REFLECTIONS ON E-LEARNING LIFECYCLE AND LEARNING OBJECTS LIFECYCLE

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Abstract

E-learning model emerged in mid-90s claiming to be the substitute for traditional classroom-based learning, meanwhile learning object paradigm have driven almost all technological researches and developments within e-learning area. Despite great investments, few authors and projects have analyzed the e-learning lifecycle and the role that learning objects play within that cycle, very few researches deal with learning object lifecycle itself, and works covering both issues can be hardly located. This paper describes the e-learning lifecycle in a comprehensive way, so that learning objects could be properly placed. The proposed framework will include all actors and products involved in e-learning processes, from the initial definition of the educational objectives associated to a learning initiative to its fulfilment, evaluation and notification. Learning objects will be addressed within this framework and its own lifecycle will be defined. This cycle will comprise the whole process that involves the learning object creation, localization, packaging, delivery and payment. Special stress should be addressed over the technological issues, surrounding the model that will make possible the framework implementation. The final aim of this paper is to identify the technological means that will improve learning object paradigm, thus upgrading e-learning model.

Keywords
E-Learning, Learning Object, e-Learning Technology, e-Learning Standards

1. INTRODUCTION

E-learning, when was initially conceived, was said to become the greatest potential market over the Internet and a promising transformation of education was prospected [1], but “despite massive investments in both hardware and software, there has yet to emerge a viable market for e-learning products. Only course management systems […] and PowerPoint lectures […] have been widely accepted.” [2]. These expectations have not been met due to: (1) false assumptions and myths that have surrounded e-learning since its very beginning [2, 3], (2) technology limitations associated to e-learning [4, 5], and (3) lack of pedagogical and didactic issues in technology-enabled learning approaches [6-8]. E-learning needs to overcome these problems and limitations in order to fully achieve its marketplace potentials.

Within e-learning arena, the learning object paradigm drives almost all initiatives. This paradigm encourages the creation of small reusable learning units called learning objects. These learning objects are then assembled and/or aggregated in order to create greater units of instruction (lessons, courses, etc) [9]. Besides the previously mentioned technological and instructional problems that specially apply to this paradigm, new problems arise in the learning object approach to e-learning. One of these problems concerns the lack of consideration that copyright issues play in current developments and specifications [10-13].

We think that a comprehensive definition of the e-learning conceptual framework that encompasses the learning objects would help to identify the means that solve these technological problems. This conceptual framework should necessary consider the e-learning lifecycle and the learning object lifecycle, as well as the actors, products and processes involved in them. This paper aims to define that conceptual framework. Section 2 presents an e-learning lifecycle that properly addresses learning objects. Section 3 details the actors, processes and products embraced by the previously defined lifecycle stressing its special features. Section 4 presents the learning object own lifecycle, which is

essential in the learning object-driven view of e-learning. Section 5 identifies the technologies that would critically affect the framework implementation, including those that require further research and development. And finally, Section 6 exposes the conclusions and future work.

2. E-LEARNING LIFECYCLE

A literature review exhibits that the definition of a complete e-learning framework have taken a limited consideration while major attentions are centred around concrete technological and pedagogical issues, thus limiting the e-learning picture to a smaller part of the space that e-learning really concerns. Among proposed frameworks, Greune et. al. in [12] depicts a workflow-based, pedagogical-centred e-learning scenario with different levels that includes the main (only the main) products and actors. The instructional-imposed point of view restricts the model so that it does not deal with individual learning objects. Daziel in [14] presents a learning object lifecycle comprising the main processes (creation, storage, search, delivery, licensing and digital rights management). Payment and pricing issues are not addressed. Daziel also presents a global use case that closely resembles an e-learning lifecycle (including its main actors and processes). However, such educational-centred lifecycle does not comprise each individual learning object cycle.

We think that the e-learning conceptual model could be more accurately described using the concept of lifecycle (instead of using the concept of framework). The lifecycle concept stresses the end of the e-learning process and the loop need underlying any e-learning initiative. So we have refined and adapted existing models to create a new e-learning lifecycle that overcomes these issues.

