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THE CASE OF THE TECHNOLOGICAL UNIVERSITY OF SAN JUAN DEL RÍO FOR THE NECESSARY SKILLS FOR WORK PERFORMANCE

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Abstract: This paper analyzes the skills to adequately perform a profession and the training process. The powers are useful and necessary tool in the development of an educational program in the research study evaluated the development of skills of a sample student in the Information Technology and Communication Educational Program at the Technological University of San Juan, Queretaro, Mexico, during the professional practices. The results show the need to balance the university's role in the generation and transmission of knowledge in the development of thinking skills to achieve the skills required at work.

Keywords: higher education,professional training, technological universities, skills, professional performance, Mexico.

INTRODUCTION

Although training for professional work is not the only function institutions of higher education must fulfill, it is without doubt a vital function. Given the importance of the function, it is useful to ask what type of training these institutions should offer, what skills are a priority in the current socioeconomic and cultural context, and of course, what the effective contribution of institutions of higher education is in developing such skills. This study approaches these subjects to evaluate the degree to which the process of professional training in a technological university contributes to students' acquiring the necessary skills to perform adequately in a profession.

The technological universities were created in Mexico in 1991, with the intention of diversifying the supply of higher education by offering two-year majors to high school graduates and awarding a degree as a university technician. This option aims at professional training that is closely related to company requirements in the region where the schools are established, in order to facilitate graduates' quick incorporation into the productive sector (workforce).

Since their creation, the technological universities have become fundamental in the policies of higher education. They were conceived as a privileged option to meet the training needs of the younger population demanding education as well as the productive sectors demanding qualified human resources. The educational authorities have the firm conviction that the technological universities offer the type of education that the country requires to meet some of the challenges of national development, including coverage, diversification of options, pertinence of education, and satisfaction of market needs. Due to the above, the subsystem of technological universities has seen accelerated growth, increasing from three institutions in 1991 to 74 at present. To achieve their objectives, the technological universities assume an educational model centered on polyvalent, flexible training that is intensive and linked to the productive sector. And this is where the model is unique: it attempts to abandon the idea of the school as the only location for professional training and promotes training in the productive sector linked to the sector's needs, in order to prepare competent professionals.

Polyvalence refers to training in one or several groups of activity or in general activities that are applicable to all branches of production; the intention is for graduates to have the ability to adapt and make an occupational transition. Based on these factors, study plans are divided into four levels: *a)* basic: 19% of the total hours of the major; *b)* generic: 29%; *c)* specific: 37%; and *d)* flexible: 15%. Only 37% of the time is reserved for specialized knowledge while the rest is dedicated to a general and flexible level.

Intensity is made manifest in two directions. On one hand, contents are concentrated into their fundamental aspects, with an elimination of elements not conducive to practice (SEP-CGUT, 2010); thus study plans are organized into a ratio of 30% theory and 70% work in laboratories and workshops/companies. On the other hand, the use of time is intense. Courses are taken in six fifteen week periods, with thirty-five hours per week (seven hours of work per day) and a total of three thousand hours (equivalent to 80% of a conventional undergraduate degree).

The technological universities subsystem aims at the pertinence of majors, contents, and learning methods through links with the productive sector. The goal is to know professional requirements, evaluate profiles, agree on supports for practice sessions, and create employment channels. The educational model anticipates linking the university technician to the productive sector throughout the training process, by means of visits, company internships, and diverse projects. Such links reach their peak with a company internship during the sixth and final four-month period, when students are incorporated into a company to develop a useful company project under the supervision of an academic adviser (a technological university professor) and a company adviser (in charge of the area on the firm's behalf).

Given the technological universities' professional vocation, questions about their contribution to professional training that meets the needs of the current employment world become fundamental. An examination must be made of the agreement between the technological universities' educational supply and the needs of the labor market in terms of required skills; study must also be made of the degree to which students achieve expected learning. In this manner, we shall attempt to determine if technological universities offer relevant training and if so, to what degree.

Skills in Professional Training

The concept of skills was originally applied only to labor. However, the concept is now significantly influencing the field of general education, not only because of its contribution to preparation for employment, but also because of its support for educational transformation focused on integral training.

In the labor context, this concept was first utilized in 1960 to identify the abilities a worker should have to perform adequately in the job market. The discussion includes positions that focus on the outside demands on individuals, associating skill directly with occupational demands and describing skill in terms of what the individual must demonstrate: performance. Other positions are centered on the underlying factors of individual responses (Malpica, 2007), such as cognitive, motor, and social/affective elements implicit in what the individual must do. Hager and Beckett consider both elements. They combine *tasks*, which are the activities of an occupation that are manifested in its undertaking, and *attributes*, which refer to individual abilities: knowledge, competencies, aptitudes, and values. As a result, these authors define skill as "a relation between an individual's aptitudes and the satisfactory performance of the corresponding tasks" (Hager & Beckett, 2007). They also indicate that although attributes are necessary for skill, attributes alone are not sufficient; the concept of skill must include the notion of aptitude or ability applied to certain tasks.

