

Intelligent Authoring Tools for Digital 3D Interactive Contents Towards a Knowledge Industry in Colombia

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Abstract — *The Colombian Government has recently launched an ambitious ICT plan of USD 3000,000,000 for the next 4 years to achieve social and technological insertion of this country in the Knowledge Society. A major concern is that the human resources and intellectual capital at Higher Education needed to meet the challenges posed for said Colombian Strategy are scarce.*

Our work discusses the following major issues:

➤ *Improving the productivity of students and teachers through extended learning and lecturing with intelligent tools and a new pedagogic model involved.*

➤ *Forming Author Lecturers for creating digital content to produce 3D interactive self-learning educational contents using augmented and virtual reality, so that students may have experience with applications in Virtual Simulation.*

➤ *Editing & creative authoring of Interactive Living Books.*

➤ *Permanent upgrading of new interactive learning & self educational devices/material.*

➤ *Creating and maintaining new 3-D interactive bibliographical data bases with stand-alone, on-line and mobile file applications.*

The final purposes in terms of expected results are the following:

➤ *Creating an Industry for digital 3D Interactive Contents in Colombia's Knowledge Society with state-of-the-art technology.*

➤ *Creating various specialized teams of authors, producers and tutors of simulation systems and their applications.*

➤ *Creating an International Certification Unit in the subjects mentioned above within our Institution.*

Several research projects are underway in the FESSANJOSE- related to:

➤ *Intelligent System Tools for Undergraduate and Graduate Students & Teachers: iCOACH [3].*

➤ *Cognitive Managers: Competence and Knowledge Management and Managers.*

➤ *Models: Analytic Tools for Academic and Management Governance; Tools for Future Strategic Analysis [5] [7].*

➤ *ICT Powered Education for Industrial Productivity.*

The Government of Colombia has been working to increase the coverage in higher education by enacting the 1188 Law of Education of 2008, recently regulated by the Decree 3495 that mainly promotes quality conditions and standards to strengthen the national quality system in Superior Education and to introduce the possibility of democratizing knowledge, enabling the opening of education by Propaedeutic Cycles, i. e. Professional Technician, Technology, and University degrees on engineering education.

The skills and professional profiles of each Propaedeutic cycle are described within our curricular coherence matrix.

The Colombian ICT National Law 1341 of 2009 was enacted to narrow the gap between Colombian students and these new

technologies; in addition, it evolves towards the latest advancements in media and communication technology, including those developments that allow the Knowledge and Software Industry to accomplish improved competitiveness with new technological solutions, which in turn will facilitate Colombian social and economic emergence through the various applications enabled by this new knowledge industry.

A brief discussion is given to conceptualize this new industry through given inputs and byproducts, production functions, intellectual capital formation, intellectual assets, artifacts vs. mental-facts and many others. In this sense FESSANJOSE leads several research projects aimed to build intelligent authoring tools and re-qualification of teachers and lecturers at work in order to generate new knowledge and digital contents for ICT/Virtual Education.

Initially, we are planning to train around 600,000 teachers and lecturers, including the re-qualified workforce, within the next 4 years. An important item of these figures will be the number of new permanent jobs created: at least 100,000.

Keywords: Authoring tools, Augmented reality, Intelligent knowledge based systems, ICT, Hypermedia, Virtual reality.

I. RATIONALE

A. Background

Tertiary student desertion is a nationwide problem in Colombia, critically impacting culture, economy and society in general. Several IES (Superior Education Institutions) have performed studies pointing out the prevalence and recurrence of this problem. Another problem is the academic governability of the IES Institutions which imply additional demands for their management, including financial sustainability.

One answer that addresses all these problems is our research Project: intelligent

virtual systems with mathematical and computational analysis capabilities. It includes the design and implementation of the iCOACH model, a knowledge-based intelligence tool, presented as a high computing instrument designed to follow up with each student throughout the academic curricula in the relevant engineering school at the FESSANJOSE.

