SEQUENCING OF CONTENTS AND LEARNING OBJECTS

Secuenciación de Contenidos y Objetos de Aprendizaje

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Abstract: In this article we state a vision of selection and sequencing of learning contents in the context of curricular design from a constructivist viewpoint. We point out the importance of having tools and autonomous criteria which lead these processes in the field of web-based formation from our own bases or from external ones and with preeminence over the ones that are derived from the configuration of technological tools. We also stand out this importance from the need to have standard formats for data exchange.

Inasmuch as this overstatement is important, it's of outmost relevance in the context of e-learning, it being for general purposes, for formation, for corporate training or for academic formation. It's also relevant for ruled formation, as well as informal and unruled formation. We also mark the needs stated by the e-learning industry in relation to the instructional design of learning objects, needs which are both a priority and a challenge.

Then, we develop the grounding of the theories that rule the procedures for the selection of contents, their basic tenets and the description of the sequencing techniques. In particular, we will focus on three of them: *Content Analysis Technique, Task Analysis Technique* and *Elaboration Theory.*

Finally, as a conclusion, we will try to enunciate several questions, not developing the answers, though, in this article: Are the concept of Reusable Learning Object (RLO) and the requirements for interdependence of Learning Objects (LO) compatible?. If they are compatible, what are their requirements?

Keywords: Learning objects, reusability, usability, learning technology standards, e-learning, curricular design, content sequencing, Content Analysis Technique, Task Analysis Technique, Elaboration Theory.

Resumen: En este artículo planteamos una visión de la selección y secuenciación de contenidos de enseñanza. Señalamos la importancia de contar, en el campo de la formación apoyada en redes, con herramientas y criterios autónomos que guíen este proceso desde unas bases propias, externas y con preeminencia sobre las que derivan de la configuración de las herramientas tecnológicas, y desde la necesidad de contar con estándares de formato de intercambio de datos.

Este planteamiento adquiere especial relevancia en el contexto del *e-learning* de propósito general, tanto en el de formación como en el *e-learning* empresarial o en el universitario. También señalamos las necesidades que plantea el *e-learning* en la actualidad en relación con el diseño instruccional de objetos de aprendizaje así como de la metainformación que acompaña a estos. Necesidades que constituyen una prioridad y un desafío.

Exponemos brevemente las teorías sobre selección de contenidos, los presupuestos básicos y la descripción de las técnicas de secuenciación. En particular: La *técnica de análisis de contenidos*, la *técnica de análisis de la tarea* y la *Teoría de la Elaboración*.

Por último como conclusión intentaremos abordar, no en su resolución sino solo en su propuesta como enunciado, dos preguntas ¿el concepto de objeto de aprendizaje *reusable* es compatible con los requisitos de interdependencia de contenidos de aprendizaje? Y si es así ¿qué requisitos han de cumplir éstos?

Palabras clave: Objetos de aprendizaje, reusabilidad, usabilidad, estándares de e-learning, e-learning, diseño curricular, diseño educativo, secuenciación de contenidost, Técnica de Análisis de Contenidos, Técnica de Análisis de la Tarea, Teoría de la Elaboración.

1. Technological tools (platforms and networks) as educational resources. Technological environments as special learning environments. Constructivist perspective and curricular design.

A classic standpoint prevailing in many countries in our environment, based in the constructivist learning theories - which stress the idea of the student as the centre of all cognitive processes and therefore of all learning and teaching processes – is the one that places technological tools (computers, networks, platforms and software) in a complex framework of content, processes, and learning conditions, but also of human relations.

These ideas are familiar to us since they are the building blocks of our learning activities design, our educational intervention, and also our guidance/counselling and dissemination in courses, seminars and other activities for further training. In the following paragraphs we will just make a brief summary of them in order to contextualise our work. As a consequence, its lacks conceptual accuracy or depth. A more detailed analysis would be out of the intention of this article.

