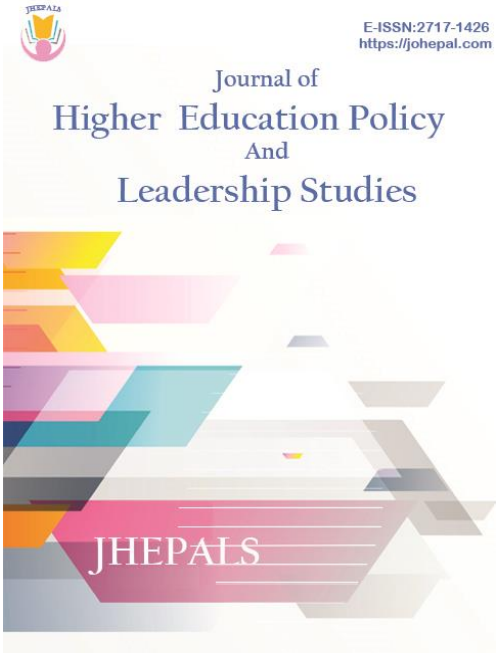
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# The Production of Knowledge During the 4th Industrial Revolution: A Mexican Case Study

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# The Production of Knowledge During the 4th Industrial Revolution: A Mexican Case Study

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**Elida Sánchez-Cruz** *

## Abstract

Higher education institutions play a critical role in research, innovation, and the production of knowledge, all of which are hallmarks of the 4th Industrial Revolution (4IR). To avoid continuing at a disadvantage, countries utilize policies that facilitate the generation of knowledge and, as a result, have an impact on the country's development. In this context, we look for understanding how the production of knowledge policies are implemented in a public Mexican university in the period from 2018 to 2021. For this study, a case study and documentary research were used. The results indicate that there is a policy framework that promotes research, innovation and teaching according to the 4IR; however, a closer look at the persons in charge of the production reveals that some researchers produce recognized knowledge while others, with the lower academic training, lack any production.

**Keywords:** Higher Education; 4th Industrial Revolution; Production of Knowledge; Mexico; Professors

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## Introduction

The current context necessitates more flexibly organized research systems and approaches which promote the production of knowledge; in order to nurture science that serves society in the widest sense. Partnerships amongst universities and investment in research are growing exponentially in many countries, so that new knowledge becomes linked to development goals worldwide. However, there are concerns about whether developing countries, such as Mexico, are prepared for the challenges rapidly brought by the 4IR.

In this century, it is crucial to recognize the fluidity with which the world is run. The static, rote, fixed and immovable knowledge that was lived for centuries remained in the past because it lacks adaptability to face new challenges. Today, it is necessary to train generations capable of adjusting to the changes and challenges that arise every day. To this end, higher education institutions play a key role in participating in the production of knowledge and training qualified labor force. But there are growing concerns about whether Mexico is prepared for the global needs considering the connection between higher education and the current context. If Mexico's public higher education system is to keep up with the 4IR and develop the human capital that will be necessary in the future years, it must take massive measures.

The main objective of this study is to know how research policies were implemented in a public university in the 2018-2021 period and as a subsequent objective to describe the training of researchers in a higher education institution, the type of production of knowledge people develop at an institution and finally, to identify and describe trends and variation. The results of the study can help leaders, policy-makers and researchers to recognize areas for improvement and development. The article is distributed in 4th Industrial Revolution (4IR), International Rankings and knowledge production, Higher education and the 4IR, Mexico and research, methodology, discussions and results, and the conclusion at the end.

### 4th Industrial Revolution (IR)

During the 21st century, thanks to the production of knowledge, there have been a series of stratospheric changes that make human life easier and allow an inexorable advance of the knowledge society. For example, today's communication allows interaction with thousands of people via social networks, having access to information from the other side of the world is possible within seconds, transportation allows the movement from one continent to another in a couple of hours, even trips to space are made without causing any surprises. In addition, great changes have been developed in the virtual environment such as the Big Data, smart cities, the Internet of Things and Artificial Intelligence, which are essential tools for managing the new era, known as the 4IR (Kayembe & Nel, 2019).

