

Practice and professional training of the civil engineers at the Instituto Tecnológico de Oaxaca

Formación y práctica profesional de los ingenieros civiles en el Instituto Tecnológico de Oaxaca

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Abstract

The main objective of this contribution is to analyze the training process of the civil engineers at Instituto Tecnológico de Oaxaca in the bonding setting that this institution establishes with the regional environment. To bring context to this process we elaborated a historical reconstruction of the Tecnológico Nacional de México (TecNM). The theoretical apparatus gets its basis on the formation theory by Bernard Honoré with contributions from Guilles Ferry, Gadamer and Yurén. In this analysis the bonding is conceived as an enhancing analysis activity of the training process. The methodology is of the qualitative type, with ethnographic approach and a case study. Based on the theory, analysis categories and indicators were built, which were used to elaborate a guide for interviewing and another one for observation. Some partial results indicate that neither the institution nor the teacher are assisting in a satisfactory and adequate manner the different tasks of the bonding with professional settings. These shortcomings do not favor an appropriate professional training to the needs of the regional environment.

Resumen

El objetivo de esta contribución, es analizar el proceso formativo de los ingenieros civiles del Instituto Tecnológico de Oaxaca en el marco de la vinculación que esta institución entabla con el entorno regional. Para dar contexto a este proceso, se elaboró una reconstrucción histórica del Tecnológico Nacional de México (TecNM). El engranaje teórico se fundamenta en la teoría de la formación de Bernard Honoré, con aportaciones de Gilles Ferry, Gadamer y Yurén. En este análisis, la vinculación se concibe como actividad potenciadora del proceso formativo. La metodología es de tipo cualitativo, con enfoque etnográfico y estudio de caso. Con base en la teoría, se construyeron categorías de análisis e indicadores, con los cuales se elaboró una guía de entrevista y otra de observación. Algunos resultados parciales, indican que tanto la Institución como los docentes no atienden de manera suficiente y oportuna las diferentes tareas de vinculación con los escenarios profesionales. Estas carencias, no favorecen una formación profesional pertinente con las necesidades del entorno regional.

Professional training, Bonding, Qualitative

Formación profesional, Vinculación, Cualitativa

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Introduction

The Tecnológico Nacional de México (TecNM) is a national system of technological higher education, made up of 254 federal and state campuses. Its mission is to train professionals in different fields of engineering (<https://www.tecnm.mx>). Since its creation to date, it has gone through stages in which it has been affected by economic, social and political factors, which have had an impact on professional training and its link with the environment.

Since their foundation, the technological institutes have focused their study plans and programs on the needs of each region. The mission of this educational system was to link with the different sectors of regional societies. One of its purposes was to focus professional training on the needs of each region (Martínez and Godínez, 2001). One priority was to provide students with training linked to the regional reality (Hernández, 1976). Another relevant aspect was that teaching should maintain a close relationship between theory and practice, through the experience shared by professors in their professorships.

Thus, during the first generations, the professional training of students was strengthened by both the institution and the teachers. With this objective in mind, throughout its history, curricular reforms and pedagogical innovations were implemented and approved by the General Directorate of the National System of Technological Institutes (formerly SNIT, now TecNM), to strengthen the students' training process.

The first, in 1973, was based on Educational Technology and the systematization of teaching. Teachers were trained to prepare descriptive charts and organize teaching based on behavioral objectives. The academic model was based on a credit system and a reticular curriculum. The second, in 1983, was based on the previous academic structure. A new curricular model was designed based on Jean Piaget's Genetic Psychology and David P. Ausubel's Meaningful Learning, with emphasis on the learning process. The third in 1993, which consisted of simplifying the programs. From the 55 existing programs, they were reduced to 17. Subjects were divided into basic sciences, engineering sciences, engineering design and multidisciplinary training. The professor was assigned the role of mediator and promoter of knowledge (Sanchez, 2015, p. ii).

