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4.0 Education Characterization for the Human Capital Formation

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Abstract: In a time like the present, decisive for higher education institutions, which are in need of a transformation and adaptation of their curricula to the digital age, they are presented as the most important elements to achieve this update: the innovation of its procedures and flexibility.
A descriptive research and analysis of the current literature in the world was carried out, in order to look for tools that allow to show the characteristics and technologies that describe the fourth industrial revolution; the human capital field specific needs were identified, and the requirements and technologies needed for their implementation in educational institutions were established.
With the information collected from the research of the theoretical framework, a questionnaire was created that was applied to professionals with experience in the industry in the Monterrey metropolitan area, to validate what was found on previous publications, such as the use of innovative technologies, social interaction and knowledge in STEM competencies (science, technology, engineering and mathematics) that are essential for the development of professionals with a 4.0 profile.

Keywords: 4.0 Education, Human Capital, STEM

1. Introduction

The fourth industrial revolution has generated changes in educational models and teaching paradigms, these changes happen thanks to technology, by establishing different education models that facilitate the way of learning and understanding Pedagogy. From the change in the students learning needs, now we have a bi-directional and autonomous over the control of content, education advanced from 1.0 to 3.0.

The topic of education 4.0 has already been presented in conferences such as "EDUNOVATIC 2018" where controversy is generated about what would be the profile that companies seek to develop professionals with a profile linked to industry 4.0.

By transforming conventional classrooms into smart classrooms to carry out more realistic practical cases faced by professionals in the sector, linked to teamwork, you can help develop the profile that is being sought.

2. Theoretical Framework

Education must be related to industrial advances, economic and technological development, and social mobility to enable young people to be at the forefront of knowledge to be competitive.

2.1 Industry 4.0

The concept of Industry 4.0 emerged in Germany in 2011, to refer to an economic and political strategy based on technology-based strategies (Ynzunza, Izar, & Bocarando, 2017). It is characterized by generating added value through the automation and digitization of processes. In addition to revolving around electronic and information technologies.

Industry 4.0 means a disruptive change not only in the manufacturing industry, but also in business and the way consumers behave, Navarro and Sabalza mention that Industry 4.0 has a series of advantages:

- More efficient processes with lower costs.
- Manufacturing companies could obtain resources of higher quality and precision, with superior performance.

• It can lead to a notable increase in flexibility and agility, both in the total value chain and as its different links.

• The development of added services that complement the benefits of the products or equipment offered by the manufacturing company is extraordinarily facilitated.

For this reason, adapting to a new reality generated by this revolution is essential to have competitive advantages over other companies, or, at least, keep up with them. Navarro & Sabalza (2016).

2.2 Education 4.0

2.2.1 Definition

Industry 4.0 is currently defined by a series of events that could be considered evolutionary (due to its rapid but continuous adoption) and disruptive (since the changes occurred in a vertiginous way). The speed of adoption of this series of events has led to a revolutionary approach. The educational approach is no different and must adapt in the same disruptive way. In real practice, learning models have not shown the same speed of adaptation and the teaching practice hasn´t developed at the same rate as technology adapts to industry. Sánchez D. (2019)

2.2.2 Education in México

Within the pedagogical approach of the 2016 educational model, it is intended to train students with a greater capacity to discern, interpret and handle information and that their learning acquire meaning for their personal and social development. The aspects of personal and social development that this pedagogical approach pursues are: intellectual openness, that is: adaptability, appreciation for art and culture, appreciation of diversity, promotion of gender equality, intellectual curiosity and continuous learning; Sense of responsibility, which involves: initiative, perseverance, reflection on one's own actions, integrity, rejection of all types of discrimination, peaceful coexistence, respect for legality, care for the environment, ethical attitude and citizenship. Alanís, A., González, G., & Hernández, J. (2018)

2.2.3 Use of technology for education 4.0

One of the advantages is that today's children are already digital natives, so incorporating them into technology is a natural process, technology brings them closer to a world to which children would not otherwise have access, and details that quality and quantity of content far exceeds what we can extract from books or other content. We cannot go against something they already have. Pérez Arroyo, E. (2019)

