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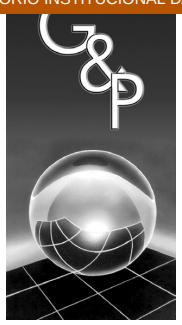

A comparative analysis of the competences required in contemporary professional practice of engineers and those in the national curriculum guidelines for engineering courses

Uma análise comparativa entre as competências requeridas na atuação profissional do engenheiro contemporâneo e aquelas previstas nas diretrizes curriculares nacionais dos cursos de Engenharia

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Abstract: The notion of competence is increasingly present in the academic and professional environments. In this context, engineering education in Brazil has established, through curricular guidelines, a roll of competences to be developed during the undergraduate courses. Based on this legislation, a question arises on the adequacy of these definitions regarding what is actually required to professionals. Thus a survey was conducted with engineers in the work market to verify the adequacy of the established legislation to the competences required in practice. It was observed that technical knowledge is fundamental, and well-developed in educational institutions; however, the management area, although addressed to some degree in the guidelines, is not developed during graduation, becoming a deficiency to be corrected by professional engineers.

Keywords: Competence; Engineering; National Curriculum Guidelines.

Resumo: *A noção de competência é cada vez mais presente no ambiente acadêmico e no mundo do trabalho. Nesse contexto, o ensino de engenharia no Brasil estabeleceu, através das Diretrizes Curriculares para a graduação em engenharia, um roll de competências a serem desenvolvidas durante o curso. Com base nessa legislação, surge o questionamento a respeito da adequação dessas definições ao realmente requerido pelos profissionais em atuação. Dessa forma, procedeu-se à pesquisa junto a engenheiros atuantes no mundo do trabalho, a fim de verificar a adequação do estabelecido na legislação e ao requerido na prática. Observa-se que o conhecimento técnico é de fundamental importância e bem desenvolvido nas Instituições de Ensino; contudo, a área de gestão, embora prevista em algum grau nas diretrizes, não é desenvolvida durante a graduação, sendo detectada como uma deficiência a ser corrigida pelos engenheiros.*

Palavras-chave: *Competência; Engenharia; Diretrizes Curriculares Nacionais.*

1 Introduction

According to Lucena et al. (2008), for more than two centuries, "what" and "for what" the engineer should learn depended on the country or region in which he was to work, however, today the need for knowledge and the way of acting tend to be more homogeneous, due to the existence of greater mobility in the professional practice, which in fact did not occur a few decades ago.

Lucena et al. (2008) point out that the organizations that defend engineering education are motivated and concerned about the need for institutions to have a training program in keeping with current reality, especially with the levels of mobility and competitiveness in the sector.

Allied to the mobility of performance, changes in the labor market and in society, as a whole, affect the characteristics necessary for the contemporary engineer for his adequate professional and social performance. One can mention, for example, the increasing efforts to act in order to preserve the environmental conditions, to improve and to develop

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sustainable processes, with a view to the quality of life of the population.

In the 1990s, the debate about the profile of the engineer for the new millennium intensified, the term "competence" came to occupy a prominent role in studies on the profile of the contemporary engineer and also according to Lucena et al. (2008), in Europe and the USA, important studies were begun to define what the necessary competences would be for the engineer, as well as to discuss the need for reform in the education system.

In Europe, the Bologna Declaration was signed in 1999, with one of its objectives being to define the training to be achieved by graduates of higher education courses, including those in engineering. In the US, ABET *(Accreditation Board for Engineering and Technology)* established in 2000, new criteria for the accreditation of engineering programs, depending on the changes in the profiles required for the work of engineers (ABET, 2014).

In Brazil, following the world trend, there were also discussions about the profile of the engineer, and was published in 2002 with the objective of enabling the formation of a professional in line with the current needs of society and the labor market, Curricular Guidelines Nationals of the Engineering Undergraduate Course, who propose the profile of the engineer with a generalist, humanistic, critical and reflexive emphasis.

Tonini (2011, p. 4) explains the concepts of general and critical education, as relevant data for engineering teaching, reflecting on the role of educators in the sense of:

> [...] To contribute to the critical and generalist training of the engineer - critic if he is able to organize his knowledge in a structured manner and with priorities for his training; and generalist if, in seeking the knowledge, the engineer makes that his vision of reality is no longer restricted to the accumulation of theories, in a context of production previously established, starting to constitute an explanatory matrix for problems and enigmas that surround man and its existence.

Based on the current scenario, it is noted that the performance of the engineer, besides being based on solid technical knowledge, should be associated with non-technical knowledge in order to achieve the goals and aspirations of society and the labor market. However, the questions to be asked is whether the proposed changes to the Engineering egress profile, to be achieved by Higher Education Institutions, are compatible with that required for their practice.

In order to obtain the answer of such questioning, the research was carried out with engineers working in several companies with headquarters or branches in Minas Gerais, in order to obtain the vision of these professionals in relation to the most important competences in their scope of performance.

