

Re-engineering Of The Teaching In The All Fields Engineering Curricula: A Review of Current Educational Changes In Engineering Education

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Abstract - *This work arises from my participation on the “curriculum modernization” process at the Escola de Engenharia da UFMG (Engineering School at the Federal University of Minas Gerais) and on the selection process for the admission to the course at Doctorate Level at the Faculdade de Educação da UFMG (Education Faculty at the mentioned University). For some years concerned with the engineering teaching questions, I am trying to understand in a more critical basis the complex questions coming from the curricular area in order to be better engaged on it, and, as possible, to contribute to a more suitable problematic rendering of the features concerning the all fields engineering area. The initial part of this proposal was the result of a social-historical research that allowed to devote some considerations to the all fields engineering teaching and curricula. In this case, it was not difficult to verify that we still are very linked to traditional curricular ideas which unable us to carry out reflections about the existing curricula. This way, we look at the curriculum and we are unable to think about other ways to organize it, exactly because we do not know how, and we are not habituated to transgress the “existing curricular order” as is suggested by the critical and sociological curriculum theory. Next, is described the so called “re-engineering” and its respective correlation with the educational reform, and right after, is presented my justification concerning the research showing that the study has the purpose to clarify the several questions that, today, puzzles me and on the belief that the educational field will help me to better understand, discuss and reflect about the matter.*

Some considerations about the teaching process and engineering history

To start a very discussion about the engineering teaching, the major importance should be given on describing it under a historical focus trying to catch, even in a speedily manner, some remarkable events of its evolution. In 1795, with the foundation of the École Polytechnique in Paris, it was established a model for engineering school that, in its turn, would be pursued at that time by many other countries, including Brazil. As an illustration of what included the first education linked to the national engineering, it can be mentioned the foundation, in 1810, of the

Academia Real Militar with a seven years course. The first year was dedicated to supply the almost non-existing high school; the second, the third and the fourth years were composed by basic disciplines and the three remaining years, by military and engineering applied disciplines.

Consequently, starting in 1876, appears the traditional Escola de Minas de Ouro Preto, still in the Second Empire, right after accompanied by five other schools, founded in the beginning of the Republic. Generally speaking, the teaching process was very demanding, but little objective. It comprised an “encyclopedic” type curriculum, as stated in Telles [26] who points out: “many teachers only taught matters that had little or none interest..., ... though the teaching process, generally, were deficient, there was a solid mathematical-philosophical education on the basic disciplines...”. It is also interesting to point out that, as per Goodson [10] “by this time on the history, the curriculum worked, at one time, as a main identifier and mechanism of social differentiation”.

Up to the end of the Second World War little was changed concerning the number of schools, in such a way that, in 1946, there were only fifteen institutions for engineering teaching purpose with the preponderance of the Civil Engineering courses. As from that time, a fast evolution is observed, or in better words, the start of a very accelerated “boom”, both in the number of institutions and in the quantity of courses, modalities or qualifications. This fact comes to happen within a differentiated educational model directed to specializations and mainly devised by the United States of America, which appraised and heavily invested in technological research by political and economical reasons under a context of strong arms race, consequence of the “cold war” with the former U.S.S.R. (Union of Socialist Soviet Republics). As consequence, in 1962, by way of a pretended state control of the new teaching institutions, probably trying to assure a quality minimum for the professional education, moreover, a minimum of equivalence among courses of the same nature, by the first time, appear the engineering minimum curricula.

Right after, exactly in 1968, the Brazilian university system is changed with the “University Reform”, as described by Hernani Sávio Sobral [25] who symbolized it as “a rationalization process to turn the universities more productive” through a close connection with the known philosophical slopes of Taylorism and Fordism. Then, a deepening of the

analytical movement of specialization will occur more and more. With the University Reform, some positive points to the general teaching can be observed. The increase of teachers under the “exclusive dedication” regimen, for example, allowed more docents consigned to the attempt of solving the existing problems within the various courses. But, a negative factor concerning the teaching process arises from the lack of information of the specialists, mainly, in the “basic cycle”, in view of the real interests of the engineering courses. Though the uprising of new contents that are important for the engineer graduation, the subject of the “basic cycle”, practically, remains the same.

Moreover, some inquiries currently performed in several national universities, as described by Neves e Filho [16], disclosed a great school evasion, with “a higher frequency over the two first years of the course”. One of the major reasons, among the many existing, for this evasion as per Cardoso [4], is concerned with the curricula. Therefore, he says: “a new curriculum can be the solution for the engineering”. In any wise, in spite of the great complexity that comprises all these questions, in a speedy analysis, it can be verified that, due to the technological growth, the currently engineering curricula present subject more and more comprehensive. By other side, however, they become more and more fragmented due the presence of increasingly higher number of school disciplines.

