The impact of the work of junior researchers and research professors on the improvement of the research competences of Engineering students at a University in North Lima

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Abstract– In Peru, the university law makes explicit the policies that universities must implement to promote research; this has allowed the investigative dimension to be strategic and necessary in professional training. This article shows the set of strategies developed by a private university in Lima to enhance the investigative skills of students of the engineering faculty; with the support of Junior Researchers, Experienced Researchers, Full-Time Professors, and Authorities; all this virtuality. These actions allowed students and teachers to complete their research work (indexed in Scopus) and to continue working on the completion of the thesis. These achievements are indicators of progress in the research competencies of the engineering faculty students and teachers (23% of the university's scientific production is provided by it).

Keywords— Research competences, Formative Research, Professional Formation.

I. Introduction

Research as a generator of development is an aspect that developed countries take into account; for this reason, their universities contribute in the generation of knowledge, the universities of the USA, England, China, etc.; they are those that are present in the first places of the world rankings of those that research the most [1].

In Latin America, research in universities in recent years has progressed; however, only some institutions are present within the universities that do the most research in the world [2]. This is correlated with the influence [3] and the number of researchers in the region, who contribute to the preparation of research projects, systematization of research work, generation of patents and new human resources dedicated to research.

In Peru, after university law 30220 [4] there was a change in the scientific production of the universities, all of them had to go through a licensing process; where one of the basic conditions of quality is to have the investigative dimension strengthened and with strategies to guarantee its sustainability. Many of them (47 universities and 2 graduate schools) were denied permission to continue operating [5] and the common denominator was weakness in the research issue [6], they had no researchers, scientific production was very low, teachers with very few investigative capacities, which led to university training being directed only to the technical and pragmatic question; which one of the basic principles of a university was not fulfilled, which is

the generation of knowledge that contributes to the development of the country. In these times of pandemic, all universities have had to guarantee their educational service through virtual teaching; in this sense, the investigative dimension has also had to be developed.

The 12-year-old study university has as an educational proposal the comprehensive training of its students, where formative research has been a pillar in its development process [7]. An important strategy that allowed development was the incorporation of international researchers [8], who share their experience to teachers and students, which they were able to participate in international congresses, in projects with internal and external funds, thus strengthening their research competences and passing several to the level of junior researchers and research professors. The strategy for this year is making use of virtual tools, to have greater contact with students, in the role of teachers of research courses, which has allowed us to enhance the investigative skills of the students of the Faculty of Engineering.

This article is structured as follows: Section II, in the methodology part, shows the strategies that were carried out at the university so that the work of junior researchers and research professors strengthen the investigative competencies of the engineering faculty. In section III, important results are shown, such as the acceptance of student research work in international congresses, journals that reach high-impact databases (Scopus) and the increase in the percentage of publications by students and teachers compared to the total publications that are in the university. At the end, in section IV, the discussions regarding the experience we had, and we are going to promote in the future.

II. Methodology

To guarantee the improvement of the research competences in the students of the engineering faculty, the relevance of applying the following strategies was seen:

A. Restructuring of the formative research program in recent cycles.
B. Training of full-time teachers by researchers.
C. Incorporation of graduates as junior researchers in research centers.

D. Incorporation of junior researchers and research teachers in the teaching of research courses, making use of virtual tools.

A. *Restructuring of the formative research program in recent cycles*

The university has a formative research program [9] consisting of three levels.

- First level: First, second and third cycle students have a first contact with research; in which they are trained around reading comprehension, writing and use of databases. Students submit basic essays and monographs by paraphrasing the ideas of other authors and making short and complete references correctly.

- Second level: In the fourth, fifth and sixth semester students develop research work; but the content is already related to the basic courses of the specialty.

- Third level: The third formative research program in the engineering faculty corresponds to the courses of Scientific Research Methodology (7th cycle), Thesis Seminar (8th cycle), Thesis I (9th cycle) and Thesis II (10th cycle). At this level, students must carry out research work in scientific article format and start their thesis project.

For this stage of 2020, the objectives of each course were restructured so that students can develop research works in scientific article formats, in MIC 50% of the article must be guaranteed and culminate in the Thesis Seminar; likewise, for the Thesis I and Thesis II courses we must guarantee the thesis project and the initial part of the final thesis. We detail this restructuring in Table I. In this way, we will speed up the completion of the thesis in the shortest time after graduation, since in all these 4 semesters the students acquire research competences in the preparation of research papers.

