

Enhancing Productivity in Higher Education

Enhancing Productivity through Curricular Innovation

Cognitive Based Curricula

1. Introducing the topic

Improving the productivity of Higher Education is an ambitious objective worthy of enhancement for several reasons. In fact, Higher Education is the main concern for a growing number of persons all over the world and its necessity becomes obvious especially in the developing countries. Several concomitant components of equal importance influence the Higher Education setting in any country. These components are complementary and sustain themselves mutually (mutually sustainable?). One of these components is the curriculum. The term «curriculum» is used here in its educational sense and includes therefore, not only the list of courses that forms its content, but also the teaching methodology, the objectives of the program concerned, and the assessment approach. That is why, the innovation at the level of the curriculum, is an intrinsic part of the productivity issue and can be very decisive if we want Higher Education to cope with the worldwide needs.

In many countries Higher Education suffers from a lack of «contextualisation». Even before the era of globalization, developing countries «imported» their academic programs and realized, too late, that these programs do not correspond to their needs and do not meet their expectations. Besides, changes in curricula in the developed countries as well as in other countries, even the so called innovative changes, remain very often within the boundaries of “pre-set” frameworks, such frameworks being in general very close to the historic development of the different specialties. Disregarding some rare exceptions, dealing with curricula in Higher Education remains VERY conservative. Essentially, innovations touch on (i) the content that evolved with the evolution of Science and Technology, and (ii) some techniques of teaching that followed the advancement of the Pedagogy.

The end of the twentieth century saw, among others, a breakthrough of the Cognitive Psychology and its repercussions on the educational world. But it was only

a breakthrough. Indeed, few pedagogues were concerned with the drastic changes that Cognitive Psychology was to bring to Applied Pedagogy. Even when the individual works of famous authors (namely Vygotski, Piaget, and Searle) were studied thoroughly, very few tried to make the links between these works and their impact on Education. However, Cognitive Psychology, which combines the Developmental issues (physical, intellectual and emotional), the Language impact (at the communicative and pragmatic levels), and the construction of Knowledge (in Concepts acquisition as well as in Information Treatment), created an educational atmosphere that had the potential to change all the educational practices.

In fact, whereas each of these constituent elements of the Formation is often taken as an independent monolith, the psycho-cognitive approach embraces the principle of their interdependence. Thus, any evolution in knowledge is an evolution that continuously takes all these components into consideration. It seems normal to address the learning issues in primary and elementary schools. However, educators are more skeptical when it comes to the Secondary or to the University levels. This is the issue that this chapter addresses: Does the adoption of the cognitive approach (or the Psycho-Cognitive approach) improve results in Higher Education and enhance productivity? Even if some are very skeptical about the «psychological» impact at the Higher Education level, compared with its impact during the first years of schooling, the cognitive component remains of great importance. In what follows, I will present the specificity of the Cognitive approach and its relation to the Curriculum, and I will propose some changes that need to be adopted for a better academic output, illustrating that with some examples to back up my proposal. I will then end with a conclusion.

2. Describing the specificity of the Cognitive Approach in terms of Curriculum Design.

The Cognitive approach that I present is based on the original works of Gérard Vergnaud, whose works continue the works of Piaget, but in a more exhaustive way, touching the practical sides of Knowledge Construction in any formation. Considering the acquisition of «concepts» as an important constituent element of Knowledge, Vergnaud launches the idea of “Conceptual Field”. This idea includes a specific definition of the term “Concept” and places any knowledge acquisition in a broader and more realistic setting. The changes that such a theory implies fall within the realm of the Cognitive Psychology. They constitute a drastic turning point when it comes to issues of curricular practices.

The starting point of the theory is that a concept exists only if it is operational in a well defined set of situations and its utilization in any of these situations is not independent of other data and other concepts related to different domains such as the Language or the Logic or simply sometimes the daily experience of the learner. This is what I call the longitudinal dimension of a conceptual field. It takes into consideration the constructivist approach and the idea of the concept as defined and introduced by Vergnaud. Having in mind the importance of an operational dimension essential to Knowledge Construction, Vergnaud, set the following three-dimensional definition for the term “concept”:

- a. The set of Situations in which it operates.
- b. The set of the Invariables that make it operational.
- c. The set of Symbols that allow communication and expression related to it.

On the other hand, pedagogues are inclined, when developing their didactical techniques, to opt for independence among disciplines and even sometimes among the different domains of the same discipline. The adoption of an educational strategy may be considered as a first attempt to remedy such a divergence. But adopting a uniform methodology as the main reference to fill the gaps between the

different didactical techniques used here or there, does not offer a solution to the fundamental problem of the curriculum contents. This is where the importance of what I call the “horizontal” dimension of a specific conceptual field comes in. This is the case for “different but interdependent disciplines.” The case of Physics as it relates to Mathematics is obvious, but it is also the case of Mathematics regarding the sensorial experience of the learner and his mastery of language. Without these two components, the first intimately bound to the daily experience and the second to the potential of communication, a mathematical conceptualization at a certain stage of development can become uncertain. This is what I call the horizontal dimension of a conceptual field. The assimilation and the “operationality” of a given concept, depend on combining these two dimensions. I will discuss this view briefly in the following paragraph.

