

# Teachers' Training in Engineering and Computer Sciences Courses under Integrative Approach

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## Abstract

*This paper presents the author experience on teachers' training in Doctor and Master Sciences Program in Computer Sciences. First of all, it is perceptible, at Brazilian context, the necessity of inclusion of teachers' training contents, usually outer of traditional technological courses program. Those pedagogic contents do not substitute, or even, compete with technical contents. By the other hand, they contribute to improve teachers' skills required by nowadays demands in technological area. Those changes are particularly important for future Doctor and Master in Sciences people and it refers to a practical question, in the Brazilian case. Most of participants will work as docents on the increasing number of national universities. It will be presented and discussed several practical questions provided by students which have followed the discipline titled: "Pedagogic Practice under Integrative Educational Environments". Conclusion points out presence of pedagogic aspects contribute to modify, positive way, professional profile in technological areas concerning the near future demands.*

**Keywords:** *Teachers' Training, Technological Education, Integrative Educational Environment.*

## 1. Introduction

The present paper presents a new approach concerning engineering and computer sciences education considering UNESCO "Complex thought" cathedra [1] as a theoretical approach and Kristen Nygaard [2] complex knowledge modelling to education. The author concrete experience with this educational approach is has been presented in ICEE conferences since 1998 and about eleven ICEE publications can be found in ICEE proceedings explaining many details which are not the aim of the present paper. This paper discusses about pedagogic aspects from a discipline ministered in Computer Sciences Doctor and Master Program from UFSC University. Teaching process are discussed in terms of Brazilian context. The experience theoretical foundation as well as some practical questions will be presented and analyzed.

## 2. The "Pedagogic Practice under Integrative Educational Environments" Discipline. Formal Contents and Signification

The discipline titled "Pedagogic Practice under Integrative Educational Environments" is supported by educational and informatics domain of knowledge theoretical foundation. The discipline topics refer to a whole educational model applied to education in technological areas, like engineering and computer science courses. Its contents complement professional profile from the Master and Doctor students.

### 2.1. Discipline Theoretical Foundation

Below it is listed some pedagogic directives which support integrative educational proposal.

- a) 'Pertinence of knowledge'. This directive, derived by Edgar Morin, refers to integrative focus which embeds social, economic, ecological aspects, as well as local demands which composes the central pedagogic axis. This real world vision, aggregate relevance to technical contents and

increases student motivation. This principle supports university contribution to social and economic development. [1]

- b) 'Integration of knowledge'. This directive refers to projects which are considered as central pedagogic axis. In this directive, different kinds of information appear all together without discrimination at first glance. Under this approach, also called Project Oriented Focus, knowledge representation models appear from generic aspects towards particular specialized issues/methods/operations, like engineering aspects, math methods and so on. Project Oriented Focus also was suggested by Abet Criteria 2000. [3]
- c) 'Increasing difficulty' supported by a sequence of projects concerning a thematic, explored from easy to sophisticated aspects. This refers to the present paper author proposal to lead with complex approach in terms of knowledge modelling since beginners' level. See details at iNEER book [4], chapter 18.

## 2.2. Discipline Main Modules

Table 1 illustrates the four main modules of discipline topics. The modules are briefly described, as follows:

- a) Module one. *Knowledge modelling focus under integrative view*. This integrative focus in education is supported by two theories. The first one is the 'Complex Thought' theory applied to education derived by the president from UNESCO Complex Thought cathedra President, Edgar Morin. [1] It concerns to a theoretical foundation in terms of open system focus. And, the second theory concerns the Object Oriented knowledge modelling tool derived by Norwegian Emeritus Professor Kristen Nygaard, from Informatics area. [4] The present paper author proposal unifies both theories dealing with integrative/complex approach supported by Object Oriented informatics modelling tool using a transversal thematic as central axis. This module content was presented in the ICEE 2012 Workshop, Finland. [5]
- b) Module Two. *Teacher/learning communication*. It emerged after authors' previous experience involving students with learning difficulties during 24 teaching semesters. It has aggregated new aspects to the educational model, like human subjectivity and diversity direct affecting class room activities. Different communication languages and knowledge about learn styles, like provided by Kolb Test has been discussed with students. [6] Students have filled the Kolb Learn Styles Inventory to perceive their individuality. After Kolb Learn Styles test results, it is remarkable that self identification style was a factor of motivation during the discipline activities. In addition, students have filled Brain Process Channels test.[7] Finally, Milton Erickson model applied to Education, was presented to students.[8] The Teaching/learning communication module also was exposed in a ICECE2011 Workshop, Portugal. [9] This module specially represents new contents to technological careers students because it is not usual discipline about human behavior and to self identification aspects considering subjectivity and diversity of human learning styles.
- c) Module three and four. *Contents evaluation and Environment instrumentation*. Contents evaluation refers to the process evaluation of contents including some dimensions associated with integrative directives. Environment instrumentation refers to a new focus under integrative principles. Both modules content were already presented in previous ICEE conferences. [10]

Table 1. Discipline Four Main Modules.

Module 1	Integrative Knowledge Focus (problem, projects, curriculum)
Module 2	Integrative Teaching/Learning Communication (subjectivity- diversity combined directives)
Module 3	Integrative Students Evaluation (evaluation tools combination)
Module 4	Integrative Instrumentation (pedagogic tools combination)

### 3. Practical Questions Provided by Students

The discipline students were stimulated to point out several practical questions. The students proposed questions were enough generic to be useful to understand educational practice in our specific context. Their opinion about the discipline contents are resumed below.

