REGMPE

Revista de Empreendedorismo e Gestão de Micro e Pequenas Empresas

Cognitive Transcription of Industry 4.0: Interdisciplinary Approach in Courses at a University Center

Felipe Goularte Peiter[1]
Matheus Rech[2]
Rafael Henrique Mainardes Ferreira[3]

Abstract:
The main objective of this article is to analyze the concepts related to Industry 4.0, in professionals from different areas, verifying the interdisciplinarity and diffusion of discussions on the subject. The research was carried out at the Centro Universitário Campo Real in the city of Guarapuava-PR, using bibliographic analyzes, and, still in the face of multiple case studies, taking the research as an exploratory and descriptive character. The free software Cmap Tools® was used to help diagnose the different ideas about Industry 4.0, in order to formulate and outline the analysis using concept maps. Thus, the work provided a great knowledge about Industry 4.0, mainly to the priority areas of innovation, technology and engineering, exhibiting a scarcity of information to the most distant areas of these axes. It is important that current concepts are listed with interdisciplinarity, especially when the object of study is or is referred to in the academic or educational environment.
Key words:Industrial Revolution. Knowledge Maps. Concept maps.

1. Introduction

The Industrial Revolutions completely transformed people's lives, with the assembly lines, by mass production, electricity and information technologies, causing workers to obtain an increase in their income, and also causing a technological competition center of development economic (SEBRAE, 2016).

Since then, the advancement of technology has expanded between the physical and digital world, with highly trained, interconnected systems opening up new possibilities throughout the value chain, reducing costs, increasing speed, resulting in brilliant products and services, shaping fourth Industrial Revolution.

Industry 4.0 or the Fourth Industrial Revolution was baptized in Germany, being the result of great technological advances, mainly of the processes in the companies, thus this radical change of technology, makes to totally change the model of the industries of what is known today (MARTIN, 2017).

[1]Campo Real University Center - eng-felipepeiter@camporeal.edu.br
[2] Campo Real University Center - eng-matheusrech@camporeal.edu.br
[3] Campo Real University Center - prof_rafaelferreira@camporeal.edu.br
Peiter, FG, Rech, M., Ferreira, RHM; Cognitive Transcription of Industry 4.0: Interdisciplinary Approach in Courses at a University Center. Magazine of Entrepreneurship and Management of Micro and Small Enterprises V.4, Nº3, p.95-107, Sep / Dez. 2019. Article received on 12/11/2019. Last version received on 11/21/2019. Approved on 12/18/2019.

It is visible, despite this solidified panorama, that the concepts and understandings regarding Industry 4.0 are still very diffuse, bringing difficulties in understanding and limitations with academic discussions. Popkova, Ragulina and Bogoviz (2018) reinforce that the difficulty in finding a central axis of discussion for this new technological and industrial wave, can be matched by the accelerated development of technologies and automation, generating a diffusion of knowledge and rationalities among those involved .

Given this perspective, this article aims to show the importance of interdisciplinarity by analyzing the diffusion or understanding of Industry 4.0, which according to Umbelino and Zabini (2014, p. 4), "interdisciplinarity implies a way of producing knowledge which implies an exchange of theories and methodologies, thus producing new concepts, thus seeking to meet the multiple nature of phenomenological complexities ". With this, the research provided the use of concept maps and diffuse concept analysis on this theme, as well as on the general overview of technology and current industrial changes.

2. Industrial Phases and the Transition 4.0

The Industries have been going through changes in the last centuries, every major change is called a Revolution, with that, according to Revista Logística (2015, p. 1), "to understand the current stage of Industry 4.0, it is worth remembering a little of the Revolutions previous ", which is explained through Table 1:

Industrial Revolution	Period	Characteristics
First 1.0	XIX century	Mechanical strength; steam engine and great growth in production and transportation capacities.
Monday 2.0	Early 1900s	Mass production; automobile sector and multiply productive capacities.
Third 3.0	Early 1960s	Automation; design to manufacture and digital revolution.
Wednesday 4.0	currently	Intelligent factory, real-time interaction with demand and flexibility.