As a result of the globalization process and the signing of the Free Trade Agreement between Mexico, the United States and Canada (FTA), educational policies for higher education were oriented towards new quality criteria. Based on these criteria, several reforms were approved at TecNM:

- In 2004, the focus on competencies was implemented for study plans and programs, with the objective of adapting academically and administratively to changes in the global and national environment. This reform was formalized with the Educational Model for the 21st Century. This model consisted of three dimensions: philosophical, academic and organizational (DGEST, 2004).
- In 2012, the programs were restructured to adapt them to the professional competencies approach. Based on the three aforementioned dimensions, their axis of union was the integral formation of the student (Idem, 2012).
- Finally, in 2015, the Dual Education Model was proposed for the bachelor's degree. This model proposes a flexible strategy of actions, mechanisms and resources between the TecNM and companies, to articulate professional training with the demands of current technological development in an effective and efficient manner (TecNM, 2015).

All these reforms were applied in the Instituto Tecnológico de Oaxaca (ITO) since its foundation in April 1968. Its creation responded to a demand from the region so that young people of scarce economic resources could have an opportunity for professional training within the state. The civil engineering career was created in September 1973, with the objective of training civil engineers in an integral manner with a human, analytical, creative and entrepreneurial vision, capable of identifying and solving problems efficiently, effectively and pertinently, through the planning, design, construction, operation and conservation of infrastructure works, within the framework of globalization, sustainability and quality, contributing to the development of society (<https://www.itoaxaca.edu.mx/civil>).

A characteristic of the System of Technological Institutes in Mexico has been its adaptation and compliance with the decisions regarding educational policy, as well as the curricular reforms established by the Ministry of Public Education (SEP). In this way, all the previously mentioned reforms were applied by superior indication. However, they did not materialize in the training process because they lacked a substantial component: teachers' knowledge, understanding and acceptance of the meaning of each of these reforms. From the planning stage, they were not integrated into the change processes. Therefore, they did not understand the real scope of such proposals.

According to Malagón (2006, p. 86), the situation described above allows us to affirm that conventional pedagogical systems have shown their inability to respond to the current needs of an integral education centered on creativity, understanding, participation and social construction of knowledge that contributes to satisfying social deficiencies. Undoubtedly, the needs referred to by Malagón have been neglected in the TecNM, to give greater importance to administrative processes, such as the accreditation of careers and quality certification under the ISO 9000 scheme, requirements that are fulfilled with an economic and political, rather than pedagogical, eagerness.

Derived from the previous approach, the authors questioned the conditions that prevail during the training process of the civil engineer. Specifically, those related to their link to the demands of the social, labor and economic environment of the region. In this way, a research question was derived with which it is intended to find explanations to the exposed problem: How is the professional training process of civil engineers of the Technological Institute of Oaxaca carried out in relation to the link established with the regional and national environment? The specific question on which this contribution is focused is the following: How is the linkage of the civil engineer training program with the needs of the regional environment?

Theoretical reference

Professional training and linkage

The present research aims to explain a formative process. For this reason, the concept of training is an axis for the theoretical framework. Training, as Honoré (1980) states, is not only limited to the school environment, but is inscribed as a process that is present in the different spaces of human activity. The different social and cultural interactions that affect the life of a subject, generate knowledge and experiences that allow him/her to develop capabilities, skills and aptitudes that enrich his/her professional performance (Sánchez, 2015).

Understood as a process influenced by the different spheres of human activity, training is conceived as a permanent construction, the result of the interaction of the individual with his environment and depends on cultural, political, social and historical conditions that shape the context of each person (Dueñez and Barraza, 2015).

The interactive and experiential nature of training, allows conceiving that whoever goes through a training process (Honoré, 1980), recovers the experiences and knowledge built to propose transforming alternatives in a free and conscious manner (Yurén, 2000). Self-criticism and self-evaluation, according to this author, will favor reflection on their performance, as well as the possibility of constantly reconstructing their reality.

Reflection, therefore, accompanies this formative process and, in the case of those undergoing professional training, is a necessary condition for their professional development. Thus, the figure of the tutor or teacher as a guide acquires an important role in promoting this development (Schön, 1992).