The qualitative research was done using the data obtained by the FORQUAP research group, from 2010 to 2012. During this period, FORQUAP researched, with funding and support from CNPq, productive relations in the work situation of the technical, and engineer of mining companies. The companies surveyed are concentrated in the automobile, energy, mining and metallurgy areas, due to their great representativeness in the State of Minas Gerais.

The survey was attended by 06 (six) companies operating in the state of Minas Gerais, in sectors such as mining, metallurgy and power supply. A total of 68 (sixty-eight) individuals were interviewed, including 17 (seventeen) engineers, who are the subjects of the present study.

Based on these answers, it was sought to verify if the competences defined in the National Curricular Guidelines of the Engineering Degree in Brazil meet the current needs, as well as to identify the competences necessary for the professional performance of the contemporary engineer, in the professionals' The competences required in the professional performance of the engineer are compatible with those defined by Resolution CNE / CES 11 of March 11, 2002.

However, according to Gama & Silveira (2003), market research is useful to raise problems and deficiencies, but should be used as a subsidy by the academy to draw up solutions and proposals of profile or curriculum with a vision of the future, and not simply to define the objectives and profiles to be achieved in the short term, avoiding an immediate view of the situation.

2 Competence

Although it has gained a prominent role, especially since the 1990s, the term competence has a polysemic meaning, making it difficult to adopt a common concept among the areas that use it. Isambert-Jamati (1997, p. 103) reports that "[…] the term 'competence' (in the singular) and those of his family (competing, competently and competently) belonged to the legal language at the end of the Middle Ages". In this same direction, Dadoy (2004, p. 108) states that "[…] the notion of competence comes from to latin *competentia*, derived from *competere*, 'arrive at the same point', derived from *petere,* 'reach the same point'. It refers to 'to what should', in the old French, meant 'appropriate'", being used, at present, with distinct concepts, depending on the area of approach in which the term is inserted.

Le Boterf (2006) conceptualizes competence from three dimensions, namely: i) the size of available resources, which refers to the resources that the individual can mobilize for his action; ii) the size of actions and results, which constitutes the action itself and its results; and iii) the dimension of reflexivity, which consists in the detachment of the individual from the previous dimensions, allowing the analysis of the practices adopted and their learning from the reflection.

In relation to the resources that can be mobilized, Le Boterf (2006) indicates that they can be derived from the personal resources of the individual, such as knowledge, know-how, cognitive abilities, among others, and resources derived from the context in which he is found, such as networks of operations, competences of colleagues, database, for example. The actions and results, in turn, translate the knowledge to act in a pertinent way in relation to the situation, event or problem presented, based on the resources mobilized; "[…] knowing how to act does not presuppose the mastery of isolated aspects, it implies being able to combine different operations", in order to achieve the desired goal (Le Boterf, 2006, p. 62). Reflexivity, or detachment, refers to the extent to which the individual will analyze his practice in relation to a given event and the results obtained.

In a similar conception, Zarifian (2012) presents three statements for the term competence, with different approaches. The first approach is given to changes in work organization, due to the retreat of prescription and increased autonomy, and, under this aspect, competence is defined as "[…] 'taking the initiative' and 'taking responsibility' from the individual of professional situations with which it is facing" (Zarifian, 2012, p. 68).

The author emphasizes that the terms "take initiative" and "assume responsibility" are related to the autonomy that the individual possesses in the competency model and its consequences. Taking initiative "[…] means that the human being is not an application robot, that has the capacity for imagination and intervention that allows him to approach the singular and the unforeseen" (Zarifian, 2012, p. 69), supported by his repertoire of knowledge, experiences, etc. Responsibility, on the other hand, is the counterpart of autonomy, that is, the individual is responsible for the decisions he or she makes and for the consequences arising from such decisions (Zarifian, 2012, p. 71). Zarifian (2003, p. 85) further clarifies that "[…] autonomy is an unavoidable condition of the development of competence; the heart of the latter, however, lies in taking initiative".

The second approach focuses on the dynamics of learning, defining competence as "[…] a practical understanding of situations that builds on acquired knowledge and transforms them as the diversity of situations increases". It should be emphasized in this approach that the individual should have a practical understanding, that is, analyze and understand the situation presented to him, aided by the knowledge that he possesses and that will be mobilized for such, and, from this singular situation or of work, it will be possible to increase their knowledge based on the lived experience (Zarifian, 2012, p. 72).

The third approach focuses on teamwork and co-responsibility of individuals. In this case, the author presents the competence as "[…] the faculty to mobilize network of actors around the same situations, it is the faculty of making these actors share the implications of their actions, is to make them assume areas of co-responsibility" (Zarifian, 2012, p. 74).

Solving problems with a certain degree of complexity can hardly be given individually. In this respect, joint action (the mobilization of the network of actors) requires that all stakeholders share the proposed objective and that they are jointly responsible for the actions to be taken, which sometimes does not occur, due to the segmentation of the company in several sectors, with interconnected tasks, but with different objectives (Zarifian, 2012)

Based on the definitions presented, it is concluded that, in general, the notion of competence is centered on the individual, because it depends on their actions, facing a given situation, and their knowledge or knowledge, to be used as a guide element for Decision making in order to have the desired or expected result.