Source: Adapted from Revista Logística (2015).

Table 1 - Phases of the Industrial Revolution

The Fourth Industrial Revolution is a term used as an alternative to the term “advanced manufacturing”. This Manufacture, according to the National Confederation of Industry (2016, p. 2),

> Advanced manufacturing involves the integration of physical and digital technologies, the integration of the development stages, from production engineering and production chain to the final use of the product and the services linked to it, the autonomous operation of networks. It represents much more than the automation of the industrial process. It is, for example, the integration of machines and systems with each other (including between different factories in the same supply chain). It is the digital connection of the machine to the product.

Digital technology is the essential factor for Industry 4.0, mainly through sensors on machines to increase production, reducing production bottlenecks, consequently having greater flexibility in the company, thus increasing its consumer market.

One of the biggest positive impacts for the company is the fact of being able to monitor the whole process, reducing costs, reducing problems already in the prototypes, even before the final product, thereby obtaining high quality products, managing to create new models, having a faster return of innovations (CONFEDERAÇÃO NACIONAL DE INDÚSTRIA, 2016).

According to Collabo (2018, p. 6), “the entire factory will be connected, from production to the logistics system and the marketing and sales departments. Machines will talk to machines and parts, tools and humans. All of this through cyber-physical systems ”, which are systems that send information from one device to another.

With this, it will no longer be essential to make a schedule, the control and production planning will happen in real time, before what a human did, programming a machine, will no longer be necessary, as it will know when to decrease or increase production through artificial intelligence.

With all this revolution going on, two elements are gaining more and more strength in the industries. First, cloud computing, which is done in real time, being able to view data availability, through a device connected to the web; Second, Big Data, which manages to collect the largest amount of information, thus, seeing what is useful for the process, for example, processing customer consumption data to use in the next purchase of the own (COLLABO, 2018).

Thus began Industry 4.0, a scenario of innovation and competitiveness, demonstrating the need for severe changes in the company's production method and culture, especially where there is no preparation for such a transformation.

2.1 Industry 4.0 in Brazil

In Brazil, the Industry 4.0 concept is very recent, so the country has a long way to get to Industry 4.0, because according to Sebrae (2016), “the national industry is still largely in the transition from what would be Industry 2.0, characterized by the use of assembly lines and electrical energy, for Industry 3.0, which applies automation through electronics, robotics and programming ”.

To reach the Fourth Industrial Revolution and get closer to Germany in robotic density, Brazil would need to install around 165 thousand robots, this would take more than 100 years, because, currently, the country installs 1.5 thousand robots per year (SEBRAE, 2016).

There is a great challenge for the economy of industries, since Brazil occupies 69th place in the Global Innovation Index, this index assesses issues such as productivity growth, education, high technology products, performance from other countries, research, among others (INSEAD; WIPO, 2017).

Brazil has been shaken by trying to achieve these technological transformations since 2016, where companies started looking for solutions to enter this new market of communication and production processes. To help in this technological race, according to Maciel (2017) "the National Bank for Economic and Social Development (BNDES) estimates a movement of US $ 132 billion in the Brazilian economy through Internet of Things initiatives until 2025".

In addition to the industries reaching a level that falls under the Fourth Industrial Revolution, it is necessary to obtain trained professionals to carry out these technological automation processes, which is not easily found in Brazil and which has become a drama for national universities, as it demands training employees who do not work only in their area of expertise, but who propose integrated solutions with other areas of knowledge, developing logical thinking, with a broad vision together with humanistic skills and competences (CARMONA, 2017).

Thus, for Brazilian Industry 4.0 to be able to generate future job opportunities, each one needs to do its part, the government, with strategic ideas, entrepreneurs thinking about the future and academic institutions, training great professionals (SEBRAE, 2016).