From the constructivist perspective (Gagné, 1971), there are three elements or sets clearly defined in every learning situation: the learning results or contents (WHAT we learn), the processes (HOW we learn), and the learning conditions (the requirements a learning activity must meet for learning to happen). Accordingly, the contents are the results of the learning process, that is, the change produced in the student's cognitive material before and after the learning activity - a change understood as the incorporation of new material, the discard of the old one or the change in the relationships between elements of knowledge and/or the way of processing them. Those processes are HOW we learn; that is, the cognitive activity set off by the student in order to learn (cognitive strategies and styles), which varies according to the type of learning (according to the nature of content: facts, concepts,… or the field of knowledge) and according to the previous knowledge (previous ideas and experiences). Anyway, all these processes have something in common (Pozo, 1990): they are internal, inherent and individual to the learner. Therefore, we can only see their effects. Consequently, in order to promote this change in the cognitive material (conceptual change), in the learning processes, the teacher can only mediate to create favourable conditions for the change to occur and develop.

Each learning requires different and particular conditions defined by processes such as planning and assessment. These learning conditions are determined by two elements: the EDUCATIONAL RESOURCES and the teaching strategies, and by the interaction between them. It is within this framework that we understand the use of digital tools, as specific teaching or learning resources that help to learn certain type of contents (in particular, certain procedures, concepts and skills) associated to specific learning situations and in relation to our own didactic strategies.

This framework is neither original nor new. It is a personal adaptation of the ideas developed at the dawn of educational technology by Seymour Papert[1] (Papert, 1982) and by Horacio Reggini (Reginni, 1983) after Piaget, the Geneva School, and their works about Developmental Psychology.

Besides, Rodríguez-Roselló (1988) stresses the singularity of the contents that can be reached and of the underlying methodological conceptions in connection with computers as educational resources. This singularity can also be applied to Internet and to networks, since they allow interaction, they foster autonomous and open learning environments, and they favour research and exploration strategies.

Another dimension has to be added along the lines of the cultural development pointed out by Vygotski (1984) about the creation of tools that enlarge human capacities to learn and know: "tools created by mankind in the normal course of its social relationships and exchanges among its members. This is applicable to the technological tools since they have the capacity of symbolic and conceptual codification and representation. In particular, it can be applied to the computer as a tool which regulates relationship and exchange (mediation), as pointed out by Cole (1991, p. 412 in Crook, 1994 and 1998, pp. 49-58).

More recently, other perspectives have been incorporated either as original approaches or as adaptations of the constructivist thought or of Vygotski's ideas - we are making reference to Conversation Theory and the Situated Learning Theory.

The Conversation Theory (Pask, 1964) rests on Vygotski's idea that learning is a social event, but it adds to the idea that the acquisition of new knowledge is the result of the interaction between the individuals who participate in a dialogue, and that learning is a dialectical process in which an individual contrasts and confronts their personal point of view with somebody else until they reach an agreement. It is along this exchange and as a result of it that the incorporation of the new cognitive material takes place. From this point of view, Internet is an environment that assumes a specific social nature - that of individuals, groups, etc communicated through the net or its mediation. It also means a process through which learners build a Virtual **Zone of Proximal Development** (Vygtski, 1978). The net increases what the student is able to learn with the help of others.

Another theory is called upon to defend Internet reliability as learning environment, the Situated Learning Theory (Young, 1993). According to this theory, knowledge is an active relationship between an individual and a specific environment. What is more - learning happens when the learner is actively involved in an instructional environment of a complex and real nature.

The Internet environment responds to the premises of **Situated Knowledge** in both its two main characteristics: reality and complexity. On one side, the Internet makes room for authentic exchanges among users coming from very different cultural environments, but with similar interests (Brown, Collins and Duguid, 1989). On the other side, the unstable nature of the Internet involves some difficulty for those ones

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[1] See http://www.papert.org/, http://web.media.mit.edu/~papert/ and also the web page of Media Laboratory at MIT http://www.media.mit.edu/people/bio_papert.html.

who are not skilful in using it but, nonetheless and thanks to their peripheral and continuous participation, are rewarded with the gradual incorporation to a specific culture. So we will see that the student who is finding mathematical or statistical documental sources on the Internet attributes to them a credible and real nature - they are real resources - hardly attributable to a text or an *ad hoc* exercise.

