

A Knowledge Based Analytical Model of Propaedeutic Cycles for Higher Education: Linking with Media Education in Colombia

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Abstract—A Knowledge based system model to face the new methodological strategy on Higher Education in Colombia is presented: the propaedeutic cycles. A great challenge is presented to Superior Education Institutions: to establish the link between traditional cycles: technical, technology and professional ones with the secondary, basic and media levels. Our solution is presented linking each phase with a propedaetic component discussed in a model. The model is dialogically integrated by cognitive an informational components.

A structural system to determine and analyze the cohesion and coherence of the propedaetic cycles between competences and the curriculum knowledge. This construct enables curricular knowledge management inside the media and higher education. Several types of matrices are developed; firstly regarding columns: the longitudinal one in time (semesters); secondly the cross one grouped by curriculum subjects, (additionally each cell of them can be expressed by fuzzy values); thirdly regarding the structure: the input/output for optimization purposes.

An individualized model of student productivity to be integrated to counteract the stereotypes which considers the technical and technological cycles as relegated careers in higher education. This model is an intelligent knowledge based one which was validated with a software prototype just implemented in the FESSJ. This construct has as its mission the guarantee of quality assurance of student's propaedeutic cycles.

A multidimensional flexibility system supported on university autonomy for managing student, pedagogical, and curricular knowledge which enables the management of the heterogeneous and complex environment; this subsystem is intended to ensure continuity and permanence of the student.

The earlier is framed within a construct of curriculum knowledge and information. From this it is intended to reduce the high complexity of the harmonization and articulation of the propaedeutic cycles which face the universities when undertaking these projects.

Moreover, it is pursued to offer major clarity to the educational community and in this way to contribute to the democratization of the involved knowledge within this methodological strategic articulating efforts according to the policy of the Colombian Government which seeks not only to increase the educational population but also to a major access of the marginalized social population and of those of lower revenues in order to fulfill the right to information executed by the National Constitution of this country

Keywords- Propaedeutic cycles, media and Higher education, model, matrix of curricular coherence, student's model, expertise, knowledge management, intelligent knowledge based system, ICT

I. RATIONALE

The higher education system model by propaedeutic cycles that has been named FESSJ-PROP is a complex curricular architecture for implementation and analysis in all Higher Education Institutions in Colombia. A great challenge is presented to Superior Education Institutions: to establish the link between traditional cycles: technical, technology and professional ones with the secondary, basic and media levels. This Architecture is integrated to the Plan of Studies coherent of the three Propaedeutic Cycles; Professional Technical, Technology, and Professional. The model is supported on several dialogical components; structural components or matrix model for curriculum coherence verification and knowledge management, the management system of flexibility, and the student's productivity formation. The tests and validation of the model were initially supported on the rational on the use of the mathematical and computational instruments and, then, on the approach of the system measurement, the same rationale of the study theoretical frames, contrasting then, with the real application of the curriculum coherence matrix during the inspection on quality conditions of the Academy Peers for testing in Bogotá (March and April 2009) in all verified programs; additional a computer simulation model was designed and implemented for complementary validation. The consistence and the prediction power of the model was

demonstrated along with the development of other information construct called iCOACH as a learning prototype , which is working to an experiential learning ; iCOACH is an intelligent system based on knowledge used as a student's individual productivity tool.

A. Objectives of FESSJ-Prop Model

- To reduce the high complexity of the propaedeutic cycle harmonization which are facing the Colombian Universities undertaking these projects
- To offer major clarity to the educational community
- To contribute to the democratization of the involved knowledge within this methodological strategic.
- To articulate efforts within the policy of the Government of Colombia that seeks to increase the educational supply to a major access of the marginalized social population and of those of lower income in order to fulfill the right to information and to the democratization of knowledge executed by the National Constitution.
- To improve the prospective scope as a tool for constructing future in institutions.