To illustrate this idea, I shall propose a three-dimensional representation model. Each of the conceptual fields in question represents a reversed cone. The cones vertices are situated in horizontal and parallel planes, their axes are parallel to what I consider to be the **developmental** axis. For the needs of this graphic representation I propose two axes of reference for the basis: on one axis I place the **elements of conceptualization** (format, invariant, pre-concept, concept etc...) and on the second axis the **conceptualization status** (situation, communication, adaptation, assimilation etc...).

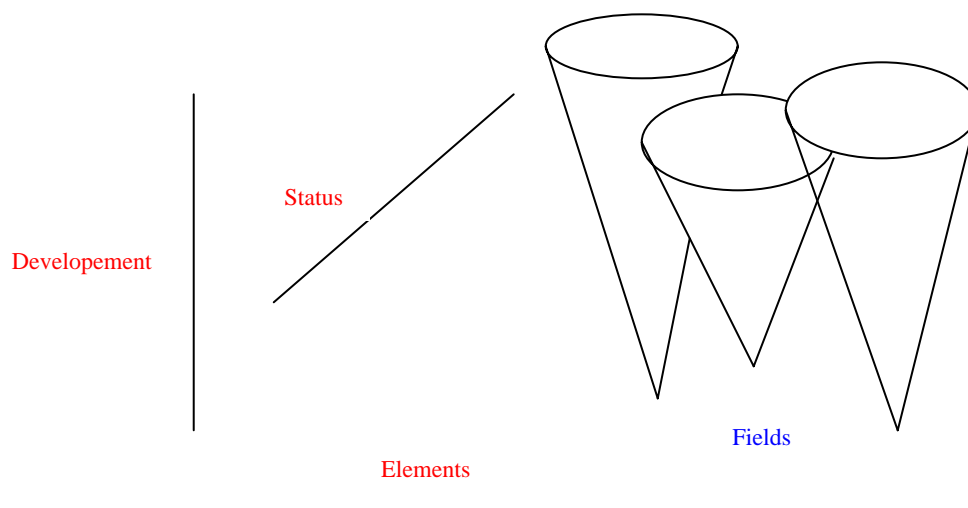


Fig 1

I have to stress that this is only a schematic representation to help in conceiving the existing relationship between the different conceptual fields in the very complex learning situations.

While the acquisition of knowledge is progressing, some conceptual fields will intersect, some will disappear whereas others will emerge. This is what I tried to configure (or illustrate?) in this diagram. It seems to me that it is a powerful (process??). A process that is far from being exhausted theoretically. Educators will do well to take it into consideration and to enrich it with their experiences and their practical remarks. It will be up to the researchers to find answers to questions and even challenges that the concerned instructor may raise.

On the other hand, the use of the term “size”(borrowed from a mathematical perspective) of a conceptual field needs to be specified. It answers a very pragmatic question with an operational objective: At a certain stage of development, how far can one go, in a specific domain, in terms of curriculum content and knowledge acquisition? The Developmental Psychology can be of tremendous help in finding the relation that exists between elements that constitute a given field and other components such as age, the mastering of language, the logic maturity, etc. But one must not forget that the experience to which the learner is exposed is an integral part of his/her potential of conceptualization and that is why the “size” of a conceptual field depends on the socio-cultural environment. This is why there will never be a universal answer to such a question. Any response, in terms of curriculum and productivity will have to be considered within the local specificity, taking into consideration:

1. The developmental components
2. The mastery of language
3. The social environment
4. The learner’s experience
5. The didactical techniques in use.

What preceded, will allow us to foresee the importance of surveying all the conceptual fields in inter-action at a certain age and in a specific environment where the experience of the learner takes place. Building this conical shape of the conceptual fields is equivalent to the construction of knowledge, and the diagram above shows how these different cones will not develop independently. The development of the conceptual field (A), represented by the cutting plane (P) will depend on the development of the conceptual field B, and this action is reciprocal. Elements introduced by the conceptual field (A) (resp. (B)) will become constituent elements of the conceptual field B (resp. (A)) and their absence (or their truncated introduction) can delay the development of the conceptual field B (resp. (A)). This is illustrated in the following figure:

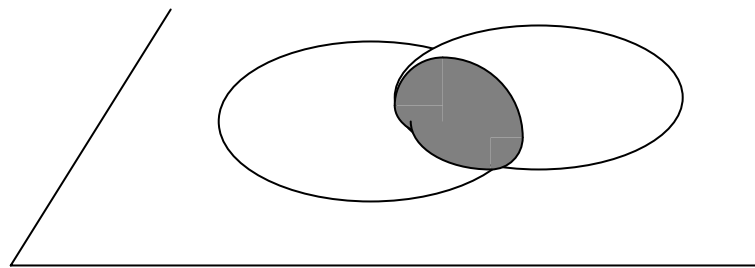


Fig 2

This is why we have to look to interdisciplinarity as a foundation of any curriculum development. University instructors have to be aware of the development of different conceptual fields which are the components of each student's construction of knowledge. These components are to be addressed both in the curriculum content and in the experimental phase of the conceptual preparation. Such a balance is compulsory for the evolving of knowledge.

This approach has important didactic consequences. It questions not only the “independence” of the different concepts involved in building the learner's knowledge, but also the foundations of the didactical techniques, and of the curriculum engineering. We have questioned from time to time the techniques used in university teaching, but rarely did we question the independence of the different

disciplines or the different domains of one particular discipline. In spite of the efforts of Cognitive Psychology and Education Science pioneers, instructors, in their daily teaching, usually act as if the learner is a “parceled being”. This has resulted in a burden for Higher Education productivity and it is why I am trying to address the issue by calling for a drastic change.

I have tried, in all that preceded, to stress the complexity of the problem that teachers have to cope with in order to improve the quality of their teaching and to achieve their aim with maximum efficiency. Not only are they called upon to overlook the technical part of their role by adopting a more consequent methodological approach, but they are also asked to change the conception of their role. Becoming educators and not only instructors, will demand from them to take into consideration the inter-disciplinary approach, the development of different conceptual fields, and the importance of adequate learning and communicative situations. The task is enormous especially because a lot of the research becomes indispensable before we are able to put these principles into practice.

3. Presenting the main changes to be adopted for implementation and the expected enhancement implications.

In what follows, I will try to develop in more details the expected changes and how they may influence positively Higher Education productivity. I have underlined so far that the cognitive approach has two direct impacts: the first is that inter-disciplinarity is a must, not a choice anymore (a must resulting from the Conceptual Field Theory), and the second is the importance of applied know how as compulsory bases in knowledge construction.

At the research level, interdisciplinarity is now becoming an important asset. Scientific development in some domains (as the Environment) was due to interdisciplinary teams from all over the world. Scientists, professors, researchers in

different domains share their knowledge, their potentials and their know how to answer more and more complex scientific questions. But this interdisciplinarity that proved to be very productive and very fertile, has not yet entered our academic undergraduate programs. In order to meet the requirements of students majoring in a given domain (A), the curriculum usually offers them a course (X) in domain (B) which is considered for this purpose as part of a “service department”. Such course is not specific to a well defined group of students. Learners from either domains (A) or (B) (and even more domains sometimes), will take it. Such a policy is in total discordance with the cognitive views. From an economical point of view, it seems to be a way to minimize costs. This is a simplistic answer to a more complicated question coming from the Conceptual Fields Theory which seeks to answer the following: Does the content of the course (X) have the same interest for students of domains (A) and (B)? Does this content have the same importance in the construction of knowledge of these students? Does this content need a remodeling in order to meet the requirements of the formation of all these students, and in what direction?

These questions are not important if we are looking for a simple face lifting of the curriculum. But they are, if we want to insure a better productivity of the teaching procedure, and a more in depth learning process. I will give here two examples:

- a. A calculus course in Mathematics is usually offered by the Math department and is regularly taken by students from various departments mainly: Mathematics, Physics and Engineering. Whereas a theoretical approach (even for the technical approach) is extolled by mathematicians, the link with applied problem solving is far more important for the mathematical analysts in their daily practice. It is also that which makes it difficult for the physicist find the reasoning behind this theoretical approach, who is unable to integrate such information to his/her approach for problem solving in Physics or Engineering. Additional courses are generally needed to fill the gaps. And we end by having a deficiency in

building the knowledge of the learners, and in diminishing the formal productivity of Higher Education, and in an economical which loss we had tried to avoid in the first place.

b. My second example is the case of a course in Developmental Psychology, offered by the Department of Psychology and taken jointly with the students of Education Science. Whereas the psychologists will stress in this course a variety of aspects but minimizing the sociological and educational issues with regard to other the relational ones, the educators will stress in the first place the physical and mental developmental aspects that come to complete the relational dimension (both intrinsic as extrinsic). Deprived of this developmental specificity, which is directly bound to the real life concerns of educators, the course loses its «applied» span, which is the basic interest of pedagogues. Such a course, will become informative and not any more a part of the educators knowledge.