It is also emphasized that competence is evidenced in a practical situation, necessitating the action of the individual. According to Ropé and Tanguy (1997, p. 16), "[…] competence is inseparable from action". Similarly, Perrenoud (1999, p. 7) points out that the notion of competence includes the individual's need to have "[…] an ability to act effectively in a given type of situation". In their definition, Fleury & Fleury (2000, p.21) reinforce the need for "a responsible and acknowledged act of knowing".

Knowledge is also a fundamental element for competence, since it will support the decisions and actions of the individual in the practical situations, so that he can obtain the desired results with his actions. According to Zarifian (2012, p. 72) "[…] there is no exercise of competence without a supply of knowledge that can be mobilized in a work situation". Perrenoud (1999, p. 7) points out that,

> […] in order to face a situation in the best possible way, several complementary cognitive resources must be taken into account and in synergy, among which are the knowledge.

It is observed that the notion of competence is associated with elements such as group work, communication, responsibility and ethics, since increasing the complexity of situations experienced by the individual, in most cases, makes it impossible for him to act in isolation, being necessary, in order to reach its objectives, the performance in team.

Another point to emphasize, in the notion of competence, is that the individual must seek the learning and the knowledge coming from the singular situations with which he is facing, increasing his repertoire of knowledge and actions for future situations that he will face.

Authors such as Le Boterf and Zarifian present definitions of competence according to the french conception, in which the competency model aims to break with taylorist logic and propose a new form of work organization, with a focus on the individual.

On the other hand, the american conceptualization line proposes competence as an element of the individual and that will contribute to the optimal performance in the execution of its tasks. It also proposes a prescription of these competences according to the type of task to be performed. It is observed that the american concept reinforces the taylorist model, residing, in this respect, one of its differences in relation to the French current. Authors such as Boyatzis, Spencer, McLand and McClelland are examples of the american strand in the studies on competence.

Quoted by Boyatzis (1982, p. 21), Klemp introduces the concept of competence as a "[…] basic characteristics of a person that result in an effective and / or superior *performance* in a job." In this respect, as discussed previously, competence is treated as an individual characteristic, which allows superior performance and, to that end, must be combined with two other aspects, which are the type of work and the organizational environment of the company.

This concept refers to the prescribing of the job position of the taylor's model, with specific competences being assigned to a specific job, and the individual, in order to achieve superior performance, must possess the knowledge, skills and attitudes, i.e. the competences, prescribed for that position, thus reinforcing the taylorist guidelines of work organization.

Finally, it should be pointed out that the concept of competence, as studied by the french, remains polysemic in the present day, since, as Ropé & Tanguy (1997, p. 16) point out, the uses of the notion of competence they do not allow a conclusive definition of competence. In fact, it presents itself as one of those crossed notions, whose semantic opacity favors its inflated use in different places whereas the concept presented in the american line is conclusive. It is also emphasized that the use of the concept of competence is increasing, with more and more companies and educational institutions adopting it, to some degree, the models related to it.

3 National Curricular Guidelines

Due to the growing need to update the curricula of the engineering courses, as well as the pressure exerted by the academic environment and the labor market, the MEC published Notice nº 04/97, with the purpose of conducting the discussion with the Teaching Institutions Superior and with the scientific society on the new curricular guidelines to be elaborated for the undergraduate courses in engineering. In 2002, as a result of this announcement, the National Curricular Guidelines for the Engineering Degree in Brazil, Resolution nº. 11/2002 (CNE / CES), were approved, with significant advances in relation to the 1976 legislation. The new Curricular Guidelines Define a new egress profile, aimed at a solid technical training and acquisition of skills and competences, with certain flexibility for the institution to achieve this objective, to be explicit in its pedagogical political project, replacing the focus in the curricular framework of the previous legislation. Teaching is no longer teacher-centered and student-centered, and the content-focused curriculum prioritizes the development of skills and competences. According to Ferreira (1999, p. 130), this action triggered

> […] a new curricular tendency that, instead of imposing a minimum curriculum, aims to define curricular guidelines with the purpose of serving as a reference for Institutions of Higher Education in the organization of its education programs.

However, the National Curricular Guidelines for Engineering Undergraduate Courses do not include in their writing the definition adopted for competences and skills. The definition of competence in the basic document of ENEM/INEP (Brasil, 2002a) and the definition of professional competence in Resolution CNE/CEB nº 04/1999, which establishes the National Curricular Guidelines for Technical Level Education, and in Resolution CNE/CP nº03/2002, which establishes the General National Curricular Guidelines for the organization and operation of higher technology courses.

The ENEM/INEP document conceptualizes competence and ability, distinguishing between the two, presenting a concept of ability as a know-how of developed skills, which refers to the concept presented by Perrenoud (1999, p. 26) when the individual realizes "[…] 'what should be done' without wanting to think, because it has already done so, it is no longer talked about competences, but about skills or habits". According to the ENEM/INEP document:

> Competences are the structural modalities of intelligence, or rather, actions and operations that we use to establish relationships with and between objects, situations, phenomena, and people we wish to know. Skills derive from acquired competencies and refer to the immediate plan of know-how. Through the actions and operations, the skills are perfected and articulated, allowing a new reorganization of the competences (Brasil, 2002a, p. 11).