Thus, in order to achieve the transition to the Fourth Industrial Revolution, you have to think big, not wait for the future, as the market demands that you improve this professional evolution.

3. Employment rates in the 4.0 era

With major market and company changes, increasing productivity, raw material, energy, economy and other inputs, the evolutionary process of industry 4.0 has advanced rapidly in all these aspects (MARTIN, 2017).

Therefore, the job market will receive several new professions, which should appear and materialize in the market in about 5 to 10 years.

The survey shows that the professions will emerge from the middle to the upper level and should gain more prominence in the areas of automotive, food, machinery and tools, oil and gas, chemical and petrochemical, communication and information technologies, textiles and clothing and civil construction . These are the spaces that are most likely to undergo transformations in their processes and rely on the domain of digital technologies to dispute their relationships in the near future (Senai, 2018).

According to Senai (2018) "the forecast is that 30 new occupations will appear in eight areas", as shown in Table 2:

Automotive	**Information and Communication Technologies**
• Hybrid vehicle mechanic • Telemetry specialist mechanic • Programmer for electronic control units • Vehicle computer technician	• IoT (Internet of Things) Analyst • Security and digital defense analyst • Cybersecurity engineer • Software engineer • Big data specialist
Food and drinks	**Machines and tools**
• Specialist in food packaging applications • Specialist in ICT applications for food traceability • Food printing technician	• High Speed Machine operator • CAD/CAM/CAE/CAI tool programmer • Designer for 3D technologies • Automation maintenance technician
Construction	**Petrochemical Chemistry**
• Construction site logistics manager • Building automation systems installer • Building automation systems integrator • Dry construction technician • Building automation technician	• Chemical analysis technician with expertise in automated instrument analysis • Specialist technician in recycling polymeric products • Specialist technician in the development of polymeric products
Textiles and Clothing	**Oil and Gas**
• Advanced fabric designer	• Specialist in seismology and well geophysics

• Engineer in textile fibers	• Specialist in drilling techniques
• Fashion product design technician	• Specialist for advanced oil recovery

Source: Adapted from Senai (2018).

Table 2 - Forecast of 30 new professions resulting from process 4.0

In addition to these new professions, other professionals will need to adapt to this new industry context, because the processes are controlled by artificial intelligence, they need a different method of work, even causing the exclusion of professionals who perform repetitive and manual effort tasks, but expanding on the other hand for employees to understand and work with the variety of technology required by this smart factory.

4. Concept maps: delimitation and content ordering

Concept maps are a basic structure, made in graphics that help to organize ideas, information, and as the name says, its concepts. According to Ormenese and Costa (2014, p. 3), "the construction of conceptual maps allows new and old concepts to interact, in addition to systematizing the meanings in a manner consistent with the texts to be worked on, consequently improving their interpretation". The concept map model can be seen in Figure 1:

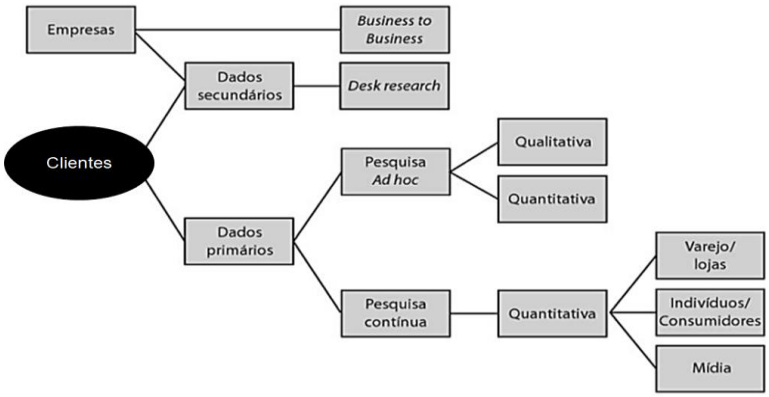

Figure 1 - Example of Basic Concept Map

The methods of collecting information for the construction of these maps can be divided into three forms.

