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ORIGINAL ARTICLE

Formative research in frame with the SDG-4 of the 2030 plan at Ixtapaluca Institute of Technological Superior Studies

Investigación Formativa del Tecnológico de Estudios Superiores de Ixtapaluca, Estado de México, dentro del ODS4 de la Agenda 2030

María Eugenia Estrada-Chavira,[*†] Horacio Eliseo Alvarado-Raya,[*‡] Pablo Emilio Escamilla-García,[*¶] y María Juana Hernández-Flores[*§]

†TecNM/TESIxtapaluca. Carretera Coatepec, San Juan 7, 56580. Ixtapaluca, México.; ORCID: 0000-0001-6190-0107
‡Universidad Autónoma Chapingo; Carretera México-Texcoco km 38.5, 56230. Chapingo, México; ORCID: 0000-0001-6190-0107
¶Instituto Politécnico Nacional. Calzada Tasqueña 1620, Paseos de Tasqueña, Coyoacán, 04250, Ciudad de México; ORCID: 0000-0001-6704-521X
§TecNM/TESIxtapaluca. Carretera Coatepec, San Juan 7, 56580. Ixtapaluca, México; ORCID: 0000-0002-1179-1966
*Correspondence to email: maria.ec@ixtapaluca.tecnm.mx; ; ;

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Abstract
Technological innovations direct to international education, referred to in the 2030 plan in the third sustainable development goal: quality education. In this work, it excels the concept formative research that has three axes: teaching, researching and society during the university level because it develops in the learner's abilities of interpreting, analysis, and synthesis. The objective in the present work was to analyze the educative research in the Ixtapaluca Institute of Technological Superior Studies (TESI) and to determine if it corresponds to an administrative process with the General theory of systems as methodology. The results show that the TESI realizes the three phases of a system: entrance, process, and exit, also, give constant feedback as needed. Accepting that in the TESI the entrance are the new entry students, the process has three curricular matters and the residency Project. The exit is the student with elements to use them in society in the work field. The conclusion was that the TESI student gets basic elements of researcher in his major. The recommendation is to emphasize the formative process as student researcher and to do more promotion to the residency process to increase the number of students on it.

Keywords: formative research, quality education, system, and TESI.

JEL: *D2. Organizations and Production*
JEL: *D21. Enterprise behavior*

Resumen
Las innovaciones tecnológicas conllevan a una internacionalización de la educación, contemplada en la agenda 2030; en el tercer objetivo de desarrollo sustentable: educación de calidad. En este artículo, sobresale el concepto de investigación formativa que contempla tres ejes internos: docencia, investigación y sociedad en el transcurso estudiantil, debido a que desarrolla en los educandos habilidades interpretativas de análisis y síntesis. En esta investigación se planteó como objetivo analizar la investigación educativa en el Tecnológico

de Estudios Superiores de Ixtapaluca (TESI) y determinar si corresponde a un proceso administrativo con la Teoría General de Sistemas como metodología. Los resultados mostraron que el TESI si realiza las fases de un sistema: entrada, proceso y salida, así como también, una retroalimentación constante. Aceptándose que en el TESI la investigación formativa de entrada, son los estudiantes de nuevo ingreso, el proceso, está representado por tres materias curriculares y el proyecto de residencia. La salida, es el estudiante con elementos para usarlos en la sociedad dentro de su campo de trabajo. Se concluyó que el TESI si enseña los elementos básicos para un investigador formal durante el desarrollo de la licenciatura. Se recomienda enfatizar en el proceso formativo como estudiante científico y se realice más difusión al proceso de residencia para aumentar el número de titulados.
Palabras clave: investigación formativa, educación de calidad, sistema, y TESI.
JEL: *D2. Production and Organizations*
JEL: *D21. Firm Behavior*

1. Introduction

In a context where technological evolution has given a step to an educative internationalization through students' academic interchange. In this interchange are known the different educative methods that are part of the knowledge training, after a basic education development in a main area. The student is taken to a high level called: formative research, in this level the student gets the necessary tools to develop the scientific method, after the student surpass this level he can produce scientific research, generally in his professional life or in other research level.

Nowdays, the society demands a diversity of professionals in different formative areas, the Ixtapaluca Institute of Tecnological Superior Studies, called TESI, is an educative institution that attends municipalities around the Mexico State, as Ixtapaluca, Chicoloapan and Chalco. Becoming aware of this necessity in the community and its surroundings, the TESI provides professionals as engineers, graduates, and architects, to satisfy an economic and a sociocultural necessity.

Investigating is a process inside and outside the educative environment, which implies the compromise to generate new knowledge. Involves teachers and students, (Organización de las Naciones Unidas, 2008). But how to develop research practices? How to develop them in the TESI?

