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Toward an instructional design model based on learning objects

Andrés Chiappe Laverde · Yasbley Segovia Cifuentes ·
Helda Yadira Rincón Rodríguez

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Abstract The present moment in the history of higher education requires setting strategies and specific action plans to guarantee a place in the highly competitive and demanding world scenario. The incorporation of information and communication technologies is one of the feasible paths to be considered, but this requires formulating proposals insuring appropriate use of said technologies seeking improvement of education quality. For this purpose, Universidad de La Sabana has developed an instructional design model based on learning objects.

Keywords Educational technology · e-Learning · Instructional design · Learning objects · New information and communication technologies · Virtual learning environments

Introduction

The enormous potential that learning objects have within the world-wide educational scene is unquestionable. However, they have been under-questioned, even before having implemented them into a consistent path (Wiley 2006).

How can this be possible? The reason is: People who are chosen to integrate the learning objects into the teaching-learning process do not know, in fact, what they are, how to use them, or how to generate them. Furthermore, the excessive management of the technical issue regarding learning objects (standards, metadata, repositories, etc.) is

A. Chiappe Laverde (✉) · Y. Segovia Cifuentes · H. Y. Rincón Rodríguez
Area de Informática para la Docencia, Universidad de La Sabana, Campus Universitario Puente del
Común, Km 21 Autopista Norte. Chía, Cundinamarca, Colombia
e-mail: andres.chiappe@unisabana.edu.co

Y. Segovia Cifuentes
e-mail: hasblady.segovia@unisabana.edu.co

H. Y. Rincón Rodríguez
e-mail: yadira.rincon@unisabana.edu.co

leading them to an early obsolescence. As a result, it is necessary to draw the technical aspect up with some educational components to reach a balance and allow not only their survival, but their exploitation toward the improvement in the quality of education at all levels.

On the other hand, Globalization is an economic, cultural, political, and social reality of our time. Of course, the educational sphere is not distant from this phenomenon and even though some years ago it was foreseen that Institutions of Higher Education (IHE) needed to prepare for this reality to face its needs, it is still unknown how to handle this situation from a strategic approach.

An alternative to consider, but not necessarily an easy one, is to definitely implement academic programs supported on the use of Information and Communication Technologies (ICT).

Quality is the factor that can influence competitiveness of the IHE the most under the globalization framework. Therefore, it is important to identify (as it will be mentioned later) that the context in which the ICT are used, the learning objects will play a main role in strengthening the quality of education, either as the core or axis, to articulate new policies and institutional strategies, or as part of different resources to be used in the process of generating new educational contents.

From this perspective, the Model of Instructional Design based on learning objects (MIDLO) presented in this document takes on a fundamental importance as a model of institutional formulation for conceiving the design and creation of high-quality academic content for Higher Education.

The challenge to higher education institutions

The Colombian Government and the Colombian Universities have taken some steps into formulating a long-term vision for Higher Education through a series of meetings and nationwide agreements. Judging by the contents included in the agendas for such initiatives, the most relevant policies for the Higher Education in Colombia (Ministerio de Educación Nacional 2003) center around five different and complementary axes:

- Quality improvement.
- The improvement of the coverage for all Higher Education subsystems.
- Modifications to the financial scheme on behalf of the State.
- The improvement of internal procedures within institutions.
- Internationalization of Higher Education.

The first two axes, along with the fifth, will be considered here as those which portray the general context of this article. One of the outlined strategies traced by Ministry of National Education (MNE) regarding these axes previously mentioned, deals with strengthening within the universities the process of creating quality contents. Within this strategy, it is said that the use and creation of contents by means of learning objects, due to their characteristics and nature, is an encouraging path to promote the strengthening in the quality of higher education from the point of view of the production of its academic contents.

In Colombia, some strategies have been designed and implemented to improve the overall conditions of basic, secondary, and higher education, but the expected levels of development have not yet been achieved. As evidenced in the MNE¹'s publication "La

¹ Colombian Board of Education or Ministry of National Education of Colombia.

Revolución Educativa, Plan Sectorial 2002–2006²” of March 2003: “The coverage, efficiency, and quality indicators of the educational system show that the advances have been slow and insufficient, and in many cases, the increases in coverage have been achieved at the expense of quality.”