Gallart & Jacinto (2005) conclude that skills are situated midway between knowledge and concrete competencies; skill cannot be separated from action, but at the same time demands knowledge. Skills must be tested by solving concrete problems in work situations that involve certain margins of uncertainty and technical complexity. Thus the concept establishes a radical difference from the old notion of qualification that made reference to skills and competencies that were applicable to a specific job title and that were handled as potential, not as the real capacity of application.

In the educational setting, this concept was initially utilized for professional training due to the implications that job requirements have on the preparation of human resources; at a later date, it penetrated into all educational levels. Questions about the skills that schools should provide have become one of the central topics of the world debate on education. The Organization for Economic Cooperation and Development (OECD) has made important contributions in this area and defines skills as "the ability to put into practice in an integrated manner the competencies, knowledge, and attitudes to confront and solve problems and situations" (INEE, 2008). The OECD refers to a system of complex action that integrates intellectual competencies, attitudes and other non-cognitive factors such as motivation, values and emotions that are learned and developed by individuals during their lifetime and that are indispensable for participating efficiently in different social contexts.2

At the level of higher education, the *Tuning Educational Structure in Europe*3 project—consisting of more than 120 universities from 45 European countries—is known for establishing the generic and specific skills that should be formed in higher education. For Tuning "these skills represent a combination of attributes (related to knowledge and its applications, aptitudes, skills and responsibilities) that describe the level or degree of sufficiency a person is able to use in carrying them out" (González and Wagenaar, 2006:80). As a consequence, the degree of realization of a competency can be evaluated through the ability that a person shows on performing a task.

Through a methodology of consulting with professors, companies and graduates, the project established a list of two types of skills: specific and generic. Specific skills are related to the professional profile and are crucial because they are directly linked to concrete knowledge of a topic. Generic skills, on the other hand, are attributes, like the capacity to learn, the capacity of analysis and synthesis, etc., that are common to all or almost all professions (González and Wagenaar, 2006) and are considered fundamental in a transforming society in which demands are undergoing constant change. According to Tuning, a college education must achieve a balance between generic and specific skills.

In spite of broad dissemination, the term, skills, generates controversy and reveals an absence of conceptual articulation as well as genealogical perspective of the concept. (Díaz (B., 2006). Tobón (2006) defines skills as complex processes of performance that are ideally in a predetermined context, with responsible action; while other authors, such as Perrenoud (1999), favor effective performance in a setting based on but not limited to knowledge. An important part of the educational sector—OECD, UNESCO—recognizes skills as abilities that integrate knowledge, competencies, and attitudes; however this integration is not always explicitly reflected in programs based on this focus. For example,
according to Tuning, a skill is the ability to analyze, while other focuses view it as the competency of thinking (Frade, 2007) that supports other skills. The diversity of treatments leads to problems, particularly in the design of programs that require the identification of the skill, the desegregation of its components, and the results of learning and educational experience.

In this article, we shall ignore the part of the subject that is related to curriculum design, and shall focus on the concept—even with divergence—to identify the results of professional training. This is possible because, as shown by the brief summary of the concept and its applications, agreement exists on the basic criteria that characterize skills: their components—knowledge (or information), competencies and attitudes—and their integration into an ability that is used. In other words, it is not about potential abilities or rehearsed acts in a controlled environment, like school, but about abilities put into practice in different settings of real life. Therefore, in this article, we shall use the term skill to identify the abilities—that integrate knowledge, competencies, and attitudes—of young people who are finishing a training process to respond effectively to the demands of professional life.

STATEMENT OF PROBLEM AND METHODOLOGY

Due to the importance of production-related professional training for technological universities, our question regards the degree to which the educational processes of technological universities take into consideration the demands of the context—not only companies located in the immediate area, but also the broader setting reported in the specialized literature on this topic. We also consider their degree of effectiveness in training qualified personnel with the required skills. Concretely, we are looking for answers to the following questions:

1) What is the degree of articulation between the abilities or skills established in the technological
2) University's professional profile and the demands for qualifications present in the work environment?
3) What are the performance requirements of the companies that receive undergraduates?
4) What is the degree of articulation between the professional training received at the technological university and the demands of employers?
5) What performance level do undergraduates show regarding the skills established in the profile and market demands?
6) What is the measurement of the undergraduates' performance in satisfying the needs of employers?

The study was centered on the Technological University of San Juan del Rio (UTSJR) and the information technologies and communication. Since this major pertains to the engineering and technology area, it significantly reveals the reason for the existence of this educational subsystem. It is also one of the most highly demanded majors, making it relevant in its field. The San Juan del Rio University is founded in 1998. Its development depicts a model that has shown its potential; therefore its evaluation can produce valuable information on the possibilities and scopes of technological universities.

To identify the skills that a graduate from the university technician program in computer science must have, we conducted a curriculum analysis to compare the graduate's profile with: *a)* the current demands resulting from the new needs for qualifications in the employment world, as reported in the literature on the topic, and *b)* the concrete demands of a group of 48 companies that receive undergraduate students from the technological university, measured by conducting a survey to determine the companies' general characteristics, use of technology, and duties assigned to the undergraduates.