With the aid of the curriculum critical theories, it is not difficult to observe that the above described problematic is not exclusively from the engineering area. After all, the curriculum is a field of constant disputes. Even without very clear directions, the curriculum is always a field for contests and conflicts among and within groups, as per Apple [1]. For all kinds of engineering there is, specifically, a necessity to observe where is the level of this contest, since through the very technical and academic formation of the professional this area, even with the ones that have been concerned by the problems related with the engineering teaching, many curricular subject and compositions are treated in a very “natural” manner, therefore, without any critical and sociological view of the curriculum.

The process of “disorder”, of “dismantle”, of “disnaturalize” and to “render problematic”, in order to transgress the existing curricular order, is about to initiate in the engineering. We are still very linked on traditional curricular ideas which unable us to promote reflections around the existing curricula. Therefore we look at the curriculum and we are unable to think about other ways to organize it exactly because we don't know how to do it and we aren't used to act this manner.

It still should be put in relief that, with the development of the quantum physics during the XX Century, new concepts and ideas based in a holistic and ecological conception were introduced in the engineering, in which predominated the paradigm of the reductive model Cartesian-Newtonian. This model consists in decomposing the thought and problems in

their constitutive parts and arrange them in their logical order. It still should be noticed that this model is being replaced by a more global world vision, where the several phenomena variables become interdependent and are treated in a systemic way.

Thus, in 1976, aiming to follow the dispositions of the Law 5540/68, the CFE (Conselho Federal de Educação - Education Federal Council) have approved the new minimum curricula for the all fields engineering through the Resolution 48/76 that, up nowadays, establishes the grounds of all curricula existing in the country. It can be observed that, in this new Resolution, although a minimum is fixed in a national basis, there is a flexibility to attend the many different situations. Another feature to be noticed is that, from the Resolution 48/76, becomes evident the necessity of a more holistic education, as discussed by João Sérgio Cordeiro [5], with the “insertion of the disciplines from the areas of the human, social and environmental sciences”. The author also alerts the fact that “these questions, although they had been focused twenty years ago, only a short while ago started receiving a more wide attention”.

Therefore, a relevant question for reflection concerns the analytical development of matters in disciplines by the schools, conforming to the old Newtonian paradigm, fact which has been more and more changing the engineering curricula into very “encyclopedic” ones. In this feature, as an analogy to the comments of Durkheim [7], “the only desirable and achievable encyclopedia is not the one that seeks to pile up in young brains all the material of the human knowledge”(my emphasis). Such being the case, a “revolutionary” curricular change, expressed in a new socially desired paradigm, becomes fundamental, where the subject of the desired flexibility should not be as only as the curricular structure, but the persons that are entangled in it. After all, as stated by Tomaz Tadeu da Silva [24], the curriculum shall be analyzed as in its actions, as in its effects: “we make the curriculum and the curriculum make us”. It is evident that the curriculum “will form” us in different ways as per what we make to it.

Maybe in compliance with a capitalist, “information” based society, where the changes on the line of conduct seems to undergo a same generalized changing process, it is also here appropriated to mention the new “Lei de Diretrizes e Bases da Educação” (Education Guidelines and Basis Law), LDB 9394/96 which suppresses the legislation hitherto in force. In this new Law, is observed a change relative to the former laws, as for example, the lack of requirement for the “minimum curricula”, showing clearly, thus, a vast flexibility, including from the beginning of school education up to the exit of the university education. Moreover, it can be verified that, at the ending of the scholastic process, the control of the education system comes to be pursued through the requests that establish “learning outcomes”, to be demonstrated by the students. This way, remains an explicit contradiction in the very Law: if by one side, it provides flexibility to the

university courses by the minimum curricula suppression, by the other side, it is able to control these curricula through the evaluation. After all, it becomes much evident that both the flexibility process and the evaluation are very present in the new Education Law, no matter how much this can resemble contradictory. Anyway, the door for innovations is open in a such way that, if this new Law can be worked with creativeness by the society and being protected the “ethos” of each area, it would be possible, perhaps, to start performing the structural changes, so many times required.

The re-engineering and the reforms of the national curricula

It can be observed with some clearness that the new model of “organizational innovations”, inspired on the Japanese school, has conducted to a great economical determinism in the sense to adjust the people’s life in all its political, social, cultural and educational features to these new forms of domination from the modern capitalism. Such model, in the patterns of the Ohnism or Toyotism, with strong predominance on the industrial optimization, has been relying basically on two main pillars, namely: the flexibility and the integration. Thus, it is found flexibility in the production organization, in the formation of contracts and wages and in the enterprises management, whereas the integration is based on the development of team’s work with a view to rapidly react to the market fluctuations and to reach a high quality level with the decrease of the costs and increase of the productivity.