In this document the objective was to analyze if the residency process in the TESI, applying the systems general theory, it can be represented as an administrative system of formative research. Under the hypothesis that, during the period of university studies, a student enters in an administrative system of education where he takes curricular subjects and realizes a residency project to develop researcher skills and to finish the graduation cycle, getting back to society with an aggregated value and to start in the labor force.

In the composition of this article are exposed theories and concepts to get through the research theory basis for scientific, fundamental phase in the university process, the next section is composed by the research methodology to apply in a mixed and descriptive research, where the research direction reach the objective; additionally is determined the theory methodology, based in two models: one focused in the productivity as a the system proposed by Ludwig Von Bertalanffy in 1950 and other focused in the contents that forms the scientific research through the formative research proposal by Turpo-Gebera (2020); Both make a complete model that helps with the gotten data analyze the TESI basic formative composition, in the state of Mexico, inside the sustainable development goals from the 2030 agenda. That's why the systemic sequency of the subjects and the academic regulation to take the professional residency, and the gotten data in official sites help to visualize how are present the formative elements in the scientific research.

The theoretical and conceptual frame are marked by the global trend towards education internationalization obligating the countries to make cooperation alliances in educative matters, allowing the university student mobility.

In New York, the result of the Development Sustainable United Nations Summit was a document that stablishes 17 sustainable development objectives, signed by the integrating countries of the United

Nations Organization (Organización de las Naciones Unidas (ONU) MÉXICO, 2016). The objective four, about quality education, guarantee an equative education, inclusive and learning opportunities for all in the life (Organización de las Naciones Unidas , 2016).

One of the conclusions of the worldwide initiative about science in the XXI century was that the governments should make grow the scientific, technical and educative careers, improving the rules in the work conditions, increasing the capacity to stop the brain drain and promote the scientific areas (Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura , 1999).

There are three axis: teaching axis, research axis, and society link axis, taking place the formative research in the formal and technical education because is a relevant factor in the normal development of the countries in the documents of planification, where the main objective is the labor formation and the improvement of the capacities to form the education and the labor market (UNESCO, 2019).

One of the tools in teaching and learning is formative research, to share the information that exists and to form researchers that have a scientific development. It is also called research by teaching, or teaching using the research method. There are summative characteristics as the directed and oriented research given by a teacher in his function and the students as personnel in development to the scientific formation (Parra, 2004).

In the research formative process is contemplated to develop interpreting skills, information analysis, no solved questions, high thinking and capacities inside the research method; all in function of the research formation (Orozco, 2016).

Also, all that is realized with the objective of grasp and develop knowledge, capacities, attitudes that are necessary for the students and teachers to develop productive scientific research activities, in benefit of the technological innovation and the academic or productive advances (Guerra, 2017); (Guerrero, 2007).

There are scientific criteria well known by the scientific community as the methodology that are together with the epistemological basics, which are opposing the positivists-empiricists and the hermeneutics. Also, there are researchers that defend history and critical theories. But not matter the methos to solve the scientific problem should do in a systematic form with a proof to generate the scientific method: The phenomenon studied should be legals, theoretical concepts, the reality studied should be total, make use of the quantity, of the validity among others. United in the economic, social and biotechnological changes are necessary in the dialogue between the communities (Restrepo, 2003).

Researching means go through stablished ways, to travel from the science origin, to verify how is built the knowledge in the human main. Ancient concepts of the XVII y XIII centuries to the rescue of the ancient wisdom of man. In the century XVI with the scientific revolution and the coming of new sciences, the research change its meaning to looking for the unknown. Renaissance saw the research as an invention (Borrero, 2008).

The systems are a set of closed relations that in the systemic dynamics are treated as systems that are produced and reproduced to oneself, by their own operations, also, are autonomous entities, evolutionary and exempt of logic. Therefore, the organizations are characterized because of their creation and survival and respond to the organization decisions (Luhmann, 2014).

Nowadays, the organization is a system characterized by difficult environments. The systems are open socio-technical where there is an interchange of energy, matter, money and information with enter links (supplies), outs (products) and own returns to the system, in structure, in operation, function or purpose that permits to prevail in the time and the adaptation, building and readaptation process, which leads to coexist in the environment (Velasquez, 2007).

In the academy, all the organizations have three purposes: formation, research, and society linkage; The formation has to be with the interaction teacher-student to transmit the knowledge and to develop research abilities in the students, the applications of research procedures and innovations development, the evaluation between equals is relevant. The second step is the formative research, which becomes academic-scientific research (Salguero, 2022).

In the country the technical educational national institutes have special characteristics such as:

autonomy, its legislation and they have their own budget. In their direction are integrated by official sector, business and labor administrators. Their objective is to put into operation the professional technical system, coordinated with the state resources, the employers and the employees to develop quality human resources for the business sector be more productive and make activities that contribute to the country development (UNESCO, 2019).

By other side, the training of professionals in the regional economy of the educative centers influenced area is essential. In this case, formative research is fundamental for his development.