The software architecture has 3 main parts: an Edumatic Builder (a tool for improving Professor productivity), the Student Model (a personal model in which all competencies acquired are registered historically), and lastly: a knowledge base for concept verification and related items.

Also, a Knowledge-based system model to face the new methodological strategy on Higher Education for Colombia is presented: the Propaedeutic Cycles.

First, with a set of analytical and mathematical tools that allows management quantification and curricular knowledge: the FESSJ-PROP model, which is a structural system for analyzing and structuring cohesion and consistency among these cycles. Among the purposes and scope of the linear model of consistency in curricular knowledge is the simplified understanding of the methodological strategy for propaedeutic cycles and college resource optimization. Several Leontief Model extensibilities by Linear Programming and Input-Output, which analyzes dropout complexity, are included. The objective functions have 3 student levels: Deserters, In Recuperation, and Good Performance.

The latter have approached the problem by migrating from the Inter-industrial Economy Model to the new Knowledge Economy Model, by re-contextualizing the W. LEONTIEF Model from the Industrial Society to the Knowledge Society, updating it by introducing a Process Engineering model, an Artificial and Computational Intelligence

model, and a Knowledge Management and Engineering model [5] [7].

B. Specific Objectives

The aforementioned tools are required to improve the cognitive productivity of students who are exposed to a coaching system in order to strengthen their learning.

For Teachers these intelligent tools involve a pedagogic model to improve the evaluation content expertise with new functionalities.

Another goal is forming Author Lecturers capable of Creating Digital Content to produce 3D Interactive Self-learning Educational tools using Augmented and Virtual Reality, so that Students may have experience with applications that include several modern techniques such as interactive virtual simulation and immersive worlds. They also Include Creators & Authors of Interactive Living Books.

C. Final Objective

The new ICT aggressive plan of Colombia mentioned above implies a social and technological agreement of the National Administration to insert our country in the Knowledge Society. These national policies present a new challenge: creating a new economy based on knowledge and information.

Our tools aim to create a Knowledge Industry based on digital 3D Interactive Contents for the Colombian Society of the Third Millennium. In this country, the National Education Ministry has trained 50,000 teachers on general tools for virtual education (e.g. Moodle) in 3 years. With our tools we expect to train 600,000 teachers at all education levels and update their job

qualifications for the new economy. A great number of these jobs (100,000) will be both new and permanent. These people will build a specialized critical mass of authors and producers of simulation systems and applications in order to strengthen the knowledge industry. *Pari passu* is the creation of an International Certification Unit in the above mentioned subjects within our Institution, FESSANJOSE.

II. DESCRIPTION

A. Towards a Knowledge Industry in Colombia

Clearly, this industry is a mind-intensive work in which labor is an additional component to the artifacts: mental tasks to be completed by knowledge workers. Also the capital has an additional dimension within intellectual and asset capital. Knowledge has its own life cycle: acquisition, storage, dissemination, and application. This cycle is a sequence of intellectual tasks by which knowledge workers build their unique, competitive advantage for social and environmental benefit. It also comprises a range of strategies and practices used in an organization to identify, generate, display, represent, distribute, and enable the adoption of insights and experiences (knowledge).

An economy of knowledge focused on the production and management of knowledge in the frame of economic constraints is a knowledge-based economy. This definition, the more frequently used, refers to the use of knowledge technologies (such as knowledge engineering and knowledge management) to produce economic benefits as well as job generation.

Various observers describe today's global economy as one in transition to a "knowledge economy", as an extension to a "postindustrial economy". Such a transition requires rewriting the rules and practices that determined success in the industrial economy.

This new economy is an interconnected, globalized one where knowledge resources such as professional competencies and expertise are as critical as other economic resources. According to the analysts of the "knowledge economy", these rules need to be rewritten at all levels: from firms and industries to public and politics, as well as ICT & knowledge-related topics.