B. Specific Objectives

- To enable the curriculum analysis in time power, by periods, and in the knowledge power by areas and assignments.
- To quantify the university production in knowledge development for the student by propaedeutic cycle.
- To apply the new tendencies of engineering which are approached by models: model driven engineering, showing the good applicability of the model by propaedeutic cycles
- To enable the comprehension and management of the methodological strategic by propaedeutic cycles.
- To face accurately, the complexity involved in multiple dimensions.
- To demonstrate that the student productivity and higher education quality run hand in hand in each propaedeutic cycle.

C. Final Objective

It is intended to structure a computational pedagogical model from pedagogic models: the institutional one and the engineering based on multiple intelligences, defined in the Institutional Educational Project PEI.

II. MODEL DESCRIPTION

The model of the Higher Education System Model by propaedeutic cycles as mentioned earlier is complex curriculum architecture for analysis and implementation in all Higher Education Institutions. It is carried out by supporting on 3 components. Linear Model of Curriculum Coherence,

Flexibility, and Student's productivity. These components are described next:

A. Linear Model of Curriculum Coherence

It refers the logical-cognitive relationships among the architecture parts of an educational system. It is as much an analysis instrument as a linear mathematical structure that communicates (all communication action is a pedagogical one), enabling the justification of a study plan and giving it as an organized and complex totality interlinking the interior and external coherency and consistency.

Among the objectives are:

- To manage knowledge enabling a morphologic analysis to a study plan on higher education.
- To eliminate inconsistencies and make viable the curriculum optimization of the PEI.
- To improve the prospective scope of the PEI.
- To quantify the production of the universities in the development of knowledge in students (competence culture) by propaedeutic cycles to redesign the expertise areas in each cycle as well as the know-how.
- To give priority to and classify the competence areas.
- To contribute to develop a curriculum without errors and ambiguities.
- To construct the input/out matrix or as a foundation of the optimization and structural analyses.

Among the objectives and scopes of the curriculum coherence linear model is:

- Non-complex comprehension of the methodology strategy by propaedeutic cycles.
- Optimization of university resources.
- The curricular coherence model is expressed as a matrix which is as much an instrument analysis as a lineal mathematical structure, enabling the justification of a study plan, which gives a sense as an organized and complex totality.

The curriculum coherence is the strategic alignment between a study plan with its objectives, justification, given the purpose and view, duly articulated with the PEI, The external coherence refers to the alignment of the educational style of FESSJ to the professional profiles and intellectual capital which demand the industry, the government, science, and technology in a global society. The model based on educational processes according to the curriculum study plan, where an assignment (including classes, workshops, tutorials, laboratories etc.) is associated to an expertise unit. The matrix method is of morphological type to obtain a system contradictions free without the unwanted entropy. The coherence also implies harmony, and articulation between teaching and apprenticeship, alignment, and synchronization.

The system diagram of the matrix model is expressed as follows: rows representing expertise of each level against

columns in which the corresponding curricula subjects is arranged (See the Matrix below).

In the figure 1 the link is expressed as a propaedeutic component formed by the intelligent iCOACH in order to increase the student productivity in each cycle and also some assignments of connecting in order to meet the prerequisites of each cycle. It is suggested to have both a terminal cycle with their corresponding competences with and the cycle for following higher levels. We did the design for Systems engineering and it was presented to obtain the Qualified Register of the program.

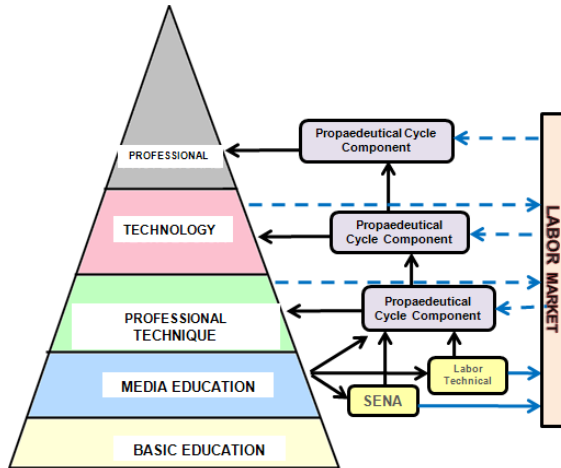


Figure 1. Propaedeutic component formed by the intelligent iCOACH

The Coherence additionally implies:

Characteristic: Holistic and integral view i.e. the entire complexity of the curricular system transcends knowledge in all its conceptual administrative, methodological, educational, normative dimensions.