Education promotes employment, increases income, improves health, and reduces poverty. Also, impulses the economic growing in the long term, stimulates the innovation, strengthens the institutions and promote the social cohesion. To reach the before exposed is necessary, to increase the level of learning, base the design of public politics according to the students learning (which is translated as more years of education, higher incomes and less poverty), build coalitions and to align all the actors in the system to favor the learning (Grupo Banco Mundial, 2018).

2. Methods and materials

Following with the methods and materials, the present research was developed under a mix approach: qualitative, since the university formative components, based in the 2030 agenda and quantitative, in the data collection through the TESI historical registers and official web pages from the government of the State of Mexico, information validated in the linkage department of the TESI, also, the descriptive focus, according to the data analysis of the students registered to do the residency process; qualitative, because of the information gotten from internet and quantitative when is done the statistical basic analysis as: averages, variances and standard deviation.

In this way, can be analyzed, through tables, the student´s data that enter to realize the professional residency, impacting the knowledge as an exit process in their professional formation.

The main theory in this research is the systems theory that is used in administration, this was stablished by the German biologist Ludwig Von Bertalanffy, around the 1950´s years, where stablished that the systems are interdependent with all the disciplines, this system is applied as entrance and exit process. The research formation at the TESI is fed by the residency process. The residency process was taken from the 28th article of the TESI intern residency regulation. After that, was realized a descriptive analysis and it was calculated the effective index: dividing the number of students that finished the residency process by the students that started the process multiplied by 100.

The methodology based in the Turpo-Gebera (2020) theorization scheme is appreciated where it integrates formative research with the research that is done as science. In this scheme the university level represents formative research where the sense is given by the teachers of the education institution.

2.1 Systems theory

An organization is a system of roles and relations with a target objective. The objective can be reached with processes taken in a structure that permits emerge the necessary characteristics to develop in an environment (Velasquez, 2007). An organization is defined according to establishment and aggregation of activities and the necessary means that flows between them vertical and horizontal mix to realize stablished objectives in the enterprise structure (Schvarstein, 2001).

The German biologist Ludwig Von Bertalanffy, in the fifties, proposed an interdisciplinary theory known as: Systems General Theory addressing problems in each science and giving principles of type physical, biological, social, and chemical, among other common general prototypes in the sciences. This was a step to avoid the frontiers and to fill the void between them. The systems cannot be understood separately in each part, but there is a reciprocal dependency on all the disciplines and the necessity of their integration having the following characteristics:

1. An integral trend of the natural and social sciences.
2. The integration is conducted towards a system theory.

3. Theory is getting bigger to enter in the study the not physical fields of scientific knowledge, such as social science.

General System Theory Premises

1. The systems exist inside the systems and have subsystems; this subsystem is part of a supersystem, and this is a system of a bigger system and so on.
2. The systems are open. They have an infinitive interaction with the environment, interchanging potency and knowledge.
3. The structure is what makes the system function. According to the objective the system interchanges information with other systems.

System´s Parameters

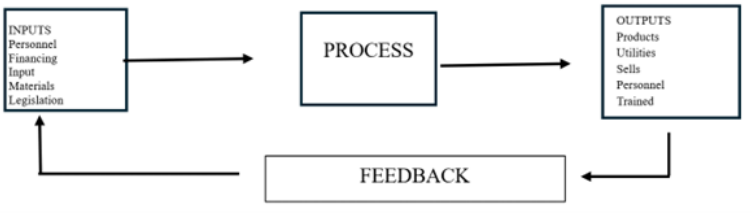
1. Input: The Beginning point gives the material and the information to operate the system.
2. Through-put: Mechanism that converts the inputs and outputs.
3. Output: The outputs are the results of the system. In a system the products are called final products while the subsystem products are intermediate products.
4. Feedback: The system responsibility is to compare the standard output before stablished.
5. Environment: Is the surrounding in which the external system is developed. The system and the environment are interdependent, the environment sends resources to the system, this gets it, processes and gives them back to the environment. The system adapts to the environment with which it interacts because of this depends on its survival.

The systems can be varied:

1. Physical or concrete, according to its constitution.
2. indetermined, composed of precepts, philosophy, plans, hypothesis and ideas.
3. by its essence are: open or closed. If they don´t have a relationship each other are closed.

In the structured systems the elements and relationships are combined rigidly producing an invariable output. The open systems, by other side, present interchanging relationships with the environment by means of countless inputs and outputs. They adapted with the environment to survive (Chiavenato, 2004).