The first method begins by asking the interviewee about their main sources of knowledge in the organization, among people and documents, and it is advisable for a better construction of the map to continue with the approach until everyone in the organization has been interviewed. The second method is to ask employees, individually, what knowledge they have and where they get to do their job. Each response generated by employees is analyzed and embedded in the organization's map. A third method includes the interactive assessment of the competencies of

each employee by himself and his supervisor, enabling the participation of the entire work team (ANDRADE; SANTIAGO, 2001).

Following the concepts of Andrade and Santiago (2001), it is also possible to create other completely new methods or making adaptations to the known ones, regardless of which one is chosen, it is important to choose the one that best suits the research objective, taking into account relation available resources and availability of the company.

5. Methodology

The present research used qualitative and bibliographic analysis, which according to Gil (2008), the bibliographic research is made by scientific articles and books, being developed from what has already been written, to give a greater focus on subject, based on the bibliographic review. Also according to Gil (2002, p. 134), "in qualitative research, the initial set of categories in general is re-examined and modified successively, with a view to obtaining more comprehensive and meaningful ideals".

As for the objectives, the research is presented in exploratory, case study and descriptive research. Exploratory research enables a more comprehensive link to a technological transformation, making it more understandable and providing the development of new concepts. This approach to the theme presents a qualitative form, making it possible to identify opinions and facts exposed by measuring their results more clearly (GERHARDT; SILVEIRA, 2009).

The case study has as objective, detailed and broad knowledge, being an exhaustive and very deep study. Exploratory research aims to collect data from a specific population (GIL, 2008).

For the survey, professionals from nine areas were interviewed, with only six able to answer about the concept of Industry 4.0. This reflects a lack of knowledge or diffusion of the concept, enabling new practices of discussion or learning in an interdisciplinary way.

This research was carried out inside the Centro Universitário Campo Real, located in the city of Guarapuava, in the interior of Paraná. This locus of research was chosen due to the expansion of academic possibilities 18 years ago, enabling interdisciplinarity and unification of discussions between courses in different areas. For the collection of testimonies, therefore, the research opted for the variety of academic backgrounds, in order to represent the mental maps distancing or intersecting between the interviewees' rationalities. These statements are highlighted in Table 3 below:

Occupation area	Testimonial
Economist	It covers all the concepts of current technologies and sustainability, making room for robotization, automation and rational use of labor.
Civil engineer	It is the path to Industrial change, even the issue of the courses themselves, the vision within the institutions is already different, because of technology, until recently civil construction was all manual, today it is already replaced by machines in cases of laying bricks, plastering walls, with this the market will undergo major changes, because we do not know how the professions and courses will be for the next generations, an example that may exist, a drone that measures the entire terrain, something else with this technology is to reduce the titles of CREA, which today are more than 3000, and want to decrease to 50 more comprehensive titles with some skills.
Electric engineer	Industry 4.0 is the use of data obtained through automation to generate information and from that point on to see what can be improved in the process, example of Big Data, where you have several process data and through this intelligence you have the purpose of doing fit in needy areas.
Production Engineer	Knowledge industry, automation, artificial intelligence, high problem solving, the machines themselves will program themselves and have their own diagnosis, a situation that the Agrarian Cooperative started two years ago, a pilot project on a single machine, if it happened some problem she would correct herself. The objective of industry 4.0 is to replace human capital in some functions, cease to exist some professions and appear new professions, there will be a productivity gain that will impact the worker with the loss of manpower at work, but the most adapted will be able to deal with it.
Mechanical Engineer	Indústria 4.0 is the 4th Industrial Revolution, implantation of artificial intelligence where it has the management and control part working with neural networks, big data, before having only data from sensors to control you can now make analyzes of these data transforming into information to identify failures before they happen, managing to manage and control the entire process.
Historian	Industry 4.0 is something that is changing, a factor of something that is in the present is analyzed, being of short duration.

Source: Research data (2018).