Academy management is coherent with the PEI when the difference between the achieved in face to the wanted is null, curricular coherence.

The PEI is the expression of the proper philosophical comprehension of the educational task and it acts as definition of identity, exercising the university autonomy, recognized by the Constitution and Law.

B. Matrix Description

Several types of matrices were developed (figure 6); firstly regarding columns: the longitudinal one in time of the study plan (academic semesters); secondly the cross one grouped by curriculum subjects according to their applicability; additionally each cell of each matrix can be expressed as fuzzy values. The groups are: (1) Basic Fundamentals, (2) Scientific and technical fundamentals, (3) Professional Basic, (4) socio-humanistic and business, (5) Professional components, (6) Experimentation Scientific/Technical and (7) Advanced Topics, and thirdly regarding the structure: the input/output for optimization and structural analysis purposes.

The matrix presented below is formed by 4 blocks: Technical Labor Degree designed for students from basic

education (9th grade), Professional Technical for students from high school (11th grade), Technology and Professional.

C. Basic Matrix

In general this matrix A is of $M \times N$ for knowledge management, where:

M rows represent the levels of the competence expertise of the curricular organization.

N columns represent the assignment subjects (knowledge offering) as functional and unitary areas educational processes involving classes, workshops, tutorials, laboratories, etc of knowledge of the plan.

Each coefficient (cell), is of the binary type, e.g. can be $a_{ij} = \{0, 1\}$

It is 1, if exists direct implication between the expertise area and each assignment of the cycle study plan. It is 0 otherwise: values fuzzy dashboard in the basic matrix.

D. Fuzzy Matrix

On the other hand, each coefficient (cell) representing the cohesion and coherence of each assignment with the competence, can have other qualitative values / fuzzy logics, i.e.:

$A_{i,j}$ = (null, middle, high) represented by colors in the matrix: [blank, red, blue].

This type of Matrix can be of two classes: the longitudinal in time (i.e. by academic semesters of the study plan and the transversal knowledge, where the curriculum knowledge of the subject is grouped as mentioned above. Below is presented a longitudinal matrix with fuzzy values just specified earlier..

E. Curriculum Quantification from the Matrix: Cognitive Contribution

The cognitive contribution of the j subject is obtained by the following matrix:

$$\sum_i a_{i,j} n_j = d_j \quad (1)$$

Where n_j is the corresponding subject credits d_j is the cognitive contribution of the j^a subject for each propaedeutic cycle (columns).

F. Other Metrics Obtained from the Matrix: Production

The cultivated expertise is given by the production i as follows:

$$\sum_j a_{i,j} n_j = b_i \quad (2)$$

Where b_i is the i^a production expressed as cultivated expertise for each competence unit (rows). For each cycle see below the corresponding values obtained.

FREE ON TECHNICAL LABOR		EXPERTISE	232
FREE ON TECHNICAL LABOR	BASICS COMMUNICATION SKILLS	851	
	BASICS SKILLS TOWARD ENTREPRENEURSHIP DEVELOPMENT	60	
	BASICS SKILLS TOWARD ANALYSIS AND DESIGN OF SYSTEMS DE SOLVING.	2156	
	BASIC SKILLS IN TELECOMMUNICATIONS AND ELECTRONICS	744	

Figure 2. Expertise cultivated technical labor

TECHNICAL-PROFESSIONAL		EXPERTISE CULTIVATED	
TECHNICAL-PROFESSIONAL	TECHNICAL SOFTWARE DEVELOPMENT	99	
	PROBLEMS DEFINITION	108	
	OPERATIONAL COMMUNICATION CAPABILITIES	63	
	MAINTENANCE AND EVOLUTION	49	
	PROBLEM SOLVING	102	
	ENTREPRENEURSHIP	89	
	TRAINING ON RESEARCH	66	

Figure 3. Expertise cultivated technical professional

The expertise demands the specific competence determination or high performance in a domain in each cycle.

