is not yet identified.

Everything indicates that the invasion of artificial intelligence (Petropoulos, 2018) will lead to machines performing functions inconceivable to date and to dramatically change the global job outlook, as robotics is already doing. The impact of people hyperconnectivity, the great storage and data processing capacity, and disciplines such as neuroscience and nanotechnology will change our world, just as in previous revolutions. The manual work era is transitioning towards the mental work era. Work will continue to exist, but the nature of the tasks will change.

As Jarche states[3], we are witnessing the birth of a new job paradigm, where standardized job based on time and the technical improvement of skills is transitioning towards individualized, creative, and innovative work.

For a long time, the big companies have managed their human resources under the criteria of obedience, diligence and individualized intelligence. Nowadays, most of the emerging companies specially promote talent development: initiative, creative, passion. Learning moves from formal to informal, knowledge goes from explicit to implicit, and value changes from tangible to intangible (Jarche, 2013).

While the three first revolutions had a main impact on machinery and hard technology, in this fourth one we are the cornerstone of this great transformation. As human beings, we have no option but to face the posed challenges in an individual and collective manner (Jarche, 2018). This implies the willingness to change from the people, but also from all political agents, from public and private sectors—academies, companies, unions, etc.—and from the overall society. We must reform established organizations and institutions, commit to new emerging agents and support citizens, whose lives may be impacted by future changes (Neufeind, Reilly & Ranft, 2018).

It is foreseeable that there will be three type of main changes (Loshkareva, Ninenko, Smagin & Sudakov, 2018, pp. 53-54). On one side, new work tasks will generate new professions demanding new competencies (Emerging Skills). On the other side, changes in current professions will demand the transformation/evolution of the professional competencies required until today (Transforming Skills). And in the worst cases, the disappearance of some work tasks—particularly the routinary ones—will make certain competencies obsolete, thus, causing the extinction of some professions (Obsolete Skills).

And because "nothing is permanent but change" (Heraclitus), the "employability" of people—that goes beyond employement itself— shall be strengthen to the maximum (Echeverría et al., 2008, pp. 93-103). This includes "the transferable skills and qualifications that strengthen people's ability to benefit from education and training opportunities to find and keep a decent job, evolve in the company or change job positions, and adapt themselves to the evolution of technology and job market conditions," as defined by the International Labor Organization[4].

Skills

Since the early 2010s, there are several types of reports that intent to predict the skills considered necessary to face the types of changes identified by Loshkareva et al. (2018, pp. 53-54). There is even the "Skills Revolution" report (Manpower Group, 2017). Some of these reports highlight their foreseeable obsolescence, particularly for less-qualified employees. Other reports predict the decline of professionals caused by the emergence of

2 http://bruegel.org/

3 http://jarche.com/

4 Recommendation No. 195, 2d of the ILO on Human Resources Development (2004) https://www.ilo.org/dyn/normlex/es/f?p=NORMLEXPUB:12100:0::NO::P12100_INSTRUMENT_ID:31253

