

# Innovative Web-Based Teaching Strategies and Tools

## WEB-based Enabling of Education and Research in ISTE The ChipsnSalsa Portal

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**Abstract**— *WEB-based education tools that incorporate static content, video-on-demand, live synchronized video, as well as collaboration research spaces, often present information as isolated and diffuse topics compromising the integral learning and research experience. The Ibero-American Science & Technology Consortium (ISTEC) "ChipsnSalsa" WEB project addresses this problem by integrating content into structured but flexible information maps and contextual databases. It enables students to take advantage of the content, and turns the WEB portal/gateway into a diligent information provider that orders the information optimally for their particular needs. Similarly, it enables researchers to have specific and accurate access to the most relevant information in their research, while establishing knowledge bases, real-time peer review, and repositories for future work and long haul ongoing projects. It also provides them with virtual labs and real-time online publishing. Double indexing with full text index and metadata information, and relating the content in a common structured metadata organization.*

*Index Terms*  $\frac{3}{4}$  Chips n Salsa, Chips and Salsa, Metadata indexing, Learning Threads, Pre publishing, Research threads, Web Based Education.

### WHAT IS CHIPS NSALSA?

ChipsnSalsa is a Portal Gateway System Developed by the Iberoamerican Science and Technology Consortium (ISTEC). It is a Portal because it gives access to a compendium of educational and research information. It is also a gateway since it enables the publication of content as well as live presentations while isolating the author from the technical details. This then enables users to access this information through the campus private network, Internet and Internet 2, and even wirelessly[1].

More broadly, ChipsnSalsa maybe be thought of as a platform to provide efficient access and publication means to a wide variety of content. Such content covers a broad spectrum of file formats and services including, video, sound, text, and interactive teaching modules that use web-

based remote software and hardware experiments and simulations.

Chips nSalsa may be used in the following areas:

- Education: Enabling the Creation of Educational content
- Research: Providing a platform for sharing and exchanging knowledge in a remote cooperation and joint development environment.
- Publishing: Providing versioning of documents and publishing through virtual local Area Networks (LANs).

### CHIPS N SALSA – EDUCATION

ChipsNSalsa enables the publication of static content material consisting of presentations, videos, exercises, animations, etc. It achieves this capability using both Video on demand Servers and Multicast and Broadcast Servers with multi rate or variable rate video encoding technology. It also provides a “problems and examples” Server that is implemented using a Matlab Web Server, that enables the students to have access to previously built examples and interact with them according to specified instructions. Every such course also benefits from the online discussion forums that enable to have moderated discussions in which all the students and teachers are able to interact and work together. The system also doubles as a Web Page hosting server for the personal WebPages for the students as well as the instructors

### ChipsnSalsa – Education Content Generation

The content generation and publishing capability is provided using a real-time online publishing server that enables the distribution of synchronous multimedia content. Such content might include video, audio and text or any of their combinations. It also provides a series of tools to enable the teacher to publish static content without major html coding or content editing.

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During a regular synchronous presentation, the information and interaction are saved for future reference and incorporated into the class outline. This interaction is also guaranteed by a series of tools that enable the students to turn in their homework online, as well as papers or any other student-generated content.

## CHIPS N SALSA – RESEARCH

The research facilities provided in the chipsnsalsa portal include two major areas of interest, one related to the actual research effort, which provides researchers with access to organized and carefully selected information relative to their field of research. This may also provide them with tools to use very specific or costly equipment remotely. The second area is related to the actual publishing of the work developed by the researchers in the form of papers or articles.

The tools incorporated into the system to provide the above functionalities are the following: An archive of documents, code, and preprint versions intended to serve both as a knowledge repository and a publication service. Also included is the address and reference-sharing portal. This is an online book-marking facility that empowers the classical website and reference book-marking with the expert comments of the researchers who save their own addresses and also share them with the community. This enables others to have access to this information and streamline the information and reference collection.

Since efficient information exchange is a key concept of this project, a series of private and moderated forums are offered where several groups are able to create their own meeting and discussion groups. The group leaders can then moderate such groups. Due to budgetary constraints in Latin America for teachers and students, it was important for the project to provide researchers and students with the chance to operate and interact with lab equipment remotely. This became possible thanks to the Virtual labs portal which is a service that interfaces the actual Laboratory equipment with Matlab and enables remote users to interact with it through the web.