Table 3 - Testimonials from professionals regarding Industry 4.0

Thus, to assemble the knowledge map, we used the Cmap Tools® software for cognitive transcription, version 5.05.01, making it possible to identify the perception of Industry 4.0 in different areas.

6. Results and Discussions

Starting from the methodological outline, the research enabled the graphic illustration of the concepts, in a transcriptive way. The transcription of concepts, according to Gil (2008) favors qualitative research, generating categories or axes that make it possible to analyze and justify the theme being evaluated.

Figure 2, below, reflects this transcript, in order to synthesize the statements collected graphically.

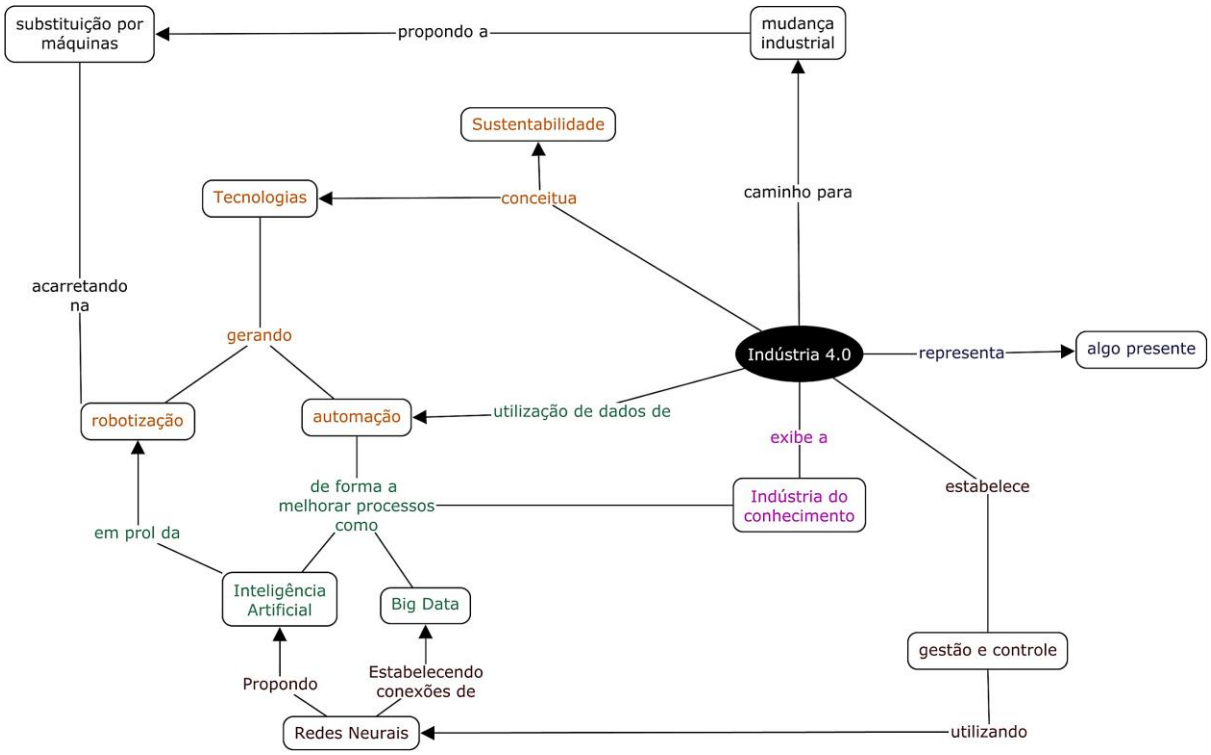

Figure 2 - Search result: conceptual map on the theme Industry 4.0

The making of the concept map, or mind map, was presented to the professionals, being carried out individually and following the order established by Table 3, listing the testimonies previously.

It is possible to verify that engineering, in general, is more connected to the subject of Industry 4.0, because, according to Vedovato (2017), “we can see that engineering has always stimulated revolutions. The need to carry out activities differently and better has always been the starting point for changes ”. This Revolution will demand more from each area of engineering, and it is mandatory to know more and more its basic concepts in order to remain the essence of development.