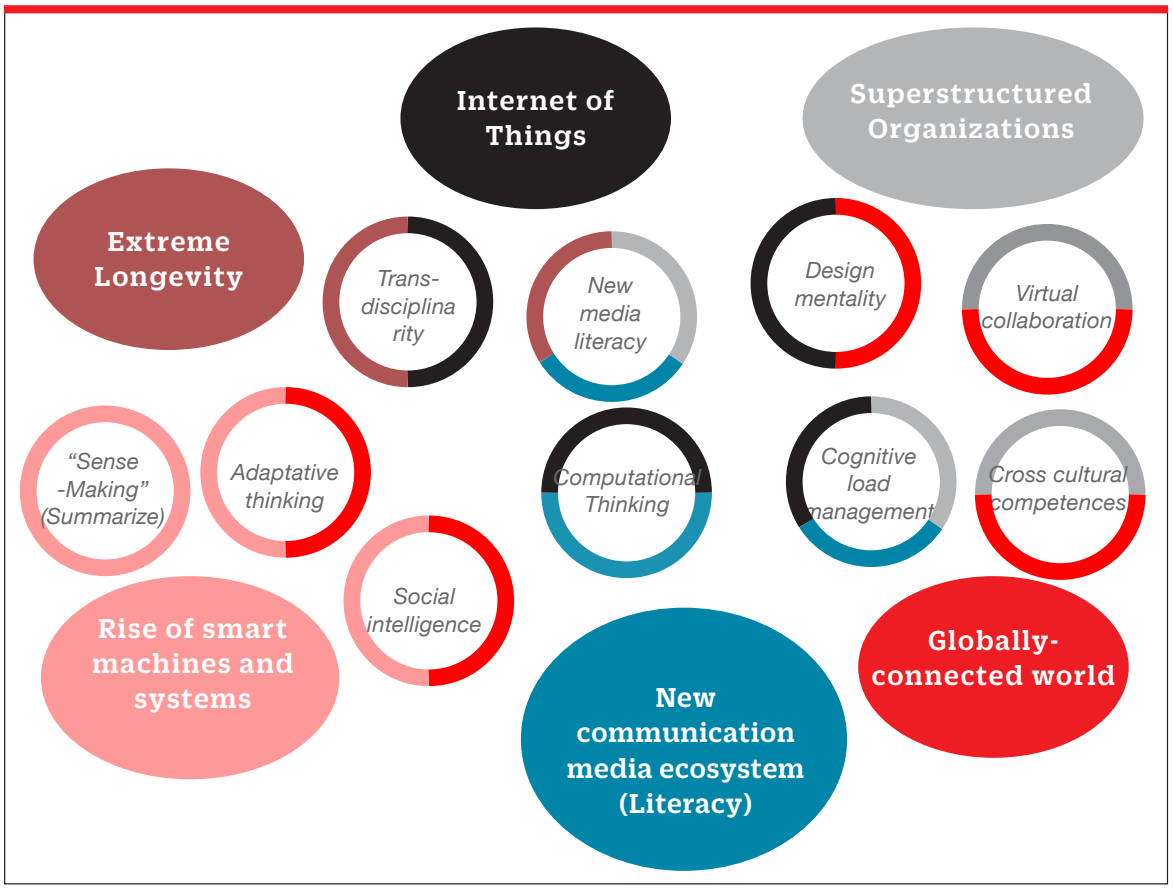

Figure 2. *Main factors (6) that will re-shape the future work landscape and the skills (10) related to them, foreseably demanded in 2020. Adapted from* Future Work Skills 2020, *by A. Davies, D. Fidler & M. Gorbis, 2011, pp. 6-7. Copyright 2011 Institute for the Future for University of Phoenix Research Institute.*

new competencies or their great transformations (Manyika et al., 2017). All of them present the underlying concern about the Revolution 4.0 impact on people's employability.

Among the first best-prepared reports, *"Future Work Skills 2020"* (Davies, Fidler & Gorbis, 2011), developed in the*Institute for the Future* (IFTF*) for the University of Phoenix Research Institute* stands out. Similarly, through its process "Foresight to Insight to Action[5]," makes predictions on several areas such as eduction, technology, demography, work and health, as well as an annual forecast called "Ten-Year Forescast[6]," which uses the signal technology. These are usually small and/or local innovations and disruptions that have the potential to grow in size and geographical distribution.

To detect them, experts from different backgrounds and disciplines worked together in an idea-contrasting workshop in the Palo Alto Institute (California) location. They identified the main causes of big disruptive changes in the 21st century and how these will probably create the need for a set of key skills for the future workforce. Unlike other studies, that intent to predict specific work categories and requirements, this research analyzes the skills that will potentially be required in different jobs and work environments, instead of focusing in future job positions.

In this way, six main drivers (see Figure 2) were identified for future jobs and their ten most relevant skills. While all six drivers are significant in

5 http://www.iftf.org/what-we-do/foresight-tools/
6 http://www.iftf.org/iftf-you/programs-initiatives/ten-year-forecast/

shaping the landscape in which each skill emerges, the color-coding and placement indicate which drivers have particular relevance to the development of each of the skills that we believe will be most needed in 2020.

The results of this research present implications for individuals, business, government, and educational institutions, which—according to the authors should: "a) Place additional emphasis on developing skills such as critical thinking, insight, and analysis capabilities; b) Integrate new (communication) media literacy into educational programs; c) Include experiential learning that gives prominence to interpersonal skills—such as the ability to collaborate, work in groups, read social cues, and respond adaptively; d) Broaden the learning constituency beyond teens and young adults through to adulthood; and e) Integrate interdisciplinary training that allows students to develop skills and knowledge in a range of subjects (Davies et al., 2011, p. 13).

Better known that this work is the report from five years later: "*The Future of Jobs. Employment, Skills, and Workforce Strategy for the Fourth Industrial Revolution*" (WEF, 2016a), developed by the *World Economic Forum* in cooperation with the *Global Agenda Council on the Future of Jobs and Gender Parity*, in addition to the support of the *Adecco Group, ManpowerGroup and Mercer.* Prominent academic experts, international organizations, professional service companies, and human resources directors from important organizations contributed to this report.

Its purpose is to analyze the current and future impact of the main Revolution 4.0 transformations in the employment rates, the skills, and the recruitment patterns in several industries and countries. To this end, an exhaustive survey was applied to a pool of human resources directors and senior talent and strategy executives from leading global employers, representative of more than 13 million of employees in nine wide industrial sectors from 15 important developed and emerging economies (WEF, 2016a, pp. 49-56). The survey respondents were asked to imagine how their organizations' job positions would change until 2020, far enough so that many of the current trends and transformations would already had started to establish, but near enough to value adaptation to the present, instead of speculating on future risks and opportunities.

Just as in the IFTF report, the main change factors—drivers—were identified: demographic, socio-economic and technological. These factors are expected to significantly impact on employment, as the paper of Astigarraga and Carreras on this same RIDU edition discuss. Based on these factors, an experiential in-depth analysis was conducted on the content of the the Occupational Information Network[7] -O*NET model (WEF, 2016a, pp.49-56), one of the most popular among market researchers around the world. Based on this analysis, a "Core work-related skills"[8] set was obtained for most of the occupations, including a combination of 35 relevant skills and competencies, plus the occupation specific specialized knowledge (see Table 1).

According to the survey respondents, by 2020, more than a third of the set of skills required for most occupations will be comprised of those that are not yet considered as critical for jobs.

Among them, we must highlight the top ten key skills most demanded for 2015 and their predictable evolution in the necessity rank for 2020 (see Table 2).