Objectives, methods, contents, learning conditions, assessment and resources constitute the normally accepted curriculum dimensions; that is, the intentions, actions and decisions that go with any educational or training intervention process before the instructional planning, during the different process assessments, and after in the cumulative or final evaluation. The curriculum can be more or less implicit or explicit according to the degree with which intentions, actions and decisions which are its constituents are stated or detailed; and it will have a different basis depending on the way the focus of the design and its construction is based on the principles governing the organization, contents, training objectives, learning situation or students interests, etc. Anyway, the main idea governing the principles of curricular design is to "think the curriculum;" that is, to reflect, individually or in group, on the process, its conditions, its development, and its conclusions as a working and communication tool.

Concepts and terminology

Despite the term *e-learning* deserves careful usage, which we will analyse later in order to avoid conceptual confusions, it has been extensively used in all the specialised contexts – forums, discussion lists, specific literature, etc – first in the US and then worldwide, to refer widely to the world of training and learning which, at some point or all throughout, uses the web and digital environments. Besides, *e-learning* is also used to refer to the *distribution* of knowledge within the corporate world and the technological research about it. This knowledge is usually delivered through multimedia software (training software) or web based so it can be learned by a roughly specific group of individuals. It is commonly referred to as *corporate e-learning* ("e-learning empresarial" Ruíperez, 2003), through which the corporation or company delivers training courses that are more or less assisted by an authentic net-learning system. Depending on each case, this sector can be situated half way between the publishing world and the world of private academies and correspondence courses on the one side and, in the EU, a dynamic and vigorous corporate sector on the other; it has emerged under the encouragement of the EU policies of professional and corporate training programs.

As a consequence, some concepts and terms are biased and affected by connotations that belong to the corporate world – one with strong commercial and budgetary concerns. Therefore, "course" in this context means something alike to a stand-alone correspondence course. The same happens in reference to packaging, reusability, etc. This influence even affects the whole concept of e-learning – for some sectors, e-learning *means* business. We will be using the terms *corporate e-learning* and *technological e-learning* to make reference to the world of technological development and production, both in the corporate and the research sectors.

In the following section, we will digress briefly to clarify some concepts that are used in the technological and in the corporate e-learning indistinctly with different

meanings from the traditional ones that correspond to the educational and learning sciences and, in particular, in the developments of curricular design proper.

Contents.-

In corporate and technological training, this concept is used to make reference to all the information, data and methodologies that are stored, hosted and processed in the platforms. This concept is not strictly related to the information about what is used to manage the system, which is thus secondary in importance and regarded like hardware or software. In fact, for this kind of information, the term "courseware" is used.

From our point of view, the lack of success of many web based training projects lies in this distinction in concept (mainly, in many multimedia educational courses that are massively produced) because it diminishes the central aspect of any learning process – the realization of learning, which is equated to considerations of supposed technological quality, success in the resolution of computer procedures, programs and algorithms, to considerations which, in fact, refer to the appearance, to the external look, to the presentation, with the resolution in the digital graphical environment, etc.

As mentioned above, we will use the term *content* modified by *teaching* or *learning*[2] to mean **cognitive material that is increased or modified in the learner as a result of the learning process**. Roughly, contents can be of three types: conceptual, procedural or attitudinal ones.

The data and information supported in the platforms and in the web training – not only the digital one are called *curricular materials*, after the term used for curricular design which is not exclusively electronic, but of different kinds. Just to situate the reader and without specification which would be out of the scope of this article, we may say that curricular material can be classified into didactic guides, didactic units, documents – materials in which contents are developed: notes, exercises and practice activities –complementary material – texts, images, data which are not specifically formative but are extra to the activities – professional or technical documents, live documents, resources on the Internet – instructional multimedia and simulations, student guides, instruments for formative and cumulative evaluation, and documents generated by the instructional activity itself.

Courses.-

In corporative e-learning, the term *course* clearly defines the digital multimedia or web-based material which is used to develop a training program. In an extreme case, it is a CD-ROM distributed among users, but it more often makes reference to a formative unit in an LMS (Learning Management System) which can be identified within a larger formative proposal, which is also called *course*.