Figure 1. General Systems Theory – Teoría General de sistemas

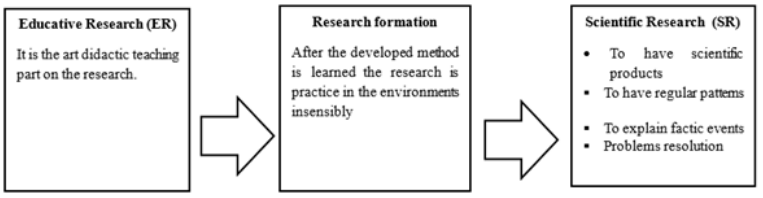


Source: https://s3.amazonaws.com/s3.timetoast.com/public/uploads/photos/12433644/proceso_sistemas.jpg

2.2 Formative Research Incorporation into Scientific Research

The scientific work as product of the formative research, can be represented as a pattern that provides own continuities of development in the projective sense, as a formative design, that facilitate the own knowledge through the teaching in the classroom developing competencies to investigate on the professional life already, as is stablished in its model (Turpo-Gebera, 2020).

Figure 2. The scientific research and the integration on the formative research



Source: Taken from Turpo-Gebera (2020).

2.3 TESI Residency Procedure

The present procedure stablishes the guidelines by which is governed the residency in the TESI.

First Article. The present procedure is of observance for all the students and academic personnel from the TESI, and has by object to establish the norms, mechanisms and activities that are applied in the planning, execution and accreditation of the professional residencies in the Technologic.

Fourth Article. For the purpose of this regulation, is understood by:

I. Program of professional residencies, as the planning and the systemic execution of activities that permits to give an answer opportune and effective for the projects demands of professional residences in the institution, extended to the residents.
II. The resident, is the student from the TESI, that is formally subscribed in the program of Residencies.

Fifth Article. The Residencies are the educative scholar strategic with curricular value that permits to the student even being in the professional formation, to incorporate professionally in the productive center of goods and/or services, through the development of a defined project in function of the graduate profile established in the plans and study programs used in each program of tutoring by teachers at the TESI.

Seventh Article. Professional residencies are mandatory in order to get the corresponding title.

Twenty-Second Article: Residency project can be realized individual and interdisciplinary (students of the same orientation) or multidisciplinary (students from different orientation) and in time last four to six months, the student should accumulate 640 minimun hours for residents and they will get 20 credits by student.

Twenty-third Article. When is required a different time in the project, can change the stated in the twenty second article of the present procedure only if there is the written authorization of the professional residencies commission.

Twenty-eight Article. The requirement that the students must have to be residents are the following:

I. To have 85% of the scholar academic credits
II. Be regular academic student (He should not ow signatures)
III. Must be written inside the thirteen ordinary semesters; and
IV. To have current facultative insurance

Twenty-nine Article. The students that have all the requirements established in the twenty-eight of the current procedure can request the official assignment of the professional residency project, in the corresponding academic division, where the student request the assignment of his academic situation in the technologic emitted by the institution scholar control department. Once this requirement is covered the corresponding academic division will give the student a signed constancy as the project official assignment and the resident presentation student letter.

Thirty-fourth Article. After the project is accepted by the enterprise, the institution or dependency should send an acceptation letter addressed to the academic subdirector; who can realize the student project assignation and to emit the respective name of his intern advisor.

Thirty-nine article. - The designation of professional residency projects for the residents' candidates will be done by the academic divisions, through the following mechanisms: I. Trought the selection of the projects bank related the career; II. The student can do the proposal of the topic directly in the corresponding academic division who can assess the relevancy; III. Probe in the corresponding academic division that the student works in any company related to the career to be valued in the project of professional residencies. Once the proposal is authorized the academic division names a respective assessor (Junta Directiva del Tecnologico de Estudios Superiores de Ixtapaluca, 2006)

2.4 Indicator of effectiveness in the process of residencies in the TESI

When an objective in an institution is stated, a system of control is established to reach a standard required. There are different types of proofs such as reports, statistics, among others. In the case of the observation to be effective should be developed completely and continuously.

By other side, to stablish a system of inspection is necessary: to define objectives, standards and indicators, to teach the personnel to comprehend and to apply the controls and to evaluate the effectivity of the given parameters (Münch, 2018).

An indicator is a particularity very precise, visible and evaluable, shows what changes were given through a process to achieve a specific objective. In the case of an efficiency index is an indicator that analyzes the grade of resources in the activities or process (May-Alvaro, 2021).

In this case the formula used was:

Equation I:

$$\%E_n = \frac{C_n}{I_n} \times 100 \tag{1}$$

Where:
%En = Clearance rate
Cn = Students number that finished residencies
In = Students number that began residencies
The results are presented next:

3. Results

TESI (Ixtapaluca Institute of Technological Superior Studies) is a deconcentrated public educational institution localized on the boundaries of Chicoloapan and Ixtapaluca, both eastern municipalities of the state of Mexico. TESI gives education to youngers in their college age coming from these two municipalities besides Chalco, another municipality in the surroundings. This institution is certified by ISO:9001 regarding educational processes, extension, budget administration, planning and quality (Universia, 2024

In 2022, enrollment at TESI ascended to 2,193 students registered, 57.4% from the total were male (1, 259) and 42.6 % (934) female. Regarding field of study, 25.1 % (550) of the total students did register for Architecture; 22.9 % (503) for bachelor's in administration; 17.6 % for Computer Systems Engineering; 15.7 % (345) for Biomedical Engineering; 6.52 % (143) for Engineer in Informatics; 6.43 % (141) for Environmental Engineering; 3.83 % (84) for Engineer in Electronics. Also, 40 students out of the total enrolled in TESI (1.92 %) registered for a master's degree in administration (Gobierno de Mexico 2020).