B. *Training of full-time teachers by researchers*

To guarantee that research at the university is carried out in a more sustained manner, it was necessary to enhance the research capacities of full-time teachers; for this, training was carried out around:

a. Writing scientific articles: In this training the researchers made the teachers know the structure of the article, the correct way to prepare a summary, the introduction, the methodology, the results, and the discussion.

b. Management of tools for statistical analysis and mathematical modeling: The researchers showed the use of some programs such as STATA, WOLFRAM and MAPLE, which allowed to know ways to analyze data and the mathematical treatment of the same.

c. Management of QGIS: The researchers used this tool to be able to show geographic spaces where there is a greater or lesser prevalence of a certain situation or problem, which can be used by teachers in their research

TABLE I
RESTRUCTURING OF THE THIRD LEVEL OF THE TRAINING RESEARCH PROGRAM

COURSE	2019	2020
Methodology of Scientific Research	Epistemology	Epistemology and 50% of the research work
Thesis Project	50% of the research work in scientific article format.	100% of the scientific article
Thesis I	100% of the scientific article	Thesis Project
Thesis II	Thesis Project	Development of the Thesis until the second specific objective.

d. References in a scientific article: The use of Mendeley was shown to be able to correctly reference the articles that help us in the state of the art of the research work.

C. *Incorporation of graduates as junior researchers in research centers*

The students of the last cycles of the engineering faculty were incorporated into the research centers with the purpose that after an evaluation of their performance they could be promoted as junior researchers. Now, we have several junior researchers who are already qualified as researchers in the Registro Nacional Científico, Tecnológico y de Innovación Tecnológica de Investigadores (RENACYT) of Peru. They have a formal employment relationship with the university and within their functions they must support research projects with internal and external funds, generation of new professors with greater research capabilities, etc.

D. *Incorporation of junior researchers and research teachers in the teaching of research courses, making use of virtual tools*

In the process of virtual training of the full-time teachers of the engineering faculty, it was possible to detect some teachers who had a greater advance in their investigative skills, greater motivation, which allowed them to soon be able to complete the systematization of several works and submit them at international conferences, which were indexed in high-impact databases such as Scopus; likewise, it was observed that in the courses they were in charge of, some students managed to systematize their research work in article format.

On the other hand, junior researchers who currently have the category of RENACYT researchers do not have the degree of teacher, so they cannot agree to take on formal teaching in classrooms; however, they had much to contribute to the students.

It is for these reasons that the academic department, the research department of the faculty and the university's research department decided to prioritize the incorporation of junior researchers in the teaching assistantship of the research courses of the last cycles, which oversaw full-time research professors. The entire process of interaction with the students was developed with the zoom pro platform that allowed the development of synchronous communications; in addition to the virtual campus that the university has that allows asynchronous communications.

III. RESULTS

Since 2019, the faculty teachers have been trained by the researchers at the university, this has allowed them to advance in their investigative skills, management of the structure of the articles, criteria for the search for the state of the art, methodology, systematization of the results and discussion. Table II shows the research works accepted in different conferences and journals, which are indexed in Scopus.

The strategies for the involvement of teachers in research activities and the policy of the university to provide conditions for it, has allowed them to have more tools to guide students in research aspects. The prioritization of teachers with the greatest advances in research developing joint work with students from the last cycles, the teaching assistantship by Junior researchers, has allowed many students to systematize their research work and have it accepted in conferences and journals whose reach Scopus, which are shown in Table III.

Within the professional training process of our students, one of the most important aspects is the development of their investigative skills. In addition to the systematization of their research papers in scientific article format, it is to guarantee the thesis that will allow them to obtain the professional title of engineer. In this sense, in this stage of the pandemic, despite the limitations presented, the students have continued to complete their thesis work as shown in Figure 1.
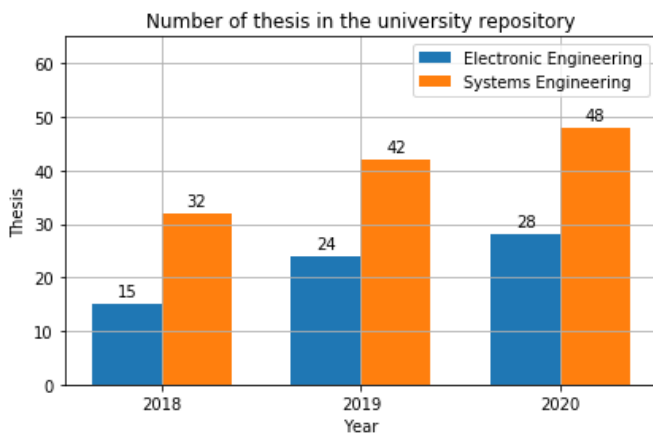