Resolutions CNE/CEB nº 04/1999 and CNE/CP nº 03/2002 present the definition of professional competence and, although there are some differences in the text adopted, both refer to the need to mobilize, articulate and put into action the individual's repertoires for effective performance in their professional practice. In these definitions, there are traces of the french current, especially in relation to the mobilization of resources or repertoires of the individual to solve work situations, but despite the effort of the CNE, as well as the use of the verb to mobilize, the definition presented strongly points to the american competence, in particular, the need for knowledge, skills and attitudes for superior performance.

> Article 6 - Professional competence is understood as the ability to mobilize, articulate and put into action the values, knowledge and skills necessary for the efficient and effective performance of activities required by the nature of the work (Brasil, 1999 - Resolution CNE / CEB nº 04/1999).

> Article 7 - Professional competence is understood as the personal capacity to mobilize, articulate and put into action the knowledge, skills, attitudes and values necessary for the efficient and effective performance of activities required by the nature of work and technological development (Brasil, 2002c - CNE / CP Resolution 03/2002).

In addition to the National Curricular Guidelines for Engineering Undergraduate Courses focusing on teaching in competences, they are also defined in art. 4, what competences and general abilities that the engineer should have, namely:

> I - apply mathematical, scientific, technological and instrumental knowledge to engineering;
>
> II - design and conduct experiments and interpret results;
>
> III - design, design and analyze systems, products and processes;
>
> IV - to plan, supervise, elaborate and coordinate engineering projects and services;
>
> V - identify, formulate and solve engineering problems;
>
> VI - to develop and / or use new tools and techniques;
>
> VI - supervise the operation and maintenance of systems;
>
> VII - critically evaluate the operation and maintenance of systems;
>
> VIII - communicating effectively in written, oral and graphic forms;
>
> IX - work in multidisciplinary teams;
>
> X - understand and apply professional ethics and responsibility;
>
> XI - evaluate the impact of engineering activities in the social and environmental context;
>
> XII - evaluate the economic feasibility of engineering projects;
>
> XIII - assume the posture of permanent search for professional updating. (Brasil, 2002b - National Guidelines Engineering Undergraduate Program - CNE / CES nº 11/2002)

It should be noted that the competences listed include those of a non-technical nature, such as teamwork and continuing education, for example, while raising the question whether the competencies listed in the National Curriculum Guidelines are compatible with those required in the professional performance of the engineer.

4 The required competences of the contemporary engineer

In total, the interviews of 17 (seventeen) engineers, from six companies operating in the state of Minas Gerais, were analyzed.

It should be noted that eleven of the interviewees carried out a postgraduate course, evidencing the need for a continuous study to perform in the area. The majority of respondents also reported that the courses are due to the need, detected by the company or by the engineer himself, to complement the knowledge in a given area.

In this first point, it is already possible to observe the need of the engineer to keep in constant update, competence defined in the Curricular Guidelines as "XIII - assume the posture of permanent search for professional updating.

Regarding the age range of the research subjects, 53% were between 30-39 years old, 30% between 40-49 years old, 12% between 20-29 years old and 5% between 50-59 years old.

The training of the interviewees is divided into electrical engineering (06 engineers), mechanics (05 engineers), metallurgy (02 engineers), civil (01 engineer) and production (03 engineers). It is clarified that interviews were conducted with areas other than engineering, since the National Curricular Guidelines establish the general conditions for engineering courses, there being no particular guidelines for one course or another, so the proposed competences must attend to all and therefore, the analysis was performed in a group with diverse backgrounds.

It should be noted that no special needs were detected in terms of competence in relation to the notes made by the interviewees of the different engineering areas present in the study.

It was tried to identify the competences pointed out as necessary for the engineer's performance, according to his perspective. To do so, the interviewees were asked to state their point of view, pointing out the competences deemed essential in their daily activities.

It should be emphasized that two points stand out in the concept of competence and by which the categorization of Chart 1 is presented, based on the interviewees' speech, namely: i) taking initiative, acting; ii) the repertoire that the individual possesses and which is used as a guiding element in his action. In this aspect the competence is to take initiative, to act, before a given event under the support of the repertoire that the individual possesses.

Also, based on the answers of the 17 (seventeen) interviewees, we obtained the framework of competences presented below (Chart 2). It is important to emphasize the way of launching the information of the table, since the competences were listed considering the french conception of the term, in spite of which also the identification of elements of the american conception were also in the interviewees' speech.

It was clarified that such a measure was adopted taking into account the interviewees speech, in which the competences listed as essential to their performance corresponded to those attributes that served as a basis for the solution of the problems occurred in a work situation, an aspect very associated to the notion of an event treated by Zarifian (2012, p. 41), as being "something that occurs in a partially unforeseen, unexpected way, disturbing the development of the normal production system", and it is up to the individual to confront and solve this problem By the event. The Eng7, Emp3 highlights the importance

Chart 1. Attributes identified as competences by interviewees divided by categorization.