In the document previously cited, the MNE expresses its concern with the decreasing tendency of the evaluations of quality in higher education, and points out that mostly for the nineties the growth in the educational offer was not accompanied by a clear law regulation and the evaluation methods and the systems of control and surveillance resulted in low levels of social and labor appropriateness. The topic of quality has become an issue of great significance for the MNE in Colombia, up to the point in which the Higher Education Quality Control System was formed, and is currently working; they intend to implement certain mechanisms to make higher education institutions start or continue their own internal quality processes associated with their substantial functions: teaching, research, and social projection.

Since the nineteen eighties, there has been a remarkable increase in the concern about the topic of “Quality in Education” as a whole. (Facundo 2004). With eager interest, it can be seen that the current definition of quality standards for educational proposals mediated or supported by information and communication technologies (virtual learning environments) is not providing the necessary results so that higher education institutions can, based on them, design and implement educational projects supported by ICT that may guarantee the levels of quality the current educational context demands.

Although it is quite clear that the topic of “Quality in Education” is complex and tackles a great number of very diverse factors (curricular aspects, teacher training, institutional conditions, etc). The context in which this article is developed focuses on the incorporation of ICT into the educational processes; this is a context in which one of the most remarkable preoccupations is still the production of quality contents to those processes.

Thus, it is appropriate to mention that the universities of Colombia, as part of their institutional strategies, have begun to respond to the challenge of quality by means of its explicit confidence and expectations in the use of information and communication technologies.

Some universities have tried to focus their path on this way through the incorporation of learning objects into their process of creation of academic programs supported by ICT, and as a support to on-campus programs, to strengthen students’ independent work.

The topic of the learning objects is relatively new. Even though there can be found references to the topic from the middle to the end of the last century, in relation to teaching, assisted by a computer, and the computerized educative materials, (Galvis 1992), it is not until a recent years that publications centered in learning objects (Wiley 2000) appear.

Why do learning objects help to reinforce the production of quality academic contents?

Right now we will state four reasons (probably not the only ones) by which it is possible to consider that learning objects tend to establish a hopeful path toward the generation of quality academic contents.

First: The experience acquired at the universities in Colombia has shown that the generation of learning objects has become a complex institutional process that goes beyond the individual production, led more by some enthusiastic teachers’ motivation. This implies that learning objects, different from any other educative material produced by a teacher in an isolated way, should follow a series of multidisciplinary processes with

² The Educational Revolution: a Sector Plan 2002–2006.

feedback and control stages whose main aim is checking its pedagogical, communicative, technical, and operative aspects, among others, in a very careful way.

Second: The learning objects should be stored in repositories that allow their public exposure. Privacy of a traditional classroom should not be a reason for mediocrity, nor a reason for disregarding the quality of the materials used within it. There is a major institutional concern about the quality of different kinds of teachers' intellectual production. Sometimes this production is subject to continuous revision and critique from the university community in general. This is the case of learning objects. The possibility of downloading learning objects from university's repositories allows its evaluation not only by academic peers, but also by students themselves who grade and make comments about the material by means of the tools available in such repositories. These comments are included in the elements that will be analyzed later to make the adjustments and modifications required.

Third: The learning objects make an easy incorporation of ICT in different formative processes. Compared to an entire course size, learning objects are considerably smaller and obey to a modular, behavior which permits its easy application as study material for independent work, self study, or as a complement in traditional, distance, virtual, or blended learning processes. Although there may be some exceptions to the rule, learning objects do not require larger nor complex programming developments as it is required in most of educational software applications. In the same way, they allow the integrated inclusion of multimedia which, if it does not guarantee, it does promote, at least, the achievement of a high level of motivation, and an approach to implement different learning styles (Keefe 1988).

Fourth: Learning objects are applicable not only as a study material, but also as a teaching strategy. An experience in building learning objects carried out by students from the Faculties of Journalism and Social Communication and Psychology at Universidad de La Sabana has shown that the development of learning objects as a project core is an innovative strategy to learn about what they are building in the first place. Discovering or recognizing new meeting points or approaches when learning a particular topic reveals pleasant surprises within the teaching-learning processes.