To evaluate the degree of performance attained by the students in terms of skills, the performance of the computer science undergraduates was examined during their company internships. Each internship provided an opportunity to examine the results of the training obtained by the young people who had finished the fifth four-month period before their formal entry into the labor market. The technological university provided all the facilities to interview teachers, to observe their educational processes, and to remain in contact with the companies that receive the undergraduates. Individual and group interviews were conducted with the director of the computer science major, the coordinator of internships, the coordinators of the academies, the professors of the five key courses in the computer science major, and all of the undergraduate academic counselors, who talked about their opinions of the professional training offered by the technological universities (curriculum, educational processes and objectives of internships). We visited ten companies in the Querétaro City metropolitan area that have close ties with the UTSJR, and interviewed eleven company advisers to determine their opinion of the undergraduates' performance and their relation with company needs. The last step was to poll fifty young people—out of a total of 95—who completed their internship during the four-month period from May to Aug, 2009, to discover their perception of the professional training and its relation with the demands of internships, and their own performance during the internships.

The Skills Required for a University Technician an information technologies and communication

The curriculum of the computer science major at the UTSJR attempts mainly to train specialized human resources to meet the demands of the formal sector of the economy, which has transformed the organization of work due to technological innovations and the economic changes associated with globalization. As De Ibarrola suggests (2004), the locations of modernism in the formal sector are being converted into the paradigmatic model. In that sense, the characteristic elements of work organization and companies' demands for qualifications configure a useful frame of reference for examining the skills demanded by the current world of employment, as well as the way these skills are considered in the technological university's computer science curriculum.

In first place, it is necessary to take into account that the increased complexity of productive activities translates into a demand for higher levels of training to carry out new types of operations with sophisticated technologies. This process, as Filmus points out (2004), tends to generate a demand for qualified professionals who must have the following skills: an ability for abstract theoretical thinking, and an overall understanding of the technological process reinforced by solid training in logic and mathematics, statistics and computer science.

Upon analyzing the profile of graduates from the university technician program in Information technologies and communication(ITC), we did not find these skills explicitly, even though the study plan includes an important block of basic sciences—mathematics, computer science and physics—that can influence the development of the ability for theoretical and abstract thinking. Neither is mention made of the overall understanding of the technological process; however, upon analyzing all of the predetermined skills, we identified that as a whole they cover several areas of action in the computer science major: programming and development of systems, networks, technical support and systems management; these should facilitate the understanding of the entire technological process that is contained in the field.

On the other hand, the productive sector demands polyvalence in workers since the new forms of organization are moving toward greater versatility in specific activities as well as toward the elimination of permanent jobs linked to permanent duties. In this scenario, several authors (Ibarra, 2007; Gallart, 2005; Filmus, 2004; González, 2006) point out that professional training must motivate the workers' ability to execute multiple tasks and functions that do not pertain to only one position, but to a wide range of associated positions. This requires one employee to integrate an ample spectrum of duties connected to heterogeneous contents. Demands of this nature were found by Villa-Lever (2006) upon exploring employers' requirements for university technicians. The employers insisted these technicians should be able to carry out multiple tasks: that in addition to operating machines, they should be able to adjust, maintain, and repair them.

Polyvalence is a basic principle of the technological university's educational model. Several of the abilities considered in the profile of university technicians in computer science conform this skill (SEP-CGUT, 2000):

- To know and manage different settings and processing equipment and their operating systems for developing applications.
- To design and develop programs using diverse programming languages and settings.
- To design, develop, implement and operate information systems that meet the needs and the efficient, productive development of organizations.
- To install and manage computer networks in the local area.
- To develop and coordinate training activities and provide technical support to users.

At the present time, there is a tendency to make the organizational forms of production more flexible, favoring a decentralization of decision-making. Increasingly more tasks require decision-making of an individual nature at moments when fast access to relevant information reduces the margin of time for making decisions (Filmus, 2004). In this framework, the following is required:

- Ability to think strategically and plan and respond creatively to changing requirements.
- Ability to observe, interpret and react with decision-making when confronting unexpected situations.
- Ability to solve problems, competence to identify, recognize and define problems, formulate alternatives, equations, solutions, and to evaluate results. Ability to transform ideas into practical applications.

- Ability to be autonomous in making decisions.

This group must include the *ability to analyze and synthesize,* which was emphasized by Tuning's project as one of the main generic skills. In the particular case of computer science technicians, the ability to analyze is fundamental since it is required in all projects related to the handling of information, to translate into technological developments that satisfy organizations' needs.

We do not find this set of skills in the profile for university technicians with a major in computer science. The absence represents a serious limitation, since these skills refer to *thinking skills* that can be applied in any activity undertaken by the graduate. In addition, these skills permit the development of other skills. As indicated by Novick *et al.* (2008), the skills and abilities of this nature—called *intellectual skills—*along with the basic skills of reading, writing and mathematics, configure the cognitive substrate that operates as the basis of the knowledge and skills that support the performance of any type of activity.
Other requirements result from the framework of the work organization, which requires cooperation and interaction among various occupational roles, and skills:

- managing information: to acquire and evaluate information; to organize, maintain and communicate information, including proper oral and written communication, as well as the mastery of languages; and interpersonal skills: communication, teamwork, cooperation, leadership, ability to negotiate.
- The profile for university technicians in computer science includes these needs:
- to analyze and specify the information requirements of any organization;
- to design, develop, implement and operate information systems that satisfy the needs for information and the most efficient and productive development of organizations;
- to develop and promote habits and attitudes that favor teamwork; and to comprehend, read and write in English about subjects related to computer science (SEP-CGUT, 2000).