In the course list inside the TESI for every educational program there must be three items regarding the development of abilities in research. These courses are considered like formative research: Fundamentals in Research, Workshop on Research I, and Workshop on Research II. The first course is for students enrolled in the first of eight semesters (freshman). The second is for students enrolled in their fourth (sophomore), sixth (junior), or seventh (Senior) semester, it depends on the field of study. The third course is only for students in their seventh or eighth semester (senior). Once the student has

completed its course body of his field, he becomes eligible as a participant in a research project with a company having collaborative agreements with TESI.

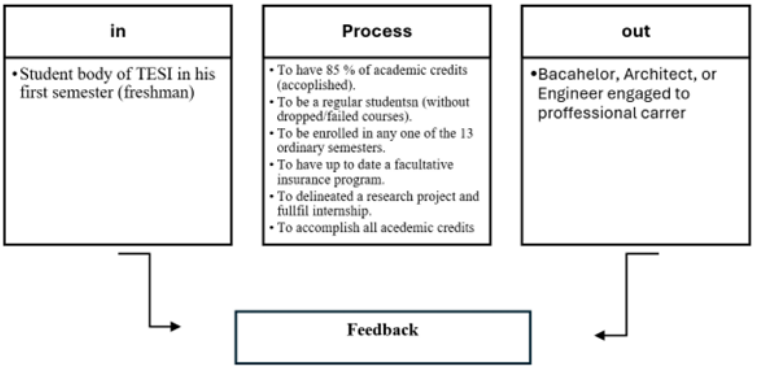
Regarding the master's degree in administration, the curriculum includes four seminars, one each semester: Seminar 1, Seminar II, Seminar III, and Seminar IV. The graduate student must complete his research proposal throughout the two years of the program which will become his thesis. Graduate students in this program are not mandated to participate in academic/research internship but they must undergo formative research alongside his curriculum accreditation and thesis to TESI granting him the Master´s Degree

The Internal Normative for Internships of TESI in his Article 28 regulates the student procedure to complete this requirement: to have 85 % of his academic credits accomplished, to be a regular student (without dropped/failed courses), to be enrolled in the thirteen ordinary semesters, and to have up to date a facultative insurance. If the student accomplishes these requirements, he can undergo his internship as a part of his research training.

The process of formative research in TESI from an administrative system point of view can be found in Figure 2, emphasizing that student must be tutored by one faculty member. Particularly, in the case of any Engineering student, two faculty members must accompany him throughout the process: one member serve as a technical adviser and the other as a methodologist adviser. Both professors guide the student pursuing his research project.

Figure 3 shows the system for formative research for TESI. Here, it can be noticed for each one of the steps shown in horizontal plane, the process every one of the TESI students must complete. The first step is to select the TESI student candidate for college studies, then they are guide through the stem courses focused in research (research justification and methodologic structure for research). At the end of the process, during the final semester of his studies, the student applies for a Professional Internship, which can be accepted only if the student is regularly enrolled, shows academic proficiency, and is capable to use his knowledge since theoretical and practical fundamentals; this, in order to achieve his professional grade as a Bachelor, Architect, or Engineer while he engages in a professional career.

Figure 3. The system for Formative Research for TESI



Source: Own elaboration on information from TESI.

The descriptive statistics by semester and describing the period from academic years 2020 to 2022 for the fields of study for TESI are present below (Table 1). In this period, 933 students applied for internships (see Figure 1). Out of them, 34 % were students from Bachelor's in Administration, 20 % from Architecture, 18 % from Computer Systems Engineering, which are the most demanded fields on TESI. Only 2.0 % of the students applying were from Environmental Engineering. It is worth to mention that the annual average of students in internship during the period evaluated was 311, with a variance of 925 and standard deviation of 31 students.

For the total of the students who applied for their internship process through formative research,

Table 1. Students from TESI who began their internship during 2020–2022.

Period	Administration	Architecture	Biomedical	Computer Systems	Informatics	Environmental	Electronics	Master's in Administration	Began
2020	130	41	16	63	31	4	13	18	298
2021	101	44	48	39	25	11	14	20	282
2022	85	99	58	69	25	8	9		353
								Total	933
								Average	311
								Variance	925
								Standard Deviation	31

Source: Own elaboration with processed data from Tecnológico de Estudios Superiores de Ixtapaluca (TESI).
Note: Maester in Administration is no considered for internships.

only 881 students ended that process, this means that 5.57 % out of them (52 students) did not accomplish the internship. Through three years considered in the study, there was a mean of 294, the variance was 2,785, and the standard deviation was 53 (Table 2). See the annex to found statistics on the other fields of study of TESI.