With this new economical conception acting in the worldwide market and considering the phenomena known as “globalization” (seek of markets in planetary scale, where the main actors are not the governments but the great business conglomerates), it can be imagined that one of the main features of this process will be a great concentration of richness and power. It is interesting to observe that, within this new context, the economical success has been reached less by top technological discoveries with the use of high technology, but through the use of processes of differentiated and varied works.

In this case, the tool used by the enterprises to reach their purposes, consist in the so called “total quality”, which as per Bertoni (in Laudares, [11]) generically represents an “optimization of the processes and works without radical changes”. However, when it is not a question of to reformulate or make changes that leave untouched the structures, then, as per Hammer (in Laudares, [11]), it shall be pursued the so called “re-engineering”, i. e., a “radical re-structuring of the processes that aim to reach to drastic improvements”. Therefore, the meaning of “total quality” is related more with an application of constant corrective measures and, conceptually, differentiates from the “re-engineering” that means the application of radical changes.

Starting from these new presuppositions and, possibly, in analogy with the thesis of S. Bowles and H. Gintis (in Petitat, [18]) where the “major focus relies upon the analysis of the school ideological role on the reproduction of domination relations, on which relations predominate in the economical sphere and that have the supremacy in the other dominions of the social activity”, it would be plausible that the State and the social watching sectors, in name of a society said consensual, come to deal with the graduation teaching in a context of stimulus and financing of the Curricular Reforms. So, since 1995, many financial resources have been invested in order to improve the graduation teaching in the country. According to Logarezi [12] “specifically in the all fields engineering, the organs have been promoting partnerships, seeking to cover in a large and integrated way the several teaching features that need urgent improvement”.

Thus, taking into consideration that the traditional teaching model for the all fields engineering, idealized in an aristocratic and elitist time, still retains many features of its origin, it is suitable to be inquired: *how was understood the “changing intentions” by the engineering schools and which were the impacts on the several national curricula due to the breaking out of the process REENGE?* (Re-engineering of the engineering teaching - conjoint action of the government organs, entrepreneurial leaderships and the national engineering representing entities).

Final Considerations

In the search for enlightenments about the complex curricular area, I started to become interested in its comprehension trough the educational area, when I realized that several of such studies had an approach under the lights of the critical and sociological theory of the curriculum. Regarding this, I pay special attention to the clearness of what these theorizations teach us because they show clearly the lack of neutrality of the curriculum, of its organization, of its subject and of its effects. For the specific case of the all fields engineering, it should be mentioned that in view of the technological education and the concerns with academic questions related with the “area of exact sciences”, the engineering schools, many times, are conducting processes of “curricular reformulation”, basically adopting a “philosophical approach” in which the disciplines are treated in an “ingenuous” form and are created by the intellectual community as they were “technically perfect”, and right after, translated in the form of “school subject”.

It can also be observed a lack of study and perception of the manner by which the curriculum of the different courses should be worked out and accomplished, moreover, of how, on the course of the time, they were being reformulated. In this case, it make sense the analysis of Popkewitz [19], based in their researches about educational change, when he states that the reforms occur, many times, under a

perspective by which “the change is saw as intrinsic to the movement or activity, but little attention is paid to the change itself”. This seems to be what is happening among us in the Engineering. In short, in a previous and quickly analysis of the curricular reformulation processes which are taking place, it is possible to understand them, in a great extent, inside a connotation of “improvement of the teaching work efficiency”, even that the changes made in the several courses have been considered as very important by the academic community, such as: reduction of the school routine hours, upright disposition of disciplines of the curricular grid and exclusion/insertion of disciplines. Therefore, I realize that the curricular area of the all fields engineering needs also many questionings, reflections and constant analysis from the professionals concerned with the area.

The general purpose of my work relies on the scrupulous investigation and hindmost critical and sociological analysis of the new curricula for the courses of Civil Engineering of the national teaching institutions linked to the process REENGE. Starting from this purpose, research questions that, at the moment, puzzles me can be expressed in the following way: *How the “proposed changes” of the REENGE edict were understood by the different schools? Which curricular changes were pursued by the schools in order to comply with the new social and regional requests? How the new engineering schools curricula were organized and which ones were able to transgress the “existing curricular order”? Which were the existing conflicts during the new engineering curricula definition?*, among others. Consequently and, perhaps, ironically, *how the verb “engineer” (which, normally for the technical area can be defined as the capability for the technologic creation and/or innovation) relates itself with the curricular change process?* Then, if the engineers, until now, were able to well apply such terminology to their, in its proper signification, actuation areas, *how this has been reflecting over their own curriculum?* Therefore, it becomes fundamental during the curricula analysis, the finding of the real meaning(s) of the prefix ‘re’ on the word ‘reengineer’ in words of the real changes on the state of art of the national all fields engineering teaching, i. e., ‘re’, *from revolution, repetition, retroaction or from which more?* Finally, I understand that after analysis done, it is possible to question and think about around the composition of the Civil Engineering courses.

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