The 4IR establishes a context in which new ideas, possibilities, creations and innovations are part of everyday life; and the main rule is about breaking limits (Kayembe & Nel, 2019) in exchange of comfort for the human life. The 4IR has an impact not only on technology, but also on the way we live, work and interact. Technology serves as a tool to give the greatest number of people the ability to positively impact their communities (World Economic Forum, 2022). However, at the same time, new unknown problems arise, which according to Jung (2020), should be handled with the support of the same technological advances and social networks.

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An example of an unprecedented situation was COVID-19. Researchers from all over the world took on the task of finding a solution to the situation that afflicted the entire world, as a consequence, the race in the production of knowledge intensified even more in the last three years. The areas of greatest influx were mainly health, economics and human development worldwide (UNESCO, 2021). As far as health is concerned, the United States mobilized in the bioscience industry and it is estimated that they established more than 400 research programs aimed at eradicating the problem (Unesco, 2021).

With the 4IR, countries are immersed in a context that benefits the development of high-level knowledge, regardless of their economic level. It is through research and the use of technology that a phenomenon of constant production capable of creating innovation exists; however, these developments are not often limited to improving those whose usefulness may be obsolete (Ruiz Buenrostro et al., 2021). The difference between countries is that advanced countries constantly make technological changes, while countries with emerging economies must pay for the cost of intellectual property that other countries invent. For this reason, it is necessary that developing countries, as Mexico, implement research policies in favor of development, higher education and innovation. Ignoring the context and the needs of the 4IR brings with it the possibility of being isolated and without the possibility of economic success.

Knowledge production is considered to be a better driver of economic growth, with an even more relevance than natural resources (Jung, 2020). The advances made in the 4IR serve as tools that contribute to the rapid growth of the government sector, society, and the private sector by facilitating, for example, communication. The use of technology such as mobile devices and computers has increased dramatically in the last couple of years and its advance has had a great impact on the health sector. For example, Rwanda and Ghana have taken advantage of the technology by using drones to collect and transport blood samples from remote clinics to health clinics (Unesco, 2021). Consequently, the knowledge production, scientific and technological advances of the 4IR facilitated the well-being of communities located in marginalized areas.

## International Rankings and the Production of Knowledge

In the context of the 4IR, the production of knowledge and economic investment in the institutions that create it, are both critical in many modern countries (Jung, 2020). Such is the importance of knowledge production in the current context that the United Nations Development Program (UNDP) and the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) established the Global Knowledge Index (GKI) with measurement and evaluation parameters among countries (UNDP, 2021).

In this ranking, the countries with the best scores in the production of knowledge were Switzerland with a score of 71.5 in first place, Sweden with 70 points in second place, and the United States with 70 points in third place. The average among the ranked countries corresponds to 48.4 points. The Latin American countries with the highest scores were Chile in 47th place with 54.5 points, Uruguay in 56th place with 51.7 points, Costa Rica in 58th place with 51.4 points, Colombia in 67th place with 49.5, Panama in 72 with 48.9, Peru in 73 with 48.8 and Mexico in 74th place with 48.7 points; that is, slightly above the average

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among the ranked countries. Regarding innovation, Mexico falls to 104th place with 25.9 points (UNDP, 2021).

Research and development policies are reflected in countries such as the United States of America and China, by increasing their investment in research and development as a share of GDP from 2014 to 2018 (UNESCO, 2021, p. 6). However, in the same report (UNESCO, 2021), it is indicated that eight out of ten countries continue to dedicate less than 1% of GDP to research; therefore, their production of knowledge and development is limited. Mexico was one of the countries that decreased Investment in research and development as a share of GDP from 0.44% in 2014 to 0.31% in 2018, instead of increasing its investment like the developed countries did (UNESCO, 2021, p. 6); thus, Mexico is at a disadvantage in the context of the 4IR.

The investment of resources in Research and Development as a share of GDP is also reflected in the number of researchers per million inhabitants. According to figures from the World Development Indicators: Science and technology (The World Bank, 2020) suggests that China had 1,307 researchers for every million of inhabitants [with a population of 1,427.65 million (Unesco 2021, p. 52)]; while the United States had 4, 412 researchers for every million people [with a population of 327.10 million (Unesco, 2021, p.52)]; finally, Mexico had 315 researchers for every million people [121.86 million (Unesco, 2021)]. Mexico is really behind in terms of the number of researchers; thus it reduces its possibilities of producing knowledge. For Gaona Rivera et al. (2017), the only way for Mexico to join the scientific community is by doubling the scientific population to promote science and technology.