The last of these reports from the 2010s—of a similar research line as the previous two, but restricted to the United States and United Kingdom—is developed by *Pearson* (leading company in education), in strategic cooperation with Nesta (welfare foundation specialized in innovation), and the Oxford Martin School (research center for global issues) of the University of Oxford. ®The result of this efforts is the *The Future of Skills report: Employment in 2030* (Bakhshi, Downing, Osborne & Schneider, 2017), which identifies skills, competencies and knowledge that professionals from different backgrounds would need to remain active in a not so far away future.[9,10]

This research results can be found in Pearson's

7 https://www.onetonline.org/

8 http://reports.weforum.org/future-of-jobs-2016/skills-stability/

9 https://www.nesta.org.uk/project/future-skills/

10 https://www.oxfordmartin.ox.ac.uk/research/programmes/tech-employment/about

Table 1
Key skills related to the future of jobs (WEF, 2016a, pp. 20-25)

ABILITIES		BASIC SKILLS	
Cognitive Abilities	***Physical Abilities***	***Content Skills***	***Process Skills***
Cognitive Flexibility Creativity Logical Reasoning Problem Sensitivity Mathematical Reasoning Visualization	Physical Strength Manual Dexterity and Precision	Active Learning Oral Expression *Reading* Comprehension Written Expression ICT Literacy	Active Listering Critical Thinking Monitoring Self and Others

CROSS-FUNCTIONAL SKILLS				
Social Skills	***Resource Management Skills***	***Systems Skills***	***Complex Problem Solving Skills***	***Technical Skills***
Coordinating with Others	Management of Financial Resources	Judgement and Decisionmaking	Complex Problem Solving	Equipment Maintenance and Repair
Emotional Intelligence	Management of Material Resources	Systems Analysis		Equipment Operation and Control
Negotiation	People Management			Programming
Persuasion	Time Management			Quality Control
Service Orientation				Technology and User Experience Design
Training and Teaching Others				Troubleshooting

Note: Adapted from The future of jobs. Employment, skills and workforce strategy for the Fourth Industrial Revolution, *por World Economic Forum, 2016a, p. 20. Copyright 2016 World Economic Forum.*

interactive web[11], which provides an overall explanation of its methodology, findings and implications, as well as a series of profiles for the future professionals. The study is not only focused on the impact that automation will have on people employability in 2030. It is based on a broader approach that considers seven megatrends (see Table 3), just as the six drivers from the IFTF study, and it does not only quantify their individual impact, but it considers the complex interactions among them, which form the future job horizon.

11 https://futureskills.pearson.com/

Tabla 2
Evolución de las diez competencias más requeridas

IN 2015	IN 2020
1ª Complex-problem solving	1ª Complex-problem solving
2ª Coordinating with others	2ª Critical thinking
3ª Team management	3ª Creativity
4ª Critical thinking	4ª Team management
5ª Negotiation	5ª Coordinating with others
6ª Quality control	6ª Emotional intelligence NEW
7ª Customer service orientation	7ª Judgement and decision making
8ª Judgement and decision making	8ª Customer service orientation
9ª Active listening	9ª Negotiation
10ª Creativity	10ª Cognitive flexibility NEW

Note: Adapted from The Future of Jobs. Employment, Skills, and Workforce Strategy for the Fourth Industrial Revolution, *by World Economic Forum, 2016a, p. 21. Copyright 2016 WEF.*

Table 3
Megatrends[12] that Form the Future Employment Demand

Technological Change	Globalisation	Urbanization	Demographics Change
Environmental Sustainability	Increasing Inequality	Political Uncertainty	

Note: Taken from The Future of Skills: Employment in 2030, *by H. Bakhshi, J. Downing, M. Osborne & P. Schneider, 2017, pp.25-28. Copyright 2017 by the authors.*

Table 4
The Ten Abilities, Skills, and Knowledge Areas most Demanded in the U.S. and the U.K.

UNITED KINGDOM	UNITED STATES
1. Judgment and Decision Making	1. Learning Strategies
2. Fluency of Ideas	2. Psychology *(Conocimientos)*
3. Active Learning	3. Instruction
4. Learning Strategies	4. Social Perceptiveness
5. Originality *(Habilidades)*	5. Sociology and Anthropology (*Conocimientos)*
6. Systems Evaluation	6. Education and Training *(Conocimientos)*
7. Deductive Reasoning *(Habilidades)*	7. Coordination
8. Complex Problem Solving	8. Originality
9. Systems Analysis	9. Fluency of Ideas
10. Monitoring	10. Active Learning

Note: Taken from The Future of Skills: Employment in 2030, *by H. Bakhshi, J. Downing, M. Osborne & P. Schneider, 2017, pp.61-71. Copyright 2017 by the authors.*

12 https://futureskills.pearson.com/research/#/homescreen

One of the most interesting aspects of this research work is its methodology (Bakhshi et al., 2017, pp. 36-39), which truly shows the new scenarios where experts and machine learning algorithms work together to generate more solid predictions, from two connected groups, one in the U.S. and the other one in the U.K. Each of these groups received a set of ten occupations, chosen randomly, to assess based on the megatrends if the demand for each one would increase, remain the same or decrease, as well to quantify the certainty degree of these predictions.

This data was used for a classification algorithm, which generated predictions for hundreds of occupations in its database. Out of these, researchers selected the ten that presented a highest uncertainty degree and asked the expert groups to re-assess them up to four times, following the same methodology. Their assessments on the analyzed occupations vary according to the corresponding regions, showing that the megatrends impact differently in each of them and, therefore, cannot be directly extrapolated to other places, even though they may indicate the expectations on employability.

Upon identifying the ten occupations that will experiment a highest demand until 2030 in both countries**13**, they defined the ten most relevant abilities, skills and knowledge areas**14** related to them (see Table 4), highlighting in the glossary**15** the primary demand of the 21st century skills.