Lastly, it is necessary to take into account that the rapid evolution of technologies makes it an obligation to think in terms of workers' permanent training. At the same time, new occupational profiles are being created and require new training to meet demands. This requires that professionals have the *ability to learn and train permanently*.

This skill is required in different settings of personal and professional performance. In this sense, a revealing result of Tuning's project is the "*ability to learn*" as one of the most important generic skills for any profession. The university technician's professional profile does not consider this skill in an explicit manner; however, it is involved in the ability to assimilate in an effective and efficient way the new technological developments of hardware and software and to evaluate their possible use in the activities that the organization conducts or work team performs (SEP-CGUT, 2000:45). Table 1 shows the comparison that we have established between the established skills in the profile of university technicians in computer science and the necessary skills for professional performance. In general terms, we see broad articulation; however, a vacuum exists around the thinking skills.

Table 1: Established Skills in the Profile of University Technicians in Information Technologies and Communication versus Skills Required in Professional Performance

Skills in the Work World	Skills in the Profile of University Technicians
• Ability to think in a theoretical abstract way. • Overall understanding of the technological process reinforced by solid training in logic and mathematics, statistics and computer science.	• Not explicitly apparent. • Implicit in the basic science component and in the specialized contents of computer science.
• Ability to think strategically, to plan creatively and to respond to changing demands. • Ability to synthesize and analyze. • Ability to solve problems. • Ability to make decisions in unforeseen situations. • Ability to make autonomous decisions.	• Not taken into consideration in an explicit manner.
• Polyvalence.	• Polyvalence: the constitutive principle of the Technological university's educational model. Broad • Technical training.
• Skills for managing information. Interpersonal skills: communication, teamwork, cooperation, leadership. • Oral and written communication, mastery of languages.	• To analyze and specify information requirements. • To design, develop, implement and operate systems. • Teamwork. • To understand, read and write english.
• Ability to learn. • Permanent training of workers.	• To assimilate in a correct and efficient manner new technological developments and evaluate their possible utilization.

Source: Filmus, 2004; Gallart, 2005; González, 2006; Ibarra, 2007; SEP-CGUT, 2000; González and Wagenaar, 2006.

The indicated elements refer to a generic plane of analysis in terms of skills that are relevant for the job world. However, it is also necessary to determine are the specific requirements of companies that employ university technicians in computer science who graduate from UTSJR, as seen below.

Skills required by companies that accept undergraduate students

To evaluate the companies' requirements in terms of the professional use of computer science, the dissemination of this technology was explored in a sample of 48 companies that accept UTSJR's undergraduate students. This exploration revealed a scenario that participates in the dynamics generated by the systems revolution to a greater or smaller degree. We found a large segment of 35 companies with a *technologically specialized profile* that have integral applications of systems, and a smaller segment (thirteen companies) with a *basic technological profile* that incorporates systems in an isolated manner without significantly impacting their work organization. Nevertheless, both groups of organizations demand qualified human resources to meet their needs.

The next step consisted in approaching the type of skills involved in these organizations' productive processes and development, which translate into qualification demands for human resources. We used as a framework analysis the projects that these companies assign to undergraduate students in computer science, since they meet the real professional requirements. Taking into consideration the degree of complexity of these projects and the skills that must be carried out to conduct them; we established a classification (Table 2). Level 1 corresponds to a project that required an elemental mastery of what the technician is trained to do—data entry, for example—while levels 4 and 5 demanded an integral performance of the functions of a university technician, involving a combination of complex skills and in general a higher level of qualification; examples are the projects known as "Technical support system for users and personnel training", of an institute, and "Development of the support module for sales with an interface for service and invoicing".

This distribution indicates that most of the projects (69%) carried out in the companies demand a high level of technical qualification. This is particularly noticeable in the group of companies where level 5 projects are executed—almost one fifth of the sample (18.5%)—that involve the performance of complex functions for which a university technician in computer science is trained. One half of the companies require level 4 projects that also need the mastery of the complex skills of a university technician in computer science. In summary, the analysis indicates that a good part of the job market for university technicians demands solid training that allows performing diverse functions in information systems processes that combine different types of generic and specific skills.

Table 2: Level of complexity of the Projects associated with the Involved Skills

Skills in the Work World	Skills in the Profile of University Technicians
• Ability to think in a theoretical abstract way. • Overall understanding of the technological • process reinforced by solid training in logic and • mathematics, statistics and computer science.	• Not explicitly apparent. • Implicit in the basic science component and in the specialized contents of computer science.
• Ability to think strategically, to plan creatively and • to respond to changing demands. • Ability to synthesize and analyze. • Ability to solve problems. • Ability to make decisions in unforeseen situations. • Ability to make autonomous decisions.	• Not taken into consideration in an explicit manner.
• Polyvalence.	• Polyvalence: the constitutive principle of the technological university's educational model. Broad • Technical training.
• Skills for managing information. • Interpersonal skills: communication, teamwork, • cooperation, leadership. • Oral and written communication, mastery of languages.	• To analyze and specify information requirements. • To design, develop, implement and operate systems. • Teamwork. • To understand, read and write english.
• Ability to learn. • Permanent training of workers.	• To assimilate in a correct and efficient manner new technological developments and evaluate their possible utilization.