The Global Innovation Index (WIPO, 2021), for its part, measures innovation and science through indicators such as scientific publications, research and development expenses, filing of international patents and venture capital agreements. The 2021 results show that only a few economies have remained in the top places for the last three years: Switzerland, Sweden, the United States and England; while the 25 countries with the largest contributions are mainly from Europe and Asia. In this ranking, the Latin American countries with the best scores are Chile in 53rd place, Mexico in 55th place and Costa Rica in 56th place. Thus, Latin American countries reflect a limited economic investment in terms of knowledge production which limits its scientific and technological contribution to the 4IR.

## Higher Education and the 4IR

Higher education is an institution in constant transformation with objectives, educational content and teaching methods that should be in accordance with the needs of the 2022 (Dung & Hang, 2019). It is also a key institution with among its responsibilities the training of new generations in a changing and uncertain labor market, as well as the production of new knowledge in response to current requirements. In other words, higher education institutions have a wide and varied task that must be adjusted to the context of the 4IR.

For some researchers (Matthews et al., 2021; Aoun, 2017), it is clear that higher education institutions have a role in the production of knowledge by training new generations to tackle the future unknown challenges. New students and professors, in the context of the 4IR, must be sensitive to the factors that drive the success of the same revolution (Butler-Adam, 2018) with diverse knowledge, ready to learn and adjust to the everyday changes. For example, those students in applied sciences must have political and

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humanistic foundations; while those students in the areas of humanities need to correctly handle the digital tools with which the world and communication are managed and operated. That is to say, there is no longer static knowledge directed in one direction, but cross-cutting, complex and continuous learning that facilitate the production of knowledge.

Higher education institutions, being strongly linked to research, development and teaching activities, can produce knowledge that contributes to national and global advancement (Xing & Marwala, 2017); therefore, policies and actions are expected to fulfill these activities. The only way in which these educational institutions can survive in the 4IR context is through an improvement in their educational system and include proposals for innovation and knowledge production. Xing & Marwala (2017) relate tertiary education with teaching, research and service with a view to the progress of the 4IR; that is, teaching and research go hand in hand for a better training of the new generations. According to Miranda et al. (2021), changes in education are related to the combination of technological advances, heutagogy, paresagogy and cybergogy in order to compete and survive in the international arena of the 4IR; this is, it is not only about teaching, but who we teach, what tools are used in the process, and what we teach.

Academics, in addition to instructing new generations and providing research capacity (Tight, 2016), become significant stakeholders in their country's innovation and knowledge. Kreiling and Paunov (2021) argue that universities and research centers have a primary role in the transfer and production of knowledge, because they transform scientific knowledge into new products and services to solve new social challenges. The production of knowledge goes beyond publishing articles, but instead seeks knowledge that has an impact on society and the country.

The 4IR presents a number of ideas for instructions and higher education improvement, as for example: rehashing instruction frameworks and approaches to extend creativity and development. Instruction within the 4IR is a complex, argumentative, and energizing opportunity to change society and better the life of human beings. The role of Higher education is to graduate new generation of competitive professionals able to provide innovative solutions to current and future challenges.

Considering the terrible global economic recession, which has exacerbated the unemployment problem, higher education institutions are expected to encourage a more flexible and imaginative approach to preparing new generations for uncertain futures (Mok et al., 2021). Given this context, advanced countries are characterized by promoting policies that facilitate the production of knowledge and, at the same time, are interested in improving higher education systems and research centers (Jung, 2020). For their part, higher education institutions and, mainly, research centers in developing countries are expected to focus on research and development, in this way, they could compete with international technological advances and stop buying foreign technology.

Escalante Ferrer (2021) suggests that the effectiveness of Higher Education should be questioned in terms of the needs of future professionals, the production of knowledge and innovation in the training of new generations, mainly in developing countries. For Xing and Marwala (2017), higher education institutions in developing countries, as is the case in Mexico, are rarely involved in promoting innovative talent, which is characterized by interdisciplinary training that encompasses technology, the humanities and the social sciences. Thus, it is necessary to implement policies that promote adaptable programs,

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improve educational experiences and the attitude of lifelong learning, especially in developing countries.