2.2.4 STEM

The term STEM is the acronym for the English terms Science, Technology, Engineering and Mathematics. It is an area that continues to grow as graduates of these fields are in high demand in the labor market. The field has registered a growth of 17% according to the Department of Commerce in the United States. Delgado, P. (2019)

To understand why the teaching of these fields is so necessary, as well as their popularity, it is important to delve into the role of the areas that comprise it. Starting with the "S" for science, it is a field that encompasses problems such as global warming, climate change or medicine. The "T" of technology that goes from computers to the digital age with Artificial Intelligence and programming. The "E" for engineering encompasses infrastructure, building, cities, and bridges design. Lastly, the “M” for math that can cover fields ranging from economics, accounting, investing and taxes, analysts, and even cryptographers. Delgado, P. (2019)

2.2.5 Learning tools for education 4.0

In 2016, during the "© 2016 World Economic Forum" the skills needed for 2020 were raised as well as the employment and Strategy of the workforce in the face of the 4th Industrial Revolution, considering that more than 35% of the skills in The workforce would change (Table 1.), predicting that with Industry 4.0 it would bring autonomous transportation, advanced robotics, machine learning and artificial intelligence, as well as genomics, biotechnology and advanced materials. So, the workforce will have to adapt to these changes so that the pace can be maintained. Gray, A. (2016).

Table 1. 10 main skills.

Top	*2015*	*2020*
1.	Solving complex problems	Solving complex problems
2.	*Coordinate with others*	*Critical thinking*
3.	*People Management*	*Creativity*
4.	*Critical thinking*	*People Management*
5.	*Negotiation*	*Coordinate with others*
6.	*Quality control*	*Emotional intelligence*
7.	*Service orientation*	*Judgment and decision making*
8.	*Judgment and decision making*	*Service orientation*
9.	*Active listening*	*Negotiation*
10.	*Creativity*	*Cognitive flexibility*

Source: Future of Jobs Report, World Economic Forum, Soft Skills (2016)

During the "© 2020 World Economic Forum" it was mentioned that technologies continue to transform jobs due to the advancement in the Fourth Industrial Revolution, so it is convenient again to train more than one billion people by 2030. The basic skills required for the jobs that currently exist are estimated to change by 42% by 2022. As for high technology skills, their demand will increase, as well as specialized interpersonal skills such as education, human resources, sales, and service. The World Economic Forum estimates that 133 million new jobs will be created by 2022, within the main economies, to satisfy what the Fourth Industrial Revolution demands. Zahidi, S. (2020).

3. Methodology

A detailed investigation was carried out, referring to the Education 4.0 literature and distance interviews were carried out with different people in areas interested in the training of professionals with an appropriate profile to work in Industry 4.0, to learn about the experiences of people who work in the industry and know the problems they have in terms of the lack of skills attached to innovation in the industry.

The purpose of the research was to collect information to know the skills needs required by industry 4.0, learning tools that will be useful in the teaching methods that are made around the development of professionals were also sought.

The group of people chosen to be interviewed are within the industry and know the needs that exist today, they know the areas of opportunity that exist because a profile or program has not been fully developed for the graduated professionals to comply with the characteristics demanded by the industry. Within the group of interviewees we have professionals from the automotive segment, this branch of the industry is one of the most innovative in the world, it is constantly seeking to improve its processes and most of the companies that are in business have their processes fully automated.

With the research and the results of the interviews, the primary needs of industrial companies in the Monterrey metropolitan area were identified and some tools that can be used by higher education institutions to develop the learning process from a 4.0 environment are presented.

4. Results

According to the literature research, the following necessary human capital competencies in Industry 4.0 were identified

- The adoption of Industry 4.0 will demand the hiring of new technical profiles from STEM branches
- Professionals with knowledge in systems integration, automation, supervision, and control.
- Professionals for the management of operations, integrations with ERP, document management or management of manufacturing orders.
- Engineers in charge of all technologies related to smart factory automation and sensors.
- Professionals in Big Data, Open Source and Middleware to integrate all systems.
- Experts in the analysis of data in real time to improve the industrial plant and business options.
- Cloud professionals to enable the connected industry.