From this perspective, the concept of professional training was developed, understood as a process during which specific competencies are deployed to solve the problems of a profession. In other words, training that is relevant to the needs of the regional environment. From a professional perspective, a training process enables the student to solve problems, make decisions and adapt flexibly to a changing world.

According to Barrón et al. (1996), professional training comprises social processes of preparation and shaping of a subject for subsequent performance in the workplace. This preparation is based on the mastery and management of theoretical and instrumental knowledge in a given field of knowledge, science, task or discipline. Professional training is linked to two basic references: the field of knowledge and the field of reality. Both, knowledge and reality, are indispensable for training to make sense.

Integrated into the professional training process, the development of competencies is a necessary condition. Learning to know, learning to do, learning to live together and learning to be, according to UNESCO's proposal, are processes that constitute a formative dynamic that, in addition to the assimilation of knowledge, includes the development of skills and values of a future engineer (<https://www.unesco.org.mx>). According to Fernández et al (2007), in the case of engineering, these competencies consist of promoting flexibility; the ability to contribute to innovation and creativity; to face uncertainties; interest in lifelong learning; social sensitivity; communication skills; ability to work in a team; and willingness to assume responsibilities.

Inherent to the process of formation of professional competencies, the actions of linkage with the regional professional environment are essential because they allow the future engineer to develop these competencies. It is through the multiple relationships between the university and the environment, as Malagón (2005) maintains, where educational practice has a determining function for the development, linkage and reflection of disciplinary knowledge with respect to the demands of the national and regional reality. Gould Bei (1997, apud Barreno et al, 2018), argues that linkage is a transforming and integrating activity, because it considers educational, scientific-technological, social and human aspects.

In the field of engineering, Rodríguez (2002) emphasizes the importance of linkage in the professional training process. To this end, he has classified four dimensions, which, in his opinion, should be addressed:

- Linkage with the labor and productive reality.
- Transfer of technological innovations.
- Linkage with productive processes.
- Orientation towards the development of competencies.

The first three are directly related to the productive and technological reality; they consider technology as a component integrated to the production processes that has motivated the specialization of engineering. The last one has an eminently pedagogical approach. The author emphasizes the importance of the link with the labor and productive reality because it is there where the future engineer will know the problems of his area and will develop the competences to solve them. In the opinion of the authors, it is in this link between theory and practice, the scenario where the inter-experience referred to by Honoré (1980) becomes a reality.

From this approach, the linking of the educational practice of formal programs with the professional environment is essential within higher education institutions because it strengthens the professional training of students to respond to regional needs in a flexible and creative way. The linkage is an imperative activity during the different stages of the professional training process. In the case of the training of civil engineers, their approach to scenarios that allow them to learn about the problems of their profession, enables them to articulate and make sense of disciplinary knowledge, by identifying scenarios in which theory finds application.

Methodology

Approach

The purpose of this research is to explain how two formative processes are articulated: school learning and linkage within the professional training process of the civil engineering career of the Instituto Tecnológico de Oaxaca. To this end, an investigation was carried out based on the perspectives and experiences of its main actors: students, teachers, authorities and employers, who construct and interpret this reality from their particular situation with respect to professional training (Galeano, 2004).

To develop this research, a qualitative methodology was chosen, understood as an interpretative process that makes it possible to analyze a social problem (Creswell 1998, apud Iño, 2018). According to Rodríguez et al (1996), qualitative research makes it possible to observe with objectivity and clarity a real subject, who offers information about his or her experiences. It is characterized by moving to the natural context where experiences occur (Cotán, 2016).

The approach to the field was supported by the ethnographic strategy, a basic method of qualitative research. A case study was also chosen to deepen the knowledge of the object under study, with the support of observational recording techniques and an interview guide.

Units of analysis

The research setting was the Tecnológico Nacional de México, Oaxaca campus, located in the capital of the state of Oaxaca, Mexico. Fourteen programs are offered at this campus, nine undergraduate and five graduate programs.