The production of knowledge, without a doubt, is a trend in higher education, but according to Escalante Ferrer (2021), research and the production of knowledge have been perverted due to the evaluation systems that exist in some higher education institutions; in which the quantity is measured more than the quality of the production. Thus, there is an overproduction of academic(?) documents with a doubtful contribution to research; but that meet the needs for researchers to be promoted or keep their jobs. Thus, in terms of scientific publications between 2015 and 2019, the volume of publications increased from 18, 321 to 23, 508; while countries such as Germany reported a 144, 201 and 152, 348 in the same period (UNESCO, 2021). Countries in Latin America, such as Brazil, also reported a total of 61, 006 and 74, 270 respectively.

Mexican researchers are recognized for their efforts to advance knowledge and technology through the National Research System (NRS), which conducts evaluations every three years. Researchers must hold a PhD and make excellent, prestigious scientific contributions in order to be acknowledged by the NRS (Conacyt, 2022). The NRS assigns grades to researchers depending on their scholarly output, with level 3 representing the highest caliber of knowledge production and level C the lowest. Through evaluation, the NRS aims to advance and raise the caliber of innovation and scientific and technological research in the nation.

The NRS is given out through a peer evaluation procedure, and recipients are assigned to one of the production levels (C, 1, 2, or 3) (Conacyt, 2022). The use of this term indicates the high caliber and regard in which scientific contributions are held. As long as these institutions have researchers who supply cutting-edge information and high-quality knowledge, this group, which covers the great majority of Mexico's higher education institutions, research institutes, and centers, represents all of the country's scientific fields. In this method, the system promotes the formation of elite research groups and the widest possible dissemination of scientific activity throughout the region.

To be designated with one of the levels of production (C, 1, 2, or 3), the NRS is given through a peer evaluation procedure (Conacyt, 2022). This moniker indicates the superiority and respect with which scientific contributions are held. As long as these institutions include researchers that supply cutting-edge information and high-quality knowledge, it is a group that represents all of the nation's scientific fields and includes the great majority of higher education institutions, research institutes, and centers. In this method, the system promotes the formation of top-tier research groups and the maximum feasible regional distribution of scientific activity.

The Global Innovation Index' (2021) mission is to provide analytical information on innovation in order to help policymakers assess their innovation performance and make defensible decisions about innovation policy and research; however, their conclusions indicate that the pace of change in the world of innovation is too slow. Since high-income economies, particularly those in Northern America and Europe, continue to top the Global Innovation Index rankings and have the best and most balanced innovation systems. Thus, despite the evaluation Mexican research system, the results are limited since 2019 to 2021 (Table 1). According to the Global Innovation Index the only economies in the Latin American region to make the top 60 are Chile (53rd), Mexico (55th), Costa Rica (56th), and Brazil (57th)

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(WIPO, 2021). With the exception of Mexico, none of these Latin American innovation hotspots have continuously risen in the rankings over the previous ten years. Brazil, however, makes a significant improvement this year, moving up five ranks and attaining its highest ranking since 2012.

Table 1
Mexico in terms of innovation (2019-2021)

| YEAR | Global innovation Index | Innovation inputs | Innovation outputs |
|---|---|---|---|
| 2021 | 55 | 62 | 51 |
| 2020 | 55 | 61 | 57 |
| 2019 | 56 | 59 | 55 |

Source: Global Innovation Index (2021)

## Research Methodology

In the context of the 4IR, the role played by higher education institutions in issues such as innovation, the training of new generations and research is paramount. For this project, we focus on the field of research within higher education institutions to learn: How were research policies implemented in a public university from 2018-2021? When analyzing policy documents, researchers should consider the explicit aims of the policy and the outcomes that will be targeted and measured as a result of it (Cheung et al. 2010); so the subsequent questions are

- What is the training of researchers in a higher education institution?
- What type of knowledge production do they carry out?
- Identify and describe trends and variation.

The study is descriptive since it focuses on making meticulous and extensive observations of an interesting phenomenon (Bhattacherjee, 2012), in this case how research policies are implemented in the chosen institution in the context of the 4IR. Descriptive research is appropriate when attempting to identify precise characteristics such as researcher training, categories such as scientific production, and trends in their knowledge production; in other words, it aims to identify specific characteristics, problems, or areas for improvement that policymakers and researchers can use.

