

ENGINEER' COMPETENCES OR TEACHER' COMPETENCES?

Norimar de Melo Verticchio

Departamento de Engenharia Mecânica - UFMG
Av. Antônio Carlos, 6627 – Pampulha
31270 901 – Belo Horizonte - MG
n_verticchio@yahoo.com.br

Marcos Vinicius Bortolus

Departamento de Engenharia Mecânica - UFMG
Av. Antônio Carlos, 6627 – Pampulha
31270 901 – Belo Horizonte - MG
borta@demec.ufmg.br

Abstract. *In this work is analyzed the possible differences among the necessary competences for the recently-formed engineers that want to act in the industry, occupying technical and/or administrative positions in relation to the necessary competences to the engineers that want to follow the academic career, in other words, being engineer-teachers. Through the guidelines curricular of the engineering courses (CNE/CES 11/2002) that define in your article 4th the competences that the graduates of these courses should acquire, it is evaluated, the position taken by MEC when defining these competences, through two different arguments. The first, considering that the academy that supplies the course should focalizet not only for the knowledge, but also for the application of the same ones. The second, it appears when comparing the competences demanded by the guideline national curricular and the aspects described by Perrenoud, that considers the competences as being originating from of each individual's cognitive formations, not being possible that all, that they received a family and educational formation different, obtain the same competences, even during the engineering course. It is verified that some necessary competences for the engineer-teachers are necessary competences, also, to the engineers that act in the industries. To transmit information, to coordinate teams interdisciplinary and to supply lectures and courses are some of those competences that need to be motivated during the engineering course.*

Keywords: *competencies ,communication, engineer, teacher.*

1. Introduction

As (Prata, 1999) “the engineering is the professional art of applying the science for practical purposes”, understanding science as the exact, human and social. The application of cognitive knowledge in an action practices is one of a lot of definitions of competence. (Perrenoud, 1999). In this mode the engineering can be considered a profession of competences.

The guidelines national curricular stipulate in your article 4th which competences and abilities graduates should be when finished your engineering course in Brazil, but those competences hold that engineer that needs and want to work inside of a class room teaching engineering and inside of a company exercising the technical or administrative charge?

Which competences that a graduate of the engineering course should have acquired in your course, for law, that would aid him in an engineer/teacher activity? Engineer is very different of the professor and administrator, if in your professional activity he should present lectures, to supply courses, to work in teams interdisciplinary, should it command people and to transmit information?

This work intends to urge her doubts on the difference between an engineer and an engineer-teacher and to analyze if there is really difference among them.

2. Competences

Many meanings exist for the word competence, the dictionary Aurélio, for example, defines that word as “quality of who is able to appreciate and to solve certain subjects”. She can still mean “ability, aptitude, and suitability”.

The dictionary Larousse commercial defines competence as: “In the commercial subjects, the competence is the group of knowledge, qualities, capacities and aptitudes that enable for the discussion, the consultation, the decision and everything that concerns yours officiates... It supposes based knowledge... usually, it is considered that there is not total

competence if the theoretical knowledge be not accompanied of the qualities and of the capacity that permit to execute the suggested decisions”.

Another definition of the term competence is originating from of the (CNE 07/1999) that considers competences as being a group of knowledge (that many denominate you know), abilities (savoir-faire formed an alliance with the practice of the work, going besides the simple motive action) and attitudes (to know-be, in other words, a series of inherent aspects to an ethical work and of quality, accomplished through the cooperation, solidarity, participation in the outlet of decisions).

Perrenoud defines competence (Perrenoud, 1999), “as being a capacity to act efficiently in a certain situation, sustain in knowledge, but without limiting them”.

The acquired knowledge during the course of mechanical engineering is not enough in himself, in other words, the acquisition of this knowledge is not the only necessary requirement for the mobilization capacity in certain situation. But to acquire this knowledge is primordial for the development of the competences demanded in the Guidelines National Curricular (DCN).