Table 2. Students from TESI who accomplished internship in the period 2020–2022.

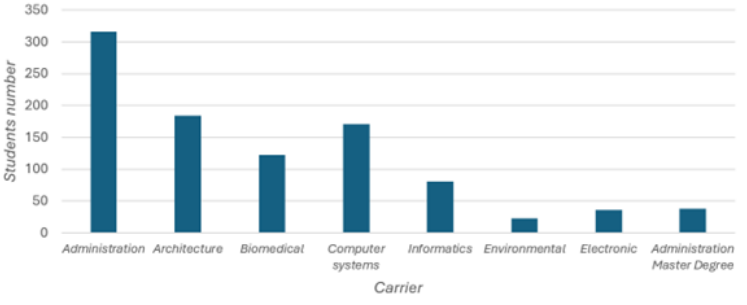
Period	Administration	Architecture	Biomedical	Computer Systems	Informatics	Environmental	Electronics	Master's in Administration	Accomplish
2020	77	41	16	63	31	4	13	17	245
2021	88	44	48	39	25	11	14	20	269
2022	99	99	58	69	25	8	9		367
								Total	881
								Average	294
								Variance	2785
								Standard Deviation	53

Source: Own elaboration with processed data from Tecnológico de Estudios Superiores de Ixtapaluca (TESI).
Note: Maester in Administration is no considered for internships.

It is worth pointing out that, from the three years of study, 2020 was the academic year with the low number of students in internship process, the main reason for this was the pause of presential academic activities and its substitution by the online way because of the COVID-19 outbreak. In Mexico, presential activities recommenced until January 2022.

Students from TESI who began and finished internship in 2020 – 2022 are shown disaggregated for field of study in figures 4 and 5.

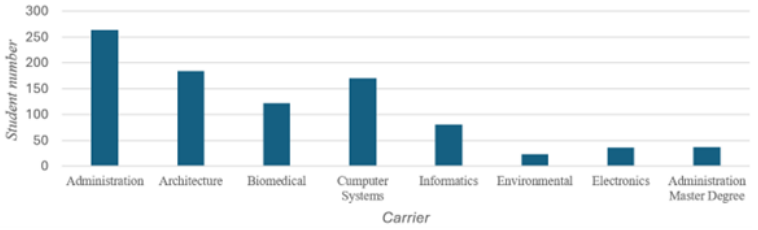
Figure 4. Students from TESI who started his internship during 2020–2022



Source: Own elaboration from data of TESI.
Note: Master's in administration are not considered for internship.

From charts 4 and 5, it is visible that Bachelor's in Administration is the field of TESI with the

Figure 5. Students from TESI who finished his internship during 2020-2022



Source: Own elaboration from data of TESI.
Note: Master's in administration are not considered for internship

greatest number of internship applications and with most number of accomplished processes, contrary to Environmental Engineering which had the lower numbers in these variables.

The indicator of effectiveness for professional internship processes for TESI was calculated by equation I, described above:

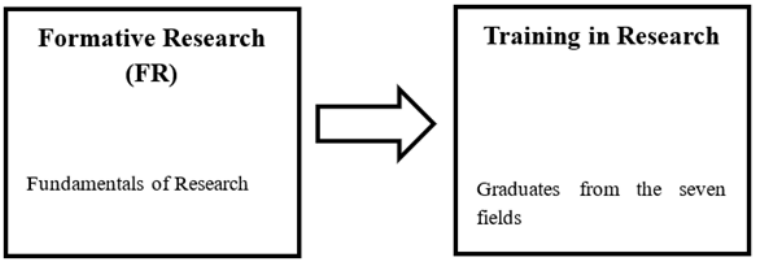
$$\%E_n = \frac{C_n}{I_n} \times 100 = (881/933) \times 100 = 94.42\% \quad (2)$$

Where:
%En = Percent of effectiveness.
Cn = Number of students who accomplished his internship.
In = Number of students who started his internship.

The indicator of effectiveness showed that TESI had an achievement of ca. 95 % of students accomplishing his internship process; only 5 % did not ended his process. Aside to this, and based on the Turpo-Gebera model (2020), in this case study for the Ixtapaluca Institute of Technological Superior Studies (TESI), the two initial steps are considered: first, the formative research which refers to the curricular courses of the academic common trunk related to fundamentals of research and methodology of research in two periods, this complementing with the professional internship project which the student undergo to obtain his professional degree; second, the training focused to research. In the system of TESI, this is represented by the research capable of develop all graduate throughout his professional career in the society (bachelor, engineer, or architect).