Conventionally, a course is known as a curricular unit that has its own accreditation or marking scheme, that contains smaller learning units or modules –areas, subjects, chapters- and that has different curricular dimensions: objectives, contents, methodology, evaluation, resources, etc.

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[2] Basically, both expressions – teaching and learning contents – mean the same, as what is meant to teach is meant to be learned by the student, even though teaching and learning are substantially different activities.

E-learning.-

We have already mentioned that in a way, the expression *e-learning* is used to name an activity: the production, support and distribution of multimedia learning material. However, without going that far, *e-learning* is more frequently used as a synonym of web-based learning, without distinction between learning and teaching (teaching activities, organisation of educational resources, etc). In this sense, we will try to project the usual terms into the digital environment and so we will distinguish *e-learning* that is, what is web-based learning proper (reaching new cognitive balances) from *e-teaching* that is, web-based teaching. However, as web-based learning is closely linked to teaching, we will also use terms such as distance learning or web-based learning systems to name full training or learning programs with objectives as the ones mentioned above. The word *training* is commonly used to mean "formative process," and so we have *teacher training* or *manager training*.

2. Learning Objects.

Surely, the biggest problem in the e-learning industry at present, which still remain unsolved in many of its basic aspects, is the lack of common and widely accepted technical methodologies, both for documents and of pedagogic nature, that guarantee the accessibility, interoperability, durability and reusability objectives of the web-based curricular material.

In the available offer on line at present, the material prepared for one system cannot, in general, be run in another keeping its original characteristics and properties.

In order to solve this problem, e-learning standards have been established. These are protocols containing specifications through which it is possible to give more flexibility to the transfer of distance learning programs concerning their format, structure and the hardware and software necessary to run them.

This process of technological convergence is extremely useful both for users and for the e-learning industry: for the products adopting these standards, it guarantees they will not become obsolete in the short or mid-term. In this way, the investment is protected.

These standards are also economical in the field of knowledge, or so is foreseen is the corporative e-learning sectors. Shared standards for the materials metadata, packaging and sequencing of resources, the interoperability of tools such as content tests, performance data and students academic data, interaction with learning programs in running time, etc all save investment in extra learning and effort in teaching design. According to these sectors, the above mentioned are an "indispensable requirements for the success of the economy of knowledge and for the future of e-learning." However, as we will point out later, this purpose is hardly compatible with the principles of sequencing of content and with the laws that rule the learners' cognitive framework which allows the incorporation of knowledge.

There have been many attempts to standardise content material for e-learning. We will just refer to them mentioning some indication about the developments towards standardisation in the instructional design in order to guide our work on aspects of instructional design of learning objects such as sequencing of content objects.

1. AICC, *Aviation Industry CBT Committee*

Most probably, the aviation industry is the first instructional consumer by nature. In 1992 they created a committee in charge of developing a norm for their web-based and multimedia instructional providers. They created a series of guides with recommendations (AICC *Guidelines and Recommendations, AGRs)* the most important of which – *AGR 010: Web-Based Computer-Managed Instruction* just barely deals with instructional design.

2. IEEE *Learning Technologies Standards Committee* (LTSC)

It is an organisation whose aim is to define an ISO norm on the use of educational and instructional systems and components in computerised environments. It takes the works of AICC and improves on them by creating the notion of *metadata.* It has more than a dozen working groups (WGs) and study groups (SGs) who develop specifications for the e-learning industry. None of them work specifically on instructional design.

3. IMS Global Learning Consortium, Inc.

IMS is a consortium of educational organisations and companies belonging to the public and private sectors. One of its main contribution has been the definition of the IMSMANIFEST.XML file (on which we will develop later in this work) to describe the content of instructional programs (courses), so that any platform can upload a course by reading its IMSMANIFEST.XML file.

The second important contribution has been the specification (**LOM**) *Learning Object Metada* as the standard for metadata. This is the specification we have chosen in our proposal for quality management. (Zapata, 2003)

Among the existing working groups, the ones working on instructional design and on competencies stand out:

Learning Design
This IMS Working Group does research on procedures to describe and codify the learning methodologies included in an e-learning program.

