International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 8 No. 4 Oct. 2014, pp. 1653-1668

http://www.ijias.issr-journals.org/

# Towards a socioconstructivist and collaborative Learning Design approach to modeling pedagogical contents used in e-learning: Implementation and experimentation

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**ABSTRACT:** The evolution of e-learning technology has pushed pedagogy actors to renew its teaching modes. However, the quality of these new forms of teaching depends on their capacity to be provided with pedagogical contents and learning paths adapted to the current e-learning context (collaborative, socioconstructivist, etc.).
This paper highlights some of the major issues faced in implementing pedagogical contents adapted to the actual context of e-learning. The aim of this research work is to propose a reference model for production of e-learning contents adapted to the socioconstructivist learning context. Thus, this work proposes to develop a Socioconstructivist Model of Collaborative Learning Design (SMC-LD) of e-learning contents, which is articulated around the two main aspects of production of learning contents: "design" and "development". At the level "design", SMC-LD suggests a collaborative design process based on the concept of life cycle. At the level "development", SMC-LD proposes a process for educational modeling, upstream of SCORM and IMS-LD standards, describing a pedagogical content using scenarios and activities. The modeling process is facilitated by an author tool to produce interoperable and reusable learning objects.
To validate its applicability, SMC-LD is implemented with Java and XML technologies and is experimented in real teaching conditions. The results found are satisfactory and encourage us to pursue this research. Teachers have appreciated the collaborative learning design approach to produce e-learning contents. On the other hand, the model has brought important educational benefits at the learners' performance.

**KEYWORDS:** Socioconstructivism, collaborative learning design, development, learning object, e-learning, norm and standard.

## 1 INTRODUCTION

Web technologies are increasingly used in a variable way by educational institutions across the world. They are integrated as much in a presential learning than in e-learning. These technologies induce significant changes in pedagogical practices. In this context, the changes performed by digital technologies are particularly determinant when it comes to the subject of educational act: the pedagogical content.

However, mediatization of pedagogical contents, suited to current learning context (online, socioconstructivist, collaborative, etc.), raises many questions. At the level "design", various studies show that, although most of what we see as individual learning becomes collaborative, and spite of the diversity of actors involved, the design of e-learning contents is effected in most of the time individually [1][2]. The design of such contents does not take into account the collaborative side, which generates contents not fulfilling their pedagogical function [3] [4], and unsuited to the socioconstructivist vision, increasingly advocated in the world of e-learning.

At the level “development”, research works show that the relevance of several norms and standards of educational modeling had been the subject of continuous debates and controversies [5]. These standards continue to privilege the documentalist approaches (case of LOM and SCORM) or show a complexity of use for no-specialists (case of IMS-LD) because they have a strong interest in standardization and issues of reuse [6] [7] [8].

The work presented in this article fits in this issue of design and implementation of pedagogical contents used in e-learning. It relates of the work on learning design and is focuses mainly on the processes of design and development of pedagogical contents of e-learning by means of Learning Objects (LO). This problematic makes complete sense when large volumes of e-learning contents exist, and therefore the question of their pedagogical quality becomes critical [3].

This work has as main objective to search conceptual and computer solutions, both at the theoretical, pedagogical and technical levels, for computer modeling of pedagogical knowledge, which should be in adequacy with current learning practices (socioconstructivist, collaborative, etc.). It comes to implement an online system of collaborative design and development of pedagogical contents, based on the socioconstructivist approach, and taking into account the whole process of learning design.

The paper is organized as follows: after having reviewed the main characteristics of the socioconstructivist approach, on which is based the proposed model, and the main characteristics of norms and standards of educational modeling, this article describes generally the proposed model and explains the theoretical and methodological foundations on which it relies by describing the design process and the development process of pedagogical contents. The article goes on to describe the conceptual structure, the software architecture well as technical choices adopted to implement the model. Finally, the paper describes the experimentation conducted, presents the main results and concludes with future works.

## 2 Socioconstructivism

Like behaviorism, cognitivism and constructivism, socioconstructivism is one of the most recent learning theories. Developed by Lev Vygotski (1896-1934), and derived from constructivism of Jean Piaget (1896-1980), socioconstructivism can be defined as an approach to learning according to which knowledge acquisition is facilitated by the inclusion of social field of learner [9]. The social world is a central concept in socioconstructivism and includes people who directly affect the learner.