The economist was the only one who mentioned the sustainable aspect, which, according to Mazarim (2010),"When it comes to long-term investments, [...] companies that exchange technologies that degrade nature for more sustainable ones generally realize a good profit." Industries generate everything we need or want, thus being largely responsible for economic development, which, being worked in a sustainable way, ends up being beneficial for the whole society.

The historian remembered to highlight the history of the present time, because this field of historical studies is remembered by Dosse (2012, p.13) as “led to explain where he speaks from, to make his craft, his tools, his scaffolding more transparent, or all the mediations that allow him to build his plot. The historiographical deviation is, under these conditions, indispensable ”. Therefore, this Revolution is taking place at the present time and should be studied over the years.

The mind map was separated by colors to differentiate the areas, where the colors orange, black, green, pink, brown and blue, represent the economist, civil, electrical, production, mechanical and historian engineers, respectively.

It is observed that the map had 3 basic outputs (outliers): "something present", mentioned by the historian, "sustainability", linked to the economist and "technology" with emphasis on engineering and economist. These outliers are indicated by the non-continuity of the map, being necessary to finalize the thought or analysis of the term and resume with new ideas.

When questioning the professionals interviewed about Industry 4.0, it was visible that those who are in an area with greater technological transformation, were able to respond promptly to the proposed subject.

7. Final Considerations

Industry 4.0 in recent years, has been gaining strength in some large companies, an example is the multinational beverage company, which according to Estúdio Abc (2017), "Adopted an

automation system to improve control of the beer cooling process and reduce temperature variations, thus avoiding energy waste".

In view of this growth over the years, the Working Group on Industry 4.0 (GTI) was created with the objective of elaborating various contributions and debates on different perspectives and actions for Industry 4.0, where themes of competitiveness, structural changes, factories were selected. future and massification of technology, in order to strengthen companies for this revolution.

According Umbelino and Zabini (2014, p. 3),"Interdisciplinarity then arises from the need for an answer to the fragmentation of disciplines, it is a dialogue between different areas of knowledge, a way of working with knowledge". Thus, it aims to encompass as many disciplines as possible, with this, it obtained a greater interaction between engineering, as they are areas in which they have similar knowledge, as shown in the conceptual map, managing to interconnect several concepts between them.

The main difficulties encountered at work were the availability of interviewees' hours. Another limitation can be verified, that some were unable to answer the question, due to lack of knowledge of the topic, as shown in the conceptual map with the 3 basic outlets (outliers).

In addition, for future possibilities, it is expected that further studies will be carried out on Industry 4.0, as it is a subject that will be discussed for some years to come, with great importance for new workers and especially for companies in general.

References

ANDRADE, EP; SANTIAGO, AC**Knowledge Mapping**: Locating an organization's sources of wealth. 2001. Available at: <http://www.abepro.org.br/biblioteca/ENEGEP2001_TR82_0493.pdf>. Accessed on: Oct 09 2018.

CARMONA, RA A **Industry 4.0 coming to "shake the world".**2017. Available at: <http://engenhariae.com.br/editorial/colunas/industria-4-0-chegando-para-sacudir-o-mundo/>. Accessed on: 05 out. 2018.

COLLABO. **Industry 4.0 and the digital revolution**: Understand what is to come and what will be the impacts for companies and professionals. 2018. Available at: <https://alvarovelho.net/attachments/article/114/ebook-a-industria-4.0-ea-revolucao-digital.pdf>. Accessed on: 05 out. 2018.

NATIONAL CONFEDERATION OF INDUSTRY. SPECIAL SURVEY:**Industry 4.0**. São Paulo: National Confederation of Industry, v. 2, 17. Available at: <http://www.portaldaindustria.com.br/relacoesdotrabalho/media/publicacao/chamadas/SondEspecial_Industria4.0_Abril2016.pdf>. Accessed on: 04 out. 2018.