Learning objects: between ambiguity and novelty

It is prudent to recognize how some well-known organizations define the learning object concept in order to identify the way this concept is being understood within the international educational environment.

The National Ministry of Education of Colombia defines learning objects as "any digital resource that can be reused to support learning. Any learning material has to be organized meaningfully, related to a learning aim, and has to be related to digital entities and deliverable over the Internet. This material should have an identification information or metadata, which consists of a descriptive list that identifies the possible use of the object, its classification and interchange". To some extent, this definition is similar to the one given by one of the international experts in this matter as David Wiley who identifies learning objects as "small (relative to the size of an entire course) learning chunks that can be reused in various learning environments" (Wiley 2000).

Wiley also refers to IEEE/LTSC (Learning Technology Standards Committee) definition which classifies learning objects under the Distributed Learning concept and indicates

that a learning objects may be "any entity, digital or non-digital, that may be used, reused or easily found by a search during technology supported learning".

Being in agreement with Wiley on this aspect, it is necessary to recognize that all the definitions available are so wide that they are vague and ambiguous; therefore, it is convenient to agree on the terms, so that in the definition, one might find useful elements or clear features that enable its design and construction.

In summary, a learning object, as a proper definition presented in this article, is a digital, self-contained, reusable entity with a clear learning aim that contains at least three internal changing components: content, instructional activities, and context elements. As a complement, the learning object should have an external component of information which helps its identification, storage, and recovery: the metadata.

Understanding the learning objects as self-contained, reusable entities will reveal its unique nature and complexity. From an educational point of view, learning objects are attractive because of their reusable feature, but at the same time, they become too complex to be designed, developed, and used in practice. It is necessary to accept their reusable feature as an asset, and not as an imposition. Reusing learning objects does not imply dealing with an indivisible unit. Conceiving learning objects as units that cannot be allowed to change its internal components is a naïve and utopian perception of it.

Being able to reuse learning objects in different contexts not only means that they should be meaningful, that is, they may be used alone, without being part of other objects (being self-contained) but it also means that they become modular, a feature which is unusual and even unknown to many instructional designers, many teachers, and content experts.

Although the LEGO concept (Wiley 2000) provides a general idea of what learning objects are, it is not feasible for our context. Neither is Wiley's atom analogy. However, this analogy has more interesting aspects than the LEGO option, and is closer to the reality of educational content management. Both analogies have clear limitations regarding its reusability, and do not correspond with the conception of the model here proposed.

As a result, a new analogy is proposed to illustrate the definition of learning objects which is closer to what the MIDLO model points: The Metaphor of Molecule Manipulation (design of new materials.)

It is possible to see this proposal as an evolution of the atom metaphor, however, this implies some important differences. For example, if an atom of hydrogen is changed by an atom of chlorine, it is possible to produce PVC, or if the glycerol is changed by methanol in the molecule of palm oil, it would be possible to produce bio-diesel.

In contrast, the metaphor of molecule manipulation not only defines learning objects as elements that are assembled to predefined structures in order to get a certain or correct performance; it goes beyond. It considers learning objects as elements which should allow being modified in its own inner composition in order to facilitate a proper educational performance, meaning the fulfilment of some instructional objectives previously defined.

Considering the previous metaphor, learning activities constitute perhaps the most complex component of learning objects. The reutilization of one or more learning objects becomes more difficult in order to articulate them properly. So, it is difficult to coordinate learning activities, almost always pre-defined, and many times not designed to run with any other.

The definition of learning objects as an entity composed not only by content but also by learning activities, makes a remarkable difference with which we consider as just informative objects. The question that consequently emerges is: In what way do learning objects (considered by the metaphor of Molecule Manipulation), influences the instructional

design of an academic program developed and supported by ICT? (Virtual Learning Environments).

Production of Virtual Learning Environments (VLE): The role of the instructional design

In general terms, instructional design is defined not only as a fundamental stage in the process of generation of VLE, but as a process itself. In this process take place the articulation and design of the main components, mostly the pedagogical ones, of an educational resource.