The proposal of the model for integration of the formative training in the scientific research consider three steps; the initial two are more referred in this research by supporting the integration of a mixed proposal and related to the professional-technical education during the internship. This helps to be efficient in quality formation and making easier the formation process of the TESI student (Figure 6).

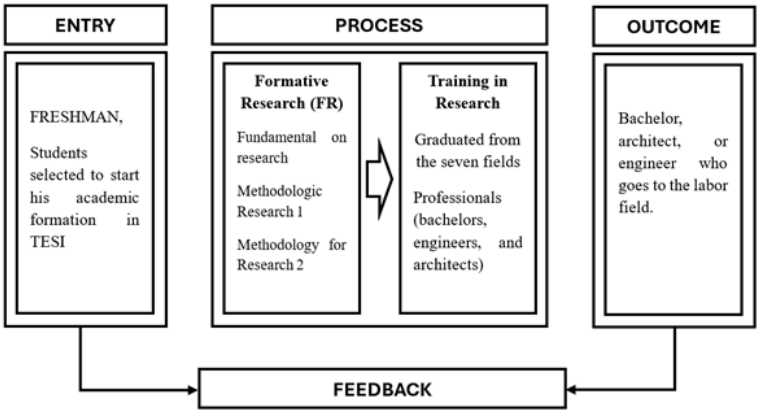
Figure 6. Scientific research and the arrange in the formative research



Source: From Turpo-Gebera, O. M. (2020).

Finally, considering the theory of systems it is evident that formative research and scientific research are integrated in the model to obtain the following scheme (Figure 7):

Figure 7. Fusion of the kind of research in a systemic process



Source: Own elaboration with data from TESI.

As it is shown, the mixing of the systematic process and the formative research results in a friendly internship process for the student with internship process representing a system of formative management by applying the general system theory. Also, the hypothesis is confirmed by observing that, during period of college studies, the student enters to the educational management system where he takes curricular topics and undergo an internship project, allowing tis to develop knowledge in research and to end his formation at graduating and get back to the society to play a role in the labor field.

In 2020, the population of Ixtapaluca was 542, 211 inhabitants, 48.5 % were male and 51.5 were female (Municipio de Ixtapaluca, 2025). In this municipality, there has been an increment in the industrial activities and commercial activities, mostly due to its vicinity with Mexico City and other industrial areas. Some industrial nodes, commercial areas and distribution centers had settled down in the area around TESI with the resulting investing and jobs in several sectors like manufacturing, logistic, and commerce. Also, people from Ixtapaluca has the opportunity to move to Mexico City and take advantage of its opportunities for jobs (Al Día en Ixtapaluca, 2023).

There are 10 universities and colleges in Ixtapaluca (Table 3)

Table 3. Universities and colleges in Ixtapaluca

UNIVERSITY OR COLLEGE
1. Universidad del México Contemporáneo (UNIMEC)
2. Universidad Azteca International Network System
3. Universidad Privada del Estado de México S. C.
4. Universidad UNIVER Milenium del Estado de México S. C.
5. UPEM Plantel Ixtapaluca
6. Tecnológico de Estudios Superiores de Ixtapaluca
7. Grupo Educativo IMEI
8. Instituto Azteca de Formación Empresarial
9. Universidad Libre de Criminalística y Derecho
1. Universidad Mexiquense del Bicentenario

Fuente: https://universidades.org.mx/municipio/ixtapaluca-f05b

From this 10 institutions, Ixtapaluca´s Tecnological Superior Studies (TESI), registered 2, 193 students in 2022; 57% were male and 43% were female. This shows that TESI attends the necessities for education and economic empowerment inside its influence area. In 2022, 170 students graduated from the different fields that TESI offers. The fields with greatest number of graduates were Engineering, Manufacturing & Building (65 graduates), Technology of Information and Communication After graduates), and Administration & Business (49 graduates) (Data México, 2025).

4. Discussion

Velazquez (2007, in his article exposes that the organization is an organic system that interchanges material and economic resources, data, also, is a technical-social system with beginning and ending (finishing activities) which gets complement from the feedback, helping to reinforce the times and the internal processes as: adaptability, reengineering and improvement, of the surrounding interaction.

The focuss of this posture is the process where the TESI´s residency has been determined as an administrative process in an educative institution. By other side, the same author stands out that the organizational systems are based on roles and the interrelationship that exist between them, for this case is looking for getting that the service given to the TESI educative community brings social and economical impacts in the surrounding zone of the institution, also, this result is gotten by means of structural alignment process of all the particulars of the context of this research, the necessary attributes are the ones that the TESI´s student who wish to be a graduate, engineer or architect must fulfill as curse internal normative and the requirements stated in order to realize formative research in their residency´s project to be graduated and go out to the society with an aggregated value as professional.