In a complex situation where at least two persons try to solve a problem, socioconstructivism then introduces an additional dimension in the construction of knowledge and the development of skills: the multiple social interactions (Fig. 1).

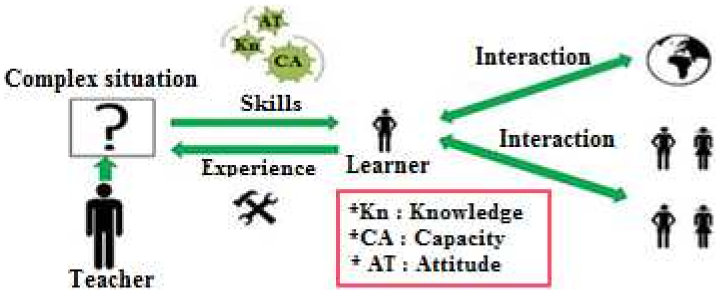


*Fig. 1. Learning according to the socioconstructivist model*

Socioconstructivism is an approach increasingly favored in the world of education [10]. This approach demonstrates superior efficacy compared to more traditional approaches (behaviorist model, transmissive model). Let us also note that if socioconstructivism seems to be advocated at the present time, it is far from being opposed to other educational models but it allows bringing together the common points between these models.

Today, and in the context of rapid technological evolution, e-learning constitutes a privileged field of application of socioconstructivist approach [11]. Digital spaces on Internet offer many tools for sharing and exchange allowing to develop all the fundamental concepts on which is based this approach: Zone of Proximal Development (ZPD), socio-cognitive conflict, metacognition and shoring process [12].

## 3 E-LEARNIN NORMS AND STANDARDS

The growing number of distant learning systems has stimulated research on systems interoperability and learning content reuse. In this context, various standards have been mainly developed to ensure the accessibility, interoperability and reusability of LO produced. These specifications can be classified according to different levels of operations [13].

### 3.1 LOM (Learning Object Metadata)

LOM is a data model published in 2002 by the LTSC (Learning Technology Standardization Committee) of the IEEE and used to describe a learning object and similar digital resources used to support learning. The purpose of learning object metadata is to support the reusability of learning objects, to aid discoverability, and to facilitate their interoperability, usually in the context of online learning management systems (LMS).

The LOM comprises a hierarchy of elements containing nine categories at the first level: General, Life Cycle, Metadata, Technical, Educational, Rights, Relation, Annotation and Classification. Each of which contains sub-elements; these sub-elements may be simple elements that hold data, or may themselves be aggregate elements.

### 3.2 SCORM (Sharable Content Object Reference Model)

SCORM, proposed by the Advanced Distributed Learning, is one of the most popular standards for learning contents. It is a set of specifications for developing, packaging and delivering high-quality education and training materials whenever and wherever they are needed. This specification promotes reusability and interoperability of learning content across LMS [14].

The SCORM has releases dating back to 2000 with SCORM 1.0. SCORM 1.2, released in 2001 is the final version of SCORM before the integration of sequencing. Beginning in 2004, SCORM began to version with different editions of SCORM 2004. The most recent release (2009) is SCORM 2004 4th Ed. SCORM is composed of three sub-specifications: Content Packaging section, Run-Time section and Sequencing section.

### 3.3 IMS-LD (Instructional Management Systems-Learning Design)

IMS-LD was firstly called Educational Modeling Language (EML) and proposed by Open University of the Netherlands. The work about EML is actually standardized in the IMS-LD specification [15]. This standard allows specifying formally learning unit corresponding to the description of the resources and the scenario managing them.

The IMS-LD specification concerns pedagogical engineers who are expert of this language [16]. Although IMS-LD was finalized, some initiatives already propose prototypes of authoring-tools. However, no authoring-tool addresses the multidisciplinary team in charge of the design of the learning unit: the non-expert end-users. The elaboration of models with IMS-LD concerns the latest of the design phase; it is required that a scenario was already pre-established. Models examples based on the UML language, and more particularly the activity diagrams, illustrate well how the results of analysis, the stories, could be graphically described as virtual learning scenarios on which formal models using the IMS-LD language will be specified. So, IMS-LD encourages the use of activity diagrams from UML for these upstream steps of the design process [17].

## 4 Proposition

Starting from the fact that, for any creative process, the most important work resides at the design [18], this contribution intervenes at the level of the design phase of the instructional design process of e-learning and proposes a Socioconstructivist Model of Collaborative Learning Design (SMC-LD) [19]. The model supports the design phase for the steps of initial requirement, analysis, design and detailed design (Fig. 2).