The processes and procedures of the generation or production of VLE in some universities vary, depending on the level of experience that they have acquired about the topic, and the evolution that they might have been able to obtain from those designs and developing processes in terms of enrichment of their efficiency and improvement of the results. However, it is possible to identify certain typical stages in the generation of VLE (Chiappe 2003), like project analysis, instructional design, media and resources production, technological implementation, and emission.

Although the emphasis in this document will be in the Instructional Design stage, it is important to realize that every stage mentioned before becomes part of the framework of the model described in this article. Each stage not only refers to the instructional designers, but to the teachers of a variety of areas of study who, in their role of thematic experts, take part on interdisciplinary teams that develop the learning objects and VLE.

The Instructional Design stage must guarantee the educational quality of the learning objects components or the VLE in which we are working on.

This Instructional Design stage might be considered as the heart of the process of generation of learning objects and VLE, as it is the moment when the content, the communication media, the technological information, the technology tools, and the teacher become a harmonic unit that works perfectly together to help students to carry out their own learning process.

At this stage, the content is adjusted and structured. A critical exercise over the definition and formulation of learning objectives or competencies to be developed must be made. Learning activities are designed and the evaluative scheme is developed; all this through an integrative look that consider pedagogical, technological, communicational, and context conditions.

Instructional design based on learning objects: the challenge

The inclusion of learning objects concept conveys a series of changes in the activities that are characteristic to Instructional Design.

David Jonassen (1994) defines some of the key elements to take into account in Instructional Design, and mentions that it is possible to elaborate the constructivist Instructional Design processes which are clearly focused toward the generation of learning environments that facilitate and do not mold learning, that allow and reinforce the personal learning processes supported in one way, in personal reflection, and in other ways, in collaborative learning processes based on real and contextualized problem solving frameworks.

The previous concept entails a fierce challenge for Instructional Designers. It's imperative to fight and jump the borders of behaviorist or cognitive instructional design

processes (as the ones most commonly used in VLE developing at universities in Colombia) that indeed are much more tempting, easier, faster, and more inexpensive than facing the challenge of constructing a learning environment designed for the complexity of a constructivist approach.

Content-based instructional design: the traditional reference

To adequately recognize the implications of Instructional Design based on learning objects, it is advisable for contrasting effects, to review the model of Instructional Design traditionally used in generating VLE, which we will call "content-based".

Content-based Instructional Design processes include, as a principal component, the structuring of units or content topics of a course led by an outline or guide determined by the virtualization unit. This outline serves as a development work guide to assist experts in contents (Chiappe 2003) so they can create a written document, in digital format, where course contents are structured and organized in an orderly and comprehensible way, although, at times, narrations or productions are generated in different formats. This guide will articulate the topics, didactic aids, learning resources, guides for students, comments, and pertinent suggestions.

Having specified and appropriately structured the contents, and having set the objectives, start the process to design learning activities that will allow students to achieve such objectives. It is worth mentioning that the design of learning activities is the main cause for success or failure of the autonomous learning process for students.

Instructional design based on learning objects: the path to be taken

Instructional Design based on learning objects is, as content-based design, placed within the same VLE generation process that involves stages as project analysis, instructional design, resource production, platform implementation, and emission. One of the relevant aspects of MIDLO model consists of establishing a clear differentiation between learning objects and information objects. Having already explained this topic, it is now time for examples.

Learning objects as they were defined previously, could be internally modified or assembled to make new learning objects for different knowledge areas, or they could also be adjusted or updated to new strategies in one course. This kind of objects are similar to the ranks proposed by Cisco Systems (1999) as Reusable Learning Objects (RLO).

The other kind of objects are the informative ones. This category could cover a wide variety of elements that some times are considered by a few experts, as learning objects, which are really different in their structure from the ones that were mentioned before. Videos, pictures, or animations could be included in this category; because of their complex level, they do not have their own learning activities, and because of this, they do not lead to explicit exercises associated with learning. These types of objects could be identified with the Cisco Systems concept of: RIO (Reusable Information Objects).

Experience has shown that Instructional Design must be different when working with informative objects, and learning objects as input material.