In (Perrenoud, 2000), competence is defined “as being “a capacity to mobilize several cognitive resources to face a type of situations ”. That definition implicates in four aspects:

- 1. the competences are not they know, savoir-faire or attitudes, but they mobilize, integrate and orchestrate such resources.*
- 2. that mobilization is only pertinent in situation, being each singular situation, even if one can treat it in analogy with other, already found.*
- 3. the exercise of the competence goes by complex mental operations implied for thought outlines, that allow to determine (more or less conscious and quickly) and to realize (in way more or less effective) an action relatively adapted to the situation.*
- 4. the professional competences are built, in formation, also to the flavor of a teacher's daily navigation, of a work situation to the other.*

Through these four aspects described by Perrenoud it is verified that the competence is interdependent not only of the acquired knowledge in the class rooms, but also of the acquired abilities during a existence of the individual in the society.

The guidelines curricular of the engineering courses (CNE/CES 11/2002) define in your article 4th the competences that the graduate of these courses should acquire during the course, according to demonstrate in the Fig 1. The position taken by MEC in this document when defining these competences it will be analyzed by two points of view.

Art. 4th the engineer's formation has for objective to provide the professional of the knowledge requested for the exercise of the subsequent competences and general abilities:

I - to apply knowledge mathematical, scientific, technological and instrumental to the engineering;

II - to project and to lead experiments and to interpret results;

III - to conceive, to project and to analyze systems, products and processes;

IV - to plant, to supervise, to elaborate and to coordinate projects and engineering services;

V - to identify, to formulate and to solve engineering problems;

IV - to develop e/or to use new tools and techniques;

IV - to supervise the operation and the maintenance of systems;

VII - to critically evaluate the operation and the maintenance of systems;

VIII - to communicate efficiently in the forms writing, oral and graph;

IX - to act in teams multidisciplinary;

X - to understand and to apply the ethics and professional responsibility;

XI - to evaluate the impact of the activities of the engineering in the social and environmental context;

XII - to evaluate the economical viability of engineering projects;

XIII - to assume the posture of permanent search of professional updating

Figure 1: Article 4th of the guidelines national curricular for the engineering.

In the first point of view, is analyzed that the teaching entity that supplies the engineering course should focalize the course not only for the knowledge but also for the application of the same ones. For (Moretto,1999) the direction of the education changed, it moved of the acquisition of contents for the acquisition of abilities and competences in the management of contents ".

The second point of view appears when we compared the competences required with the aspects described by Perrenoud, because, when the guidelines national curricular delineate competences that will be obtain, they don't take in consideration that the competences are individual and originating from of each individual's cognitive formations, not being possible that all the individuals, that have family and educational formation different, obtain the same competences.

The development of resources for the acquisition of competences can happen through:

- Of specific contents;
- Of abilities;
- Of new languages;
- Of cultural values and;
- Of the development of emotions.

As the developments of the competences involve complex and individual mechanisms, the verification of the acquisition of those competences is also shown difficult of being obtained.

3. Engineer or administrator

As (Prata, 1999) only the engineers in begin of career they work technically (hand in the mass), after some years of profession many of those engineers become technology, information and people administrators.

In a report mentioned in (Prata, 1999) done by the American Association of Mechanical Engineering in partnership with the National Foundation of Sciences both of the United States, this report gathered engineering teachers' opinions and of engineers, questioning the same ones in relation to the main elements and practice requested for the recently-formed engineers, the result of this research is suitable in the tab 1.

Table 1: What the recently-formed engineers need to know (Mechanical Engineering, July of 1996)

	Industry	Academy
1	Team work	Team work
2	communication	communication
3	project for manufacture	creative thought
4	CAD	Revision of project
5	professional ethics	CAD
6	creative thought	To schematize / to Draw
7	project	professional Ethics

As for the academics as for the engineers in the industry the social and management abilities are important, detaching the team work and the communication as the most important for the engineer's formation without, of course, to forget of the technical formation. (Verasztó *et. al.*,2003; Nguyen, 1998)

In the work accomplished for (Gama, 2003) the engineers interviewees were joined in three great classes:

- a) *Critical group: composed by those that know the formation of the modern engineer, actual in command, in advice or together to the academy, and they present suggestions of progress of the courses. Most took masters degree course, unlike the other groups. They are formed by the universities more considered (universities whose degree courses and of masters degree are well considered by MEC).*
- b) *Technical group: composed by those that act in the technical execution and present improvement suggestions. They are principally formed in universities with courses with medium concept, they pass of the 50 years of age (in Rio de Janeiro, largely formed by EFEI, Itajubá, MG, acting, at that time of the research, in the management area) or they act in technical tasks.*
- c) *Neutral Group, the others.*

"The critical group indicated a formation profile reminding the suggest engineer in the texts of REENGE, just giving some preponderance to the technical formation in potency systems in relation to the other technical formations".

According to the order of importance: 1)supplies technical of the electrical engineer's specific formation, 2)communication oral and writing, 3) basic science , 4) new technologies and auxiliary technologies, 5) operation and planning, including your economical aspects.

The Technical group didn't mark the items 2 and 5 (communication and basic sciences) among the determinant, giving complete preponderance to the technical matters. The importance of the basic sciences was considered secondary, the formation in administration and commercial vision considered superfluous. The economical aspects were considered secondary for this group, as well as the new technologies. The engineer with this profile (mentioned in this section as engineer technician-specialist) it is close to the defined profile for MEC in the decade of 70 ". (Gama,2003).

The engineer is taking administrative offices due to engineer's formation that supplies your analytic reasoning and good training in the science method. (Prata, 1999).

As the (Institute of Engineering of Australia, 1993) the engineering can be described as a vast field of knowledge in businesses/administration, science, mathematics, social sciences and technology computational. Being the knowledge in businesses/administration divided in leadership, administration of businesses, work in team and accounting.

4. Engineer or teacher

The engineer that works in the industry acting in the command of teams, positions administrative, management and even in more technical positions, will be working in teams interdisciplinary and they will need to transmit information, in other words, the communication is fundamental for the profession. (Prata, 1999; Gama, 2003; Reave, 2004).

The educational process is based on three stages: teaching, learning and evaluation. The first stage is the transmission of the knowledge. The second stage is the appropriation of the knowledge for the student. The third stage is the verification of the relation between teaching and learning. (Pinheiro, 2004).

These three stages can be analyzed of the industrial point of view, where the engineer should transmit knowledge ", or better, to transmit the information for the employees. The employees need to capture and use this information. The evaluation will be the accomplished work as it should be accomplished.

What differentiates an engineer of a teacher it is the limit of the class room and the objectives of your activities. The engineer's objective is to accomplish the activities to him delegate in the best possible way and there is not delineated physical space. The teacher's objective is to qualify the student and the physical space is, most of the time, the class room. But both professions possess several common competences.

Of the competences enunciated in the article 4th of DNC for and the engineering, it can stand out some that coincide of those described for (Perrenoud, 2000). VIII - to communicate efficiently in the forms writing, oral and graph. IX - to Act in teams multidisciplinary; X - to understand and to apply the ethics and professional responsibility; XIII - to assume the posture of permanent search of professional updating.

(Perrenoud, 2000) describes ten domains of competences that he recognizes as priority in the fundamental teachers' continuous formation. Those domains will be transferred of the class room for the company, detaching the engineer as soon as should also be a teacher. Some terms used by Perrenoud, they should be adapted for the managerial terms and some competences won't be applicable in the companies.

1. to organize and to drive learning situations.	<ul style="list-style-type: none"> • To know, for certain discipline, the contents be learning and your translation in learning objectives • To work starting from the students' representations. • To work starting from the mistakes and of the obstacles to the learning. • To build and to plan devices and didactic sequences. • To involve the students in research activities, in knowledge projects
2. to administer the progression of the learning.	<ul style="list-style-type: none"> • To conceive and to administer situation-problem adjusted at the level and the students' possibilities. • To acquire a longitudinal vision of the objectives of the teaching. • To establish bows with the underlying theories to learning activities.