The Performance of Future University Technicians in Computer Science: Demonstrated Skills

To approach an evaluation of the professional training attained by the young people who attend UTN we explored their performance during their company internship,7 emphasizing their demonstrated skills. We grouped the students according to the orientations of Tuning's project and as presented in table 3

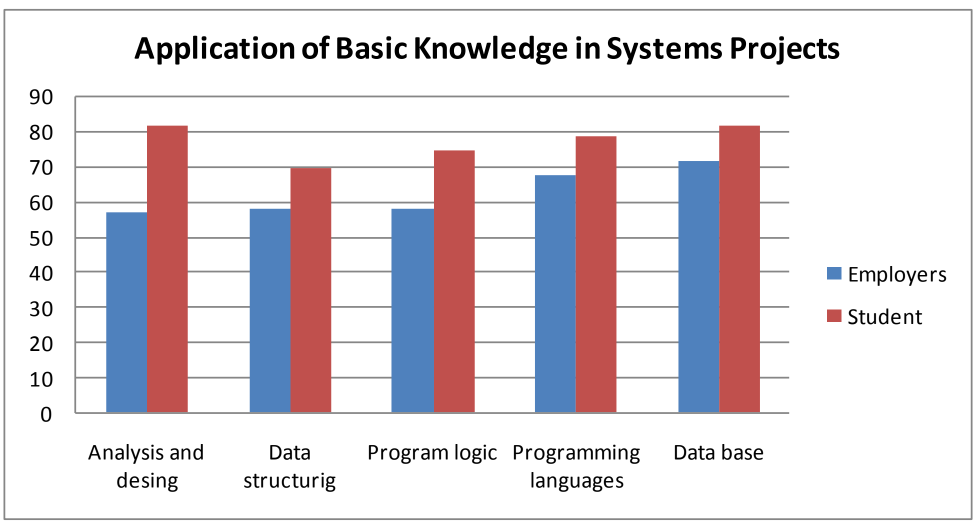
Table 3: Evaluated Skills in the performance of undergraduate students

Specific skills	Generic skills
• To have basic knowledge of the computer science area and to apply this knowledge to the development of projects related to the area. • Management of information. To specify the information requirements of any organization or person.	Assimilation and application of new knowledge. Ability to learn. • Analytical and logical ability. • Problem-solving. • Decision-making. • Ability to work as a team. • Communication skills. • Polyvalence.

Specific skills demonstrated during internship

The first specific skill explored was the mastery of *basic knowledge of the area.* This does not refer to a formal management of information but to the ability to apply information to different project tasks.
For evaluation, we started by identifying the contents or the fundamental information a university technician in Information technologies and communication must master. The interviews with the director of the computer science major and the academy coordinators allowed us to identify the following findings:
a) Logic of programming/computer algorithms
b) Analysis and design of information systems
c) Data structure
d) Data bases
e) Programming/languages

The employers evaluated the undergraduate students' mastery and implementation of these skills grade of 61 points on a scale from 0 to 100, defining an elementary mastery. The basic skills that received better grades were data bases (72) and programming languages (66) (Graph 1).



Graph 1

The major deficiency is found to be in programming logic, analysis and design, and data structure (57 points). The employers pointed out that the undergraduate students knew how to use some products— languages or data bases—but that they did not handle a well-structured programming logic.

They showed limitations in analyzing the information that would feed a system and in designing models for its organization. In this respect, one company adviser commented:

> […] They were not expected to carry out the system's conceptual designs, and were expected to know how to interpret them, to offer alternative solutions to the problems that arise during development, but they had many difficulties in doing so.

The insufficient mastery of both logic and analysis, as well as the language used in programming, obstruct an efficient performance. The comments of two company advisers are eloquent in explaining this disadvantage:

> […] they do not have a mastery of the Visual Basic language nor do they have well-defined programming logic, and these are the minimums I would expect from a technician.
>
> […] they do not know the theoretical and logical fundamentals of what they are doing and they limit themselves to the use of some applications.

The students' evaluation of applied knowledge differs widely from these opinions. While employers evaluated the mastery of knowledge with scores between 55 and 72 points, the young people's evaluations were between 74 and 88. The most notable difference is in the area of analysis and design, evaluated the worst by the employers (57), yet evaluated the best by the students (82). Even though the young people evaluate their knowledge with high scores, upon carefully analyzing the conditions of their performance they recognize that one of the main difficulties they faced was their insufficient knowledge of hardware, programming languages and tools used by companies, such as Delphi and SQL Server. This situation limited their performance and they were forced to use a large amount of time to learn quickly the basic contents necessary for project development.