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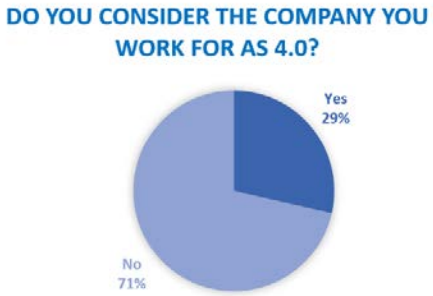

Figure 1. Percentage of interviewed who consider working for a 4.0 company. Bacre Guzmán (2020)

From the interviews it was obtained that only 29% consider that the company they work for is Industry 4.0, of which 50% belongs to the automotive segment and considers responsibility, being a worker and ethics as the most important characteristics in graduates. and within the requirements for higher education institutions is to give greater emphasis to work experience in the study plans, in addition to considering that current graduates do have the necessary skills and competencies to work in a 4.0 company, the results are shown in detail in the following table.

Table 2. Responses provided by interviewees. Bacre Guzmán (2020)

Do you consider the company you work for as 4.0?	Age range	Industrial field	What characteristics do you consider that an Industry 4.0 professional should have?	What characteristics do you consider a technical worker for Industry 4.0 to have?	Do you consider that current graduates have the necessary training to perform in Industry 4.0?	What recommendations would you make to those responsible for the curricular design of Higher Education Institutions for the formation of the future human capital of Industry 4.0?
Yes	31-60 years	Automotive, manufacturer	Responsible, hardworking, leadership, proactive, having ethics. Comply with Smart factory systems	Responsible, hardworking, ethical. Comply with training and certificates	50% yes 50% no	More emphasis on work experience. Focus on where you want to go with Industry 4.0
No	21-60 years	Educational institution, Manufacturing metal, Automotive, Department store, Consultant	Flexible adaptability, search for change and continuous improvement. Service attitude. Understanding of network operation. Be at the forefront in ICT, robotics, electronics, additive manufacturing, technologies.	They should be programmer to solve communication problems between machines or processes.	"The competencies that I have seen in recent graduates are far from those required for Industry 4.0."	Consider issues such as connectivity, big data, internet of things, artificial intelligence, so that each professional regardless of career knows how to process, structure, analyze and consult information in real time to improve decision-making

In addition, the respondents indicated that there is a general ignorance of the workers of what a 4.0 company is, in the same way they consider that higher education institutions require major modifications to their curricula to achieve the training of graduates with the necessary characteristics to be able to work in a 4.0 scenario. For which, according to what was found in literary research, the following tools are recommended:

- Gamification: It makes teacher and student; school and family collaborate.
- It allows constant interaction between students and teachers, focusing on communication as the main vehicle for learning. Use play and the creation of real learning environments as a learning engine.
- B-learning: This tool promotes the combination of face-to-face training (with teachers in a classroom) with online education (courses on the internet or digital media). B-learning takes advantage of these two methods.

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- Smart classrooms: They are usually structured by devices for each student –in that case tablets- an interactive whiteboard, a control and monitoring center and software that allows interaction between all the mentioned devices. It favors the development of capacities and participation of students.

5. Discussion

It is necessary to reflect on the new role that educational institutions must assume. In this line, from the school, we must take advantage of the possibilities and opportunities that ICTs offer us. Technology in teaching acquires an important role when it comes to proposing methodological, didactic, curricular, and organizational methods at all educational levels with an eye toward optimizing quality indexes in teaching. Currently handling concepts such as interactivity, interconnection, instantaneousness and knowledge, methodological strategies based on cooperative learning and network participation are needed. To achieve this, ICT is a fundamental and essential tool, not only because it creates a community where students can interact and share knowledge, but also because of its potential to transform educational practices. There is no doubt that the internet and social networks make available to schools everything necessary to build virtual learning communities, through multiple tools to promote communication, the shared construction of knowledge and the exchange of experiences among all members. of educational communities.

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