## CHIPSNSALSA VERSIONING

The ChipsnSalsa versioning system is part of the research and publishing facility. It enables registered users who are authenticated in the ISTECS Microsoft domain through local area connection or virtual private networks, to access a Microsoft Sharepoint server where the actual content is posted and published. This then enables multiple locations to work simultaneously on the files as well as keeping track of modifications and multiple versions of any documents. This facility integrates with the Microsoft Office suite tools to enable the online publishing as well as remote collaboration.

The whole process uses challenge response authentication for publishing and manages accountability procedures for the content included in the portal. The content is automatically full text indexed while being posted in the server.

An open source, metadata-oriented, online, multiple-version publishing system is also included. This system's documents are also full text indexed. This interface uses web forms to both submit the documents and enter the metadata information on the server.

## CONTENT UNIFICATION

Content unification inside the project is possible using a dual indexing technology, where the published content is indexed and full text searchable; This enables the hierarchization of the searches as well as the re-association and dynamic organization through variable catalogs. This content is also indexed through metadata fields that enable content publication using a dynamic metadata structure based on learning objects metadata indexing.

By jointly indexing all the online content, and due to the specific characteristics of the project's metadata, it is possible to detectibly join the content and concatenate the information, linking it inside a scientific contextual common goal-indexing schema.

## SERVICES STRUCTURE

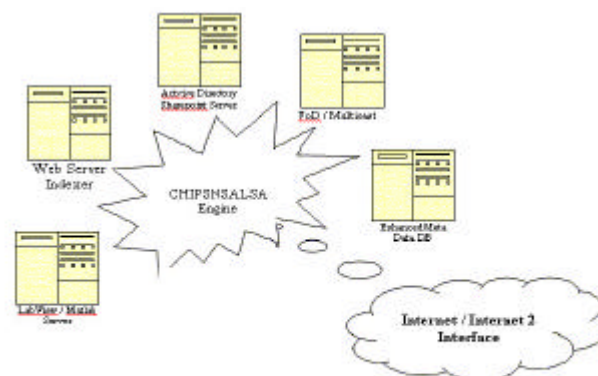


FIGURE. 1  
CHIPS N SALSA SERVICE STRUCTURE .

The project service structure is based on the integration of several commercially available technologies, which have been carefully selected and tested through the use of an indexing and publishing engine. This engine effectively interacts with an enhanced meta-data database that keeps

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information about the content scattered in the different servers and how it is related to the rest of the content available. This engine is also responsible for the actual display of the information and for keeping track of the pedagogical and research relations.

## PUBLICATION PHILOSOPHY

The project is intended to respond to a coherent publication philosophy that actually guides the characteristics of the publishing and updating interfaces. Such interfaces are intended to be intuitive to enable web-based actualizations not only of the WebPages but also of the actual multimedia content stored in the database.

Since the indexing is based on the name of the archives as well as their text content (if they have it), and the actual metadata descriptors associated with the particular learning object, any type of content is accepted. Its actual display however, relies on the facilities provided by the web server through the Matlab and Labview interfaces, and also on the client's software. Given this, we could potentially have people publishing content online that the web server may not be able to display on its own, but the publisher and the intended recipients will be able to interact and operate without any major problems. All the facilities described are intended to reduce the technological component required from the instructors and content providers.

The complete system is designed to have an open structure, which means that even though a series of services is produced and served using third-party commercial products, the actual indexing engine is capable of accepting any type of content into the knowledge repository. In this way we could potentially upgrade, update, or incorporate new products into the system as long as the content provided by them can be treated as files. This then enables us to actually keep on adding the type of content used in the teaching, learning or researching process without sacrificing compatibility with previously generated content.