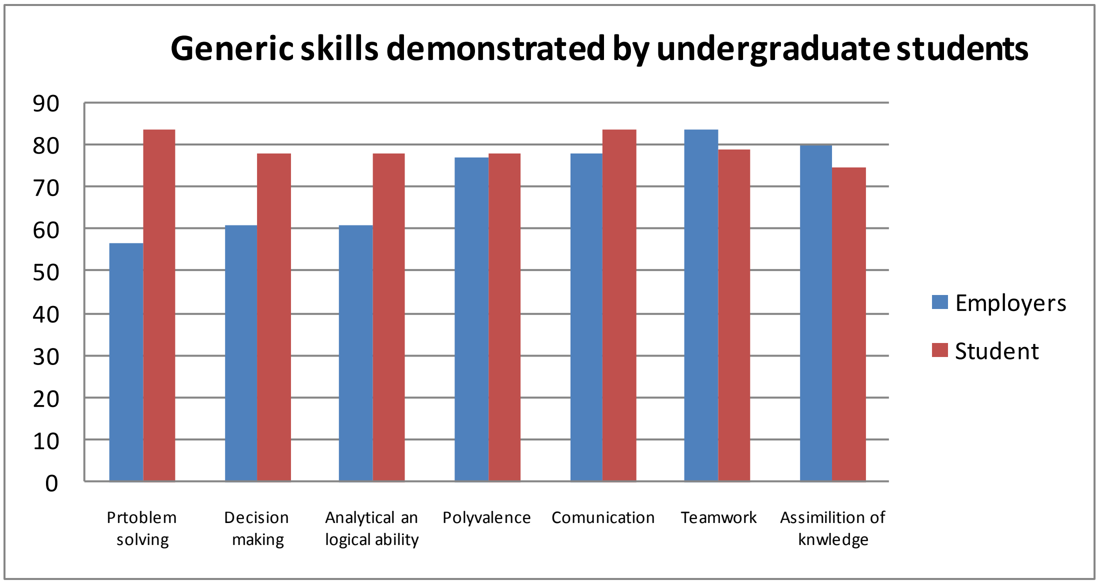
The other specific skill that was explored was the *ability to manage the information* of any organization.

Employers awarded a high score (70 points) to the ability to search for and specify information directly related to projects; however, they did not equally evaluate the ability to analyze, process and utilize information for constructing a system. This skill is fundamental in the setting of our interest because it constitutes the basis for the design, development and instrumentation of information systems that are required in the productive sector and that are the key subjects of the professional career of a university technician in computer science.

Generic Skills Demonstrated during internships

The generic skill best evaluated by the employers was *teamwork* (84 points), which is indispensable in the framework of organizational forms that require cooperation among different occupational roles.
Systems are frequently developed by work teams, on which workers must form part of collective work and make a specific contribution (Graph 2).

At the same time, *the ability to learn and assimilate the new contents quickly* obtained good scores among the employers (81 points). This skill can be the end result of years of training. We could infer that the processes followed throughout a formal education train students to assimilate contents that they did not handle during their studies, but that are required to complete tasks. According to the employers, the young people were open to the explanations and teachings derived from work and were able to incorporate this learning to the tasks they were required to execute. According to Cariola and Quiroz (2007), this skill is key in a context of increasingly complex systems of innovation and permanent updating in company operations. Specifically, in the use of new technologies, this ability is fundamental since the constant improvement of products demands the permanent training of involved personnel.



Graph 2

Polyvalence, the main priority of the technological university's educational model, was positively evaluated by the employers (75), who believe that young people have the willingness, interest and ability to work in different activities of the information systems process: development, support, planning, production, evaluation and administration of systems and resources. At the same level is the *ability to communicate* (75 points), which is of great importance in a world where teamwork is constant.

Teamwork requires a clear expression of ideas to integrate the parts of a project and to guarantee the quality of the whole.

At the other extreme, the skill the employers evaluated as the worst with respect to the undergraduates' performance was *problem-solving* (58 points). In their opinion, the young people showed difficulties in recognizing and defining problems, analyzing them and offering alternate solutions. They also found insufficient *analytical and logical ability* (61 points), as shown by the comments of a corporate adviser who offers specialized services in the area: "they are not able to follow the program, to analyze what has been done and offer similar or compatible solutions with the scheme of reference".

Another skill that employers believe does not reach a high degree of achievement is *decision-making* (61 points). Although most of the projects had very limited scope, certain decisions were required in their development; the young people faced difficulties, however, in making those decisions and work was frequently stopped because of a lack of orientation. One company adviser comments on the subject: "They were asked to create a screen and allowed to choose the methodology to follow, the structures to be used, etc., but it was difficult for them to make these decisions."

These three skills—analytical and logical ability, recognition and solution of problems, and decisionmaking—are recognized as *thinking skills*, 1994; Gallart and Jacinto, 2005; Frade, 2007) or *intellectual skills* (Novick 2008). They constitute a fundamental requirement for achieving an adequate performance in today's job world. It should be mentioned that these skills are not considered in the professional profile of university technicians in computer science, and that this void is reflected in performance that is not totally satisfactory for the productive sectors.

Upon comparing the employers' and students' opinions in this matter we also found differences. While the employers' evaluations range from 58 to 84, the young people's oscillate between 79 and 90 points. The closest evaluations are in *teamwork*, *the ability to learn and apply new knowledge*, the *search for information* and *communication skills*. The most significant difference is found in *intellectual skills—problem solving, analytical and logical ability and decision-making*—where we observe a difference of more than twenty points. The comparison of both visions is useful because it allows defining the degree to which undergraduates were able to assimilate the demands of the productive sector. The discrepancy in *intellectual skills* can be a reflection of the undergraduates' lack of awareness its implications. The origin of this effect can be traced to the training process they have experienced throughout their formal education, especially their university training.