The results of this research impact people and employers, as well as the educational systems, which the researchers consider will need first to adapt to society's changing requirements andplan for the following 20-30 years. On the one hand, they shall promote a deeper understanding, and a better practice of the teaching-learning and assessment process, based on the most-demanded skills. On the other hand, they shall offer students flexible schedules that respond to the different development and accreditation demands of their skills. To this end, they must have a faculty that is highly motivated in a productive and effective way, properly trained and in constant improvement, so that they can respond to the 21st century society's requirements.

Education

While the three first industrial revolutions mainly disrupted machines and hard technology, everything indicates that this fourth revolution is going to mainly impact people, cornerstone of the great future transformation. Even though it may sound paradoxical, to success in the robot era, we must invest on people (Pagés, 2018). Amid the fourth industrial revolution tsunami, the survival of companies shall be ensured by their members' talent, training, attraction and constantly improvement than by the technology absorption itself.

As has been internalized by, for instance, Silicon Valley (California), "Investment in knowledge pays the best interest" (Abraham Lincoln). This place holds many of the biggest high-technology companies, thousands of developing small companies (start ups), research labs, and universities, which generate a great part of today's innovations and inventions. In a digital world, with several channels open to knowledge transit, education—particularly higher education—being considered the core factor of social transformation is not a surprise (Yiannouka, 2017). There is no doubt that, "Education is the most powerful weapon which you can use to change the world... It is the great engine of personal development" (Nelson Mandela).

One of the most imperative challenges that higher education faces is to respond to the unavoidable need to update and improve the skills of an increasing number of people and, in addition, during their entire lifetimes. This implies an important change in its traditional function of training young students, directly from the institutes. They will become lifetime learners, and will recur to universities in several stages of their lives, with different backgrounds and learning paths, in formal, non-formal and informal educational settings (Schuetze, 2014).

Universities must respond with increasing flexibility to these changing requirements of the

13 https://futureskills.pearson.com/research/#/findings/findings-introduction

14 https://futureskills.pearson.com/research/#/findings/top-skills

15 https://futureskills.pearson.com/research/assets/pdfs/glossary-of-skills.pdf

VUCA society, and specially to the individual needs of these new students. Full time study programs shall live together with part-time ones, as well as having work experience or integration programs, allowing to balance them with the academic part. In the same manner, it is expected that module and cumulative accreditation systems will be established, so that students may stop their education for a while and return later having earned credits that can count towards Bachelor, Master and Doctoral degrees (Cendon, 2018).

An important mean to respond to the flexibility demand will be the digital technologies, which provide new possibilities to choose where, how and when to teach and learn (Willcox, Sarma & Lipper, 2016). They represent a great support to the teaching-learning process from the classroom, as a supporting tool, to online learning, completely conducted through digital technology. And we must not forget about other types of combined learning and teaching types, where digital resources play a main role (Bates, 2015). Most of these means enable learning adapted to the student geographical location, learning styles, and schedule or other type of restrictions. Among them, we must highlight the blockchain technology, which may provide interesting solutions to new educational settings. "It allows students to select their learning packages from an assorted offer, oriented by the trainer and supported by valuation and guidance programs, managing smart contracts and generating a follow-up record of their learning experience" (Bartolomé & Moral, 2018, p. 27).

However, it is proved that digital technologies "per se" do not automatically improve teaching-learning processes (Ryberg, 2013). They can be reduced to simply document upload and download repositories, with no improvement of the quality of student learning-focused processes. The heart of this matter is not the many possibilities that this media offers, but its contribution to improve the interaction between faculty and students, and the aptitude of the latter before individualized learning (Akbar, 2016). The new network learning concept, supported by digital technologies and the student diversity as permanent learners, demands the reconfiguration of the classic professor-student relation. This becomes more relevant before the massiveness and increasing demand for higher education, the new ways of knowledge generation, and the new means of its acknowledgement (Burkle & Cobo, 2018). New constructivist learning approaches are implemented, focused on students and to redefine the functions of the higher education faculty (Cutajar, 2016; Sursock, 2015), as requested by the European Higher Education Area and the adoption of the European Credit Transfer System.

Nevertheless, this sort of requests will be useless if they only define study plans in terms of skills. Even worse if they are incorrectly defined as abilities, as sometimes occurs, as "it is different to be able to do something than to be skillful" (Adalberto Ferrández). We must improve methodologies and assessment and accreditation systems so that the development of skills required by society becomes the foundation of university education (Villardón-Gallego, 2015; Tourón, 2018), as, for instance, the Stanford 2025 Project or MIT 2020, or the projects in the Purdue and Texas universities.

The four of them consider future scenarios of increased flexibility in learning and curricular modularity, along with the development and assessment of disciplinary and cross-curricular skills. The first one defends change in disciplinary areas to skill centers within the university academic organization (Stanford, 2013). The second one awards academic credits to those programs where students have to solve problems representing a challenge to society, and allows them to show command of the competencies relevant to employers (MIT, 2014). The third one aims at achieving something similar; it presents a multidisciplinary program that is offered to students of any specialization, where learning is based on problem solving and the credits are awarded based on the acquired and proved skills (Purdue University, 2014). The fourth one also develops individualized programs based on skills and highly focused on the use of technology. The programs offer customized degrees and certificates, adaptive and aligned to the industry through technology development (UTS, 2014).

These and similar projects have influenced some Latin American proposals, as the one from Tecnológico de Monterrey. This proposal started

to develop in its Education Innovation Conferences, especially in the third one where we participated as experts (ITESM, 2009), but only in 2013 the Institute started to create its Educational Model known as TEC21.