In a knowledge economy society, knowledge is an input/output product (regarding Leontief), while in Knowledge Engineering (KE), knowledge is a resource/tool. This difference is not yet well distinguished in the subject matter literature. They are strongly interdisciplinary, involving economists, computer scientists, software engineers, mathematicians, chemists and physicists, as well as "cognitivists", psychologists and sociologists. KE is an engineering discipline that involves integrating knowledge into computer systems (expert systems) in order to solve complex problems normally requiring a high level of competences, know-how and expertise. At present, it refers to the building, maintaining and development of knowledge-based systems. It has a great deal in common with software engineering, and it is used in many computer science domains such as artificial and computational intelligence including knowledge-based databases, Business Intelligence, knowledge based expert systems, decision support technology and many other IKB systems. Knowledge engineering is also related to mathematical logic, and is deeply involved in cognitive science and socio-cognitive engineering where knowledge is produced by socio-cognitive aggregates (mainly humans) and is structured according to our understanding of how human reasoning and logic works.

The new knowledge industry may create new jobs such as Knowledge Engineers, Knowledge software Architects, Knowledge base Administrators, Knowledge requirements Analysts, Knowledge Authoring teachers and lecturers, Testing Knowledge

bases Technologist, Data and Knowledge Stewards, Knowledge technicians Architects, Quality Knowledge Assurance Technologists, Technologist of Knowledge Governance and many others.

B. Pedagogic Model Description

Our Instructional System distinguishes three stages in distance learning, which suggest strategies to incorporate into a tutorial. The first refers to pre-seasonal activities in which motivational efforts are needed to encourage the student to achieve some concrete goals in terms of certain cognitive skills, e. g., troubleshooting. This should be reflected in the definition of goals and objectives throughout the material. A second instance refers to activities in which the author provokes reflection on knowledge, active experimentation to test knowledge, and others. The third stage is the Post-session in which feedback should be promoted and strengthened by evaluative questions and summarizing which allow the viewing, distant learner to become cognitive through achievable goals at the end of the course, while causing him to anticipate the knowledge to be acquired in the next phase.

Another requirement is related to advanced organizers as a presentation of introductory content, characterized by being perfectly clear, stable, relevant, and inclusive of the content being taught. Their main function is to establish a bridge between what students already know and what they need to know before actually learning new content. A good advanced organizer is able to integrate and to interrelate the material. There will be a summary or overview, as presented in the books, as they are often proposed at the same level of abstraction and generalization as subsequent learning material. Advanced organizers shall be highly abstract, general and inclusive in order to be effective.

The student model keeps a diary iCOACH of the skills each student has acquired allowing test customization, as well as assessment of prior experience and, if possible, projection of the motivational aspects of each student.

III. REQUIRED FUNCIONALITIES

A. Student and Teacher Productivity

Developing learning content involves at least 2 aspects that make the process cumbersome for the authors. The first is the variety of competencies, skills, abilities, capabilities, and expertise to be developed by the students. The second relates to the variety of subjects and their related cycles for updating. Authors have to create units of learning for the student, scripts for the classes, and tests for concept verification, practical sessions, interactive 3D simulations, hypermedia material, problem sets, learning pills (flashcards), and many others. Consequently, their production becomes quite complex. The above are some of the reasons to develop intelligent tools to face these complexities Another reason is to facilitate the training of thousands of authoring teachers and the creation of positions for the new knowledge industry, as mentioned above.

B. Authoring System Architecture.

Our architecture has 2 main components:

One component is related to the models. At least three models are involved: The Student Model, The Teacher Model (which implies his/her cognitive style) and Syllabus and Planning Model (rules, restrictions or sequencing strategies, courses, modules, presentations)

➤ The second component is a Virtual Tutor, a sophisticated set of instructional primitives and multiple tutoring strategies.