Category	Element	%
Repertory / knowledge to be mobilized	Technical knowledge; Specific Knowledge of the Company; English; Experience in Engineering; Communicate in written form; Project management	56.3%
Take initiative / Act	Negotiate; Hear; Troubleshoot problems; Take decision; Leadership; Interpersonal relationship; Anticipate problems; People management;	40.4%

Source: Prepared by the author.

Chart 2. Attributes identified as competences by respondents.

	Competence	% Of respondents who identified it
To know, Act, Mobilize, To communicate,	Technical knowledge	81%
	People management (encompassing team motivation)	75%
	Specific Knowledge of the Company (equipment, processes, market situation and its limitations, for example)	44%
	Engineering Experience	25%
	English	25%
	Interpersonal relationship	25%
	Project management	25%
	Leadership	18%
	Predict problems	6%
	Communicate in written form	6%
	Productivity	6%
	The importance of your work in the company	6%
	Negotiability	6%
	Listen	6%
	Troubleshoot issues	6%
	Take decision	6%

Source: Prepared by the author.

of acting focused on situations that are not routine in the company:

> *Eng7: We need to do what the customer asks for. Custom. So we need to give more appropriate advice. In addition to that we need to make process adjustments, steel projects, to always evolve. And the activities would be new product developments, or solve system problems. The well - trained technical work supports and gives a lot of freedom for the* ***product engineer working on a stage not so much focused on the routine.*** (Eng7, Emp3, emphasis added)

Thus, when they list, for example, technical knowledge as competence, the interviewees are based on the idea that the mobilization of this knowledge is the key to problem solving and argumentative power with the team or with a particular client, given situation. It is important to point out that what is important is the use or mobilization of technical knowledge in a work situation, as Perrenoud (1999, p. 54) points out, "[…] a 'simple scholar', incapable of mobilizing his knowledge with discernment in the face of a complex situation, requires quick action, will be no more useful than an ignorant". Eng5, Emp2 points out that "[…] *it is necessary to have a technical knowledge to discuss an option or alternative offered by the technician of the area*" and Eng6, Emp3 states that "[…] *it is important to have a well-informed theoretical knowledge, so that your practice*".

Similarly, the other terms listed also relate to their practical use, and are related to the verbs "to know", "to act", "to mobilize", "to communicate", and so on.

It is observed that the "technical knowledge" was the most cited by the interviewees as being relevant to the professional performance, reinforcing the importance of having a solid formation regarding the content to be taught in the Institutions of Higher Education. The emphasis on technical knowledge ratifies its position as a key element that enables the competence of the individual, since, as pointed out by Zarifian (2012), it is supported by knowledge that the individual is oriented to take the necessary attitudes in a given situation. Similarly, Fleury & Fleury (2000, p. 21) point out that knowledge is important for generating competence. However, state "[…] the knowledge and *know-how* do not acquire competence *status* unless they are reported and exchanged. The knowledge network in which the individual is inserted is fundamental so that communication is efficient and generates competence". For its part, Le Boterf (2006, p. 61) states "[…] to act in a relevant way, a professional must not only detain but also know how to combine and put into practice a coherent set of resources".

In this way, it is observed that technical knowledge is important, and the interviewees recognize this aspect as the basis for their professional performance, by mobilizing them in a work situation.

The american conception also emphasizes the importance of knowledge for the individual to be competent. Boyatzis (1982) points out that knowledge is one of the elements to enable the individual have a high performance and, consequently, be recognized as competent.

While determining the powers laid down in the National Curriculum Guidelines, it is observed that the technical knowledge is the basis of several items, among which we can mention: "I - apply mathematical, scientific, technological and instrumental engineering" (Brasil, 2002b - National Guidelines Engineering Undergraduate Program - CNE / CES # 11/ 2002).

People management is another item cited by respondents constantly. In this aspect, there are changes in form taylorist / ford work. The contemporary professional has to know how to manage and motivate your team in search of the results expected by the organization. It is evident, therefore, the need for the professional, to know how to deal with staff in order to wrap it in the process, so that, as Zarifian (2012), the network of actors mobilized in such a situation, goal or project, assume the responsibility of fields and share the implications of a given situation, which is a challenge for organizations.

It is noted also that the management of people is not listed in the National Curriculum Guidelines, as one of the competences to be developed by higher education institutions, when the formation of the student, which in fact is reported by professionals as a lack in their training.

As well as people management, interpersonal relationship, also identified as necessary by the interviewees, is presented as a key element for achieving the proposed objectives, in particular to the action with the other areas of the company, customers and suppliers. Problems or incidents with which the professional faces are increasingly complex, which, according Zarifian (2012), often exceeds the ability to solve the problem / event individually. In this context, interpersonal relationship is essential in order to have teamwork, and in many cases, solving multidisciplinary problems. If, in the management of people, it is important to know motivate their subordinates, it is also important:

> *Eng2, Emp1: Interpersonal skill. We are dealing with a customer every time. If you have a project, it is to meet your needs, and then I have to answer it satisfactorily.*

> *Eng3, Emp1: Today, on the coordinator as the adviser, an interpersonal relationship is essential.*

It is noteworthy that the Personnel Management differs from the Interpersonal Relationship, since the first establishes a relationship of subordination, which does not necessarily occur in the second case. The deal also is related to interpersonal relationships. Having a good relationship, negotiation becomes easier. Fleury and Fleury (. 2000, p 26) define negotiation as:

> Be able to discuss positively stimulate and influence other people to collaborate effectively to achieve organizational objectives, conduct processes for consensus building, aiming results satisfactory to the parties involved, and especially for the organization in internal and external situations, argue coherently, in order to persuade people in selling ideas, and accept different points of their own (Fleury & Fleury, 2000, p. 26).