Population. The present analysis was limited to the civil engineering program, which is offered in undergraduate and graduate programs. During the 2018-2019 school year, the program registered 1,438 students. Its faculty is made up of 15 tenured professors and 35 honorary professors. To date, it is the engineering program with the highest enrollment. The undergraduate curriculum consists of 260 credits, distributed in 49 subjects, which are taught during nine semesters. It offers three specialty modules: roadways, municipal infrastructure and structures (<https://www.itoaxaca.edu.mx/civil>). According to data from the federal technological institutes of the TecNM, in the state of Oaxaca, the civil engineering degree is also offered at the Isthmus, Tlaxiaco and Pochutla campuses.

Sample. By means of convenience, purposive and purposive sampling strategies, a sample of teachers, students, institutional managers and employers was selected, according to the criteria described below. The results of the present report correspond only to teachers and institutional managers.

Teachers. Those who perform pedagogical functions that make the professional training process possible. Five full-time professors (33% of a total of 15) were selected for their seniority, knowledge of the career and the labor field. In addition, five honorary professors (15% of a total of 35), who alternate their teaching activity with professional tasks in their area.

Students. Main protagonists of the professional training process. Students in their seventh and eighth semesters were selected because they have already completed more than 85% of the curriculum and are in the specialty modules during the period March-July 2021. Five students per specialty were selected. In addition, 5 students from the ninth or tenth semesters who are in professional residency. A total of 20 students (7% of the population).

Institutional responsible. Assistant director of planning and liaison, head of the earth sciences department, head of career liaison, career coordinator, coordinator of professional residencies and coordinator of social service, who manage the academic-administrative processes of the students, such as academic load, social service and professional residency.

Employers. They are the ones who directly know the problems and needs of the professional field of civil engineers. Specifically, in the field of construction, both in the public and private sectors. Likewise, they value the performance of students, as well as the needs and problems of civil engineers.

Collection techniques

The techniques selected for this research were: the observational record and the semi-structured interview. Both techniques allowed observing, knowing, interpreting and explaining a social reality, in this case the formative process of civil engineers. Being within the research scenario facilitated the approach with these actors. Through the dialogue with the informants, it was possible to go deeper and gain more knowledge about their experiences regarding the linkage within the formative process.

Construction of the categories of analysis and indicators

To construct the categories of analysis and indicators (Table 1), the problem statement, the theoretical underpinning and the methodology were used as a reference. These in turn served as the basis for preparing the interview guide.

Theoretical categories	Actors	Categories of analysis	Indicators
Training	Students	1. Perception of educational practice.	Pedagogical conditions of educational practice - Classroom management - Teacher accompaniment - Evaluation and assessment Linking professional training with the work environment - Tasks in work scenarios Relationship between teaching activity and professional experiences
Vocational Training	Teachers	2. Practice of educational practice.	Teaching strategies. Evaluation. Integration of professional and teaching experience for training. Link between professional training and work environment. - Professional experiences.
Linkage	Institutional managers	3. Management for professional training.	Institutional conditions: curricular counseling and resource management. Correspondence of activities with the student's specialty.
	Employers	4. Needs of the professional practice of the civil engineer. 5. Evaluation of the current training of civil engineers.	Conditions for job performance - Knowledge - Abilities - Attitudes

Table 1 Categories and indicators for the interview guide

The meaning of each of the categories of analysis and indicators related to the different actors in the process is as follows:

Students

Perception of educational practice.

It means to identify the students' appreciation of the teaching and learning process in the context of the study program and their professional training as civil engineers. To know this perception, we will inquire about the pedagogical conditions of their educational practice, namely: the teacher's management of the class, his forms of evaluation, as well as his accompaniment throughout the formative process. Another indicator is the link between the study program and the work environment, through which the student is expected to learn about the tasks of the different work scenarios during the social service and professional residency. Likewise, their opinion regarding the feedback they receive from their advisors, internal or external.

Teachers

2. Educational practice.

The purpose is to identify the way in which teachers put their study program into practice, as well as the accompaniment they provide to students through their theoretical-practical professional residency project. This practice includes the teaching strategies for the student to develop the competencies indicated in the program, as well as the methods to evaluate such competencies. The integration of professional and teaching experience is considered to strengthen the training process. The link between professional training and the work environment involves the relationship established by the teacher between the study program and work problems, in order to situate the student in the regional problems.