Fig. 1. Number of thesis works in the engineering faculty

TABLE II
TEACHERS RESEARCH WORKS

TEACHERS/ CONGRESS OR JOURNALS	TITLE OF THE RESEARCH WORK
Laberiano Andrade Arenas EDUNINE 2020	The Impact of Using Software to Learn Mathematics in Courses of Peruvian Engineering Programs
Laberiano Andrade Arenas EDUNINE 2020	Study of the graduates' perspectives on the quality assessment of two engineering programs at a Peruvian university
Laberiano Andrade Arenas LACCEI 2020	Diseño de una arquitectura orientada a servicios para una institución educativa superior privada en el Perú
Laberiano Andrade Arenas LACCEI 2020	Aplicación de la metodología de los sistemas blandos con enfoque sistemático en la gestión universitaria en las carreras de Ingeniería de la universidad de Lima Norte
Laberiano Andrade Arenas INTERCON 2020	Mobile advertising in Peru: The impact of SMS advertising on sales and customer experience
Laberiano Andrade Arenas ARGENCON	Automation of the short message service (SMS) delivery in a telecommunication company with Python and batch files
Julio Vásquez EDUNINE 2020	Gamification in university teaching for Systems Engineering students at a Lima North University
Julio Vásquez EDUNINE 2020	Virtual classrooms to improve the teaching-learning process in Systems Engineering courses at a University from Lima North
Alan Fierro EDUNINE 2020	Gamification as part of teaching and its influence on learning computational algorithms
Alan Fierro LACCEI 2020	Relación entre las competencias laborales y el conocimiento especializado en estudiantes de ingeniería
Jesús Vilchez Sandoval EDUNINE 2020	Appraisal of the provision of educational products and services according to the ISO-21001 standard in the faculty of sciences and engineering from the Sciences and Humanities University
Jesús Vilchez Sandoval EDUNINE 2020	On the of use agile methodologies to re-design a Networks and Data Communications course

Juan Lara	Establishment of the maintenance and review processes of meteorological equipment at the international airport of Cuzco, Peru
ICEV 2020 Congress	
David Llulluy Nuñez	On the impact of the insertion of international researchers on the investigative competences of the local engineering faculty staff and students
EDUNINE 2020	
Maritza Cabana	Good practices in pedagogy to develop professional engineering competencies in the students at a Peruvian university of north Lima in Peru
EDUNINE 2020	
Christian Castro	Impact of project-based learning on networking and communications competences
IJACSA Journal	

The contribution of the professors and students of the engineering faculty has allowed to guarantee the positioning of the university within the Scimago ranking for this year, since of the 146 articles accepted to date, 34 are from the faculty; that is, 23%. This has made it possible to sustain the advance in scientific production in the Scopus high-impact database of the study university in recent years as shown in Figure 2, in which we can see that in June 2021, we already have more than 50 scientific articles. Likewise, the development of the research competencies of engineering students, junior researchers and teachers in recent years has led scientific production to be oriented to a greater extent on applied technological research, which is why the university becomes present in the SIR WORLD 2021 [10] as one of the best positioned in Peru in the areas of Mathematics, Engineering and Computer Science as shown in Table IV.

In Peru, research has been strengthened in recent years and policies have been generated for the formal recognition of researchers. This process is carried out through a rigorous evaluation by the State to classify the researchers into two large groups: María Rostworowski and Carlos Monge Medrano [11]. For Peruvian universities, a central aspect is that their teachers are recognized as researchers by the State. In this framework, the development of the research competencies of the students of the faculty of science and engineering was strengthened with the advancement of the teachers in this dimension and vice versa as well, the teachers were motivated and advanced with the development of their students; In other words, a greater commitment was generated in them. This dynamic of interaction between teachers, junior researchers and students has also been reflected in the formal recognition as researchers by the institutions of the Peruvian State to 5 full-time teachers of the Faculty of Sciences and Engineering [12] in the years 2020 and 2021, which are shown in Table V.