In both cases, the power described as "IX - work in multidisciplinary teams," present the National Curriculum Guidelines, contemplates the possibility of development of interpersonal and Negotiability, which are important elements for the work as a team.

Specific knowledge of the company, including knowledge of equipment, processes, market situation and its limitations, for example, are also an element with recurrent quotes from respondents and relate the knowledge acquired, in general, labor or internal training and that are tied directly to the company or the specific area of expertise in which the professional is. According to Fleury & Fleury (2000), it is a technical competence, similar to the technical knowledge mentioned above, including its form of application consisting in mobilizing this knowledge to enable knowing how to act in a given practical situation. Fleury & Fleury (2000, p. 25) show how the definition of "expertise":

> Stop information and technical knowledge of your area; use them and constantly update them, seeking compliance activities, problem solving or development projects / products. Provide new knowledge developed internally or externally, ensuring its circulation.

Because it is specific knowledge of the company, perhaps it can be justified to occur no major development in the academic environment. In this regard, items listed in the National Curriculum Guidelines, how to analyze and supervise systems, are developed during graduation, based on theoretical knowledge of the most commonly used processes and not the peculiarities of each company. The reports below highlight the need for specific knowledge for professional work, including in relation to the absence of external training to do so.

> *Eng13, Emp4: The professional must have a good knowledge of the processes with which they will work.* ***There is no external training for this demand. People in the company do it all, as it is a well even specific thing****.* (emphasis added).

> *Eng7, Emp3: In my office, have to know metallurgy itself* [...]*. Processes. You have to know processes; know the company, internal constraints, product-integrated control.*

Within this perspective, it is also necessary that health professionals develop the knowledge about the business, not only about the company's processes, but also on its market position, its strategic plan, its objectives, as well as the economic situation in which it is inserted. Fleury & Fleury (2000, p. 45) point out that:

> The prospect of competitive strategy focuses on understanding the business-industry relationship. That is, the basic level of analysis is an industry, production sector or segment, and the company's strategy is established based on knowledge of its characteristics, its dynamics, its trends.

This need is supported by the testimony Eng3, Emp1:

> *Knowledge means I'm working, you must know what is happening in the steel middle because it assists in making decisions on the technical side, management, guiding the best way. We must have these visions.*

This observation also relates to the perception of their own work in the context of the company and the notion of "strategic vision" that Fleury & Fleury (2000, p. 22) define as "[…] know and understand the business of the organization, its environment, identifying opportunities, alternative", i.e. the importance of their work and performance of the company in general.

Another item reported, which can hardly be developed during the formation of the student, in the present context is the "experience in the engineering field." The engineering experience underscores the character of the possibility of developing competences by the number / amount of unique experiences in which teachers may be responsible. In this respect, Le Boterf (2006) emphasizes the need to reflect the individual over the situation that has occurred so that their development actually occurs. Similarly, Zarifian (2012) indicates that faced with a number of singular events enables the development of the individual's competence, since it knows seize such situations.

The Eng4, Emp2 reports that professional practice depends not only on training: "*It has to be accompanied by the experience*". However, it is observed that the

expectation is that the professional experience to be developed during the working life of the individual and thus to be expected that not were stated in the National Curriculum Guidelines, although the student must carry out the compulsory internship during the course and generally of short duration which allows a first contact with the business environment, but not in order to provide it with great experience in the area.

In the aspect of communication to the performance of engineering professionals, it highlighted the importance of also being able to do it in English. With the globalization of the economy and companies, which not infrequently does business in many countries, communication becomes a key element in professional practice, and the english in particular has highlighted the achievement of international communication. Fleury & Fleury (2001, p. 187, emphasis added) highlight the need to communicate presenting competence as "[…] **the set of learning** social and **communication** nourished the amount of learning and training, and downstream by the ratings system."

It appears that the "learning a second language" is not displayed as a focus during the graduation of students since it is not part of the curriculum guidelines or curriculum of Higher Education Institutions, however, the reporting of professionals confirms the importance of developing english as a second language.

However, it is clarified that the second language education is currently provided as a requirement of basic education, especially in secondary education, as determined by the average of the MEC. At this point it seems that the deficiency in basic education reflects a lack in the professional life of the individual.

The ability to "hear", also cited by respondents, is a related item to learn to communicate. Know how to communicate requires you to listen and understand what others need or the message being passed. When communicating, knowing how to listen is as important as the knowledge to express themselves, speak, write, as reported by the Eng7, Emp3: "*this professional has to know how to listen. You have to persuade people; it should not be imposed*".