#### 3.1. Innovative Discipline Contents

Students remark the discipline content was new because it extrapolates the technical focus opening doors for a broad and integrative educational view. About the knowledge modelling under complex approach, all students have good previous skills for informatics modelling under Object-Oriented tool. But, at same time, it is not usual to insert really complex themes to develop informatics or engineering knowledge systems in class room computer programming practice. On this direction, integrative view applied to knowledge systems modelling help to deal with projects which are divided in two levels. The first one, is the abstract level which is not implementable in terms of a concrete product. But the abstract aspects influence the concrete solution and the problem global vision.

#### 3.2 Useful Discipline Contents in Terms of Practical Necessity

Students perceive the discipline topics are useful to answer their 'first ask questions' concerning teachers' day by day pedagogic activities helping to overpass their inexperience in terms of real world class room tasks.

#### 3.3. Discipline Contents Cover Different Students Mind Maps Reasoning

Mind map reasoning refers to different styles of learning. Mind map reasoning can be obtained by Kolb Test [6]. The learning styles can be resumed in four different ones, see Table 2. The abstract concepts learning style, the reflexive observation learning style, the concrete experience learning style and the active experimentation learning style. Considering each person has a complete mind map but each one has a self preferential behaviour in terms of learning style, students have pointed out the discipline method stimulates different learning styles concerning class room activities. This is important to remark because technological area usually stimulate concrete analytical student mind instead abstract synthetic one. But the professional demands increases in terms of complex problems to solve. And also at technological areas it is important not only to implement but also to develop products, abstract way. Concrete activities can be combined with other kind of activities in the field of knowledge development.

Table 2. Different Learning Styles following Kolbs' Inventory Test.

Learning Style	Learning Style
Abstract Concepts	Concrete Experience
Reflexive Observation	Active Experimentation

#### 3.4. Discipline Topics Help Students to Differentiate 'Informatics Education' and 'Education in Informatics and Engineering' Concepts

Students, at first glance, were confused about the exactly meaning of educational software applications field and education in informatics and engineering application field. Informatics Education belongs to Education in Informatics and not the opposite. Education in Informatics and technological areas is more generic level then Informatics Education. Education in informatics involves several modules, not only the instrumental one. At the end of the course discipline, students understand clear that Educational Software belongs to the instrumental module concerning a whole educational proposal. Pedagogic instruments, like educational software are important but must be submitted to generic directives like subjectivity and diversity. Combination of those educational tools and face to face activities are important to arrive to an integrative proposal.

## 4. Discipline Response to an Educational Paradox

Education in technological area can bring to a kind of paradox situation. Usually, docents begin their careers without training teachers' knowledge support, in the Brazilian case. In the Brazilian context, most of the students following Master and Doctor program in Engineer and Computer Sciences field aspire to be a university docent. On this direction, they try to get the doctor title in accordance with official requirements of docent career. The students from doctor program in technological field of knowledge have exclusively Engineering or Informatics title. This means they are specialized on technical skills. They need to develop teachers skills, a specific discipline covering educational topics useful for their practical needs. They need to include teachers' training, or even, communication skills topics in their curriculum. Paradox here means a future docent must have disciplines in Doctor program which exposes educational aspects of technological education under modern approaches. But nowadays it is not usual in the Brazilian case of technological courses to offer such kind of content for students which aspire to be university docents.

## 5. Analysis of the Discipline Experience

New educational perspective. The students at the first day of class room activity were very curious about what means *Integrative Educational Environments*. It was really a new perspective for them. At first glance, they really think they would discuss about different pedagogic applications of informatics in education supported by educational software development tools. But they were astonished to perceive the discipline topics embed much more than educational software tools topics. Educational software tools constitutes an important pedagogic support, no doubt, but a whole educational proposal includes more than educational software tools development focusing different knowledge domain fields. Informatics tools in education constitute the instrumental module belonging to the whole educational proposal. And the instrumental module must be submitted to the directives set belonging to a generic educational model. The four discipline modules above mentioned (2.2) embed a set of pedagogic issues under subjectivity and diversity directives in education.

Integrative focus in education is the central discussion point. This means, integrative focus refers not only to a new experience or new point of view about the same object of study. The experience with integrative approach has pointed out a perception of another reasoning logic presuppose. And this is the hard and essential part of the problem. To adopt a new knowledge system is already hard but the migration to another system logic including, from knowledge system modelling until evaluation tasks and instrumentation, is almost a revolution. Thematic knowledge modelling focus, human subjectivity focus, process evaluation focus and instrumental focus supporting human diversity and subjectivity are the new approach to education under integrative models.

Cultural division barrier. Division about masculine and feminine culture associated with subjectivity, diversity creates additional difficulty. Authors' colleagues have spoken about their difficulty to deal with new behaviour at class room because they seem to be soft and not masculine attitudes, as usual in technological area activities.

Difficulty to assume self deficiency. Consequently, it is usual to ignore open possibilities to bring to class room.

## 6. Conclusion

On the last years, they are a great number of pedagogic projects which have been implemented all over the world under integrative view in education. [11]-[15] It is possible some of them do not have a theoretical foundation concerning integrative approach. Some of them were created under intuition referring to practical proposals. And they help to transform education. This dynamic process in education points out a paradigm shift is coming and this also means the near future will modify the disciplinary knowledge orientation towards integrative view under integrative/complex approach in education in all

knowledge domain areas. To facilitate educational changes it is important to take decisions at collegiate level and not at individual one. Same behaviour for everyone is positive and more easy do deal with innovative pedagogic aspects.

A final conclusion remarks that the way you treat knowledge affects curricular organization. But it is possible to deal with integrative proposal also under very traditional curricular organization. It is possible to work with each one of the four discipline modules independent way, with positive specific results. Potentiality of results differs dependent to how broad is the extension of educational changes.

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