Figure 1 depicts the proposed e-learning lifecycle. This cycle should start with the definition of some kind of guidelines describing the learning initiative objectives, outcomes and/or skills that learners will acquire. These items are then processed by one or more learning institutions in order to produce a curriculum that comprehensively addresses the learning needs into a suitable set of ordered subjects.

Content providers, individuals or institutions, are responsible for creating learning objects covering their correspondent expertise knowledge areas. Content providers may consider the authority guidelines and/or the learning institutions syllabus in order to create the contents, which will made its contents more likely to be purchased in later stages. But it should be noticed that content providers could compose the contents without concerning guideline and syllabus creation processes, therefore being independent of them. Publishing means, such as public repositories, are needed to ensure accessibility

Next stages concern the final contents (courses that will be delivered to learners) creation. Curriculum and learning objects offer the basis that permits the infoseeker: (1) to search across multiple pools of learning objects, (2) to find the required learning objects that cover a particular subject, and (3) to recover them. It should be noticed that some portions of the syllabus could be left uncovered; hence any kind of loop between content creators and infoseekers should exist in order to cover these ‘gaps’. Some additional technological considerations should be addressed within that process, including searching means and digital rights management (see section 5). The result of the searching process will be a set of learning objects that the instructional designers have to arrange in order to create the courses. The instructional designer must possess the pedagogical skills required for: (1) determining which learning objects are suitable to achieve the learning objectives (2) establishing the sequence of learning objects tailored to suit the syllabus, (3) defining the learning experiences that the learner should take, and (4) determining the assessment activities for properly evaluating learner performance. Instructional designer is also responsible for identifying the unsuitable learning objects (inside the provided set) as well as the sections where additional learning objects need to be incorporated, therefore feedback to the infoseeker should be required.

Once the courses have been created, they are delivered to the learners over the Internet. Then the instructor and learner began an interaction sequence that comprises tutoring, mentoring and advising about the subject. Delivery and teaching-learning processes could be carried out using any learning platform.

Afterwards an assessment process must evaluate the learner’s knowledge and performance. Course materials must provide reliable testing materials for learner assessment, and the instructor is

responsible for measuring and grading students. A reliable learning institution is needed to certify the assessment fulfilment and warrant its results. Learner records are then stored in a repository. Finally, a notification process must inform the authority about learner's achievements and e-learning initiative outcomes.