DOSSE, F. **History of the present time and historiography**. 2012. Available at: <http://www.redalyc.org/html/3381/338130378002/>. Accessed on: Oct 09 2018.

ABC STUDIO. **Is Brazil ready for industry 4.0?**2017. Available at: <https://exame.abril.com.br/tecnologia/o-brasil-esta-pronto-para-a-industria-4-0/>. Accessed on: Oct 09 2018.

GERHARDT, TE; SILVEIRA, DT**Research methods.** Porto Alegre: UFRGS Publisher, 2009.

GIL, AC **How to develop research projects / Antônio Carlos Gil.**4. ed. - São Paulo: Atlas, 2002.

GIL, AC **Methods and techniques of social research**. São Paulo: Atlas, 2008.

INSEAD; WIPO.**2017 Global Innovation Index**: Innovation Nourishing the World. 2017. Available at: <https://www.globalinnovationindex.org/userfiles/file/reportpdf/GII%202017%20Portuguese%20translation_WEB.pdf>. Accessed on: 05 out. 2018.

MACIEL, C. **Internet of Things should generate US $ 132 billion in Brazil by 2025**. 2017. Available at: <http://engenhariae.com.br/tecnologia/internet-das-coisas-deve-movimentar-us-132-bi-no-brasil-ate-2025/>. Accessed on: 05 out. 2018.

MARTIN, C. **Industry 4.0 points out ways to reach the factory of the future**: Intelligent machines and communication between processes will be a new standard for pulp and paper plants. O Papel, São Paulo, p.54-62, 2017. Monthly. Available at: <http://www.revistaopapel.org.br/noticia-anexos/1493172703_1848a7a04c4c05f94d4a08ec1b79f410_1124911907.pdf>. Accessed on: 04 out. 18.

MAZARIM, R. M**. Sustainable economy**. 2010. Available at: <https://cepein.femanet.com.br/BDigital/arqTccs/0711260084.pdf>. Accessed on: Oct 09 2018.

ORMENESE, L. A; COSTA, CL**Construction of concept maps as a teaching tool in the discipline of chemistry**. 2014. Available at: <http://www.diaadiaeducacao.pr.gov.br/portals/cadernospde/pdebusca/producoes_pde/2014/2014_uenp_qui_artigo_luis_augusto_ormenese.pdf>. Accessed on: 05 out. 2018.

POPKOVA, EG; RAGULINA, YV; BOGOVIZ, AV**Industry 4.0**: Industrial Revolution of the 21st Century. Studies in Systems, Decision and Control, v. 169. Springer, 2018.

LOGISTICS MAGAZINE**. Industry 4.0**. 2015. Available at: <https://www.imam.com.br/consultoria/artigo/pdf/industria-4.0.pdf>. Accessed on: 04 out. 2018.

SEBRAE. **Know what Industry 4.0 is and discover the opportunities it generates**. 2016. Available at: <http://www.sebrae.com.br/sites/PortalSebrae/artigos/saiba-o-que-ea-industria-40-e-descubra-as-oportunidades-que-ela-gera, 11e01bc9c86f8510VgnVCM1000004c00210aRCRD>. Accessed on: 04 out. 2018.

SENAI. **SENAI points out 30 new professions that will emerge with Industry 4.0**. 2018. Available at: <https://www.rn.senai.br/conheca-30-novas-profissoes-que-vao-surgir-com-industria-4-0/>. Accessed on: 04 out. 2018.

UMBELINO, M; ZABINI, FO**The importance of interdisciplinarity in teacher training**. 2014. Available at: <https://www.uniso.br/publicacoes/anais_eletronicos/2014/1_es_formacao_de_professores/44.pdf>. Accessed on: Oct 09 2018.

VEDOVATO, L. **The engineering of Industry 4.0**. 2017. Available at: <http://www.semesp.org.br/noticias/engenharia-da-industria-4-0/>. Accessed on: Oct 09 2018.