As a method, a case study was used that according to Yin (2009, p. 18) "A case study is an empirical inquiry that "Investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". For the case study, the Universidad Veracruzana (UV) was chosen, which is a higher education institution founded in 1944. According to its data, in 2021 it registered an enrollment of 79,617 students distributed in 77 faculties, 26 institutes of research and 17 research centers. (Universidad Veracruzana, 2021). Due to the above, it is an institution that is in the context of the 4IR and is dedicated to the training of new generations.

Considering that the UV community is wide and diverse, the case study was limited (Yin, 2009) to the research area; that is, the 26 institutes and the 17 research centers during the 2018-2021 period. IGI Global (2022) suggests that educational policies are a set of guidelines or rules that look for enhancing the quality of education and the institution's

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community. Yin (2009, p. 13) also suggests that different methods can be used in a study, in this case Documentary research was used. Documentary research goes beyond the record of facts, because it involves a process of reflection. “Documents do not stand alone” (Atkinson & Coffey 1997, p. 55), but are located in a theoretical and referential framework that explains their content. In this case, the documentary research is framed in the context of the 4IR.

The papers examined were the UV's public pages (https://www.uv.mx/) in order to determine policies connected to research and its researchers; if the information was not available, it was obtained through the National Transparency Portal (PNT). The PNT is a platform that allows users to access information that isn't always available on web pages. Anyone can request information from government agencies, and the agencies respond with official and trustworthy information using the same website. The material requested was a description of the research staff's academic training and scientific output from 2018 to 2021.

From the standpoint of academics and policymakers, the research is descriptive, therefore a thorough knowledge is not required (Loeb et al., 2017). The overall goal of the project was to determine how research policies are implemented at the institution and, as a result, to describe trends and variances in knowledge output. Descriptive analysis is used to diagnose problems, opportunities, or difficulties that practitioners, researchers, and policymakers should pay attention to (Loeb et al., 2017). The focus of this study was on the development of knowledge inside the Universidad Veracruzana's research field. No funding or conflict of interest is declared for this research study. In terms of ethical considerations, the information was available online; thus, it was public, and no permission was necessary. In addition, no names or personal information was used to avoid identification.

## Discussion and Results

In regard to the 4IR, the UV has policies relating to knowledge production, which are manifested through research institutions and centers. The institutes and research centers have the following mission and vision, according to the UV (Universidad Veracruzana, 2022):

Mission (Universidad Veracruzana, 2022):

> Promote and consolidate the generation of knowledge, technological development, innovation and creation, as well as its articulation with teaching, with a sense of academic relevance, social responsibility and national and international projection, contributing to the training of human resources sensitive to challenges and opportunities of their social environment and that contribute to improving the quality of life of society.

And as part of its vision (Universidad Veracruzana, 2022):

> The generation and application of knowledge at the Universidad Veracruzana will be recognized nationally and internationally for its high quality, innovation and relevance. In addition, it will be a fundamental element in educational programs, training human resources with a global vision, who generate and apply knowledge and contribute to the development and quality of life of society.

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Due to the above, it can be said that the research centers and institutes establish policies that promote references in accordance with the context of the 4IR, such as innovation, knowledge production, technological development, and the training of human resources in a framework that reinforces and enhances the quality of society. Policies, therefore, coincide with creations and innovations as part of everyday life (Kayembe & Nel, 2019). In turn, these research institutions are concerned with being recognized both nationally and internationally through their scientific production and teaching (Jung, 2020).

The functions of the research positions are described in the Manual for the Organization of Faculties, Institutes and Centers (https://www.uv.mx/orgmet/mofe/). The manual includes characteristics such as the regulations, the objective and the attributions of the personnel; the latter include institutional operation and management. The objective of the researchers is to "Fundamentally carry out research tasks, in specific projects derived from lines of research established in their academic entity or in any other that they participate" (https://www.uv.mx/orgmet/files/2012/12/investigador.pdf).

Researchers must also present their research advances annually, participate in research project discussion seminars, provide tutorials, and give lectures as a complement to their workload. According to UV statistics, the institution has people dedicated to cultural services, and administration, as well as a separation between teaching and research personnel (Table 2). The distinction between this study and others (Jung, 2020; Matthews et al., 2021; Aoun, 2017; Xing & Marwala, 2017) is that UV researchers are not responsible for training future generations; as a consequence, one can only wonder who is preparing the new generations for future needs. There are 577 researchers in total, with full-time (564), part-time (6), and part-time (7) researchers. Teaching personnel was not examined in this case study because their roles were teaching, tutoring, and administrative tasks; however, research was not mentioned as part of their activities (https://www.uv.mx/orgmet/files/2012/12/docente.pdf ).