## VARIABLE INDEXING METADATA SYSTEM

Variable indexing refers to the fact that while producing the metadata indexing of the information, we might come up with a rather static and structured organization for this information, it is possible to actually recombine and reorder this information to pursue different goals. For instance, suppose you have created material pertaining to a particular subject such as "solid-state physics", parts of the course just created may be used to teach different concepts. As an example, learning concepts related to the actual behavior of electrons in solid matter while being exposed to energy, may be reused to teach a semiconductors or advanced microprocessors class.

This capability is possible thanks to the inclusion of a totally new set of metadata fields related to the Learning Threads© and Research Threads © concepts.

**Learning Threads©:** The Learning Threads concept exploits the fact that any information may be re-organized and re-combined to illustrate or teach different concepts.

**Research Threads©:** Research Threads are based on the fact that research usually builds upon previous efforts, such that information contained within prior research may potentially be used to generate a Virtual Research Environment©, that contains all research information related to the new research activity. Even though the different research documents have been produced pursuing possibly different research objectives, their content could benefit other research efforts.

Next, we will briefly explain the implementation of these Learning & Research concepts inside the ChipsNSalsa project in order to provide services to its user community.

## LEARNING THREADS©

The use of the Learning threads inside the ChipsNSalsa project is related to the fact that all information contained in the portal is divided into Learning Objects[2]. These objects although different from each other, can be combined and merged to produce certain content[3]. The common problem in building such content is that while dividing the material into objects, we can atomize them into units so small that they may be hard to handle, and may swamp users with too much information. While this has been usually left to the content producers, it may become very confusing to explain to the publishers how to differentiate and correctly split objects. Our approach here is that usually whenever material is being produced, it is produced to explain a particular concept; therefore the learning object is the one that can successfully explain a concept. In this fashion, we may have a power point presentation that explains the hydrolysis process and a single illustration that explains and summarizes the photosynthesis for a certain level of viewers. As we can see, any content that we produce as part of a particular course is actually related to some concept that is part of a sub-area. Such sub-area is in turn part of another major area of knowledge given that all levels of association are also identified as belonging to a certain level of complexity in that particular field.

It is also important to notice that in order to understand any content, a certain level of knowledge in some particular area is required, and once such level is achieved, it will enable us to understand other areas of knowledge up to a certain level. This relationship is also embedded into the learning threads concept, and enables us to dynamically re-combine this information and to create content that is relative to a certain

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area of knowledge and a certain level of proficiency in that area.

It is important to notice that the ChipsNSalsa project, while keeping track and indexing the information this way, also indexes the documents using a full text hierarchical indexer. This indexer uses several catalogs that enable us to refine the indexing process and to restrict the wide scope search of a full text indexed database, by grouping the information on particular levels of knowledge as well as ad-hoc manual aggregations.

## RESEARCH THREADS©

Research threads are based on the fact that all versions of papers, code, experiments and particular formulae posted form a part of a Knowledge Data Base that could help other researchers working in related fields. This is due to the fact that the Sciences are interrelated, or are susceptible to be interrelated in particular areas. This relation is often given by structured rules and actually gives a common backbone that may be used to organize and filter information in the future. This rule scan tends to be restrictive to other proper interrelations among various scientific disciplines, so the concept of “educated guessing” is introduced in the form of additional rules in such a way to enable associations between different content, based on the educated guess of scientists working with it. The system will actually be able to display information learned through particular association from outside educated rule makers.

Since there is also a versioning system incorporated into the product, there will be simultaneous multiple versions of the database, depending on the level of stability that a project leader sets while determining the characteristics of the virtual research space.

### How does the Metadata indexing occurs

As we have seen, there is much information to be included into the metadata fields related to a particular document [4]. The inclusion of this information might result in a big burden for the publisher, so methods of automating and inferring this information are included and embedded into the system. These methods are based on the following assumptions:

- Most of the publishers have a particular area of expertise
- Most of the content generated by a user for a specific project is related
- Any content requires a certain amount of previous knowledge to be understood, and once it is learned, it enables the student to understand other content.

As we can see, the basic identification fields can be inferred from the user template and the project or course information,

as well as the specifications for the Virtual Research space. This virtual space includes data about the area of knowledge affected and the level of proficiency involved. The only information that is imputed by the actual content creator is the one pertinent to the required and enabling knowledge for each of the modules, as well as a brief text description used to supplement the full text indexing.