In this respect, it is considered that hearing, as well as knowing how to communicate, it is included in the Curriculum Guidelines in item VIII - to communicate effectively in written forms, oral and graphic.

Currently, it is also increasing the delimitation of projects to meet certain objective or strategy of the company. In general, because it is a major goal of the company, the professional involved in demand should carry out the planning and management of the project, resulting in a process with the participation of other areas and people, as well, this item refers to others, technical and specific knowledge, interpersonal relationships associated with the term control and costs in an organization. The Eng2, Emp1 has, objectively, how is the management of a project.

> *Basically, for a project to be successful, it has to be completed on time, within the established cost and quality. A project manager is responsible for the verification of these three techniques at the same time. It has to evaluate the company's performance. Check if everything was hired and is running on schedule. Check for following unforeseen activities and these entail extra costs. Check if the project is running satisfactorily, within the level of productivity expected by the company. The project manager is responsible for controlling so that none of these three strands exit the balance* (Eng2, Emp1).

By exposure above, appears that the "project management" also encompasses several competences proposed in the Curriculum Guidelines, namely: III - conceive, design and analyze systems, products and processes; IV - to plan, supervise, develop and coordinate projects and engineering services; XI - to assess the impact of engineering activities on the social and environmental context; XII - to evaluate the economic feasibility of engineering projects.

However, respondents reported a shortage in their learning, management projects or associated elements, as seen in the statements below:

> *Eng14, Emp5: The university could develop disciplines mainly in project management.* [...] *This requires the engineer manager a risk analysis, a feasibility study, in short, an initial planning for the execution to happen.*

In this respect may arise, as a hypothesis, the fact that higher education institutions are not developing all the powers provided for in the Curriculum Guidelines or may carry out contextualized form, making it difficult for the student to use them concurrently and practice during their professional life.

As for the "leadership" has a polysemic concept and, in this context, can be interpreted as a characteristic of the individual that influences the group in which it is inserted in order to guide you to achieve the desired results, however, other concepts can be used. For Maximiniano cited by Merighi et al. (2013, p. 167), leadership is defined as "[…] the process to drive and influence the actions to achieve the goals stipulated by the organizations". It is observed that, with regard to personnel management, the individual also influences the group to achieve results:

> *Eng7, Emp3: We need the people. From the moment you can believe in your work, the team can see the results happening. It is leadership ability. To get to interact with other areas; to drive to my solution, but for the company.*

So with the Personnel Management, there is no specific item in the Curriculum Guidelines that focus on leadership development in the professional. However the theme Leadership is complex, consisting of various designs and dimensions, which requires a deepening of the item in order to check how is your need in the engineering professional.

"Troubleshooting" is one of the key points of competence. There are particular situations with which the individual is faced and which require his taking initiative. The mobilization of knowledge to address specific events, explained by Zarifian (2012), it can be expressed as the ability to solve problems. And, as the professional is faced with the most unique events, the greater becomes your experience and the ability to foresee problems, i.e., solve problems and anticipate problems are two related items, and the greater the development of the individual's competence, the greater the chances of it prove able to solve or anticipate the problems with which we are faced.

> *Eng1, Emp1: It is important that the employee knows how to handle time, who knows how to negotiate, because every day we are in negotiations with suppliers, who can critically analyze the situation of the project, which anticipates future problems.*

Problem solving is a competence established in item V - identify, formulate and solve engineering problems, but we can consider it also a goal of other competences and abilities listed by respondents and the Curriculum Guidelines, since much the actions of engineers verified in interviews, relates in some way to solving problems or its anticipation, how to resolve conflicts, manage projects in order to avoid errors or failures (problems), manage the team (solving impasses, personal conflicts), etc..

Regarding the "productivity" cited by interviewees it can be characterized as the result expected from the professional. From the point of view of american concept productivity (performance) higher, can be considered as indicative of competence of professional, as highlighted by Boyatzis (1982), or as the aggregate economic value, from the viewpoint of Fleury & Fleury (2000) for the definition of competence.

In this context productivity is related to the objectives achieved by the performance of individual competently and thus it was expected that were stated in not as a specific competence to be listed in the Curriculum Guidelines, as, in fact, does not appear.

The ability to "make a decision", also indicated in interviews, is another essential aspect of competence:

> *Interviewer: In addition to technical competence, what other competences are other knowledge that an engineer needs to develop well your work?*
>
> *Eng3, Emp1: Take decision competence.*

Le Boterf (2003) points out that the individual must know how to take decision to choose the best course of action within the context presented to you. Among the various possibilities to follow, the individual makes the decision judging adopt one that is more appropriate. To Zarifian (2012), the decision-making is a consequence of the autonomy and delegated responsibility to the individual, the competence model.

Although not appear so explicitly the term "make a decision" in the Curriculum Guidelines their need for development is implicit in the other items, alias it is fundamental that the professional can develop other competences related the Curriculum Guidelines. Elements such as problem solving, design, design, supervise and coordinate, present in the Curriculum Guidelines, require decision-making by the individual.