The difference I am making between information and knowledge is neither fortuitous nor just a formality. It's the essence of the cognitive approach. An information which is not treated in context, with the proper tools and set of invariables to ensure its operationnality, and with the indispensable symbols to its communicability, is not going to become integral to the learner's knowledge because it will remain outside the concerned conceptual field. Based on this approach, the content for the academic curriculum of a specific major can no more be conceived as a juxtaposition of courses offered in different «service departments» with a concentration in the «department of specialization».

New academic options will have to drive the curriculum engineering process towards new choices based on cognitive tools and on curricular interfaces. Economic concerns, will cause Higher Education teaching to lack productivity. In the two examples mentioned above, for non major «users» of the courses offered by the service departments (Mathematics in the first case and Psychology in the

second), the objectives were weakly achieved. Generally this will result in offering redundant courses, to fill all type of gaps and materials not covered in the courses offered. This is to say that, without a proper treatment of information in situation, there is not a real appropriation of knowledge. Eventually, one ends up having parcel information in the following way:

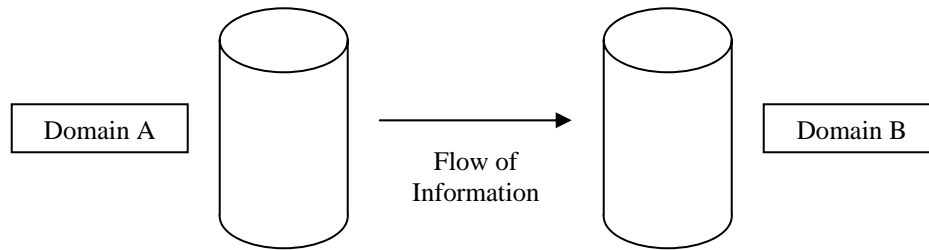


Fig 3

However the treatment of information has to be anchored in situations related to the objective of the formation. For example, integration, conceived like a limit of an approximation series in Mathematics, cannot become an integral part of the knowledge of the physicist or the engineer until it becomes a solving tool for problems in physics or in engineering. This is also the case for educators called to solve an educational developmental problem out of a relational theoretical approach. The adopted teaching method in Higher Education asks physicists and engineers (resp. educators), to «borrow» the mathematical (resp. psychological) information and to apply it in situations that they discover downstream. What we need, perhaps, is to change the “order” by asking the students to begin treating the information in adequate situations and then, at the end, to reach the theoretical framework by modeling their successive findings. This leads me to the second impact of the cognitive approach on the academic formation, namely the “experimental” basis of knowledge.

The Conceptual Field Theory is tremendously aware of the importance of the preparation phase that leads to any construction of knowledge. The classic school adopted the “magister dixit” approach as the ultimate and better manner to introduce

notions, concepts, and theory, even if this approach uses different tools for didactical purposes. The student's role was (and often, still is), to find his path from the theory toward application. True, mainly in university mathematics, this educational policy may be generalized to apply nearly to all disciplines. With the introduction of the «case study» approach especially in graduate and postgraduate studies a certain change has already been launched. Still shy and sometimes completely absent this new approach was pragmatic and realistic. The cognitive approach not only sustains the success of this new way of learning but it also gives it the theoretical foundations indispensable to its generalization for a better productivity of the whole system.

This preparatory phase can not be based on lecturing procedures. This type of teaching does not stress the critical thinking method and overlooks all the preliminary steps that use the treatment of information and problem solving procedures to change information into knowledge. A concept is mastered through its invariables and these invariables are only acquired from experience and from the utilization of this experience. Through this process the learner will master the different schemes which will lead to acknowledge the adequate concepts-in-act and theorems-in-act that will permit the development of the concept itself. This process of conceptualization within the Conceptual Fields Theory is a must if one wants the learners to build their knowledge so that it becomes «steady» and «operational». Therefore, productivity is not measured in terms of time, but in terms of efficiency. Often administrators regret that the fresh graduate they hire need intensive sessions to become updated and productive. I think that this phenomenon is due to the fact that the information forming the content of the curriculum has not been acquired by the adequate way that will permit its utilization in real life situations. Such information did not become knowledge and thus Higher Education seems to be unproductive for, our output, the graduates.