Institutional responsible parties

3. Management for professional training.

The purpose of this sector is to identify the steps taken with external scenarios to support the student's professional development, as well as the curricular counseling the student receives from the coordination. When inquiring about institutional conditions, it is intended to know how the institutional resources work to link with different companies and to put at the student's service the ideal spaces for their professional practice. Regarding the relationship between the activities carried out and the student's specialty, the aim is to identify if there is a correspondence between the two.

Employers

4. Needs of the professional practice of the civil engineer.

The aim is to identify how students integrate, innovate and solve situations in the field of civil engineering in order to verify the relevance of the professional competencies established in the study programs with respect to the needs of a constantly changing work environment. By asking about the conditions of students' work performance, the aim is to know how they value the quality, interest and commitment they show when solving problems during their internship or professional residency.

5. Evaluation of the current training of the civil engineer.

It is intended that the employer evaluates the performance of the graduated civil engineers in situations that arise in their professional area.

Results

The perspective of teachers and institutional leaders

Since this is a research in progress, the analysis presented below only offers the perspective of teachers and institutional leaders regarding the relationship between educational practice and institutional linkage.

a) Teachers

Ten teachers were interviewed, five on a permanent basis and five on a fee basis. Each sector of teachers has clear differences. The former are located in the common core, are dedicated to teaching and have job stability within the institution. From this condition, they have abandoned substantial activities such as teaching and professional updating courses, visits to companies and advising students during their social service and professional residency. The latter are located in the areas of specialty, which allows them to integrate teaching with their profession, and consequently have a closer approach to the professional reality of the civil engineer. They have an institutional limitation because they are not allowed to participate in academy meetings, in the updating of study plans and programs, visits to companies, social service, professional residency and professional exams. Their participation in these tasks is occasional.

Regarding educational practice

Teachers with basic appointments

Their teaching strategies consist mainly of power point presentations, videos and school work projects. With these activities they develop the topics of the program, which do not move towards a reality related to the profession, since visits to the laboratory, field and companies are scarce.

Teacher 1: (...) This subject, pavement design and construction, is a theoretical and practical subject, laboratory tests have to be performed (...) We do not have equipment for the asphalt area, we do not have software for pavement design, the students graduate and at work is where they begin to know it, in the field the students use it (...).) With the internet the students are already looking for videos, for example, now, with the contingency, they submit videos of other students from other universities who had the opportunity to go to the laboratory (...).

Teacher 3: (...) I am one hundred percent dedicated to teaching (...) Not participating in professional practice activities does not limit my teaching practice (...).

Students are evaluated with projects, attendance, teamwork and exams. Although the evaluation strategies are diversified, the exam occupies an important place to verify that they have acquired the professional competencies set by the curricula. However, an exam is limited to measuring knowledge and displaces skills and attitudes, which are fundamental for the student's professional practice. Teachers do not evaluate the competencies set out in the curricula because they do not identify them.

Teacher 1: (...) I evaluate them with exams, class participation, research work, internships and I also take their attendance into account (...)

Teacher 2: (...) Something that students are used to are exams, it seems that students like exams, also with exercises in class and I go over one by one what they are doing (...)

Teacher 4: (...) The main thing, I am going to be honest, for me it is attendance, it is everything. Well, they also do some work. The problem with the assignments is that they start copying and pasting, at some time I used to leave them by hand, but there were problems (...) I really see this matter of competencies as a little obscure, a little strange, I don't understand them. Honestly, I teach my classes in a traditional way (...)

Regarding Teacher 3, he did not answer the question, he did not mention the competencies of his program, he shared a screen showing the notes of his study program, but the competencies were not identified.

Another necessary aspect for student training is the professional experience of the teacher, which clarifies important topics in class, advises the field work and allows for guidance and clarification of doubts. This group of teachers lacks current professional experience. The practice to which they refer is at least 10 to 15 years old, which does not favor linking theory with practice in a pertinent manner. On this topic, their responses were:

Teacher 1: (...) Not at the moment, at least not this semester. Several years ago, in previous semesters I have participated in audits in San Luis Potosí and Veracruz in the laboratory of the Secretariat of Communications and Transportation (...)