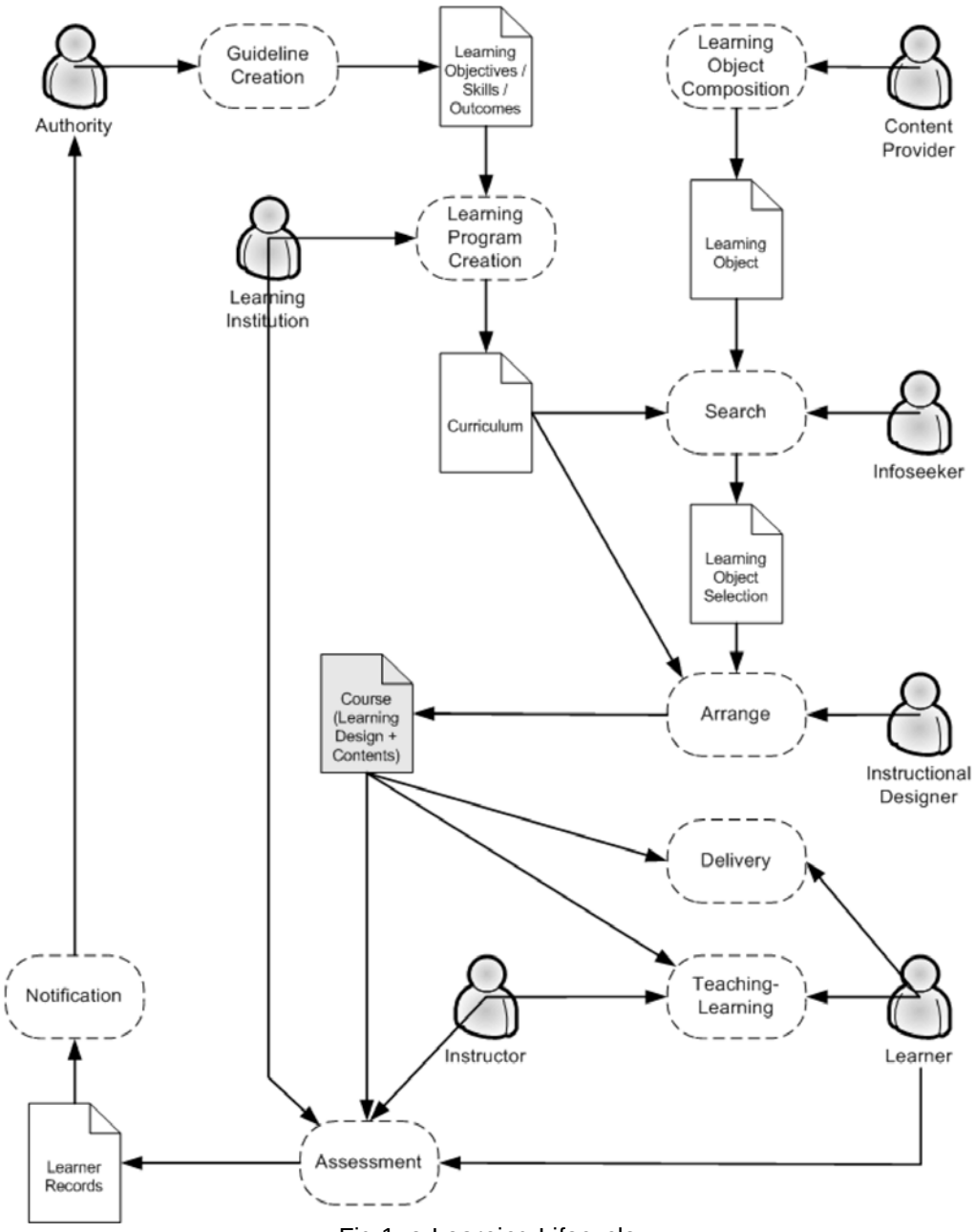

Fig.1. e-Learning Lifecycle.

3. ACTORS, PRODUCTS AND PROCESSES

"In e-learning, people are involved in the process of creating e-learning materials and making them available to a specific audience" [15]. And "An actor represents a human role played in the e-learning lifecycle" [16]. So some roles may overlap in one individual. In this section only special features concerning some actors and products are exposed. It is not possible to include a detailed description due to space restrictions.

Concerning actors, the *authority* (also called regulator) could be intended as a government that establishes the basis for a bachelor degree or a company setting the learning skills that will be achieved by its employees. The *learning institution* should be intended as the organization that is

responsible for organizing and supporting learning initiatives. It must be recognized by the authority. Content providers, infoseekers, instructional designers and instructors can all belong to the institution (be hired by the institution). *Teacher roles* are hard to catalogue. We have defined three different roles (infoseeker, instructional designer and instructor), but additional roles could be considered (i.e. tutor, teacher, mentor, assessor, etc). There is also a so-called 'broader teacher view' (only the teacher role is considered) that comprises the infoseeker, instructional designer (or arranger) and instructor roles in one single role. Content provider embraces content creator and content developer roles. And finally, it should be noticed that additional actors could play specific roles inside the defined processes. These actors are not described because they do not add semantics to the lifecycle; i.e. content distributors may be responsible for delivering courses or recognized dealers may act as mediators in different processes to ensure copyrights protection or payment fulfilment among others.

Concerning products, depending on the e-learning initiative scope, the *curriculum* could also be intended as a syllabus or learning program. A *course* consists of contents and one or more learning designs. A learning design is a set of learning activities sequenced toward a particular learning objective.