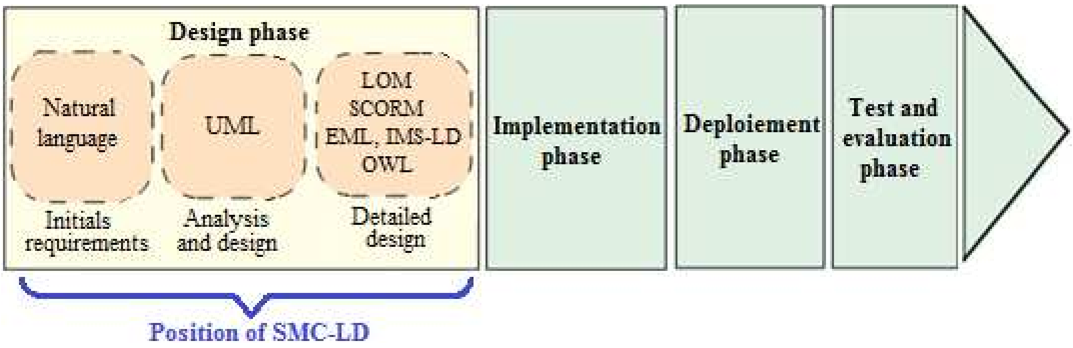


*Fig. 2. Position of the contribution within the instructional design process*

SMC-LD is a model dedicated to the design and elaboration of LO. It is a method of collaborative design and modeling of learning units, upstream of SCORM and IMS-LD models, and is focused on strategies based on the socioconstructivist approach. This proposal comprises two complementary parts (Fig. 3).

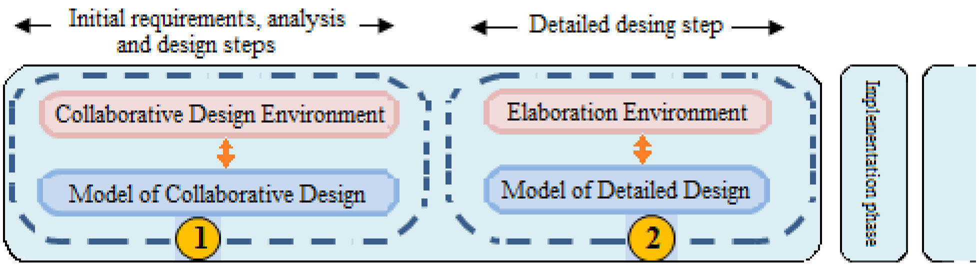


*Fig. 3. The two parts constituting the SMC-LD*

In the SMC-LD, the two parts cover respectively the two mains aspects which the model is interested: "design" and "development". The following text describes each of the two parts of SMC-LD.

### 4.1 First part of SMC-LD

To accompany the sliding of learning practices from the individual toward the collaborative, and therefore produce pedagogical contents adapted to this new learning context, this work proposes as a first contribution to establish a model of collaborative design (and not individual design) of pedagogical contents used in e-learning. The objective is to take into account the socioconstructivist approach in the design process, since this approach considers that the content to be learned always wears the color of the context in which it is designed.

This model covers the first three steps of the design phase of the learning design process (Fig. 3). The design is assured according to a well-defined approach, based on a generic life cycle adapted to the design of content according to an incremental process broken down into tasks to be completed collaboratively.

The design, which takes place in an online *Collaborative Design Environment*, is becoming less the fruit of an isolated author, but it is team work consisting of a pedagogical coordinator and several authors in charge of the design of pedagogical contents. The authors, freed from the constraints of time and place, should collaborate and exchange. Pedagogical content does not stay frozen in time, it evolves and can be revised by a succession of authors. Likewise, the content, that becomes unified, is segmented into elements finer granularity in order to distribute the design work between different authors.

### 4.2 Second part of SMC-LD

The second proposal is based on the finding that at the level of detailed design step (Fig. 2), the relevance of several norms and standards of educational modeling been the subject of continuous debates and controversies [5]. This step (detailed design) of the learning design process is the subject of the second proposal.

Thus, we were inspired of works on these educational standards for provide a method of modeling of LO upstream of SCORM and IMS-LD models. The method proposes to extend and restructure SCORM model by incorporating aspects derived primarily from work on IMS-LD: add activities and take into account the social dimension by adding a new role: the “group”.