As stated on the work documents (ITESM, 2015) and the institutional information (ITESM, 2016, 2018), the Model is focused on the relation between students and their environment and faculty, which enables the development of the their disciplinary**16** and cross-disciplinary**17** skills by solving challenges related to real problems. Assessment on the skill performance level is conducted by the collection of learning evidences, through several observation and measurement instruments, including partial and comprehensive assessments.

At TEC21, the core learning unit are the challenges and experiences designed to present students with environmental challenging situations, in order to achieve specific learning objectives. Challenges contribute to the development of two types of skills, as students need to apply their knowledge, abilities, attitudes and values in an individualized and collaborative manner.

This challenge-based learning is substantiated on experiential learning, which aims at bringing the university of life to the university life, supported by the principle that students learn more and better when they actively participate in open learning experiences than when they passively adapt to structured activities. It represents a comprehensive learning approach, which combines experiences, cognition and behavior (Akella, 2010). That is, it integrates the "to know" and the "to know-how" with the "to know how to be" of the individual (Echeverría, 2002; Martínez Clares & Echeverría, 2009). It offers students opportunities to apply their knowledge in real situations, where they face problems, discover on their own, try solutions, and interact with other students (Moore, 2013). In other words, TEC21 completely share the idea—which we often repeat—that skills are apprehended and showed in a progressive tense, because "Knowing is not enough; we must apply. Willing is not enough; we must do" (Johann W. Goethe). Skills in general and the professional performance skill in particular differentiate between what need to be done in a defined situation and facing this in a real situation.

This Model seeks to delve into, integrate and apply knowledge through different learning modules that provide students with theoretical and practical knowledge required to respond to the challenges. Its design is based on the challenges' requirements, that are provided in advance or at the same time, representing a progressive change that is different from the traditional study program. As expected, the professor plays a critical role in this model, by performing one or several functions (designer, instructor, assessor, tutor, mentor) aimed at assisting students with the learning process and the development of skills by experiencing the challenges.

All these educational proposals significantly evidence how Revolution 4.0 has started to promote the transformation of higher education institutions, to look after the constant learners of the 21st century during the development of the skills required to face the challenges in the new scenario. The way of accessing knowledge, the learning models, and the management systems of these education centers try to adapt to the current times (WEF 2015).

Educational models based on the Cartesian-mechanical philosophy—where learning is achieved by reflecting on past experiences—are started to be supplemented by other way of learning. While in traditional models, learning is achieved from past actions and the current behavior is based on the old one, the new models present a way of learning by emerging futures. Practicing mindfulness—*hic et nunc*—is what enables the achieve-

16 The *disciplinary skills* include all the knowledge, abilities, attitudes and values considered necessary for professional performance. Its development implies a progressive construction based on the core skills up to the discipline's final skills (ITESM, 2016, p. 6).

17 The *cross-disciplinary skills* are developed along the training process in any discipline; they are useful for the graduate students' life and directly impact on the quality of their professional performance. TEC21 aims at developing the following skills: leadership, entrepreneurship and innovation, critical thinking, problem solving, ethics, citizenship and social mortgage payment, global perspective, intellectual curiosity and passion for learning, collaborative work, communication in a foreign language and command of foreign languages, and command of information technologies (ITESM, 2016, pp. 6-7).

ment of the "insight" (finding), because "when it is obvious that the goals cannot be reached, don't adjust the goals, adjust the action steps." (Confucius). We must remember that "the young do not know enough to be prudent, and therefore they attempt the impossible - and achieve it, generation after generation" (Pearl S Buck).

In summary, Revolution 4.0 demands an education that promotes learning or unlearning to learn again, an education that is not only focused on the objective, but also on the subjective.

Guidance

If we are absorbed by the "liquid modernity" (Bauman, 2003) of a volatile, uncertain, complex and ambiguous society, and we are focused on "learning for a constantly changing world" (Thomas & Seely Brown, 2009), it is not unusual that people in general and university students in particular face the "paradox of choice" (Schwart, 2004), because "the trouble with our times is that the future is not what it used to be" (Paul Valery).

As the academic systems present more options, flexibility and versatility, and the access to so many different resources increase, the previous decision processes and plans made during the training period become increasingly complex (Martínez Clares & Echeverría, 2018). Before, we used to select an academic program with a defined amount of subjects that we had to successfully master in a series of courses and, after receiving the education institution's approval, we received an occupation for life. Nowadays, becoming an expert in something and acquiring knowledge in a particular area may be required to follow certain occupation, but is unlikely to be enough for the upcoming times. Ortega y Gasset's omen from the mid 20th century is becoming increasingly real: "To be a technician—and only a technician—is to be able to be everything and, accordingly, to be nothing specific."

As mentioned before, something similar happens in the work environment. The times where you could find a job fairly easily and the issue was to "get" into one, to later "jump" or "promote" to another that would provide greater economic, social and/or personal satisfaction are over. Currently, a society that is completely employed and have the security of lifetime employment is increasingly rare (Avent, 2017; Rifkin, 2010; Williams & Srnicek, 2017). In addition, the professional environments are increasingly mixing; therefore, the ability to perform several activities and tasks has become an upward value in the job market (Moravec, 2013; Roca, 2018). Physical and neuronal mobility becomes a culture for the VUCA society (Mack, 2015) and Revolution 4.0 is opening a hundred doors for each one that closes (Navarro & Sabalza, 2016).