Teacher 2: (...) I do not have professional experience, only in my doctoral stay I was at the Mexican Institute of Transportation, a research body of the Ministry of Communications and Transportation and at the Center for Research and Advanced Studies (CINVESTAV), (...)

Teacher 4: (...) It is not always, only when they request my services, I am a consultant for some companies as design, studies and projects (...)

In the authors' opinion, this sector of teachers does not see professional experience as a bridge for students to identify real problems in their profession and receive guidance on those problems. For this reason, they consider that notes or technological tools are sufficient. According to their opinions, technology will replace such experience.

Teacher 3: (...) Right now, for example, in moodle I have everything, I have direct links to connect to meet, the whats app group, all the basic information we can have such as the diagnostic test. Meet as a tool has helped me a lot, I have also been using google drive, all the technology tools. I have no major problem (...)

The relationship of this sector of teachers with the problems of the regional environment is limited. This is one of the reasons why the visits to the companies marked in the syllabus are not carried out. They argue that the process takes a long time and the coordination in charge of managing this activity requests many requirements.

Teacher 4: (...) I do not visit companies, the truth is a responsibility, it is a lot of paperwork, something can happen to the students and the parents can hold you responsible (...)

Teacher 5 (...) I have several acquaintances who are in construction sites and I ask them to let me know when they have a collado so that I can send my students (...)

Teachers with honorary appointments

Their teaching strategies coincide with those of regular teachers. The difference is that they are able to refer to concrete cases and experiences. In their classes, they make demonstrations that illustrate the theory with some cases that they solve in their professional environment due to their professional practice.

Teacher 6: (...) I am dedicated 50% to teaching 50% to my profession (...) It favors my teaching practice because it allows me to be updated (...) I consider attendance, punctuality, participation and I have not taken exams for more than 10 or 15 years (...)

Teacher 7: (...) I teach the subjects of water supply and sewerage. They are totally practical subjects, taken in the last semesters, seventh and eighth. In these subjects you have to do a project (...) Professional experience is basic for teaching. I respect the profile of each teacher, (but) I think that sometimes they fall into very theoretical aspects. Explaining only what comes in the book, of course, is correct, but I realize that students are very attracted to professional experience (...) Besides, with my professional experience I can say: 'what it says here is done this way' (...).

With regard to the evaluations, they are mainly directed towards the projects they have carried out, without disregarding the exams, team work and participation.

Teacher 7: (...) I evaluate with projects, but I don't give the same grade to everyone because with the team assessments I give, I can see who are the ones who work the hardest. The online exam is complicated because it is practically a group exam, it is an open book exam, in a team, but related to the projects and there I detect those who do not participate in the project. I also consider the participation (...)

Teacher 10: (...) I examine all the concepts seen, I am not so strict in the sense that I ask for the definition as it is, but what interests me is that with their own words they can interpret the different concepts. I evaluate them with the research topics I have left them, diagrams or processes, to see the process of an environmental impact. At the end I give them an exam of all the units seen, 10 questions from unit 1 to unit five, key questions to analyze that they have the basic knowledge, a final diagnosis. I want them to tell me what each of the eight chapters consists of, I know it is difficult, but in the future they will know what an environmental impact statement consists of.

For this group of teachers, the institutional regulations do not open space for them to participate in important activities for the career, such as curricular updates. The following case was an exception:

Teacher 9: (...) In 2019 I had the opportunity to be invited, I participated and the curriculum was restructured, in the specialty subjects (...).

Initiative and interest can be seen in these professors, but normatively they are unable to participate beyond their class. Some of the honorary professors request support from the regular professors for outings or visits, but the latter do not collaborate with such initiatives.