4. LEARNING OBJECT LIFECYCLE

A definition of the learning object lifecycle must complement the proposed e-learning framework. Learning objects are intended to be the core elements of the e-learning approach, thus a detailed description is needed. The learning object lifecycle begins when the reusable learning objects are created by the content creators. Current literature on the subject states that the learning object lifecycle ends when that object is delivered to the final learner [14, 16]. Even if this delivery is done successfully according to copyright restrictions (i.e. allowing access to authorized learners or denying it to unauthorized ones), we consider that this lifecycle should not be completed up to the moment the author gets the return of investment of the initial development.

Figure 2 presents the learning object lifecycle within the proposed framework. According to that model, content providers (organizations or individuals that create and publish learning contents) create the initial learning objects (LO). A digital right (DR) specification (called rights object) must be attached to each learning object in order to complement it in a twofold way: First, it ensures that the copyright restrictions are distributed with the object; and second it may content the payment data (price, payment mode, etc.). Payment data will not be attached when the objects are intended for free use, but the rights specification should be attached to the learning object even if the object is intended for free use, "if for no other reason than to avoid the risk of inappropriate commercial sale of free public domain items" [14].

The learning object (with its digital right specification) is then stored in a repository. This repository, and other distributed repositories across the Internet, must publish the learning objects information in order make possible for federated search engines to find them. When the resources are published, infoseekers and instructional designers use a LCMS (Learning Content Management System) to built courses by assembling learning objects. These learning objects have to be retrieved from the local repository or from remote repositories using the federated search system. The LCMS is hold responsible for presenting license agreements to instructors, and instructors must accept the licences in order to include the learning objects in the courses.

After creating the learning experience, the course must be published in the LMS (Learning Content Management System), so that the final users (learners) can access the learning contents. Learners connect to the LMS and access to the courses; when a specific learning object needs to be accessed, it is delivered to the learner so that he or she can receive the instruction. Instructors must also connect to the LMS in order to perform tutoring and mentoring tasks.

In order to complete the learning object lifecycle, one more process and two more flows are required. A 'payment management' process must collect the payment data from learners (provided by the learners or by the organization he/she belongs to) and the learning objects usage (retrieved from the LMS) in order to execute the charges related to the learning objects the have been accessed. The payment management could handle extra issues, such as billing and invoicing, discounting, payment

modes, etc. The LMS is hold responsible for presenting license agreements to learners, and learners must accept these licences so that learning objects could be delivered to them.

Finally, the payment management process pays to the content creator the owed amount for the learning object usage. The payment management is depicted as a process in Figure 2 because it could be integrated in the LMS, it can be implemented as an external system, or the service can be handled by (outsourced to) third parties.