This is one of the main differences between the classical approach of curriculum engineering and the cognitive one. The first gives a lot of importance to

the didactical techniques and minimizes the importance of the methodological aspect which is the basis of any know-how. The second, by contrast, asks all didactic techniques to comply with the imperatives of cognitive constructivism. This is why, experience and its utilization become constituent elements at the basis of any curriculum and not only elements of applied work. This is illustrated in what follows:

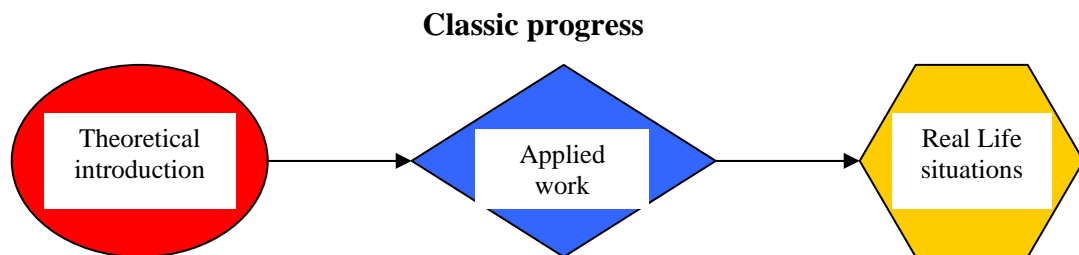


Fig. 4

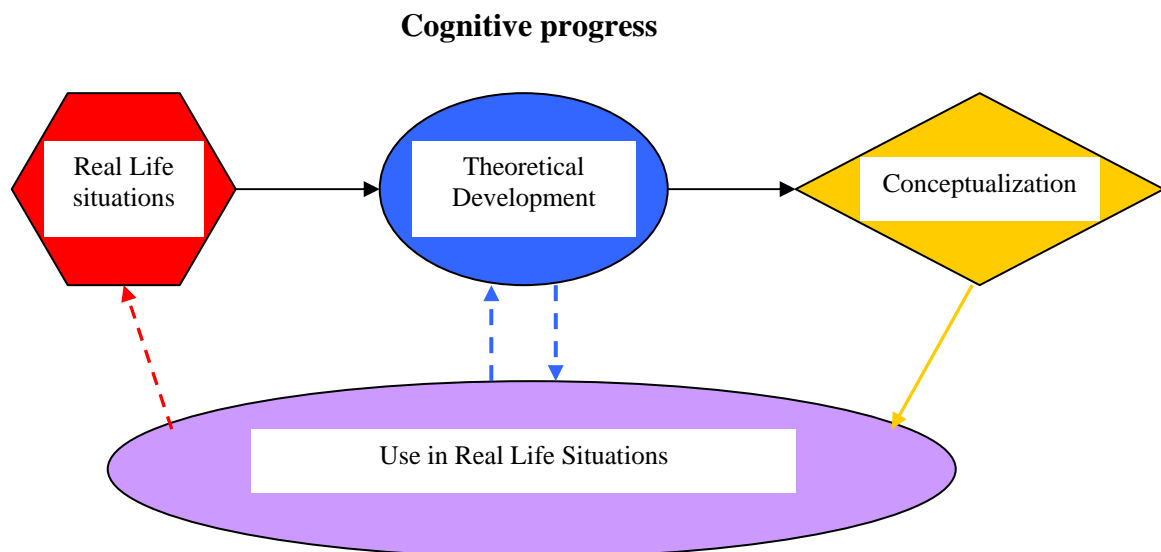


Fig. 5

The difference between the classic diagram and the cognitive one is not formal, it is a difference in depth between an acquisition of information that applies too late to real life situations, and a knowledge building anchored from the very beginning in real life situations. That is why the implied methodological changes are not simple adjustments of some didactical practice. Even the treatment of

information takes a new aspect because it is bound intimately to real life situations and not to theoretical setting. On the other hand, the building of knowledge is a part of the procedure itself and is induced by a “scientific” approach whatever the field of specialization is.

In order to cover all aspects related to the curriculum, I have to underline the fact that the recommended conceptual and methodological changes, have an impact on the process of assessment. Being productive means a valorization of the final product. The assessment of the work by community will fire back on Higher Education. I don’t think that we have to envisage the productivity only for «internal» purposes, this is why, we need to rethink our methods of assessment in the light of this same approach.

The cognitive methods have not yet answered all the questions related to assessment and evaluation. But we can, nevertheless, make the following remarks:

- i. The relation between experience and the gradual acquisition of concepts allows instructors and learners to be aware of the evolvement of the learners’ competencies. This will require from the instructors to define the course objectives in terms of competencies and not only in terms of required information.
- ii. The relation between knowledge building and real life situations helps the instructors to assess the students’ potentials in utilizing their knowledge. By creating simulated situations, instructors will be able to test to what extent students are able to treat information in new situations, which shows that their knowledge is becoming more and more operational.
- iii. The relation between the different components of a given concept and the relation between several concepts of one specific conceptual field can be evaluated through synthesis tests. Such tests, while, seemingly similar to the classical ones, will be, in fact, different, because of their methodology, their objective, and their structure.

4. Case to illustrate the proposal

In order to illustrate this quite innovative proposal, which aims at enhancing the productivity of the Higher Education, I am going to give as an example the curriculum of an Education Science Department. Let us assume that the objective of such a curriculum is to prepare students graduating with a BA+TD (4 year program) to become teachers in elementary schools, with a possibility to undertake, after a while or immediately after their graduation, an MA degree.