These situations and an endless amount of similar possibilities cause anxiety in people, worried for having to take unknown paths. The present society and maybe even more the future one offer more future alternatives than any of the former; but it is difficult to leave our comfort zone and reinvent ourselves every day (Forés, Sánchez & Sancho, 2014). On the other hand, we have more and better information than ever, to be able to make a better informed decision. But the current issue is not the lack of information, but the excess of it. The information volume is so large, and the access to it so diverse, that it is hard to know which information is needed, how to obtain what we are looking for, and how to better use the information we have, to make compared decissions. (Wheatley, 2014).

It is not unusual that, for instance, lately some organizations as OCDE (2003, 2004), OIT (2004), CEDEFOP (2004, 2006) or the European Council and the Council of Heads of State Governments of the European Union, among others, recommend the strengthening of policies, systems and practices of constant guidance. In the presence of the current signs, they praise the establishment and development of guidance constant processes, which allow citizens of any age and along their lifetimes to: "a) Define their abilities, skills and interests; b) Make decisions related to education, training and employment; c) Manage their personal life paths in relation to education, training, job, and other settings where they could acquire or use these abilities and skils" (CE, 2004, 2008). This process involves a number of individual and collective activities of information, counseling, advise, among others, as well as the diagnosis, development, assessment, and accreditation of the skills required to make decisions and manage the life and professional projects.

This concepts notoriously distinguishes from the behaviorist visions of guidance, which reduce it to reaction functions of just "assistance" or "emergency solutions for problems" of a personal, social or "labor adaptation" nature. We must do more than to guide people through safe and secure paths; we must teach them to guide themselves in a world where "when we thought we had all the answers, suddenly, all the questions changed" (Mario Benedetti). It is not worth to "give a man a fish"; you have to "teach him how to fish," as a Chinese proverb states.

Guidance needed by Revolution 4.0 is intended to promote the development of the required skills, to be able to identify, select and/or redirect personal, academic, and professional alternatives, based on the potential and life project of each person, compared to the offers of education and socio-labor environments (Echeverría, 2008, p.14; Echeverría & Martínez Muñoz, 2014, pp. 25-26). The main goal is to "become such as you are," as Pindar used to motivate the Greek athletes. This "such as you are" involves "who you may become" for everyone.

This is the core principle of the guidance intervention model created by Watts (1996). Known by its acronym—DOTS—it aims at answering four essential questions: Who am I? (*Self-awareness*), Where am I? (*Opportunity awareness*), What will I do? (*Decision learning*), How will I do it? (*Transition Learning*) (Echeverría & Martínez Muñoz, 2014, pp. 28-29). It was created in the 70s to "apply vocational concepts into the school study program within the framework of a true guidance culture" (Watts, 1996, p. 214), and it has been used for this purpose by many of the European Union states. Theoretically, it can be used in any area and at any age, but the underlying vocational concepts may not completely respond to the "vucational" guidance required in the present.

New proposals—such as the Theory U (Scharmer, 2017; Scharmer & Kaufer, 2015)—would probably be more relevant for the Revolution 4.0 challenges, which require new awareness and new collective leadership abilities, to face the challenges in a more conscious, intentional and strategic manner. It is a personal development method, focused on counteracting resistance to change and transforming human beings and organizations, through a set of skills that promote the timeless "know yourself" (*γνωθι σεαυτόν*). It is based on the search for innovation within each person, and inside the institutions, job centers, etc., in a synergistic cooperation, to achieve a group result that is greatest than the addition of individual impacts.

It suggests that human actions often come from a *blind spot*, located inside people and around them as society, where consciousness, focus and intention states generate. It is blind as it is a invisible dimension of our social field. We usually understand why, what for, or how we act; we are even aware of the others' actions, but we are not clear about our action motivations. Therefore, we must answer the question "who are we? and where do our actions internally originate?", both at a personal and collective level.

To change reactive responses and fast solutions for generative responses that address the systematic root of problems is one of the most important challenges of our times at a personal (think), group (discuss), institutional (structure), and global (organize ecosystems) levels. To this end, the developers of this theory and its practice recommend a five-step path, presented in Figure 3. It involves creating first a close connection with the exterior world, and then approaching a place of knowledge from within, to materialize the new proposals. That is, discovering the future by acting.

The bottom part of this process is called "*presencing*", a combination of the English words "presence" and "sensing". It represents a stage of high attention that allows individuals and groups to change the interior space from where they are functioning. It represents the internal portal where we have to leave everything not essential behind. That is, "letting go" of the old Ego (left side of the U) and opening to ("letting enter") the best future possibilities of the Being (right side of the U), setting a subtle connection with a deeper knowledge source. The essence of "*presencing*" is experiencing the arrival of the new and transformation of the old. Both egos—current and future—meet on the bottom part of the U and start to listen to each other and resound together. Then, individuals and groups start to act at a higher energy level and perception of a future that offer