All the pedagogical functions described above are implemented in the form of an author tool that allows facilitating the generation of LO compatible to SCORM format. This tool, which represents the *Elaboration Environment*, is designed as a module integrable to the online *Collaborative Design Environment* or to any LMS.

This second contribution is a complement to the first. It constitutes the second part of the SMC-LD and covers the detailed design step of the design phase of the learning design process (Fig. 3).

## 5 THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF SMC-LD

In the SMC-LD, the modeling of a Learning Unit (LU) follows a process consisting of two complementary phases (Fig. 4):

- *Collaborative design phase*: it covers functionalities of the first part of SMC-LD and it is taking place in three steps: initial requirements, analysis and design. It is done collaboratively and in natural language according to the V life cycle, and through an online "*Collaborative Design Environment*".
- *Development phase (detailed design)*: it covers functionalities of the second part of SMC-LD and it is taking place in three steps: structuring of content, creation of learning path and creation of didactic scenario. In this phase, the content development is done through an "*Elaboration Environment*", developed in the form of an authoring tool.

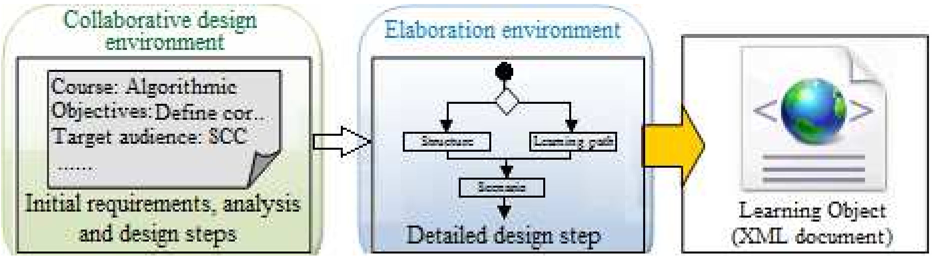


*Fig. 4. Process of design/development of a LO using SMC-LD*

The result of the modeling process, which includes the two phases described above, is an interoperable and reusable LO, formalized by an XML document. In the following are described each of the phases.

### 5.1 COLLABORATIVE DESIGN PHASE

This phase is a process of collaborative design of contents similar to what we find in software engineering. Design is ensured according to a life cycle that brings several advantages [20]: promotes traceability, improves the visibility on the content evolution, promotes the collaborative work, etc. Considering its advantages, the choice fell on the model known as "V-Cycle". Fig. 5 illustrates the steps of the collaborative design process of contents.

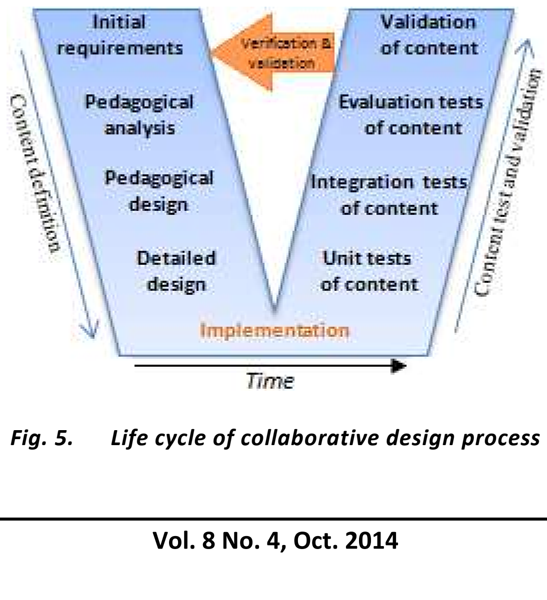


*Fig. 5. Life cycle of collaborative design process*

The design process takes place in an online "*Collaborative Design Environment*" and is done in natural language and through descriptive texts and schemas. On completion of this process, the authors must have a database of detailed resources in order to deduce the graph of the sequence of activities of learning unit and their staging by role.

### 5.2 Development phase

This phase is a process of modeling of contents designed (in collaborative design phase) as a LU and then development of these contents as a LO. In SMC-LD, the structure of a Learning Unit (LU) is constructed from three components: objectives & prerequisites, components & and method. To take into account socioconstructivist approach, this structure introduces, in addition of the usual roles: "learner" and "teacher", a new role which is the “group” (Fig. 6).