TABLE III
STUDENTS RESEARCH WORKS

TEACHERS/ CONGRESS OR JOURNALS	TITLE OF THE RESEARCH WORK
Carlos Mendoza Santos	Web application design for the control process of public schools
IJETER Journal	
Hillary Vargas	Pet food dispenser design using Raspberry Pi
IJETER Journal	
Casanova Rosales	Implementation of a system for the development of virtual exams at the Universidad de Ciencias y Humanidades under the pmbok approach
IJETER Journal	
Alexandra Ramos Bernaola	Analysis of the Use of Technological Tools in University Higher Education using the Soft Systems Methodology
IJACSA Journal	
Alfredo Chiara Sotomayor	Mobile application oriented to the attention of blood donors in the medical centers of northern Lima
EIRCON	
César Jauregui Saavedra	Analysis of the use of technological tool in the e-learning process
ANDESCON	
Jhoel Ramos Romero	Analysis and prevention of IoT vulnerabilities by implementing a lightweight AD-IoT intrusion detection system model.
ARGENCON	
Richard Roca Ulloa	Computer security in the emerging technologies of the Internet of Things
ARGENCON	
Fanny Ventocilla Gomero	Impacto de la educación virtual en tiempos de pandemia en la universidad de Lima Norte
ARGENCON	
Anthony Ramos Romero	Mobile Application Design with IoT for Environmental Pollution Awareness
IJACSA Journal	

Richard Arias Marreros	Design of a mobile application for the learning of people with Down syndrome through interactive games
IJACSA Journal	
Luis Romero Tuanama	Design of a mobile application for the automation of the census process in Peru
IJACSA Journal	
Lilian Ocares Cunyarachi	Prototype Electronic Glasses to Improve Vision in Older Adults
IJACSA Journal	
Luis Nuñez Tapia	Prototype of an Automatic Irrigation System for Peruvian Crop Fields
IJACSA Journal	
Juan Hinostroza Quiñonez y Manuel Vásquez Cunia	Non-invasive Device to Lessen Tremors in the Hands due to Parkinson's Disease
IJACSA Journal	
Jason Chicoma Moreno	Tactical Robot Prototype for SWAT and Emergency Response Teams in Peru
LACCEI 2020	
Fredy Criollo Sánchez, Cristian Mosquera Sánchez	Design and implementation of a telescope for blind people based on an atmega controller
IJETER Journal	
Joseph Marín Alvarez	Transmission of climate parameters using low budget wireless communication modules in Ventanilla, Callao, Peru
ICEV 2020	
Joseph Marín Alvarez	Monitoring of marine litter collection device using LoRaWAN on the Peruvian coast

TABLE IV
RANKING SIR WORLD FOR AREAS – UNIVERSIDAD DE CIENCIAS Y HUMANIDADES[10]

AREA	WORLD	LATIN AMERICA	IBERO AMERICA	PERÚ
Arts and Humanities	619	103	155	5
Computer Science	663	127	183	3
Energy	676	135	192	6
Engineering	565	90	140	2
Mathematics	544	69	123	1
Social Sciences	820	155	215	9

TABLE V
TEACHERS OF THE FACULTY OF SCIENCES AND ENGINEERING RECOGNIZED BY THE PERUVIAN STATE AS RESEARCHERS

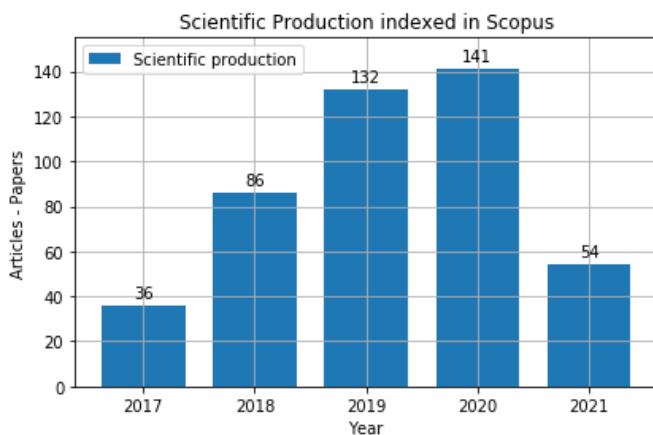| TEACHERS	GRUOP
Juan Julio Vásquez Paragulla	Maria Rostworowski II
Laberiano Matías Andrade Arenas	Carlos Monge Medrano III
Jesús Alberto Vílchez Sandoval	Maria Rostworowski I
David Llulluy Nuñez	Maria Rostworowski II
Hipólito César Reyes Del Carmen	Carlos Monge Medrano IV

Fig. 2. Scientific production 2017 – 2021 of the University of Sciences and Humanities

In this context of a pandemic, international congresses were developed virtually, which was a great advantage that the study university took advantage of, since expenses for stay and travel were dosed, which allowed us to register our students' articles and teachers, despite the economic difficulties that were experienced.

IV. DISCUSSION

The training of full-time teachers by researchers (to enhance their investigative skills) gave them better tools to guide and motivate their students in the systematization of their research work.