The following Chart 3 shows the comparison between the provisions in the Curriculum Guidelines and the correspondences between the competences displayed by the engineers during interviews.

In general it is observed that the National Curriculum Guidelines cover a large part of the need of contemporary engineers, regarding the competences to be developed, which reinforces the progress made in relation to legislation of 1976. Professional Needs often listed by engineers e.g., the law covers technical expertise, project management and interpersonal relationship.

It is noteworthy also that there are a number of competences related by non-technical character of respondents and essential judged on the performance of contemporary engineer which reinforces the research previously conducted by Ferreira (1999), Salum (1999) and Nose & Rebelatto (2001), indicating that the engineer must not currently have great technical knowledge only for his acting, but combine it with no technical competences.

Thus, it is observed that the powers listed by the respondents can be divided into three main blocks, namely: i) the competences being developed during the degree as required by the curriculum guidelines; ii) competences identified as required, but not contained in the Curriculum Guidelines and iii) competences to be developed during the working life of the individual.

Regarding the first point, project management stands out for though, the Curriculum Guidelines present the items III, IV, XI and XII that enable the development of this competence for the future engineer for graduation, considering the definition of management projects submitted by respondents. Interviews show the great need of these training issues across the participating engineers research.

Chart 3. Competences defined in the National Curriculum Guidelines and those listed by respondents engineers.

DCN (Brasil, 2002b)	interviews
I - apply mathematical, scientific, technological and instrumental engineering	Technical knowledge
II - design and conduct experiments and interpret results;	
III - develop, design and analysis systems, products and processes;	Project management
IV - to plan, supervise, develop and coordinate projects and engineering services;	Project management
V - identify, formulate and solve engineering problems;	troubleshoot
	Preview problems
VI - to develop and / or use new tools and techniques;	
VI - oversee the operation and maintenance systems;	Expertise / Specific knowledge of the company
VII - critically evaluate the operation and maintenance systems;	Expertise / Specific knowledge of the company
VIII - to communicate effectively in writing forms, oral and graphic;	Communicate in written form / Listen
IX - work in multidisciplinary teams;	Interpersonal relationship
X - understand and apply to professional ethics and responsibility;	
XI - to assess the impact of engineering activities on the social and environmental context;	Project management
XII - to assess the economic feasibility of engineering projects;	Project management
XIII - assume the posture of permanent search for professional development.	Professionals, although not expressly stated, have sought for constant updates by personal initiative or on the initiative of companies

Source: Prepared by the author.

With regard to technical knowledge, respondents claim to be well developed in the most prestigious institutions, but warn of the number of institutions that have been opened without the same quality standard.

On the second point, there is the management of people, indicated by respondents as essential to the performance of contemporary engineer, however, not related to the National Curriculum Guidelines as a competence to be developed during graduation.

In the third block are the competences listed by the engineers as necessary, but that will be developed throughout working life, for example, professional experience and expertise of the company, including, there is recognition of the professional in relation to certain development impossibility competences in the external environment to the specific characteristics to which it is subject to certain items.

5 Conclusions

It appears that the notion of competence has gained ground steadily in the workplace and in the academic, generating changes in the formation and performance of the engineers mode. Given the new forms of work organization, with the competence model being adopted in greater or lesser degree of coverage, combined with accelerated professional mobility and facilitated by globalization, higher education institutions are being pressed to adopt and develop competences in their students in order to maintain harmony with society and the world of work in order to allow the entry and development of its graduates in the new world.

In Brazil, the changes in the educational system resulted from the changes in legislation defining guidelines for curricula, conducted by the Ministry of Education, preceded by consultation with the higher education institutions. It is observed that the new curriculum guidelines have important advances with the inclusion of non-technical competences to be developed during the graduation, in addition, of course, the technical competences.

It is emphasized that the modifications of the Curriculum Guidelines 2002 for the established in 1976 brought advances in training Brazilian engineers in order to enable their training is carried out in line with the changes in society. However, it should be noted that the need for improvements and adjustments will be constant in the new political and economic conditions currently outlined, and studies to define which direction to take will be increasingly required. For example, it can be seen that the research conducted in the late 90s, by Salum (1999) and Ferreira (1999) did not indicate so as explicit the need to develop competences related to managing people / projects in form that was observed in this study.

In general, it was found that eleven of the fourteen tasks defined in the National Curriculum

Guidelines have been cited or are directly related to those mentioned by respondents as essential to the performance of contemporary engineer.

However, the study demonstrated a deficiency in the development of non-technical competences during graduation, the example, the lack of competences related to personnel management, currently considered by respondents as a key element in the engineer's role. It was observed also that technical competences are being further developed, which can be the result of long technicist orientation of engineering courses in Brazil, coupled with extensive technical knowledge of area teachers.

There is also the need to adapt educational institutions in order to enable the development of the tasks defined in the Curriculum Guidelines and also identified as essential by respondents, however, with disabilities in academic focus during graduation.

It is important, however, point out that competences were cited that are not covered in the Curriculum Guidelines, which may indicate the need for future adjustments, in particular as regards the management of people, by the recurrence in quotes as a necessity in the professional and how deficiency in undergraduate curricula.

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