TECHNOLOGY		EXPERTISE	
TECHNOLOGY	GENERATION OF SOFTWARE SOLUTIONS	52	
	SOFTWARE SOLUTION OF ENTERPRICE PROBLEMS	123	
	ADMINISTRATIVE MANAGEMENT CONTROL	45	
	TELEMATICS SOLUTION BUILDING	32	
	ANALISIS/DISEÑO/ARQUITECTURAS EMPRESARIALES DE SOFTWARE	109	
	NEGOTIATION OF SOFTWARE AND ENTERPRENEURSHIP	5	
	TRAINING FOR RESEARCH AND INNOVATION	86	

Figure 4. Expertise cultivated technology

The cognitive process is associated with learning instruments of more complexity.

PROFESSIONAL CYCLE		EXPERTISE CULTIVATED	
PROFESSIONAL CYCLE	ORGANIZATIONAL KNOWLEDGE	83	
	CREATIVITY FOR THE IDENTIFICATION OF PROBLEMS AND THEIR SOLUTION	87	
	SOLUTION ENGINEERING PROBLEMS	86	
	ENTERPRISE ARCHITECTURE	65	
	USABILITY SYSTEMS ENGINEERING	20	
	ENTERPRICE AND ICT GOVERNANCE	71	
	MANAGERIAL SYSTEMS	26	
	ENTERPRICE INTELLIGENCE	36	

Figure 5. Expertise cultivated professional

The expertise approach implies the competences development as a dynamic continuum and is associated to formation processes during long life of an individual and also are affected by technological changes and social practices. In the knowledge society the competences structure is variable and also intellectually more demanded.

Other significant figure shows a measure of how well the different subjects of the Study Plan within a propaedeutic cycle work together to provide a specific expertise of functionality of the competence system displayed above in the transversal curricular coherence matrix.

III. REQUIRED FLEXIBILITIES PER PROPAEDEUTIC CYCLES

The actual Education System is rigid, hard and forces the student to reentry as contrasting with propaedeutic cycles in which the flexibility is mandatory. The curriculum is defined as the set of criteria, study programs, methodology and processes contributing to the integral formation and to the national identify construction, including aids the scholar human resources to put into practice the policy to carry out the PEI, the institutional educational project. The flexibility refers to the curricular, academic, pedagogical and administrative ones, that is, the use of the university autonomy to manage knowledge as well as the study plan for whom do not accomplish with the requirements to come up to higher cycles, and besides to relocate learning contexts supported by ICT.

Curricular flexibility is the structure defined as the content organization, methodologies, and selected vocational training to develop study plans of school programs in which the contents are selected according to their importance, pertinence, appropriateness, technological, scientific, social and economic impact on account of the competences wanted to be cultivated and developed in the technician, technologist, and engineer.

The structure has been provided with a solid common nucleus in each cycle and elective subjects which will consult the stage of this art. The broad experience of FESSJ in the first cycle consolidates the possibilities of this flexibility.

Academic flexibility is an open and dynamical organized system which intends to transform the rigid structures which are uncoupled as it corresponds, wherein prevails the integrated work in the application and search of knowledge, defining the professional area. An open system promotes self management

and self regulation. The strategic alignment of an institution is an imperative: PEI

The pedagogical flexibility that applies the educational strategy as a coherent unified, and integrated framework of school decisions promoted by the educational model, underlies the mentioned self-regulation and self-control by a student in his learning enabled by the ICTs, which allows him to enter to diverse learning spaces and environments tending to new educational communicative and interaction forms and also knowledge access. In the same way the controls on the student about how to reach knowledge are implemented via electronic, information, and cognitive micro-worlds cultivating the competences which were already explicated as well as the involved strategies in the educational model that:

- Considers the integration of Academic Credit units of each engineering aspect.
- Creates educational mastery linking education, research, and social projection as pointed by FESSJ, and
- Entails to new virtual spaces and contexts of personal autonomy in the students' learning, besides admitting that they perform project of each propaedeutic cycle.