Based on these considerations, there are two different approaches to develop the Instructional Design, which could be considered as two different working levels: first, the

Instructional Design to work with informative objects, and second, the Instructional Design to work with learning objects.

The instructional design to work with informative objects

The working model for this approach is explained in Fig. 1 (see list of figures). The first thing that can be discovered from this Instructional Design based on informative objects is that, as a result, learning objects are produced.

The Fig. 1 shows three big components. An activity or a set of learning activities which have problem characteristics, informative objects (contents), and some contextualized elements.

In this case, learning activities are considered by Instructional Design as an axis that joins the construction of learning objects and all efforts will be made to produce these activities.

The main function of the Instructional Design will be to develop one or more learning activities, which could handle a set of informative objects coherently, and which could reveal learning objects content.

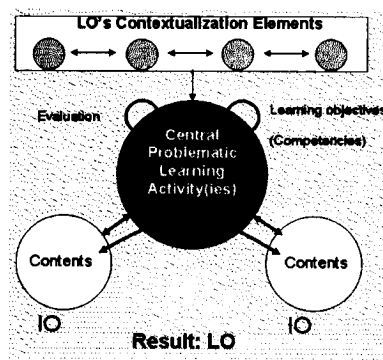
The challenge now is to design a well-thought-out activity or a set of activities, which could allow the informative objects to easily interact, and to be an answer to the requirements of the final learning object. On the other hand, learning activities do not only have to be coherent to the internal learning object, they also have to be as flexible (generic) as possible, so they can easily interact with other activities from other objects in complex educational structures.

Additionally, the Instructional Designer should be worried about the construction of contextualized elements, which he would have to build with an expert, or with the course teacher; tasks such as: A welcome speech, an introduction, the explanation of learning objects topics, the evaluation format and its criteria, and all the possible elements that could help the students understand and identify learning objects as a whole, and not only as a set of components.

The contextualization elements should be designed and handled as modules, so they could be removed in certain circumstances, or reconstructed by the Instructional Designer so that when they are joined with other learning objects, there is no redundant information.

This way to orient the Instructional Design could be defined as Level 1 (micro level).

Fig. 1 Construction of learning objects based on Informative Objects



It has been mentioned previously that the learning objects must have an external information structure that allows its recognition within a saving file. This structure of information must give reference (metadata) about the contents of learning objects. Considering this aspect, the metadata of learning objects will have to offer information to the Instructional Designer about their contextualizing elements, the learning activities and the informative data which is inside. In such way, the use of the complete learning objects, or some components will be possible, giving to the Instructional Designer the necessary flexibility to effectively integrate the process of Virtual Learning Environments (VLE), or for the construction of learning objects of a larger size.

Instructional design to work with learning objects

The exercise of Instructional Design based on learning objects entails a much more complex working level in terms of the difficulty to integrate different objects which have their own activities and contents, and are almost never thought to work well together.

Unlike working with informative objects, in this approach, the activities of the learning objects should be melted or integrated so that they would be perceived as one activity or a set of related activities.

The working model for this approach is explained in the Fig. 2. (See list of figures)

As it was expressed above, it is important to notice that in this Instructional Design approach based on learning objects, the result is the generation of other more complex learning objects, or Virtual Learning Environments (VLE) courses.

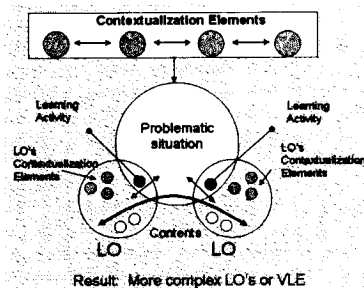
This working model proposes what we call an articulator axis, which is an element or set of elements that configure the core of learning objects or VLE. In this case it is no longer a learning activity or a set of them. The Instructional Designer task has to focus in the design of a problem situation (case, history, game, etc.) on which the other learning objects components depend.

This task becomes more complex when the modularity of each one of the objects has to be considered. It means that, as it was mentioned before, learning objects have its own internal contextualized elements, its own contents, and its own learning activities.

This form to orient the Instructional Design could be defined as Level 2 (macro level).