Teacher 8: (...) As far as outings are concerned, at some time the most I could take them out was to the ethnobotanical garden and from then on I can't do it anymore because it involves managing the truck. Who is going to take them, who is going to be responsible, and as I am a fee-paying employee it is not possible, it has to be a basic one. I would have to be in coordination with some of them, but nobody wants to be responsible, because it is not their group and I understand that. This stops me (...).

b) Institutional managers

The institutional managers are in charge of managing the work spaces to comply with the requirement of social service and professional residency. Six were interviewed. Three of them are trained as civil engineers. They should know the academic and administrative needs and processes of the students and the career.

The other three are not trained in civil engineering, attend all the specialties of the institution and do not necessarily know the specific practice of the civil engineer. However, both groups assume their functions only with an administrative approach. They adhere to institutional regulations and lose sight of the student's needs and the relevance of the linkage for the training process.

Regarding the management of professional training

Regarding the administrative advising of students, when they define their academic load, they turn to the coordination and sometimes choose subjects without sufficient knowledge of the curriculum. In order to advance, they choose non-serialized subjects, because they do not know that they require previous knowledge and competencies. Without such knowledge, it is difficult for them to obtain accreditation, which causes them to fall behind or even cause their definitive withdrawal. Although the regulations include that students should receive timely advice from the career coordination or designated professors, so that they can go through the curriculum in a planned and organized manner, this is not complied with.

Responsible 1: (...) It is convenient to advise them and in fact it is done in the first semester, I explain to them why they have to take their subjects in order, when students choose their subjects I try to make them do it in order (...) The problem is that there are students who choose subjects that do not correspond to them and although they are not chain subjects, they are subjects in which they must have certain competences to be able to take them. The consequences are that students recur or take special exams and when they reach this point the guidelines limit them to no more subjects and they have a maximum of 20 credits, priority must be given to the special exam (...).

Each semester students are faced with insufficient scenarios, for this reason, in some cases, they look for their social service and professional residency scenarios in order to perform in their area. The support coordinations state that they do not have a structured work plan to link students with the productive sector. In addition, there is no systematized database of companies to contact.

Responsible 2: (...) I have been building this database, I talk by phone with the construction companies and when I attend the congresses, many people go there, construction companies, companies, I introduce myself and ask for their card, then I contact them requesting the space for my students, at other times it is the students who seek their own spaces for their professional residency (...)

Responsible 3: (...) As such a work plan with residents does not exist, I have not seen it. The heads of liaison should call me so that together we can go to the company. There are no companies for students to go to for their residency. The students often look for the companies. My job is limited to preparing letters of introduction (...) I have a directory of the companies that I am collecting, it is only a list. I have no links with the companies, I have no communication (...)

They recognize that there is no communication between the coordinations, which does not favor the linkage because there is no structured and coordinated work plan. They limit themselves to giving a talk to the students when they leave for their social service and professional residency, as well as receiving their reports.

Responsible 1: (...) (with) the liaison coordinator we do work as a team, but we only receive the reports, I do not know if there is communication between the coordination and the department of technology management and liaison, in theory there should be communication (...).

Responsible 3: (...) There are no precise actions, what I see is a lack of interest (sic) on the part of the authorities (...).

Other interviewees affirmed that there is communication between the areas responsible for supporting social service and professional residency students. However, the scarce information they provided suggests that they are unaware of the problems experienced by students in work settings. Nor is there a Council and a Liaison Committee, which would be responsible for linking the institution with the business, public and private sectors. In addition, they affirm that the student is the one who has priority in the Institution, therefore, they are equipping laboratories so that they have more tools to defend themselves.

Responsible 5: (...) The electronics, computer, electrical, mechanical and civil laboratories, with these we are specializing the laboratories for the students (...) Now we are seeing what we have never seen before, teachers are working with students, although there are very few teachers who want to participate, right now we only have one. We want the teachers to be accredited (...) We do not have a linking council, not because when we arrived with the pandemic we were late, this is a pending task (...) What we do have is a Quality Management System. We have already had the first audit, the second internal audit is coming (...) A current database of the companies is being created, we want to carry out a type of control (...).

When we tried to inquire about the relationship between the student's activities and the specialty they are studying, no information was provided, so it was not possible to assess the concordance between the training programs and the tasks performed in those scenarios.