A classical approach will design a curriculum like this:

The B.A. Curriculum T.D.			
<u>The University requirements courses</u>	<u>The Department requirements courses</u>	<u>Elective courses</u>	<u>Different didactical courses</u>
Liberal Education Computer Literacy Communication Skills	Education (mainly) Psychology (1 or 2) Sociology (1 or 2) Statistics (1)	From inside or outside the Department	General Introduction Teaching methods for different subjects Observation and training

Fig 6

In this case:

- i. No special attention is given to the students as future teachers. What will be their capacity to perform in terms of body language, communication human skills, resolution of conflicts etc? The University Requirements even if they are important are not tailored to fit with the specificity of the department objective. On the other hand, the specialized courses are not designed to fill such a gap because of their “specialized” aspect.
- ii. The Psychology, Sociology and Statistic courses, when offered, are offered from the perspective of the departments within their own objectives. Each course may

- give valuable information but will not be integrated with other information coming from any other source.
- iii. The Education courses will cover generally, History of Education, the different schools of thought in Education, some basic principles about curriculum design, school documents and class management.
 - iv. The TD courses, offered in a fourth year, focus on different didactical tools for different disciplines under the general title “Teaching...”. Class observations and lessons planning complete the teaching diploma requirements.
 - v. The percentage of electives will vary from one university to another. Some universities will give their students the option to go for a minor which may or may not be related to the field Education.

A cognitive approach will address the issue from a totally different perspective. Even if the student does not want to go for a TD, but only for a BA in Education, he/she will have to know the real life situation of Education. The know how, which answers the famous question “What works” has to become an answer to specific needs dictated by the students’ knowledge, which has to be built from situations experienced in classrooms, in schools, with principals and fellow teachers etc. This is why, the listing of the curriculum courses will be far more difficult than the one illustrated in the table above.

- i. The liberal education courses will have to reflect the acts that the students will have to perform (or at least will have to be able to perform) in a school setting.
- ii. The computer literacy courses will not just be an introduction to classical software. They will have to stress the computers as a learning tool especially for remedial use in class. Other personal enhancement skills will have to be introduced in terms of conflict resolution, problem solving approach, debates techniques etc.
- iii. The communication skills should not only reflect language mastery, but also, they have to prepare the students to choose their body language, the way they will address the students in different age, the pragmatic aspect of any communication etc.

- iv. The Psychology and Sociology courses will not address only the general aspects under the terms Child Psychology or Introduction to Psychology or even Educational psychology or Sociology of Education. The stress is to be given to how Education can be directed and influenced by psychological or sociological aspects. A critical approach to the study of real life situations, and case studies, are basic ingredients given to the future educators to ask themselves about the proper methods of teaching in a special social environment and within psychological constraints of students, and parents.
- v. Introductory Education is not only an introduction of theories and practices that succeeded here and there. But it is also the complex relation between human development, social needs, knowledge building, logic maturation and communication abilities. Critical thinking is the basis of such an approach in Education courses. Such courses can be only the synthesis between theory and class observation and practices.
- vi. The basic changes to be introduced will have to be worked out by specialists and reviewed after field assessment. Research, and applied research have to be undertaken in order to make the proper adjustment all along the line.
- vii. The enhancement of productivity in terms of economy, money and time is not to be addressed only during the Higher Education formation, but also and especially when the graduates start to perform in real life settings.

Accordingly, and taking into consideration all the remarks stated above, a good representation of such an approach will be the following:

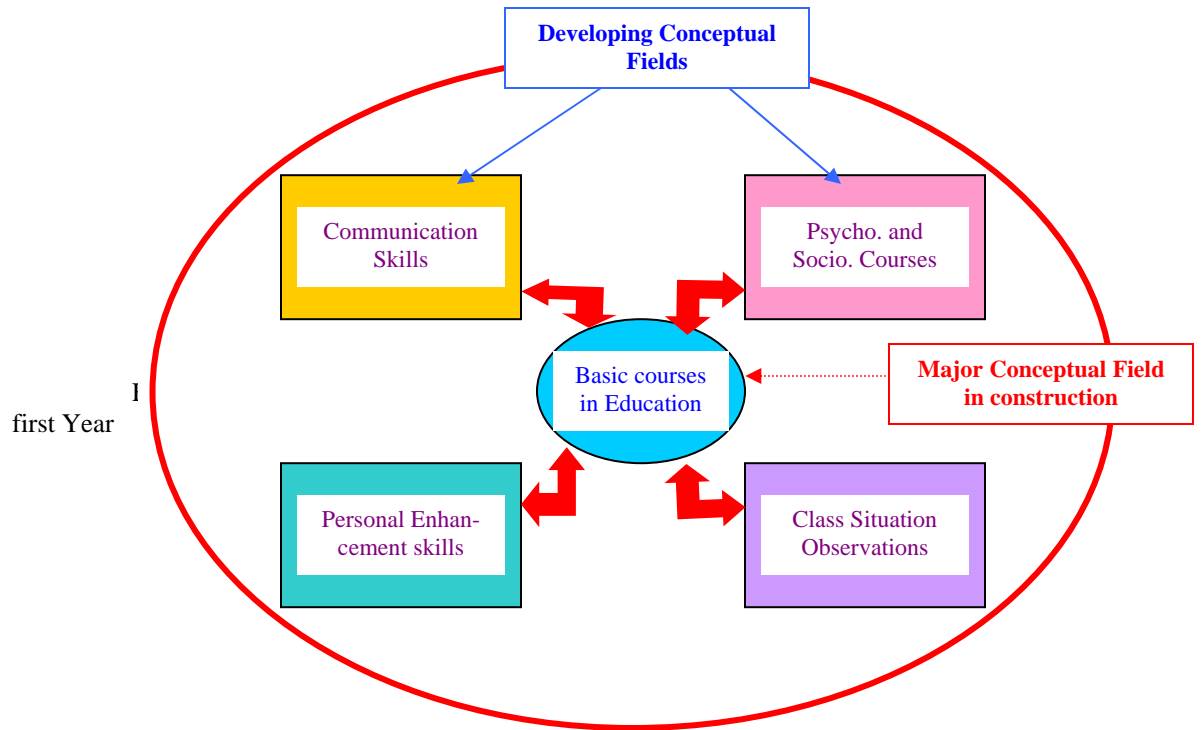


Fig 7,a

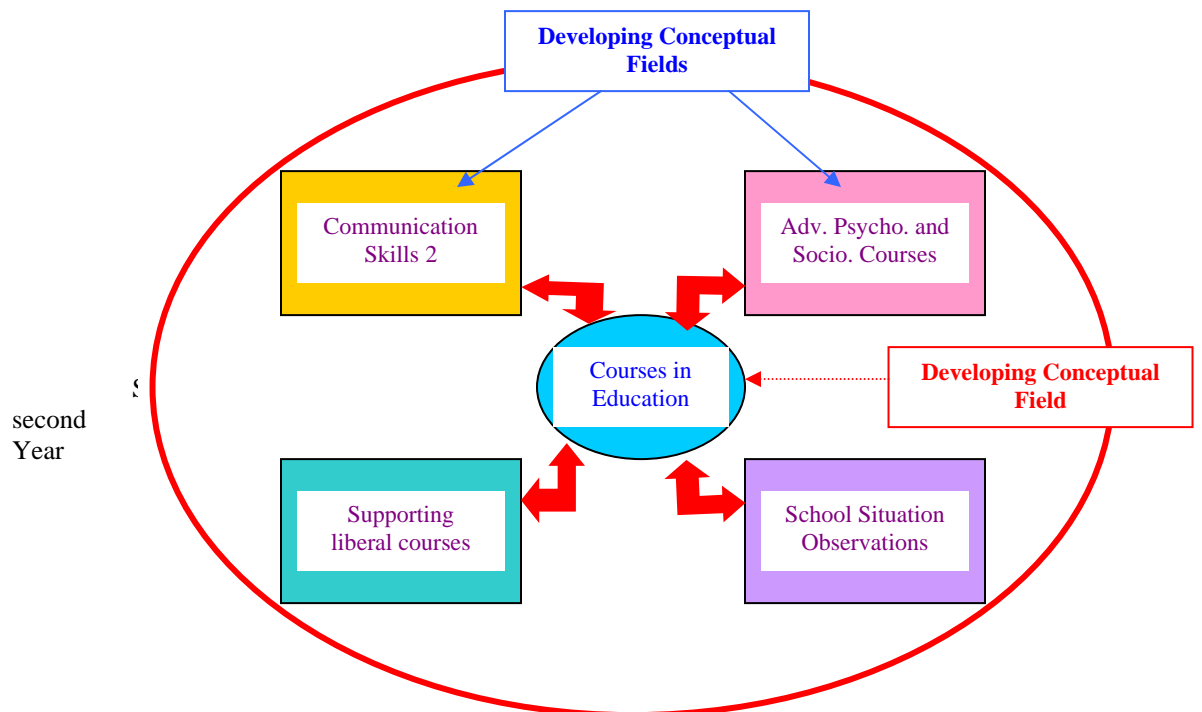


Fig 7,b

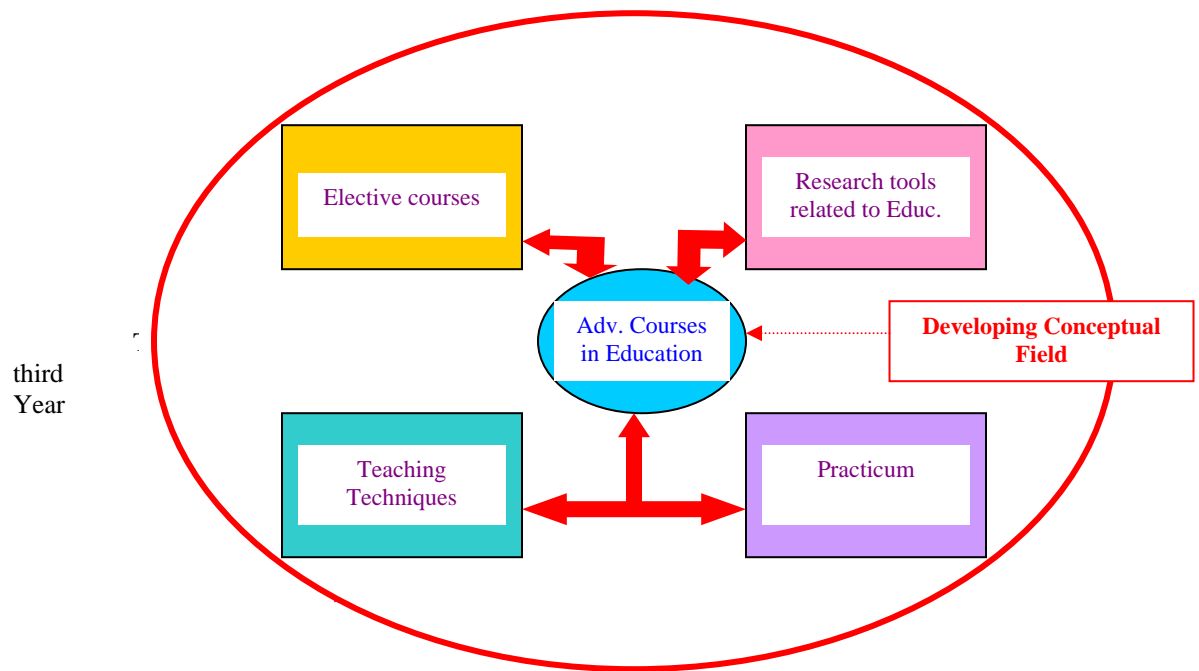


Fig 7,c

These three figures can be best summarized in a tri-dimensional power point presentation showing the evolvement of the different conceptual fields, their interaction and the role of the personal development in knowledge constructivism.

Such a proposal may have the disadvantage of being very compact in terms of the curriculum. The prerequisites of the courses will be very difficult to adjust for two or three semesters within a specific academic year, while it may be easier to plan the offering of courses within one year in terms of co-requisites. Such a change may have an important impact on the classical approach of liberal education. It may seem also that such a proposal has the disadvantage of reducing the number of electives and of requiring more major related courses. But if we look at it from the perspective of productivity of Higher Education, it seems to me that the main advantages are:

- i. The ability to condense a 4 year program into a three year program because of the intensive use of real life situations, in observation, analyses, synthesis, and practice.
- ii. To have graduates who are critical thinkers and know exactly the field of their future work and who have had the chance to enhance their competences during their university formation.
- iii. To have graduates who had participated actively in building their knowledge by linking it intimately to real life situations.

5. Conclusion.

An example from the engineering department may be also given as an example to support this proposal. But it will make this chapter too long without adding new ideas to it. Since I have experienced such a change at the university where I work, and since I am trying with my students to develop these ideas by defining different conceptual fields that form university majors, I am totally aware of the magnitude of the proposed changes. But I think that in order to make Higher Education more productive internally and more responsive to the community's direct needs, such new approach is a must. Until now, only major universities dare to make such changes and they have made a difference. Nowadays we have the theoretical background that enables all the Higher Education System to work for such an improvement.

The psycho-cognitive approach, based on constructivism, on personal development and on mastering different communication tools, is, I think, the proper framework for substantial changes. We will have to revisit our teaching strategies, in light of this curricular approach by trying to make any class situation a communicative and didactical situation. We have to bear in mind that that value of our graduates will depend on how well we prepare them to be flexible and operational in the market and at the same time have the necessary skills to further their studies in terms of research. The potential of some countries, especially the developing ones,

does not allow them the luxury of wasting efforts and time. For such countries a productive Higher Education system that caters to their needs in the best way, by linking teaching to the local situation, sustainable development and human encounters, is essential. The more Higher Education is productive, the more such countries will be able to cope with worldwide requirements of quality. Introducing such changes in the curriculum is, in the long term, an efficient way to produce the needed qualified manpower. This does not diminish the importance of such an approach, from the scientific point of view, to all other countries, because enhancing the productivity of Higher Education is today an important component of all national policies.

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