Table 2
Academic staff by function and time dedicated

| Academic staff by function and time of dedication (does not include academic technicians) | | | | |
|---|---|---|---|---|
| Time spent | | | | |
| Function | Full time | Part time | Per hours | Total |
| Professors | 1, 540 | 16 | 2,369 | 3, 925 |
| Researchers | 564 | 6 | 7 | 577 |
| Culture and other services | 115 | 2 | 144 | 261 |
| Administration | 78 | 0 | 157 | 235 |
| Total | 2, 297 | 24 | 2, 677 | 4, 998 |

Source: Universidad Veracruzana, 2022, p. 48
https://www.uv.mx/informacion-estadistica/files/2022/01/05-Academicos_2021.pdf

Out of the 577 researchers who are dedicated to the production of knowledge, 353 researchers are recognized by the NRS (Members of the NRS, p. 3, https://www.uv.mx/investigacion/desarrollo-investigacion/regiones-2/), which represents 61% of all UV researchers. Therefore, the 353 researchers respond to the scientific population that promotes science and technology (Gaona Rivera et al., 2017); and in addition, they have internationally recognized publications (Conacyt, 2022). However, the

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level to which the researchers belong is unknown: C, 1, 2, 3. The remaining 224 researchers are not recognized by the NRS (39%) (Figure. 1).

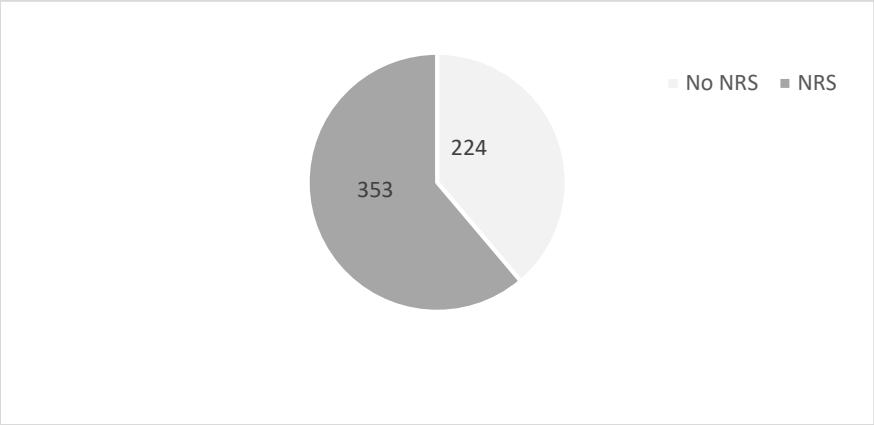



**Figure 1.** UV Researchers recognized by the NRS
Source: Members of the NRS, p. 3 (https://www.uv.mx/investigacion/desarrollo-investigacion/regiones-2/) and Universidad Veracruzana, 2021, p. 48 (https://www.uv.mx/informacion-estadistica/files/2022/01/05-Academicos_2021.pdf)

Although the academic training of the 577 researchers is not published on the UV pages, it may be assumed that the 353 NRS researchers have a doctoral level, given this is one of Conacyt's requirements (2022) (What is the training of researchers in a higher education institution?). According to PNT folio 069/2021, 169 researchers have a PhD, 37 have a master's degree, 2 are B.A. candidates, 10 have a Bachelor's degree, and 6 are Master's candidates (Figure 2). Further research should be done in terms of the academic credentials of the researchers because it is expected that they produce new knowledge and respond to the needs of the 4IR; however, researchers with very basic education may lack the appropriate tools to perform such tasks. According to data, Mexico reported to have very few researchers (315 for every million people) (The World Bank, 2020) and the investment in research was reduced in 2018 (UNESCO, 2021, p. 6); having these two disadvantages, Mexico needs to invest in people who can respond to the challenges brought by the 4IR.