C. Functionalities

The following list enumerates several prototype functions, most of which are partially implemented with our prototypes: the management of at least 30 types of item formats, including the following:

- Multiple choices with single answer or Multiple answers, scoring of all response options to set the number of options that must be taken in response.
- Rank in order of response options scoring matrix to assess potential order.
- Pairing or correspondence
- Fill in the blanks: one or multiple
- Response Test
- Oral Response
- Question and numerical answer
- True and False

D. CAPABILITIES TO RESPOND:

- Drag and Drop
- Display with explanations
- Place hot spot
- Selection of options from a drop-down list
- Features to produce items
- Inserting images, audio, video
- Inserting hypermedia materials.

E. TESTS AND ITEMS ADMINISTRATOR

- Storage and management of questions on local and remote repositories
- Organization of items by "issues" with classification levels and sublevels
- Wizard building items
- Integration of multimedia elements (full audio, full video) and repository
- Integration of graphics (GIF, JPEG, PNG, WMF, BMP), unlimited repository of these elements
- Schema Definition scoring and weighting of items in the tests as defined by structures and needs

- Import/Export questions according to international standards
- Collaboration with multiple authors
- Workflow Settings for the development and implementation of test questions
- Implementation of roles or user profiles and assigning permissions to access or security functions and levels
- Last modified audit.

F. BUILDING TESTS

- Management of test structures as needed
- Organizing questions into exams (based on predefined structures)
- Intentional or random selection of questions for meta-tags or specific subjects
- Defining representation of questions in the test structure (predefined, random or branched) and management of pre-defined or random response options
- Multiple forms of representation of questions (one by one in list, block)
- Response time limit per item or test block.
- Control of the evaluated time (display or hide)
- Different forms of evaluated test representation: browser-based online, CD, print, PDA, Cellular
- Delivery assurance levels by browser
- Customizing the test by inserting participant name, date and time
- Customizing the rendering format (questions and tests)
- Customizing the test at the end of page.

G. KNOWLEDGE BASE CONTENTS

- Options to cut, copy and paste into the handling of questions, assessments and resource files
- Modification of representation by more than one author, and author control

- Multiple authors simultaneously developing and publishing content in the repository
- Linking E-learning/M-learning contents and test questions.

H. SECURITY SYSTEM

- Definition of roles and permissions for administrator and author levels; Delimitation of logins by IP; Folder Access Control
- Security control to protect tests from being copied, printed or shared on the computer where the test is developed.

IV. CONCLUSIONS

A. WORK IN PROGRESS

Several projects inside our research efforts are underway. The new academic program on systems engineering with the methodological strategy on Virtual Education is in progress. To date, it is the first program structured by propaedeutic cycles in this country [8]. It required working with other fields related firstly with the student cognitive style investigation and secondly with his/her characterization and features. Felder Test and the EEPA Test were both applied. The investigations resulted on four bipolar scales: Active - Reflective, Sensing - Intuitive, Visual - Verbal and Sequential - Global. Moreover, the EEPA Test is an assessment based on problem solving, producing results on four learning styles: diverging, converging, assimilated and accommodated.

The purpose of the classification was to characterize the socio-educational profile of students in the engineering systems academic program, which enabled us to understand the social and academic status that may impact their performance. This facilitated the design of virtual program contents for the new Systems Engineering Virtual Program by Propaedeutic Cycles.

B. FUTURE RESEARCH WORK

As part of the European Community Convocation (Sala 3D), links and partnerships should be identified and established to produce knowledge. Among the highlights of future projects:

➤ Creation of a Centre of Excellence for Teacher Training-authors of thematic content, evaluative, digital (Multimedia and Virtual Reality extended), supported by three-dimensional interactive simulation instruments.

➤ Fundraising for professional software development is imperative. Development complies with international standards to build and consolidate the intelligent tools matrix analysis of curricular coherence, so widespread and friendly efficient management involves Curriculum for each propaedeutic cycle. The above mentioned instruments aid competence management, with different granularity.

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