Competency Definitions
This IMS Working Group is dealing with the creation of a standardise way to describe, refer and interchange competency definitions. In this specification, the term *competence* is used in a sense that includes skills, knowledge, tasks and results of all types of learning. Its main interests lies in trying to formally represent the main characteristics of a competence, regardless of its use in a particular context and allowing, in this way, the information transfer from one program to another.

4. ADL SCORM

In November 1997 the US government launched a program headed to provide tools, services and systems so as to be able to take learning and instruction to all who may require them, regardless of time or place or, mainly, of the platform the

instructional provider used – that is how ADL *(Advanced Distributed Learning)* was born.

ADL (Advanced Distributed Learning) is a program of the Department of Defense of the United States of America and of the White House Office of Science and Technology to develop principles and working guides for the starting up of effective, efficient and large-scale web-based educational project. This program gathers the best of the previous proposals and merges them into its own improved standard.

That is how, three years later, SCORM (Sharable Content Object Reference Model) is born out of this organization. In this model, a series of guidelines and requirements are specified so as to define what the content of a web-based learning system should be like in order to make it feasible for transference, integration and reuse in different platforms, i.e. for interoperability.

Consequently, a new philosophy of sharing learning resources has emerged; one which is head to form and affect the world of web learning nowadays. In fact, this is the initiative that has spread through facts and statements – in forums and through its acceptance by content factories.

Some of the most important concepts used in this philosophy are:

Packaging
Set of specifications addressed to programmers and suppliers of didactic material, LMA, web-based learning systems and training services. The packed didactic objects have a description of their structure and location on line, as well as some technological characteristics about the included data.

Repositories
Collections of resources, documents or information of any type accessible through Internet or a digital net. In case of e-learning, they can include the learning resources, the metadata describing them, or both.

Metadata
These are structured textual records. It is a structured set of descriptive labels of information objects used for cataloguing learning material. The purpose it to facilitate its location and usage in the net or in a repository, so that is why they include the material requirements and a description of the way in which they can be implemented.

Instructional Design
In the context of ADL-SCORM it means the development of a working space that allows the combination of pedagogic diversity and innovation, and the possibility of exchange of interoperable and reusable material. Its central objective is to establish criteria and methods for the instructional design of the learning materials in use.

The SCORM model is thus formed by a set of specifications that allow the development, packaging and distribution of learning materials in the required place and time, preserving their functionality and characteristics.

The materials produced under the SCORM standard should comply with the following four principles:

1. **Reusability**. All curricular material and, in particular, learning objects should be suitable for reuse with different tools, in different platforms and in different technological and instructional contexts, specifying the degree of reusability.
2. **Accessibility**. Tools and products following this standard should allow the follow up of the behaviour and learning and academic history of the students.
3. **Interoperability**. Information should be interchangeable among all platforms (LMSs) bearing this standard.
4. **Durability**. Technological products deve loped under this standard should avoid the obsolescence of the materials.

SCORM norms, administered by ADL, define how materials should be published and how metadata should be used. They also include specification to represent the structure of the instructional modules through XML and how the API – Application Programming Interface[3]- should be used.

SCORM criteria can be grouped, in general, into three categories:
1. Those referred to the packaging of materials. They deal with the way in which the contents –or *course,* in corporate e- learning- of an instructional module are stored, the way in which they are related to each other and the way in which the information will be delivered to the user. In reference to a *course*, these data are kept in a file called **imanifest.xml**
2. Those referred the communication performance. They detail the environment to perform the information, and classify the information into two groups: the commands and the students' metadata.
3. The course metadata. They are of two types: those one which include the information of the course proper, and those which include the student's material.

The updated version of SCORM is 1.3, which can be obtained from http://www.adlnet.org .

A good practical example of SCORM can be found at www.scorm.tamucc.edu .

References on e-learning standards

The information given about different standard systems in this part of the article can be obtained through the following references, from where we have also obtained data for this summary:

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(www.luvit.com)

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[3] **API:** *Application Program Interface*. Set of programming conventions that establish how to request a service from a program.