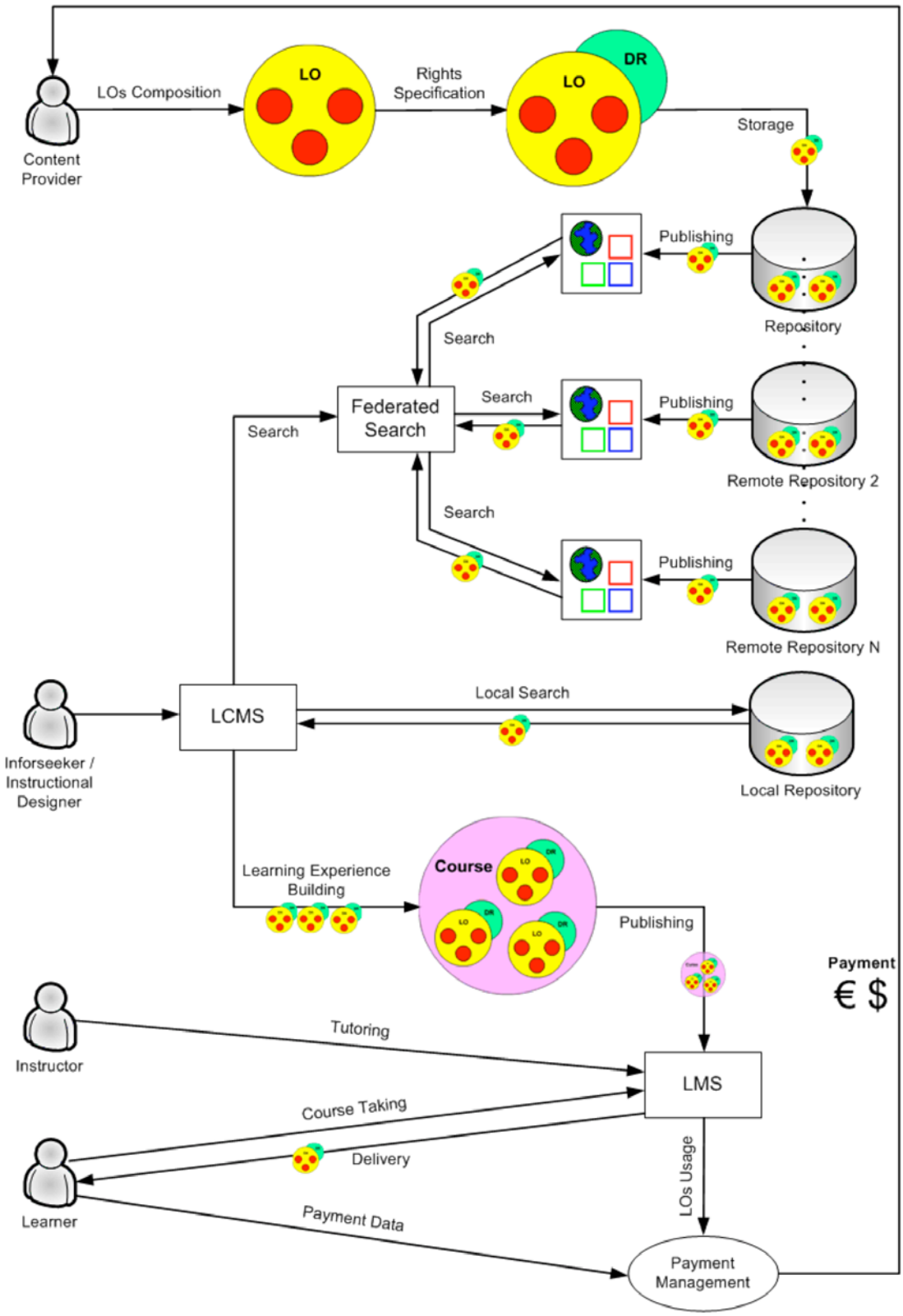

Fig.2. Learning Object Lifecycle.

5. TECHNOLOGY ENABLERS

The model comprises the complete e-learning and learning object lifecycle, and enables a flexible control, delivery, and payment model for learning objects. But, what are the technological requirements to make the model implement-'able'?. In this section the current e-learning technologies that are necessary to realize the model are identified. Some of these technologies require further research and development that are also described.

First of all, compliance with current e-learning standards and specifications is necessary. Concerning content creation, LOM (Learning Object Metadata) standard [17] should be used to catalogue learning objects in order to enable precise searches. And SCORM (Shareable Content Object Reference Model) specification [18] should be used in order to ensure: (1) courseware interoperability among different platforms (LMSs and LCMSs), and (2) a common pattern for describing and reporting access to learning objects, so that learner could be charged for them and content providers could be paid.

Concerning digital repositories, current specifications such as Digital Repositories Interoperability specification (DRI) [19], developed by IMS, should be used in order to ensure learning objects storage and retrieval interoperability among systems. Learning objects will be published in these repositories so that federated search engines are able to search, discover and access them [20].

So far current technology adoption seems to cover the necessities required for model fulfilment, but in our opinion research and development in a twofold way is required for a complete accomplishment. First of all, the lack of didactic concepts adoption is considered to be one of the greatest deficits in current e-learning approaches and solutions [21]. To overcome these problems active research is being carried and some specifications that handle didactic and pedagogical issues currently exist. Among these specifications IMS Learning Design [22] is designed towards describing teaching-learning processes in a formal way, whereas IMS Simple Sequencing [23] and SCORM Sequencing and Navigation [24] specifications allow instructional designers to build learning experiences tailored to each learner needs and knowledge. Even so, in our opinion further improvements are required to properly address pedagogical issues within the proposed e-learning framework.