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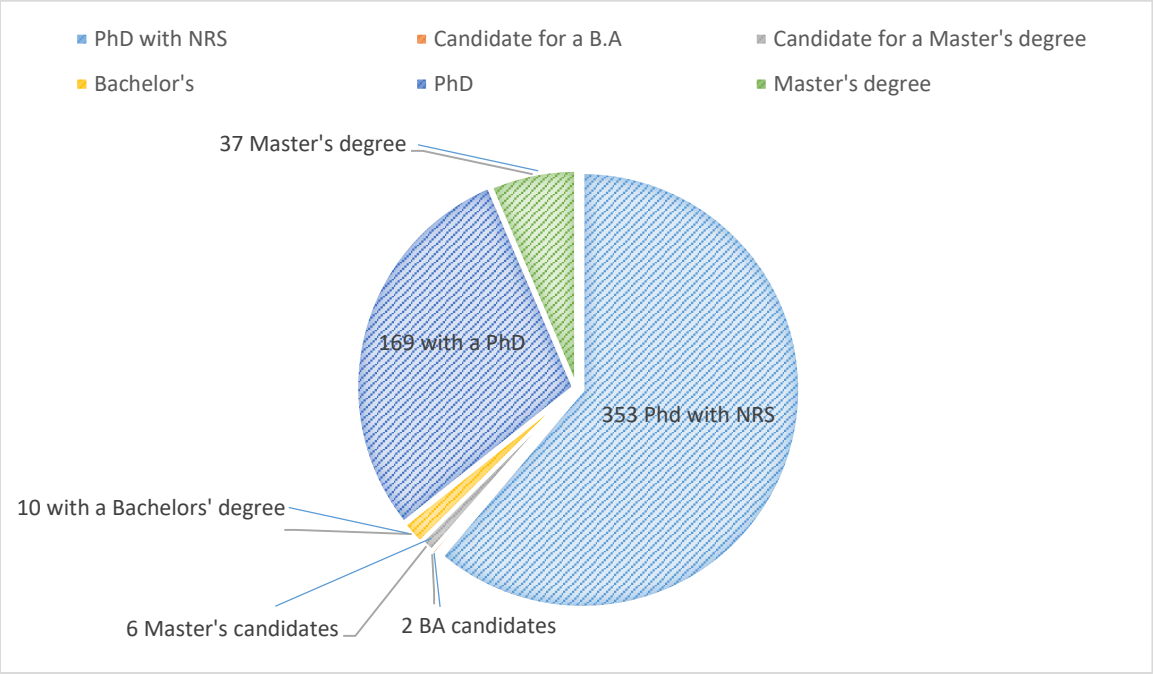



**Figure 2.** Academic training of the UV researchers
Source: Own elaboration with data obtained through the Plataforma Nacional de Transparencia Folio 069/2021 and Universidad Veracruzana, 2021, p. 48 (https://www.uv.mx/informacion-estadistica/files/2022/01/05-Academicos_2021.pdf)

From 2018 to 2021, researchers at the undergraduate, bachelor's, and master's candidate academic levels published a wide range of items (What type of knowledge production do they carry out?), including newspaper notes, interviews, conferences, book presentations, local journalistic notes ,videos on YouTube, blogs, books, articles, and book chapters; that is, production of knowledge that does not necessarily require peer review and whose impact on societal advancement may be debatable (Kreiling & Paunov, 2021). Although the UV evaluation mechanism is unknown, as Escalante Ferrer (2021) points out, research and knowledge creation have been distorted because quantity is valued over quality; in this study, videos on YouTube, blogs, book presentations, and local journalistic notes were not considered. This study, however, only looked at the output of articles, book chapters, and books (Table 3).

Table 3
Undergraduates, Bachelors', Master's degree researchers' publications 2018-2021.

| Editorial | Articles | | | | Book Chapters | | | | Books | | | | Total Per Editorial |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 2018 | 2019 | 2020 | 2021 | 2018 | 2019 | 2020 | 2021 | 2018 | 2019 | 2020 | 2021 | |
| UV | 4 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2* | 3* | 1 | 0 | **16** |
| Other | 5 | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **13** |
| Total | **9** | **5** | **4** | **4** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **0** | **29** |

Source: Author's analysis with data obtained through the Plataforma Nacional de Transparencia Folio 069/2021

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According to the data, three researchers were on the process of writing books from 2018-2021, with no other publications; while at the same time, eight researchers did not publish anything during the same period. Researchers must present their research advances annually as a supplement to their workload, according to UV standards; nevertheless, the policy's application is questioned. 16 articles were published under the UV editorial and 13 using other editorials. For the books*, four out of the five were translations of other original books.