The remaining technical metadata fields are included to provide the access server with specific information about the content so that it can later be displayed. However since the content is generated and published through the same server, this may be redundant. The metadata set for the technical identification is related to the mime types itself in most of the cases. This can be inferred from the server and in special cases the technical supplemental information should serve this purpose.

## TECHNICAL CAPABILITIES FOR ONLINE REAL-TIME PUBLISHING

The ChipsNSalsa and the ISTE Philosophy are based on the belief that although education is related to content, the content used for education purposes is not just the information published online; the content is enriched by the value-added by the interaction among students and teachers. It is then crucial to not only enable this relation but also to record and save it. During this process, the technological aspects should be transparent to the final user, as well as to the instructors so that it doesn't cloud the teaching/learning process. Also a key concept of education is the sharing and reuse of knowledge [5]. In order to streamline this process and enhance the remote class experience, the project provides in addition to the usual services (regular web course publishing facilities, automated video on demand, and video broadcast server) a facility called the life videoconferencing module. This module incorporates the concept of the publishing server. Remote or local instructors log into this server and using their personal computers and a web cam, can stream their live synchronous presentation within which the video sound and text presentation are synchronized. Local students can interact with a teacher, and their questions and reactions are also streamed over the web, while students at remote locations interact using remote meeting technology. Students not able to access the original live content record the whole presentation as well as the interaction for later review or first-time access. All technological details of this process are hidden from the participants and the teacher who is only responsible for managing his presentation and interacting with the remote meeting software.

The complete system is explained in the following illustration. As we can see the information gets published on both Internet 1 and 2 using variable rate technology enabling

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every user to get the most of their network connection as well as through the University of New Mexico (UNM) wireless network gateway.

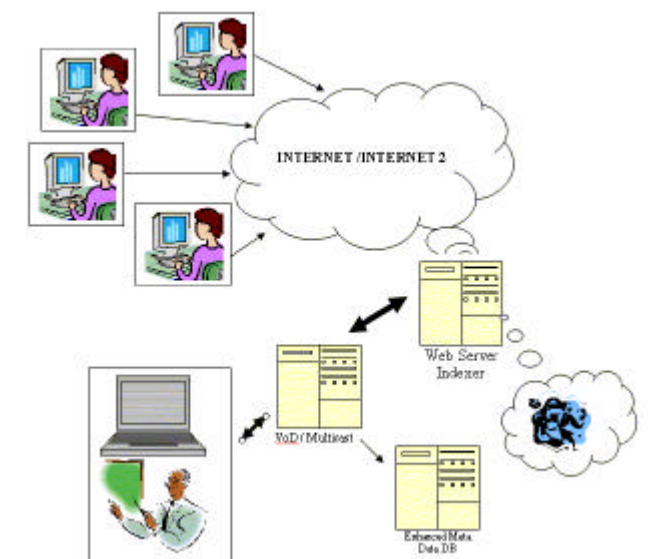


FIGURE. 2

REAL-TIME ONLINE SYNCHRONOUS CONTENT PUBLICATION AND INDEXING

The content is posted on the web server and is also full text and enhanced Metadata indexed on the Metadata database, joining the content already available.

The user authentication can be done using either regular Internet connection or if the member is in one of the ISTECS network universities, using virtual private networks. As we can see, the project provides a Unified point of Publication for the users as well as a gateway to technological facilities for their own implementation.

It is important to mention that information can be stored in any of the ISTECS nodes as long as it is published inside the scope of the full text indexer and the metadata indexing direct interface utility. This way we access information generated using any tool and saved anywhere. This is totally coherent with the joint development characteristics of the product that establishes publishers and developers distributed all over Latin America.

### THE MATLAB INTERFACE

It is possible to run MATLAB m-files functions from a web page using the MATLAB web server. MATLAB is a useful tool to run demonstrations of educational value in remote computers that don't have MATLAB installed, and where the cost of a license for every single computer may be prohibitive. An interface has been constructed where a MATLAB function can be run and its results presented as a web page, while the modifications in structure of the original m-file program are reduced to a minimum, in such a way that programmers don't have to learn many new elements to

be able to present their programs online. More sophisticated web-based interfaces can be built depending on the needs. Files can be uploaded and run live using the publishing facility that is incorporated into the interface and is available for instructors and students.