The Instructional Designer may face three different scenarios: first, where there are already the learning objects (in saving files) and it is necessary to modify them or to integrate them in a new VLA; the second scenario is when only some learning objects exist, and it is necessary to generate additional complementary ones and also, the new VLA structure, and the third scenario is when one begins from nothing.

Fig. 2 Construction of complex learning objects or VLE based on simple learning objects



The model formulated raises to the Instructional Designer the following challenges: for the first scenario, the challenge consists in designing the problem situation so the designed learning activities can be used coherently in learning objects. Nevertheless, it is always possible to use the selected learning objects partially. In other words, the own internal modularity of learning objects must allow their different components to be used, or not be used, and it must allow modifications according to the requirements of the Instructional Designer.

The second scenario allows the Instructional Designer to generate complementary learning objects having as reference some existing learning objects. This situation permits the application of both perspectives of Instructional Design based on information objects and on learning objects to generate first, the missing learning objects and second, to generate the problem situation that would integrate such learning objects to a VLE structure in particular.

The third scenario, being similar to the previous one, as far as the application of the two perspectives of Instructional Design is concerned, is however different in that there is no established referent to generate learning objects. In this case, the Instructional Designers can initiate the design process from Level 2 (macro level is suggested), defining the problem situation of the VLE and then, specifying its contextualized elements, and finally, generate the learning objects that will provide the contents and activities to be learned. Those learning objects are made by implementing an Instructional Design Level 1 process (micro level). In this way, the contextualized elements of learning objects can be avoided, since those of the VLE would provide the necessary information to be properly understood.

Conclusion

The learning objects, which have been studied from their transportability and storage dimensions, lack the academic treatment so they can be understood and used by teachers and students. Not in vain, learning objects are still considered a "subject for experts." Lots of work and energy have been used to define ways to pack, transport, and implement learning objects in different platforms, (which are eminently technical endeavors) and very little reflection has taken place in relation to their use in academic practical exercises when generating a Virtual Learning Environment.

The instructional design model based on learning objects may be the opportunity for Instructional Designers to provide learning objects with the vitality and importance they deserve within the contemporary educational scene. Achieving this objective would be possible if clear guidelines are indicated and the necessary conceptual referents are established (as this model tries to do) for the good development of teams in charge of generating Virtual Learning Environments, always considering learning objects as important components within this process.

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Andrés Chiappe Laverde is an Industrial Designer at National University of Colombia. He holds a graduate Diploma in Research and Higher Education Teaching at Universidad Autónoma de Manizales. He also holds a Master's Degree in Educational Technology at Instituto tecnológico y de Estudios Superiores (I.T.E.S.M.) of Monterrey, Mexico. Since the end of 1999, he has dedicated himself to work on virtual education as a subject of study and development. He has participated in interdisciplinary work teams within specialized units of virtual education as a developer, instructional designer, and general director. In 2003, he published a book entitled “¿Porque el tigre no es como lo pintan?—La virtualidad como estrategia de modernización educativa.” (Why does not the tiger look as he is painted? “The Virtual” as Strategy of Educational Modernization). He is presently Professor and Researcher of the Teaching Information Technology Area of Universidad de La Sabana.

Yasbley Segovia Cifuentes studied Systems and Public Accounting at Santo Tomas de Aquino University. She holds a Graduate Diploma in Tax Auditing and a Master's Degree in Information Technologies Applied to Education at Universidad Pedagógica Nacional. She published the collection entitled “Guía Práctica” (Practical Guide) as orientation class text, and several digital education materials. She has been a Professor of different subjects related to Information Technology in addition to being tutor of Distance Education. She presently performs as Director of Teaching Information Technology Area at Universidad de La Sabana.

Helda Yadira Rincón Rodríguez has a Bachelor Degree in Education Supervision Administration at Universidad de La Sabana, a Graduate Diploma in Environmental Education, and a Master's Degree in Education Multimedia at University of Barcelona. She has been a Professor and Researcher in subjects such as: prospective in education, virtual education, educational multimedia, and education information technology standards. She published a book entitled “Telemática Módulo Básico” (Basic Telematic Module), and several digital education materials. She presently works as Academic Coordinator of the Teaching Information Technology Area of the Universidad de La Sabana.