The pedagogical accompaniment of the research teachers and Junior researchers to the students of the engineering faculty have enhanced their investigative skills, which has allowed them to systematize articles that were accepted in conferences and journals whose publications will be indexed in Scopus.

The progress of teachers and students in their research skills has allowed their contribution to be 23% of the scientific production of the university. This will allow the university to continue advancing in its positioning within the SIR IBER (15th place in Peru in 2020) and to remain one of the most researched in the country [13].

To make sustained progress in the research skills of students, it is necessary to advance with the research skills of part-time teachers, since the impact they could generate on students would be more powerful due to the large percentage of them.

To continue creating spaces where students can socialize their work; it is strategic to continue with the financial support

and the priority that the study university has given to the investigative dimension of its comprehensive training proposal.

To that extent, it is important to take advantage of the opportunity to have virtual investigative events at the national and international level; likewise, to continue sending papers to journals indexed in Scopus.

REFERENCES

[1] SCIMAGO, "Research and Innovation Rankings 2020," *SCIMAGO INSTITUTIONS RANKINGS*, 2020. https://www.scimagoir.com/rankings.php?sector=all.

[2] F. De-Moya-Anegón, E. Herrán-Páez, A. Bustos-González, E. Corera-Álvarez, G. Tibaná-Herrera, and F. Rivadeneyra, *Ranking iberoamericano de instituciones de educación superior 2020 (SIR Iber).*, 1st ed., vol. 1, no. 1. Granada-España: Granada: Ediciones Profesionales de la Información, 2020.

[3] S. Moutinho, "Latinoamérica reúne solo 0,53% de los científicos más influyentes del mundo - SciDev.Net América Latina y el Caribe," *Sci Dev Net*, Dec. 20, 2018. https://www.scidev.net/america-latina/comunicacion/noticias/latinoamerica-cientificos-mas-influyentes-del-mundo.html (accessed Nov. 23, 2020).

[4] Ministerio de Educación, "Ley Universitaria Ley N.° 30220," Lima-Perú, 2014. Accessed: Nov. 23, 2020. [Online]. Available: http://www.minedu.gob.pe/reforma-universitaria/pdf/ley_universitaria.pdf.

[5] SUNEDU, "Universidades con Licencia Denegada," *Superintendencia Nacional de Educación Superior Universitaria*, Aug. 20, 2020. https://www.sunedu.gob.pe/lista-de-universidades-denegadas/.

[6] S. Rosales, "Sunedu: investigación es el punto más débil de universidades que no obtienen licenciamiento," *Gestión*, NOTICIAS GESTIÓN, Lima-Perú, Jun. 14, 2019.

[7] C. Mugruza-Vassallo, "Integral and transformative engineering coursework in formative research for undergraduate curricula," in *Proceedings - Frontiers in Education Conference, FIE*, Nov. 2016, vol. 2016-November, doi: 10.1109/FIE.2016.7757633.

[8] D. Llulluy-Nunez and J. Vilchez-Sandoval, "On the impact of the insertion of international researchers on the investigative competences of the local engineering faculty staff and students," Mar. 2020, doi: 10.1109/EDUNINE48860.2020.9149544.

[9] F. A. Rojas, G. Villar-Mayuntupa, and A. Roman-Gonzalez, "The formative research in the development of reading and writing skills and their impact on the development of indexed publications by engineering students," Mar. 2020, doi: 10.1109/EDUNINE48860.2020.9149495.

[10] SCIMAGO. Universidad de Ciencias y Humanidades Ranking [Internet]. Scimago Institutions Rankings. 2019. Available from: https://www.scimagoir.com/institution.php?idp=80130

[11] Renacyt. Reglamento de Calificación, Clasificación y Registro de los Investigadores del Sistema Nacional de Ciencia, Tecnología e Innovación Tecnológica - Reglamento RENACYT [Internet]. Lima-Perú; 2019. Available from: https://portal.concytec.gob.pe/images/renacyt/reglamento_renacyt_version_final.pdf

[12] CONCYTEC. Investigadores en el Registro Nacional de Ciencia, Tecnología y de Innovación Tecnológica [Internet]. Consejo Nacional de Ciencias, Tecnología e Innovación Tecnológica. 2021. Available from: https://ctivitae.concytec.gob.pe/renacyt-ui/#/registro/investigadores

[13] Universidad de Ciencias y Humanidades, "UCH es reconocida entre las universidades que más investigan en el Perú ," *Universidad de Ciencias y Humanidades*, Aug. 14, 2020. https://www.uch.edu.pe/uch-noticias/p/uch-es-reconocida-entre-las-universidades-que-mas-investigan-en-el-peru.