Administratively, the flexibility supposes a range of possibilities to the educational offer within the culture of educational service to the research, the academic units which compose an outstanding institution as FESSJ from the policies which assign it for relevant, important, and appropriate making-decisions according to the Development Plan 2008-2015. This flexibility entails to the necessary reengineering of the administrative processes for its ISO certification

To change, if required, the policies and flexible strategies, that is, it is necessary to state the actions in different university forms for the adjustment to the organizational change that implies to manage the Technique Professional cycle to a broader level the Technology and the Engineering level. The earlier requires thinking over the sense, purpose of the Management Model, the curricular and scholar systems, which are coherent, appropriate, and suitable to the FESSJ as a Higher Education Institution.

A. Student Productivity

Dropout university rates at national level are critic by its cultural, economic, familiar, and institutional implications. Several Higher Education Institutions have carried out studies, some of them by the Office of Higher Education, evidencing a prevalent and regular problem. For the first time, the design and construction of a tool iCOACH is presented. This one is based in knowledge and is powered by technology on artificial and computational intelligence apart from knowledge engineering as instruments of high information to record each student and assignment of the first semester. The architecture of the system involves three components: an edumatic constructor of tests and exams (professor's tool), a subsystem based on the student's modeling, and in another administration and security modeling. Several developments have preceded this project, which makes of the framework along with its methodology very reliable; on the other hand, it is intended to

work according to international standards in order to obtain a good quality of the implemented product, to construct a system for checking the student concepts; the project was performed within Edumatic and the synergy Architecture and Software Engineering to set up the planning, the analysis, and the determination of the educational requirements to specify the design of an intelligent and systematic edumatic system with student's cognitive assessment for virtual modality.

B. Components

Several presentation matrices mentioned above were identified and grouped. Each of them is composed of various sub-matrices and vectors which highlights the coherence for each propaedeutic cycle. The feedback sub-matrix, corresponding to the objective cycle which allows quantifying the knowledge articulation of the current cycle of further cycles to strengthen the implicit competences. The feedforward sub-matrix allows quantifying the articulation of the current cycle processes and its feedback to the formation of the superior cycle competences. Within the vectors are those of production or cultivated competence vectors for each cycle and the cognitive vectors, among others. The solution is complemented with a system architecture framework to display the complete outlook of the curricular information or visor 360° of the academic logic, whose complexity deserves to be approached with accuracy methods and techniques.

IV. CONCLUSIONS

We have accepted the challenge proposed to the Superior Education Institutions: to establish the link between traditional cycles: technical, technology and professional ones with the secondary, basic and media levels.

Our solution is presented linking each phase with a propaedeutic component discussed in a model.

The Coherence Matrix is a kind of macroscopic of great quantity of curriculum information and competences, allowing the corresponding knowledge management.

This initiative sets up a way toward the architectural of information of IES on account of Colombia Education Law 1188 which is explicit about the curriculum complexity.

The model seeks to be an institutional learning instrument in the community and handles knowledge, thereby from these experiences is expected that IES go beyond of the simple management of the ICTs.

It is seen that is entirely feasible an ethos for research and knowledge in the technical and technology institutions. Likewise it is also seen that this policy based on propaedeutic cycles far from being a utopia really enables the democratic way to knowledge as proclaimed in the world summits on information society: Geneva and Tunisia

The construction of visor 360° not only as analytic instrument but also as support to architectural documentation a long with the model generates great expectation as credit of high quality in Higher Education with the prototype iCOACH, which has been performed. It evident one more time the flexibility of its professional implementation for the national academic community.