The modest degree these skills are carried out in the computer science major offered at UTSJR constitutes a serious disadvantage in professional life since, as we have pointed out, intellectual skills are increasingly required in a job world whose organization is flexible and changing. It is noteworthy that employers perceive this need and believe that: "instead of teaching very concrete languages, it would preferable to improve the young people's intellectual training, giving considerable weight to abstract reasoning, that would allow them to learn and handle any tool quickly".

At the same time, it is useful to notice that these skills are directly related to specific knowledge of the professional field of system. In the above point we indicated that the subjects of analysis and design, data structuring and programming logic did not show satisfactory results; we could assume that insufficient mastery in these subjects is reflected in limitations in the skill necessary to put them into practice. In this sense, we find plausible the statement by Frade (2007) regarding the existence of a close relation between knowledge and thinking skills since knowledge produces skill and skill produces further knowledge.

Problem-solving permits illustrating this relation. According to the OECD (2003), this skill implies understanding a situation, identifying the information or relevant restrictions, presenting possible alternatives or routes for a solution, selecting strategies, solving the problem, reviewing and thinking about the solution and communicating the results. Therefore, it has a complex character that involves other thinking skills such as understanding and reflection, as well as conceptual and procedural knowledge to understand how processes occur, which factors intervene, how they are organized, and so on. In short, a university technician requires solid knowledge of the computer science field to be able to identify where problems arise and how to solve them. In this sense it is useful to take into consideration the indications by Ruiz (1998) regarding the new productivity guidelines that demand knowledge as well as the application of knowledge in solving problems that constantly arise in production processes. All seems to indicate that there is little use for isolated knowledge that is learned by memory. On the contrary, knowledge should be supported intellectual skills or thinking skills that enable its use and application in solving problems in the real world.

DISCUSSION OF RESULTS

The curriculum for university technicians information technologies and communication covers to a good degree the main skills needed for adequate performance in a job world that is impacted by new technologies: polyvalence, management of information, and overall understanding of the technological process. Although the relevance of the educational program is shown, we find a void in intellectual skills, which are not explicitly incorporated into the professional profile of university technicians.

Current demands for training point to the need to have not only a disciplinary knowledge of
exercising the profession, but also the skills that allow that knowledge to be applied in solving the diverse problems that arise in productive activities. Requirements for professional training aim at integral preparation that, in addition to favoring technical abilities, also covers broad intellectual training and solid knowledge for understanding processes. Professional performance requires technicians to understand work processes through the information they receive, and to have the ability to analyze information in abstract terms and apply it in diverse and complex contexts. These conditions must be present in professional training programs; however, this goal has not yet been fully reached.

The analysis of the performance of undergraduate students in the computer science major at UTSJR revealed a level of basic sufficiency in the mastery and application of three sets of fundamental knowledge in the area.

This result reflects limited training that will have consequences on participating in today's society—characterized as the society of knowledge—and on having access to the job world in favorable conditions. Sectors that produce knowledge-intensive goods or services favor the role of workers who have a solid basis for solving problems and, in parallel form, for generating new knowledge through obtained results.

In the sphere of generic skills, undergraduate students showed an outstanding performance in teamwork, the assimilation and application of new knowledge and, to a lesser degree, in communication and polyvalence. It is useful to emphasize that these skills have an important attitudinal component since they imply a willingness to carry out the tasks that involve this sort of behavior. The young people showed positive attitudes toward teamwork, learning, interpersonal communication and performance on diverse tasks. These skills are a good example of the integration of the three central components of the concept—knowledge, skills, and attitudes—since they require useful information for carrying out tasks, skills for understanding a project as a whole and in its different parts, and personal skills for working on a team, along with a positive attitude about employment. In this respect, it is important to emphasize that the company advisers also positively evaluated other attitudes that students revealed in their performance, such as responsibility, respect and the willingness to learn. We can affirm that this type of attitudes represents an important basis for using and demonstrating skills.

The young people showed a lower degree of accomplishment, however, in analytical and logical ability, decision-making, and problem-solving. Such results are of concern since they refer to intellectual or thinking skills that are fundamental for adequate performance in life in society as well as on the job.

The causes for the insufficiency would have to be traced in at least two locations. On one hand, their absence from the curriculum; the result may be due to a lack of pedagogical strategies to promote these skills since they are not considered as an objective of learning in higher education. On the other hand, we have the low mastery of knowledge that is reflected in limitations in understanding and designing pertinent processes, solving problems as they arise, and making fundamental decisions on the steps to follow.

In line with the contributions generated by the discussion of skills in the educational field, this study has shown that it is impossible to separate knowledge from skills. Learning to learn and learning to do are to a large measure inseparable (Delors, 2005). The acquisition and understanding of knowledge requires certain skills—such as thinking—while at the same time, solid knowledge offers a basis for developing abilities like decision-making and problem-solving. For the technological universities, this represents a central challenge. Whether or not a skill-based curriculum is incorporated, the technological universities will have to implement educational transformations that lead to more efficient
and relevant professional training.