Unlike researchers with a weaker educational background, researchers with a master's degree have a consistent output (Identify and describe trends and variation.). There is a total of 147 goods in the knowledge creation of master's degree researchers, with 63 publications belonging to UV editorials and 84 to other editorials (Table 3). In accordance with the information gathered, four researchers did not engage in any type of knowledge generation between 2018 and 2021; another researcher was on sabbatical, while another one was on a commission. As a result, six researchers with a Master's degree did not publish anything. Furthermore, one researcher reported four articles from 2016 and 2017, which seemed out of place; when searching for these articles to verify the year of publication, the authorship did not match with the name of the UV researcher.

The findings support Escalante Ferrer's (2021) assertion that the creation of knowledge and innovation in poor nations should be questioned. A researcher was also claimed to have a book in the works throughout the time period, but it was not included in Table 4 because it was not yet published.

Table 4
Researchers with a master's degree

| Editorial | Articles | | | | Book chapter | | | Books | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2020 | 2021 | 2018 | 2019 | 2020 | 2018 | 2019 | 2020 | |
| UV | 21 | 9 | 10 | 0 | 13 | 1 | 8 | 0 | 0 | 1 | 63 |
| Other | 9 | 19 | 11 | 2 | 18 | 10 | 10 | 2 | 1 | 2 | 84 |
| Total | 30 | 28 | 21 | 2 | 31 | 11 | 18 | 2 | 1 | 3 | 147 |

Source: Author's analysis with data obtained through the Plataforma Nacional de Transparencia Folio 069/2021

Mexico is putting itself at risk of falling behind during the 4IR by cutting research spending. The findings imply that the UV has a political framework that encourages knowledge generation; nonetheless, greater emphasis should be paid to researchers' academic training and scientific output. That is, consider the quantity as well as the quality of their labor.

## Conclusion

It is critical that higher education institutions implement policies that foster research, innovation, and contribute to the country's development in the framework of the 4IR. Unlike Xing and Marwala (2017), the study institution is involved in setting policies and supporting knowledge production by having a separate research area and employees committed solely to this task. A closer analysis into UV researchers' characteristics and knowledge production in the context of the 4IR indicates that they span from BA candidates to PhD level, which

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was unexpected, especially for researchers with an academic level such as BA candidates and BA. According to the findings of this study, international rankings that quantify the number of researchers per million people in a country do not reflect their scientific output, because, as the study revealed, there are researchers who do not provide any scientific output.

Conclusions are vague, expectations are high, and circumstances are unclear. Because the number of doctors with NRS is higher than the number of researchers without recognition, these researchers' dedication to development and innovation is recognized. At this point, the institution must pay close attention to research conducted by researchers who are not members of the NRS and whose role, in the context of the 4IR, is to develop knowledge.

In addition, by decreasing research spending, Mexico puts itself at risk of slipping behind during the 4IR. To avoid falling behind, Mexican public higher education will need to take massive measures in line with the 4IR, as well as even more massive steps in line with the 4IR, if it is to develop the human capital that will be necessary in the future years. Knowledge that may not have the appropriate quality to contribute to the progress of the region and country is taken into account, such as blogs, YouTube videos, and articles in local newspapers, according to the data collection. Rather than tripling the scientific population, as advocated by Gaona Rivera et al. (2017), it is proposed that researchers obtain PhD academic training and be encouraged to join the NRS, which ensures a degree of contribution to the scientific community.

The distinction formed by the UV in terms of personnel committed to teaching responsibilities against staff dedicated to research is especially intriguing, because the contribution that researchers may make in the creation of new generations to face new challenges and unpredictable futures is underutilized. As a result, comparison investigations with other higher education institutions are recommended to determine how staff is allocated, if researchers contribute to the teaching of younger generations, and to investigate the research that UV professors could conduct. This study was limited to researching the research area in this regard, but it is unknown what kind of training teachers have and how they contribute to the development of knowledge.

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## Human Participants

There are no human participants in the present research; however, necessary ethical considerations are observed in alignment with the journal's ethical guidelines.

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