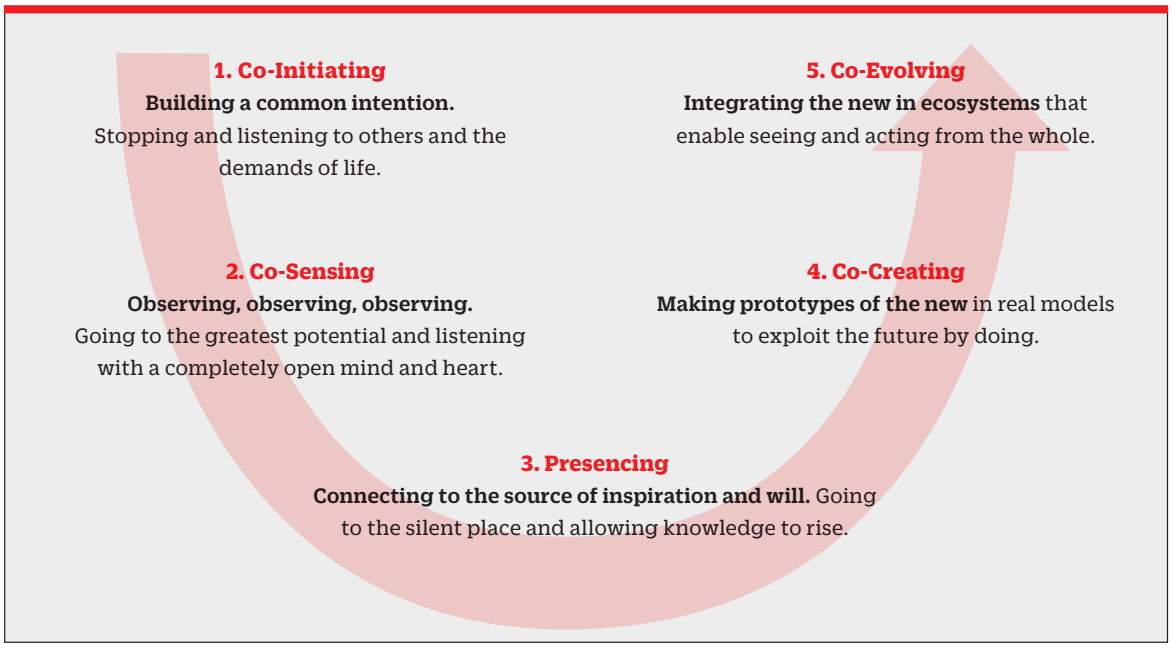

Figure 3. *Phases of Theory U. Taken from* Abordando el punto ciego de nuestro tiempo. Un resumen ejecutivo del libro de Otto Schamer, *by Z. Patarroyo & J. Ruiz, 2012, p. 9.*

new possibilities, which they can sense emerging.

To go through the U as a team, organization or system, a particular social technology of *presencing* is required (see Figure 4), and without developing these seven abilities, it is difficult to achieve the results of the five-step process, described above.

1. *Downloading*: Being aware of the starting position—knowledge, strengths, weaknesses (personal and professional)—before beginning any project.
2. *Seeing*: Paying attention with an *open mind* to the context of our own situation. In this stage, we should start researching our intended project's ecosystem (how it is done), by researching information, contrasting sources, the development of our own conclusions, and avoiding any judgements, which prevent the opening of new exploration spaces.
3. *Sensing*: Connecting to the change forces with an *open heart*, whose cognition style is based on integrated groups, instead of isolated elements. The important thing is to empathize, based on the understanding and interpreting of relations, actions, customs, quests and losses that the human being performed in the project ecosystem.
4. *Presencing or Transforming*: Connecting to their deepest origin and intention. While an open heart allows to see the whole situation, an *open will* permits to act from an emerging entirety. This inflection point in the U, defines the zero point to go to a new project approach, seeing new possibilities that may have been unnoticed before.
5. *Crystallizing*: Accessing power to achieve goals and results. In this point, we start to think conscientiously, focusing on each event, reflection upon a concrete goal, conceiving procedures, trying to find a solution for a problem, etc. We look for reality, from some uncertainty as we do not have sound and stable foundations yet.
6. *Prototyping*: Moving from abstract to concrete, by designing what we intent to achieve. It tries to counteract the acting without thinking (reactive action), reflecting without acting (analysis paralysis), and taking without acting (verbosity). It involves re-linking thoughts (head), feelings (heart), and will (hands) in a learning