2. *Making Sense of Learning Specifications & Standards: A Decision Maker's Guide to their Adoption*, The MASIE Center e-Learning CONSORTIUM, 8 March 2002.

3. *E-learning Interoperability Standards,* Sun Microsystem Inc.

4. *Utilización de SCORM en el diseño de cursos y sistemas de gestión de aprendizaje en entorno Web,* Begoña Perela Moreta.

5. *Click2learn Briefing: eLearning Standard*s, Claude Ostyn, Learning System Strategist, Click2learn Inc., November 2001

6. *A Standard for Succes*s, P.J. Connolly, October 2001.
URL: http://www.infoworld.com/articles/tc/xml/01/10/15/011015tclearn.xml

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9. *QS Media, e-Learning,* URL: http://www.qsmedia.es/elearning/default.cfm

10. *SCORM Concept*s,
URL: http://www.eduworks.com/LOTT/tutorial/scormconcepts.html

11. *IEEE Learning Technology Standards Committee (LTSC),*
URL: http://ltsc.ieee.org/

12. *IMS (Instructional Management System) Global Learning Consortium,*
URL: http://www.imsproject.org/

13. Advanced Distributed Learning (ADL) Initiative, URL: http://www.adlnet.org

14. AICC, The Aviation Industry CBT Committee, URL: http://www.aicc.org/

Reusable learning objects

The philosophy of *sharing resources* goes beyond on-line courses. As such, *reusable learning objects* are digital resources that can integrated in different learning contexts to support instructional programs with varied objectives, users, etc. They can be reused indistinctly without any adaptation.

L'Allier (1997) defines an LO as 'the minimum independent structure containing an objective, a learning activity and an evaluation instrument.' Wiley (2002) describes an LO as 'any digital resource which can be used to support learning.'

As we can see, the concept that results from taking into account both definitions is really vast and can be applied almost to any didactic object in digital support with huge substantial differences in the teaching intervention and levels of use, from a presentation in a traditional class, or a digital photograph to explain, for instance, a gothic window in an Art lesson, to a full virtual subject.

Reusability is a different concept. As we will see, an object is not completely reusable in different instructional or technological context. In our case, we will see the instructional ones and the problems that pose in the field of the instructional design. This fact sets the basic issue: what is the degree of reusability of an object?

Reusability (Sicilia, Miguel-Angel and García, Elena, 2003) thus, can be claimed to be the most important characteristic of the learning objects. However, it is difficult to measure because reusability refers to anticipated situations and future uses.

This aspect forces the specification of the possible contexts of use to determine the degree of reusability of the learning object, and that the total reusability be defined as the resulting degree of sufficiency for each of the specified possible contexts – having in mind that reusability is not one and only, but depends on the context.

However, it is not simple or one-dimensional either. Reusability of a learning object should also refer to the different characteristics that define it, and so we will deal with sequencing, for instance.

It is widely accepted the fact that the design of the LOs implies, basically, three disciplines: instructional design, computer technology and library technology.

Instructional design, as understood under ADL-SCORM, makes room for the definition of the *learning objectives* that rule the creation of the LO. Information and communication technology, digital technology in general, is the obvious operative base from which this type of resources are produced, making use of the philosophy of object-oriented programming, putting special emphasis in aspects such as sharing, inheriting and integrating resources to cater for different objectives. Finally, library technology and the sciences of documentation supply the necessary methodology and theory to catalog the access, classification, storage and search of resources.

In spite of all the above, the main objective of the LOs is to achieve the possibility for teachers and students to adapt the instructional resources to their own learning and instructional objectives, interests, needs and learning and teaching styles.

As the theoreticians of the reusable LOs state, the challenge that companies and learning and research centers which work on corporative e-learning and e-learning for other institutions that may need them, in relation to the LOs proper, to the repositories which will store them and to the tools that will process them, face is not only to offer the possibility to find *learning contents* (instructional programs), but *significant and relevant contexts* for students, where to find ready-made contents. (Longmire, 2002)

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