One of the first elements that deserves revision is the large number of subjects (34) included in the curriculum.8 It does not seem useful to saturate the content of study plans because the time students need for reflecting and appropriating knowledge would be reduced. This curriculum configuration may be considered a product of the ruling cult of knowledge in our universities, which has resulted in the inadequate handling of skills and attitudes and has caused excessive use of repetition and memorization to assimilate knowledge (Silva, 2006). For training in engineering, Rugarcía (2006) warns that an emphasis on information leads to teaching methods that cover only one dimension of the profile for graduates: concepts and information. Yet little attention paid to the other two components of any profile, and which are more important: the development of thinking skills and the formation of attitudes related to values. This author concludes that the number of subjects, topics, and bibliographies must be reduced and teaching methods transformed to combat memorization-based or mechanical learning among students. Technological universities should take into account that excess content can asphyxiate the possibility of working on student skills and attitudes, and can lead to insignificant learning.

Another aspect of the intensity principle worthy of examination is the norm that dictates that 30% of the curriculum should be directed to theory and 70% to practice. An examination of the training process in the computer science major at UTSJR (Silva, 2006) showed that students perceive an inverse relation: too much theory and not enough practice. The students' statements suggest that during practice hours, exercises are not

carried out that would lead to an understanding of classroom concepts and postulates and their integration into significant learning; nor is adequate attention paid to the development of thinking skills. Thus "theoretical knowledge" is not grounded according to the demands of professional practice. The strategies most used do not always lead to the development of a
skill, but instead lead to training in following previously defined steps and procedures to find a solution in an exercise.

To remedy the distances and confusions regarding these important dimensions of the educational process, Rugarcía (2006) offers useful orientation for designing programs. According to this author, practice can be understood as the ability to attain or handle knowledge in problem-solving; it is not limited to application but also contemplates the possibility that, through practice, new knowledge or learning may be acquired. Simultaneously, it is necessary to show the importance of theory, understood as the knowledge of sciences and disciplines relevant for exercising a profession. Thus theory can be applied to solving problems, as well as to assimilating new knowledge of the schemes a student already possesses. In other words, solid scientific and technological knowledge is fundamental for solving many of the problems faced on the job, as well as for foreseeing or anticipating problematic situations and innovating practice. From this point of view, it would be worthwhile to ask if only 30% of the time is sufficient in all subjects to assimilate the relevant theory for the professional field. This also motivates questions regarding the pertinence of giving homogeneous treatment to all subjects. Such a practice seems to be a reflection of confusion about the meaning of the dimensions of theory and practice— confusion that often occurs.

An additional element should be considered. According to De Ibarrola (2006), in the economy of knowledge (in which this factor is a productive force of great importance), the notion of knowledge is redefined and evolved. No difference is marked between theory and practice or between abstract and applied knowledge; instead, the importance of job performance resides in integrating both in order to carry out productive tasks and solve problems based on knowledge. If we take into consideration this relevant framework of reference, we could state that absolute differences between the two concepts seem obsolete. The demands of professional training point to the need to integrate theory and practice to generate general knowledge as well as knowledge of value for exercising a profession that responds to the needs of the job market.

Lastly, it is useful to examine the link to the productive sector, a central principle in this educational model, which couples production with current trends in professional training programs. The aim is to intensify practical training and close connections with the job world in order to facilitate the application of knowledge in solving real problems at work. The productive sector is also expected to enrich students' intellectual training with new knowledge. However, although the model foresees permanent student contact with the productive sector, such contact is established fundamentally during the sixth four-month period in a company internship, when the student has practically graduated. Evidence shows that in practice, the university seems to be the only source of knowledge that is assumed valid.

Throughout the educational process, the use of other locations—like companies—for this end is low (Silva, 2006). Such a situation not only contradicts the spirit of the technological universities, but also fails to meet the challenge of a new system for professional training that promotes exchanges between the school and the company as areas for supplementary training.

In synthesis, although UTSJR has established a curriculum that includes the main challenges of professional training, it still requires a profound process of revision to evaluate achieving the mission of:

Offering Mexican society higher education of good quality, as a strategic means to improve human capital and to contribute to raising the competitiveness required by an economy based on knowledge, with the integral preparation of University Technicians who can support the transformation and development of the diverse sectors in the nation (CGUT, 2010).

All seems to indicate that this mission is not achieved simply through training focused on the technical aspect of performing a job. On the contrary, integral training—intellectual, technical and attitudinal—is required to train competent professionals able to respond to the complex changing demands of the job world. It is necessary to take into consideration that the horizons of this type of training hold not only adequate job performance, but also integral education that provides training for participating in society and life in general.

The university plays an important role in the generation and transmission of knowledge as well as in the development of skills and attitudes for applying that knowledge. In that sense, training in skills offers substantive orientation for educational systems in general and for professional training in particular. As Malpica indicates (2007), such training attempts to modify curriculum design, teaching practices, and evaluation centered on learning concepts, theories or techniques—learning that is reduced to information the student stores. Instead, learning situations should be diversified to permit students to adopt a more active role, to understand the meaning and function of these principles, and to exercise their usage in situations in which principles are combined in different ways. The challenge consists of overcoming the strong tendency to focus on transmitting knowledge, in order to aim at the
integration of knowledge with individual skills and attitudes for the effective management of different settings in life.

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