Responsible 4: (...) Nothing is done because everything is solved at the moment. For example, the engineering residencies are specific, they are answered punctually and as the issue is unique, it does not have to be taken to the academy (...) It is not discussed in the academy. Because of the flu (sic) the boys do not go to the company. In the past, there was no problem (...)

Responsible 5: (...) We made an analysis and from there the student's specialty comes out so that the company knows what the student should do. There is no feedback, (from the social service or the residency) it is limited to administrative work rather than academic work. We are the administrative part (...).

For this sector of informants, the formative and social character of the linkage for professional training is of little relevance. For most of them, the conception of the relationship as an administrative task and not as a transforming process for the professional performance of the civil engineer prevails.

Responsible 3: (...) They focus on the linkage only as a service, there are agreements to provide a service, for example, to teach courses (...) For me, the linkage is to be able to enter into this topic with companies and with society itself, to see the deficiencies that society has and to be able to enter with an innovation project, the linkage is not only with social service or professional residence, it is also in the postgraduate area, I feel that a strategy is needed to link with all sectors, this would benefit the student.

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Conclusions

The present contribution focused on explaining the participation of teachers and institutional leaders of the Instituto Tecnológico de Oaxaca in the process of professional training of civil engineers. The point of interest was the linkage actions carried out through the activities of the teachers in their educational practice, as well as the efforts of the institutional managers so that the students have work scenarios. The following conclusions can be drawn from the analysis carried out:

Despite the implementation of the competency-based approach in 2004 and its subsequent modifications, in the case analyzed during this research, a growing distancing between academic training and professional reality can be seen. This distancing is manifested by the insufficient linkage of the Tecnológico with the different social sectors. Student visits to companies in the region are scarce; there is bureaucracy in the procedures to go out into the field; the study plans and programs do not respond to regional needs. These problems affect the professional training of future civil engineers.

The absence of timely academic and administrative counseling during the different stages of the career, prevents students from orienting themselves adequately within the study program. In addition, it influences the possibility of forming an integrated and sequenced representation of the profession for which they are being trained.

The lack of professional updating of full-time teachers is a deficiency that limits their teaching practice because, when faced with problems of the profession, they are not updated to identify and solve students' doubts. Consequently, students do not receive the necessary and timely professional help to solve them.

There is a significant imbalance in the teaching staff, of which 15 are full-time and 35 are honorary. The difference lies in the ability of both to bring students closer to the real problems of their profession and to show their experience in solving these problems, i.e.: "...what it says here, is done this way...". The aforementioned difference influences the willingness of full-time professors to be employed. On the other hand, honorary professors have an integrated vision of theory and practice, which allows them to be oriented towards the linkage.

On the part of the institutional managers, who are in charge of the linkage, there is a lack of knowledge of the needs and problems of the students in relation to their work scenarios and experiences. This lack of knowledge implies that the relevance of the institutional linkage within professional training is lost sight of. Consequently, decisions are not made in a timely and pertinent manner to support students during social service and professional residency.

The linkage is assumed as an administrative process, rather than an activity that makes it possible to transform and in turn integrate training with the professional and social sectors. Thus conceived, outreach has been circumscribed to three administrative activities: company visits, social service and professional residency. The qualitative nature of the function of the coordinations has lost sight of the students. For this reason, both teachers and the Institution should assume the responsibility of paying more attention and strengthening the links with the different social sectors to favor the quality of the professional training of civil engineering students.

Within the professional training process, networking is a component that does not depend on isolated actions such as visits to companies or poorly advised internships. In this activity, teaching functions and institutional support are combined, which will allow the student to situate himself in the scope of the problems and needs of the profession. The actions of the professor to link his subject with the problems of the profession, as well as the orientations that the student receives during his performance in work scenarios, must be combined with the capacity of the Institution to manage sufficient and adequate spaces for the students.

The professional practice of the civil engineer has a social function because with the support of current technology he/she plans, designs and solves problems related to urban and rural infrastructure, which means a real relevant contribution. In order to fulfil these tasks, networking is a necessary activity that allows the development of competences and gives meaning to the training process.

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