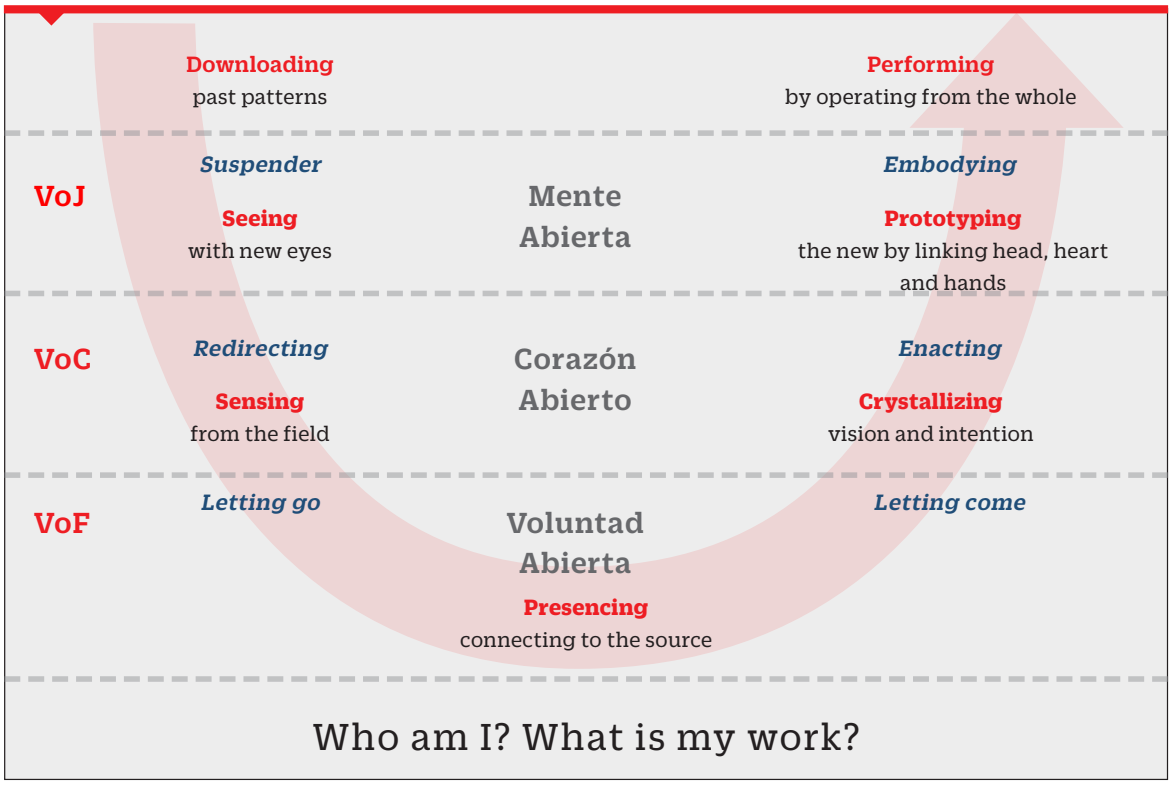

Figure 4. *Theory U: Abilities to develop (Sacanell, 2018).*

and practical application context.

7. *Performing by operating from the whole*: It usually starts when the team moves from a reflection and research period to a co-creation flow where they contribute with something really new. It is the highest expression of the team potential, by stopping to react to problems as they did before and being prepared to crystallize their "total presence" state in a different action manner.

As suspected, Theory U may be considered as a guidance intervention model similar to the DOTS Model, which allows to make compared decisions not only applicable to ego-systems, but also to project ecosystems. The "where am I?" (*Opportunity awareness*) will be located at the left side of the U, the "who am I? (*Self awareness*) will be located next to the "what will I do?" (*Decision learning*), in its inflection point and the "how will I do it?" (*Transition learning*) will be located at the right side.

Conclusions

The fourth revolution is here to stay and, if it is not properly faced, it could generate greatest social consequences than the ones experienced by the former revolutions. We must remember than "the world is a dangerous place, not because of those who do evil, but because of those who look on and do nothing" (Albert Einstein).

We still do not know how this is going to evolve, as the acceleration in innovations makes really hard to anticipate contents and the concrete scope of transformations. However, it is increasingly evident that "the answer must be integrated and comprehensive, involving all agents from global politics, the private and public sectors, the academics, and the civil society" (Schwab, 2016a).

Neither technology nor its disruption is a force exogenous to human being control. The responsibility to guide its evolution is ours, and of all the decisions we take as citizens. Just as the most re-

levant scientific from the last century said: "I fear the day when technology surpasses our humanity. The world will only have a generation of idiots" (Albert Einstein).

We must seize this opportunity, as it is up to us to direct the Revolution 4.0 towards a future according to our common goals and values. We have to change our traditional strategies for learning of our mistakes. We have to be proactive (Tegmark, 2018). "The most we think on how to benefit from the technological revolution, the most we will evaluate ourselves and analyze the underlying social models that these technologies embody and enable, and we will have more opportunities to shape the revolution in a manner that improve the world situation" (Schwab, 2016b, p.13).

And we will have plenty of aspects to reflect on, share and act upon; even though, from the education intervention perspective, it will be better to focus on the Revolution 4.0 impact on people, as we have been discussing before.

It is particularly worrying the risk of inequality, which may be generated by automation, increasing the gap between return on capital and work performance in an increasingly dual job market, with sectors of low qualification-low wages on one side, and high qualification-high wages on the other, which may provoke rising social tensions.

The challenge we face is not solved just by improving qualifications. It is a necessary measure, but not sufficient. Besides, it is necessary to link skills and job positions in a world where currently some companies are already aware that in the new work paradigm: "It doesn't make sense to hire smart people and then tell them what to do... (Better) hire smart people and let them tell you what to do." (Steve Jobs)

We will increasingly need professionals with a wide foundation of technical and methodological knowledge, but along with the added value of cross-disciplinary skills, mentioned before, to face the speed, scope and depth of the great upcoming transformations (Echeverría, 2016b).

On the one hand, these changes demand that people present a constant disposition to always seize and use every opportunity they get to update, delve into, and improve their pool of knowledge and to adapt to an ever-changing world. On the other hand, they demand educational systems to must urgently maximize the four core aspects of learning: a) *Learn to know*, discover, and understand the surrounding world; b) *Learn to do*, combine representational and operational knowledge, use them in concrete situations and impact on the environment; c) *Learn to live together,* develop the perception on human diversity, be aware of people similarities and interdependence, and collaborate with others; d) *Learn to be*, promote independent thinking, feelings and imagination to develop the individual personality, act in accordance to the beliefs, take on responsibilities, and make compared decisions (Delors, 1996).

In summary, to become what we are, by clarifying possibilities in a logical way, so that we can identify, choose and/or redirect personal, education and professional alternatives, in accordance to the potential and life project of each person.

If we intend to face the future—which is already the present—we need new awareness and constant updates both in the technique skill (to know) and the methodological skill (to know-how); that is "TO KNOW" capitalized, as well as the participative and personal skill (to know how to be), which provides human activities with "FLAVOR". This is the best way of going through the new world with an open mind, open heart and open will, and, thus, to be able to savor the flavor of knowledge, which could never be replaced by machines.

"Only he who places the candle
facing the blowing air will be successful;
never he who waits for the air to blow
towards where he placed the candle."
(Antonio Machado)

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