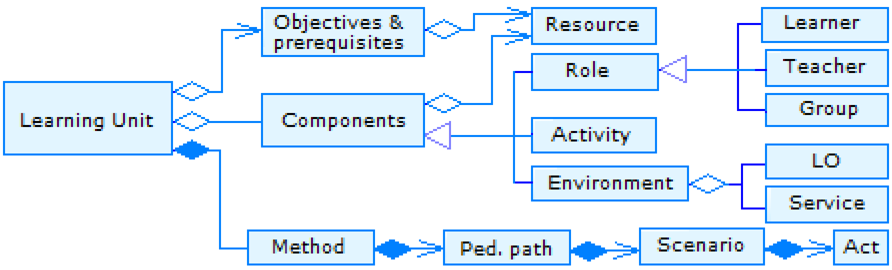


*Fig. 6. General structure of a learning unit*

The process of developing an LO therefore consists in describe the structure of the LU in terms of objectives and prerequisites, components (roles, activities, environment, etc..) and method necessary for the implementation of this unit. This process is composed of three main steps:

- *Structuring of content*: consists in structuring the LO. The comparative study of main pedagogical standards allows us to say that the structure the more apt to represent a LO is the hierarchical structuring. The LO is structured as a tree whose root is the LU and the branches are composed of concepts: sub-LU, activity, sequence and act.
- *Creation of learning path*: consists in creating learning paths in order to organize transitions between activities. Transitions can be expressed through four types of links: default, prerequisite, conditional and empty link.
- *Creation of didactic scenario*: consists in creating didactic scenarios in order to plan sequences relating to an activity. The scenario organizes the knowledge of activity in a series of pedagogical acts, sequentially executed on mediatic resources used. A sequence has an initial state of start and a final state to meet. Transitions made between two acts are performed in accordance with the rules of precondition and post-condition.

## 6 Conceptual architecture of SMC-LD

The general architecture of SMC-LD is based on the main functionalities ensured by the model: collaborative design and development of e-learning contents (Fig. 7).

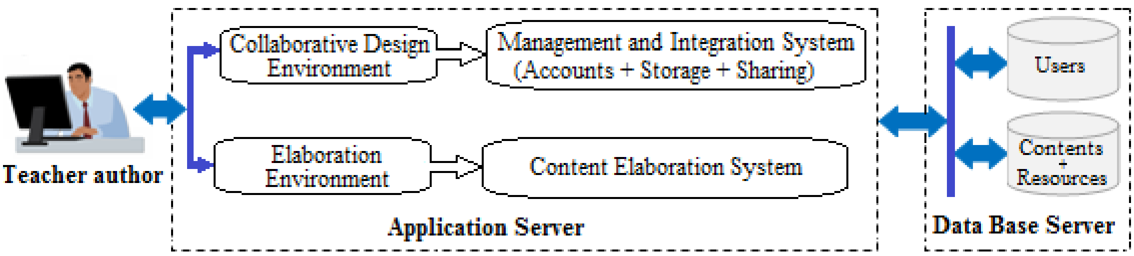


*Fig. 7. General architecture of SMC-LD*

In this architecture, we can distinguish two constituent parts of SMC-LD: "*Management and Integration System*", which ensures collaborative design of contents, and "*Content Elaboration System*" which ensures contents development. In what follows, are described each of the two systems.

### 6.1 Content Elaboration System (CESys)

CESys is a teacher environment allowing to modeling, creating or editing LO according to the development process defined above (section 5.2). This system offers to authors four types of tasks:

- Pedagogical task: creating the structure and the learning path;
- Didactic task: didactic planning;
- Mediatic task: mediatization of scenarios and designing the interface of the LO;
- Technical task: indexing, storage and import of resources.

At the end of the development process, the CESys generates the executable version of the LO produced.

### 6.2 Management and Integration System (MISys)

MISys aims to make available to teachers an online environment allowing multiple possibilities. This is an LMS that ensures two main functions:

- *Management function*: MISys serves to manage the database of LO, resources, users accounts, training, etc. It also offers the possibility to test the developed content and simulate its use.
- *Integration function*: MISys brings together the functionalities of SMC-LD by:
    - integrating the Collaborative Design Environment of contents. The collaboration is facilitated by the exchange and sharing by using communication tools (chat, forum, video conferencing, etc.);
    - integrating the CESys as an additional module, which enables online creation of LO.