	<ul style="list-style-type: none"> • To observe and to evaluate the students in learning situations, in agreement with a formative approach. • To do periodic evaluation of competences and to make progression decisions.
3. to conceive and to do to develop the differentiation devices.	<ul style="list-style-type: none"> • To administer the heterogeneity in the ambit of a group. • To open, to enlarge the class administration for a vaster space. • To supply integrated support, to work with students bearers of great difficulties. • To develop the cooperation between the students and certain simple forms of mutual teaching.
4. to involve the students in your learning and in your work.	<ul style="list-style-type: none"> • To raise the desire to learn, to explain the relationship with the knowledge, the sense of the school work and to develop in the child the solemnity-evaluation capacity • To institute and to do an council of students (class council or of school) and to negotiate with them several types of rules and of contracts. • To offer optional activities of formation, à la carte. • To favor the definition of a personal project of the student.
5. to work in team.	<ul style="list-style-type: none"> • To elaborate a team project, common representations. • To drive a work group, to lead meetings. • To form and to renew a pedagogic team. • To face and to analyze complex situations, practices and professional problems. • To administer crises or conflicts.
6. to participate in the administration of the school.	<ul style="list-style-type: none"> • To elaborate, to negotiate a project of the institution. • To administer the resources of the school. • To coordinate, to manage a school with all your partners (neighborhood, parents' associations, language teachers and origin culture). • To organize and to do develop, in the ambit of the school, the students' participation.
7. to inform and to involve the parents.	<ul style="list-style-type: none"> • To manage meetings of information and of debate. • To do interview. • To involve the parents in the construction of knows.
8. to use new technologies.	<ul style="list-style-type: none"> • To use editors of texts. • To explore the didactic potentialities of the programs in relation to the objectives of the teaching. • To communicate at the distance through the telemetric. • To use the multimedia tools in the teaching.
9. to face the duties and the ethical dilemmas of the profession.	<ul style="list-style-type: none"> • To prevent the violence in the school and out of it. • To struggle against the prejudices and the discriminations sexual, ethnic and social. • To participate from the creation of rules of common life referring to the discipline in the school, to the sanctions and the appreciation of the conduct. • To analyze the pedagogic relationship, the authority, the communication in class. • To develop the sense of responsibility, the solidarity and the feeling of justice.

10. To administer your own continuous formation.	<ul style="list-style-type: none"> • Knowledge explicit the own practices. • To establish your own balance of competences and your personal program of continuous formation. • To negotiate a formation project common with the friends (it equips, school, net). • To wrap up in tasks in scale of a teaching order or of the educational system. • To welcome the friends' formation and to participate in her.
--	--

Figure 3: Ten domains of competences for the teachers' formation
Competences of reference more specific Competences to work in continuous formation

In these ten families of competences we can modify the terms school for company, students for employees and teacher for engineer. The items 1, 5, 6, 8, 9 and 10 are the most common in the two professions.

The global competence cited in item 1 can be transferred for the managerial atmosphere, considering that the engineer should have technical knowledge of your activity and to work through your employees' capacity, qualifying the same ones to improve the revenue of the company. To administer the progression of the learning is management your employees, this administration and accompaniment aid in the improvement of the employees' capacities.

It is important that the employees cooperate to each other and act in way the assistant in the growth of the company and in the improvement of the execution of your activity, for that to happen each employee should have your motivated qualities, the item 3 of the competences leads us the this reflect.

To work in team, to participate in the administration of the company, to use new technologies, to administer your formation continues and to face the duties and the ethical dilemmas are inherent competences of engineer's profession.

To inform and to involve the parents, it can seem strange, but to involve the employee's family is used by the companies to motivate the employees to feel that they are part of the company.

The competences mentioned for (Perrenoud, 2000) they are focus for the teachers of fundamental teaching but they can be used by the engineers in your attributions as in the academy as in the it company.