Secondly, available specifications must be extended to incorporate digital rights and price modelling within individual learning objects. Current literacy quotes the current standards deficits regarding the integration of copyright and price concepts [10-12, 21], and it present some methods (and even implemented systems) to cover the identified lacks. These methods include: (1) Integrating digital rights expression languages within the learning objects description. The digital rights description could be attached to the learning object or it could be stored externally and pointed by the learning objects [14, 16]. (2) Extending current metadata descriptions to include digital rights or pricing models [12, 16]. And (3), defining new methods of integration regardless of current specifications [10, 25].

Finally, the developed system/s should be integrated with current commercial payment gateways. For that purpose content provider needs as well as costumer (learner) needs should be considered. Possible payment models include pre- and post-payment, as well as micro- and macro-payment.

6. CONCLUSION AND FUTURE WORK

A set of key deficits in current e-learning approaches can be identified after a quick review of current systems and literature. These problems arise from the learning object paradigm that has driven a great number of e-learning projects. This paper has set the foundations to overcome these problems and to improve the technological approach to e-learning. The e-learning lifecycle has been established. Learning objects have been placed within that framework and its own lifecycle have been defined. Finally, the technologies that will make possible the framework implementation have been identified, and technologies that require further research and development have also been described. So adopting identified technologies and making the necessary improvements, the technological approach to e-learning comprising learning objects could be upgraded to overcome its current problems.

To attain the proposed objectives three important milestones should be achieved: (1) Full compliance with current standards and specifications, thus ensuring content and system interoperability. (2)

Address copyright and payment restrictions within current e-learning approaches extending current specifications. Addressing copyright within learning objects and subsequent payment integration in e-learning initiatives could mean a determinate shift in e-learning marketplace. And (3), increase attention paid to pedagogical and didactic issues over technological issues.

Future research lines include:

- Competencies integration. An intense work is being carried out on competency definition and standardization. As a result of this research, many specifications have been developed [26, 27] (or they are currently under development [28, 29]). Competencies must be integrated into the proposed framework as a medium to: (1) clearly define authority learning objectives, (2) determine each curriculum element (subject or module) expected results, (3) facilitate learning object search and arrange processes, and (4) measure, record, and notify learning results. Competencies will allow the definition of learning objectives and learning results in a machine readable way, so e-learning will be able to reach a new level of automation. However, to reach this level along with a high degree of interoperability requires a hard work of the e-learning community to properly define a taxonomy of competencies related to each field of knowledge.
- Ontologies. A ontology is a formal definition of a set of knowledge comprising a definition of terms and relationships that help machines to perform semantic actions. Such a formalization of the proposed framework will be useful for: (1) getting a deep knowledge and comprehension of the e-learning elements, and (2) enabling a semantic approach to the processes involved and product generated in the learning actions. Besides, ontologies offer a great potential in other fields within the proposed framework, i.e. an extensive cataloguing of learning objects topics regarding common ontologies will enable semantic searches [30].
- Web services and SOA (service oriented architecture) approaches promote a highly interoperable way for creating systems that can be adopted in e-learning projects. “The identification and implementation of all common web services based functions would be the building block for a wider e-learning framework and could be implemented in all different stages of e-learning lifecycle” [16]. The proposed framework could be defined in terms of web services because “in the near future, it will be common for e-learning applications to offer their services using the new Web Services supporting technologies” [31]
- Processes and roles automation. Figure 1 depicts the e-learning lifecycle in terms of processes, roles and products. Human actors play specific roles in processes in order to create products. ¿What roles could be automated/subtituted for software agents to upgrade e-learning performance? A deep analysis of these roles should be done facing them in a machine process-‘able’ way. “It is critical to automate the instructor’s role in online training in order to reduce the cost of high quality learning” [4]. Instructional Designer ‘full’ role is hard to automate, but some actions (i.e. content arranging) could be carried out by machines. So for some roles a full automation could be achieved, while for other processes only partial computer assistance could be possible. The final aim will be to define a model where Individuals participation in the processes would only take place when is absolutely necessary.

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