MISys is used by three types of actors: administrator, teacher and learner. The identification allows the user to access the interface that is dedicated to him. In the case of the teacher, it will eventually pass to CESys.

## 7 Technical choices and Implementation

To implement the two systems (CESys and MISys) that compose SMC-LD, software architecture adopted is based on evolved technological choices, used in the development of modern forms of e-learning (Web 2.0 technologies. The implemented prototype includes a “teacher environment” offering the possibility of collaborative design and development of contents, and a “learner environment” giving the opportunity to attend training paths (Fig. 8).

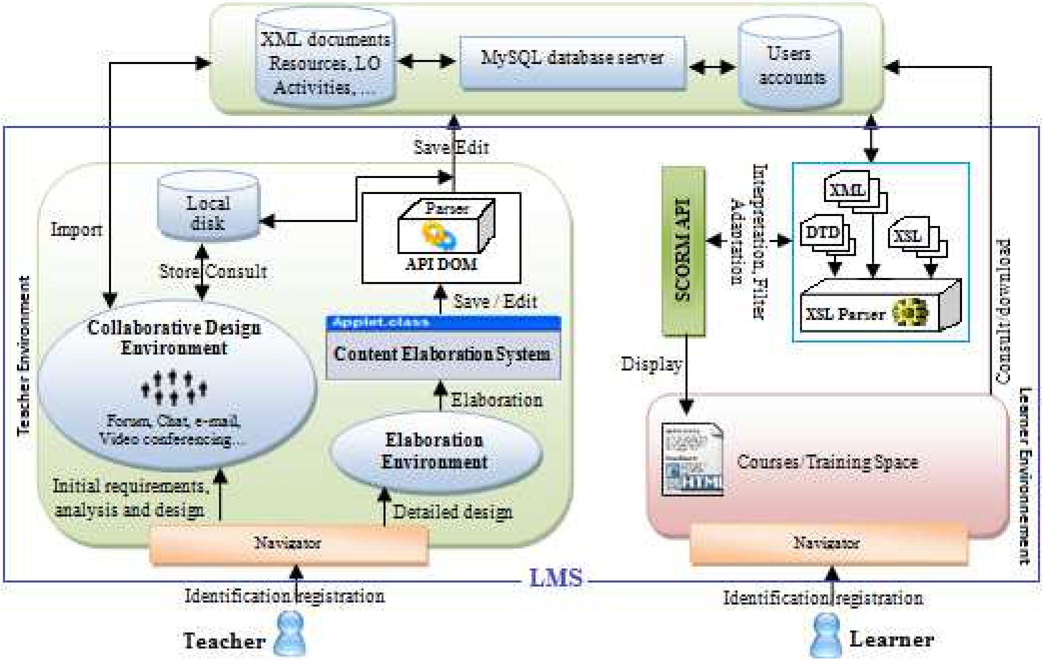


*Fig. 8. Software architecture of the prototype implemented*

This architecture, open and scalable, allows to customize and to develop the system in order to extend its basic functionalities. Many modules and extensions that allow enhancing the prototype can be downloaded and integrated freely. In what follows, the different software tools adopted in this architecture will be presented and justified.

### 7.1 Management and Integration System

MISys is implemented using an LMS because the work realized in this article is a work of learning design and not a work aimed the establishment of a new platform. Thus, following the comparative study of the main existing LMS, and view ease of use and pedagogical flexibility it brings, the choice fell on the Dokeos LMS.

MISys is therefore set up using Dokeos (version 2.1). This LMS works under Linux, Windows and Mac, according to the combination Apache (HTTP server), MySQL (database server) and PHP (development language). It incorporates a tool of Mind mapping, called Dokeos MIND, very useful in collaboration between authors.

### 7.2 Content Elaboration System

Given the functionalities that the CESys must offer, the choice of programming language is directed to Java. It is an object oriented language, portable and having a great richness of basic libraries. These qualities seem appreciable to develop the CESys in the form of a Java applet that can be integrated into MISys or any LMS.

### 7.3 Structuring and Indexation of LO

To describe the structure of LO, it was agreed to use XML. Indeed, XML is adapted for the storage and manipulation of documents representing the LO, and this through the markup syntax very suitable for the hierarchical structuring adopted. XML separates content from the presentation by using XSL and allows to standardize description of LO produced.

Thus, the LU produced includes resources, activities, roles, acts, sequences, etc, assembled in a Zip file. All of the tags related to the structure and the type of their content will be defined using the Document Type Definition (DTD) or XML Schema. The rules of display will be defined in the XSL stylesheets (eXtensible Stylesheet Language).