Formative research has two steps: First, la one focused in the practice, whose is the most recurrent, this one is on march by the teacher´s responsibility to fortify the study in the applied composition mostly analysis and operation; as a second step, the research is addressed to apply the learned skills on academic workshops as is proposed by (Manrique, Valle, Revilla, & Revilla, 2020). This work shows how was done at the TESI´s institution, determining the required subjects that the student must have as a graduated or an engineer prospect in order to do the academic scientific project to finish the university and to get the final degree.

Pointing out the UNESCO (1999) rhetoric, where stablish that the educative institutions as the Ixtapaluca Institute of Technological Superior Studies look for the professional technical systematization formation, which components are in transversal form the practice vision that contributes the employees and for other side the academic part given by the teachers, with the finality of contribute in the human resources quality, which promotes the productive development in the zone organizations, solidifying and moving the economic activity that brings benefits to the professional formation that looks the student in the professional residency´s process.

5. Conclusions

The TESI´s residency process obeys to a gestion administrative system, because is adjusted to the outline of the author Ludwig Von Bertalanffy stablished in the fifties, which contemplate: an entry, a process and an output with constant feedback given by the teachers who is the student advisor in all the process. Also, from the model stablished by Turpo-Gebera (2020), only two phases are fulfilled: instructive and formative research, when the student finishes the university.

The TESI´s student accomplishes three normative courses: Research fundaments, practice research 1 and 2, before the residency´s professional project, with this finishes the formative research project concluding the process when the student is graduated and goes back to the professional field.

In the analyzed period, the 2020 year was the year that less registered students to do residency's; 315 students but only finished 262 students. Year that began the COVID-19 pandemic and were implemented the online classes.

From the TESI seven careers, the most population at the graduate level was the administrative carrier, in second place architecture carrier, and in third place the computational systems engineer. The

one with less participation were: in first place environmental engineering, in second place electronic engineering and in the third place, computer science engineering. However, all the carriers bring social and economical development to the families in the region.

Contribuciones:

María Eugenia Estrada-Chavira: Conceptualization, research, methodology, project management, validation, visualization, writing of original draft, writing, revising, and editing.

Horacio Eliseo Alvarado Raya: Formal analysis, drafting, original draft.

Pablo Emilio Escamilla García: Formal analysis, drafting, original draft.

María Juana Hernández Flores: methodology, supervision, validation, writing, revising, and editing.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Annexes

Annex 1. Student´s descriptive statistics that realized residency in the administrative and architecture carriers,

Period	Administration graduates				Architecture			
	Enrolled	Failed	Finished	Annual	Enrolled	Failed	Finished	Annual
2020/1	21	6	15		9	8	1	
2020/2	109	32	77	92	60	20	40	41
2021/1	9	0	9		24	10	14	
2021/2	92	12	80	89	47	17	30	44
2022/1	8	0	8		57	5	52	
2022/2	77	1	76	84	51	4	47	99
Average 2020/2022				88.30				61.33
Variance				10.90				710.90
Standar Deviation				4.04				26.66

Source: Own elaboration with TESI data.

Annex 2. Student´s descriptive statistics that realized residency in the Biomedical and Computater systems carriers.

Period	Biomedical Enginering				Computer systems enginering			
	Enrolled	Failed	Finished	Annual	Enrolled	Failed	Finished	Annual
2020/1	7	6	1		12	7	5	
2020/2	18	3	15	16	64	6	58	63
2021/1	31	6	25		10	6	4	
2021/2	38	15	23	48	42	7	35	39
2022/1	16	0	16		13	5	8	
2022/2	50	8	42	58	63	2	61	69
Average 2020/2022				40.67				57
Variance				320.9				168
Standard Deviation				17.91				12.96

Source: Own elaboration with TESI data.

Annex 3. Student´s descriptive statistics that realized residency in the computer science and the environmental engineering carriers.

Anexo 4. Student´s descriptive statistics that realized residency in the electronic carrier and administration master degree.

Period	Computer science				Environmental enginieringl			
	Enrolled	Failed	Finished	Annual	Enrolled	Failed	Finished	Annual
2020/1	6	6	0		6	6	0	
2020/2	39	8	31	31	38	4	34	34
2021/1	3	2	1		2	0	2	
2021/2	32	8	24	25	31	11	20	22
2022/1	13	2	11		13	6	7	
2022/2	20	6	14	25	25	2	23	30
Average 2020/2022				27				28.67
Variance				8				24.89
Standar Deviation				2.83				4.99

Source: Own elaboration with TESI data

Period	Electronic Enginering				Administration Master´s Degreel			
	Enrolled	Failed	Finished	Annual	Enrolled	Failed	Finished	Annual
2020/1	2	2	0		10		10	
2020/2	15	2	31	13	8	1	7	17
2021/1	11	6	5					
2021/2	10	1	9	14				
2022/1	9	9	0					
2022/2	12	3	9	9	22	2	20	20
Promedio 2020/2022				12				13.33
Varianza				4.67				30.89
Desviación estándar				2.16				5.56

Source: Own elaboration with TESI data