5. conclusion

The challenges faced by the professionals are big, current of the speed with that have been generating and transmitted the new knowledge. The formation continues, in other words, to learn to learn is fundamental for the professional's success. If those changes are challenges for the engineers, we should analyze the impact caused for the employees of technical level, and in that context the paper of the engineer/professor becomes indispensable to reduce this impact in the employee and in the company. (Pinheiro, 2004; Silva, 1999).

The more you swims against the current, more it is necessary to swim, therefore in the scientific and technological evolution there is not definitive landing to be reached - the escalade is it continues (Long & Telles), for that reason to administer your continuous formation in several areas of the knowledge is fundamental for the engineer of the century XXI.

A research accomplished by the Society of Manufacturing Engineers, in the United States, it identified 14 gaps in the competences wanted by the companies and obtained them by the engineering exits the more constants were in the communication competence, work in teams, to interact with people of different areas, to write and to speak. (Seat, Parsons, & Poppen, 2001).

The flexibility curricular can supplies possibilities so that the engineer can acquire the knowledge and the new necessary competences for engineer's profession.

Engineer's profession demands a formation with a high degree of technical knowledge, but that formation needs to be accompanied with the capacity to use those knowledge and to transmit them with efficiency.

To transmit information is a necessary ability there are all the professions, engineer's profession, is not different, and the engineer works together with several people that possess different formations and cultural levels, as well as the teacher that works as different types of students.

This work had for objective of calling the attention for the competences that can be important for the engineer, creating like this an "engineer model" to be formed. It is necessary a detailed study of the engineer's demanded competences as in the company as in the academy, so that the universities can supply for the students the tools that they need for work.

6. References

- Prata, A. T., Formation of the Engineer: challenges of the educational performance, tendencies curricular and subjects of the technological education, "Comments about the engineer teacher's performance", Florianopolis, ed of UFSC, 1999.
- Perrenoud, Ph, to Build the competences from the school, Porto Alegre, Artmed, 1999.
- CNE/CES resolution 11-02 - Guidelines national curriculares of the degree course in engineering. Available in <http://www.mec.gov.br/sesu/ftp/resolucao/1102Engenharia.doc> access on November 01, 2004.
- Perrenoud, Ph. Ten new competences to teach. Porto Alegre: South Medical arts, 2000.
- Moretto, V. P. Construtivismo: the production of the knowledge in class. Rio de Janeiro: DP&A, 1999.
- Veraszto, V. E.; Simon, O. F.; Filho, B. J.; Almeida, N.; Snachez, G. C. THE engineering and the engineers along the history In: BRAZILIAN CONGRESS OF TEACHING OF ENGINEERING, 2003, Rio de Janeiro. Annals... Rio de Janeiro: Military institute of engineering, 2003. CD-ROM. Clark, J.A., 1986, Private Communication, University of Michigan, Ann Harbor.
- Nguyen, Q. D. (1998) The essential skills and attributes of na enginner: comparative study of academics, industry personnel and engineering students, Global Journal of engenieringg education, vol 2. n°. 1, Australia.
- Gama, S. Z.; Silveira M. A. the engineer's competences: vision of the job market In: BRAZILIAN CONGRESS OF TEACHING OF ENGINEERING, 2003, Rio de Janeiro. Annals... Rio of military Janeiro: Instituto of engineering, 2003. CD-ROM.
- Reave, L, Technical communication instruction in engineering schools a survey of top-ranked u.s. and canadian programs. Journal of Business and Technical Communication, Vol. 18 No. 4 - October 2004
- Pinheiro A. C. F. B; Burini E. R. V, teaching for competences - The challenge of the education of the century 21. In: BRAZILIAN CONGRESS OF TEACHING OF ENGINEERING, 2004, Brasília. Annals... Brasília: University of Brasília, 2004. CD-ROM.
- Long, W. P.; Telles, M. H. Programa of development of the engineerings: current situation.
- Seat, E.; Parsons; J. R.; & Poppen, W. A. (2001) Enabling engineering performance skills: A program to teach communication, leadership, and teamwork. Journal of Engineering Education, 90, 1-12.