### THE LABVIEW AND REMOTE LABORATORY INTERFACE

LabView technology, especially the remote panels concept, makes the construction of remote laboratories simple. An experiment mounted in a remote laboratory, may be tested from a web page, at any time, without the presence of an instructor, and as many times as the student wants.

Virtual Instruments (VIs) are published using Remote Panels and the LabView web server. Only the installation of an agent on the client computer is needed to enable it to run fully functional VIs, as if it were directly connected to the instrumentation under test. An example experiment has been constructed using GPIB interface to connect a computer with two instruments (Oscilloscope and Signal Generator), allowing the remote user to change the parameters of the instruments and to execute measurements as desired. The interaction facilities enable the instructor to make live concept illustrations using the equipment remotely, while being able to grant control of the interface to any remote party enabling cooperative work with the equipment [6].

The value of remote laboratories especially for Latin America, is the possibility of sharing expenses between several institutions. As each university performs best in a specific topic, only one (and very complete) laboratory needs to be acquired, instead of many small labs for each university. The use of Remote Labs Technology makes the experiments available in every place where the users have permissions to access them.

These Remote labs are useful not only for regular students and instructors but also for researchers throughout the world interfacing and working together with very specialized equipment.

### DEVELOPMENT CHARACTERISTICS

This is a continuously developing product with stable versions. The development teams distributed in Latin America update different parts of the product with the conversational interface being developed in Mexico [7], the indexing system in Argentina and the publishing and metadata development in New Mexico, USA. Even though the product uses commercial tools, the publication and interaction facilities as well as the engine are open source based.

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Since this is a project destined to be replicated throughout Latin America using replication nodes that are local to the ISTEAC member universities, not only software but hardware considerations are important to the success of the project. The hardware architecture has been developed to support the publication software as well as the ISTEAC network particular characteristics. We have thus created a rather heterogeneous network that mixes Microsoft Windows-based networks with Sun Microsystems NFS services, as well as coordinate object replication using Oracle databases and CVS for content replication. The portal replicates twice a week by default, enabling the users to access all newly added content. The users are globally managed using a NIS identification system replicated into the Microsoft domain server technology.

## CURRENT IMPLEMENTATION

The exact current project implementation in the UNM node has the following technical components:

- 3 Online Servers
  - Windows 2000 Server
  - Solaris
  - Linux Suse
- Services
- 2 Oracle databases
- Video on Demand and Multicasting Video Servers
- Online Publication
- Discussion Servers
- Documents repository
- Full word indexing server
- Publication server, Matlab Server integration and Interaction
- Authentication, Certificate and Active Directory Server
- Java Servlets and Apache Processing server
- Full distributed database shared with Europe
- Perl scripts
- ODBC CGI interaction
- XML, PHP migration in progress.

## CONCLUSIONS AND FUTURE WORK

The overwhelming acceptance of the initial version of the portal with several regional and country level education agencies willing to support, use, and contribute to the project throughout Latin America, has shown the usefulness of the concept<sup>[8]</sup>

The initial user interface evaluations have been very positive and contributed to guarantee the intuitiveness and simplicity of the interface, while helping the product to better serve the needs of its final users.

The double indexing system enables the product to serve both structured and clear objective based queries and

requests through the use of metadata as well as more specific ad-hoc enquiries using the full text indexing capabilities. Currently, the project team is actively working to complete the standardization and international regulations quality assurance compliance of its areas, especially in the metadata area, formulating an extensive database implementation and concept mapping of its fields. The total content indexing schema is in the process of being posted to an open source initiative, and the interaction interface is being enhanced and re-engineered to guarantee that it addresses the final user needs. An official first release is expected by the end of the year 2002.

## ACKNOWLEDGEMENT

We would like to thank the support of the Electrical and Engineering Department of The University of New Mexico as well as Microsoft Corporation, Sun Microsystems, Hewlett-Packard, and the Ibero American Science and Technology Consortium for their support to the project.

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