To index LO produced, an LOM application profile was used. The choice of this standard is justified by its implementation in most storage systems of LO [21] and its capacity to facilitate the sharing and reuse of LO. The LOM application profile chosen allows to overcome the criticisms worn on this standard (abstraction, genericity, etc.), and responds to our LO classification that aims to distinguish between pedagogical resource, didactic resource and mediatic resource.

### 7.4 Java API for XML Processing

To edit XML documents (that represent LO) from the CESys, the passage XML-Java is done using the Java DOM (Document Object Model) API. Java DOM is a standard proposed by the World Wide Web Consortium (W3C) and plays the role of interface to edit an XML document. This parser is perfectly suited to the programming of interactive applications.

Finally, in order to render available and to test the SMC-LD, the prototype implemented has been hosted on a Web server that runs under Linux (http://www.socio-foad.org/).

## 8 Experimentation

This section consists in testing the use of the proposed model in real teaching conditions in order to validate its applicability. Although SMC-LD aims to provide generic solutions to all areas of education, the experimentation conducted focuses on our field of teaching which is computer science, and concerns the design and development of learning objects for teaching the "algorithmic and programming" in scientific common core of the Moroccan secondary cycle.

This exercise of experimentation was established during the second semester of teaching in the spring 2014 and took place alternately between two phases: (1) an experimentation of the SMC-LD on the field, with a team of teachers, and (2) a practical test of contents (produced with SMC-LD) with a group of learners. In what follows, the paper presents the characteristics, the methodology and the results of the two experimentations.

### 8.1 Experimentation of SMC-LD

This first experimentation, which lasted two weeks, consists in test on field the collaborative learning design approach. Its purpose is to highlight the strengths of our approach to consolidate and its weak points to correct.

#### 8.1.1 Participants

The process of collaborative design and development of pedagogical contents is experienced with a group of five teachers of computer science coming from secondary cycle. This choice is justified by the fact that the methodology used to test the model is based on the method of Nielsen that proposes to use a small number of test users (5 participants) for lifting more than 80% of the problems of a software system [22].

During the collaborative design of pedagogical contents, teachers were completely distant from each other. The guidelines formulated indicate that the design must be done collaboratively according to the V life cycle: pass to the test, and then validate each step of design completed. The coordination between teachers is assured by ourselves since we're in charge of the administration of the design space.

#### 8.1.2 Methodology

The adopted approach is based on the analysis of empirical data coming from two types of sources: (1) a survey conducted among teachers which play the role of content designers, and (2) the observation of the behavior of these teachers in the experimentation sessions through analysis of recorded traces.

The survey is based on the technique of "usability test" of Nielsen which consists in measuring the degrees of usefulness, usability and acceptability of a software solution by end users [23]. It is conducted using a questionnaire developed from heuristics Nielson [24] and administered online. The questionnaire, submitted to teachers at the end of the experimentation, evaluates aspects related to the design of pedagogical content and to the usability of the proposed solution. It is built with a limited number of questions (12 questions). The majority of questions are multiple choice types. The items were measured using Likert scale [25] of 5 points: 1: unsatisfied, 2: neutral, 3: somewhat satisfied, 4: satisfied, 5: very satisfied.

The observation of the behavior of teachers participating in the experimentation rests in turn on capabilities of tracing offered natively by the Dokeos platform. We focused on a quantitative analysis of traces collected (number of open sessions, usage statistics for each tool, number of connections, etc.).

### 8.1.3 Results and interpretations

The experimentation conducted has given an overview of the relevance of our proposals and has highlighted new perspectives. Thus, the initial objective concerning teacher motivation has been reached. Teachers have preferred to work with this technique of collaborative design rather than traditional and individual design. They were very enthusiastic about this type of experience.

#### 8.1.3.1 Observation of teacher behavior

The access to the teachers' traces is done using the "Tracking" tool included in Dokeos. Analysis of these traces has allowed us to note that, of the five teachers of the overall population, 5 have used the platform (a utilization rate of 100%).

At the level of collaborative design environment, a very dense activity was observed. Thus, we counted a total of 113 connections with an average of 22.6 connections per teacher. The number of connections has evolved during the second week of the experimentation. So, we counted 44 connections made during the first week. The number of connections began to increase in the second week during which we identified 69 connections (Fig. 9).

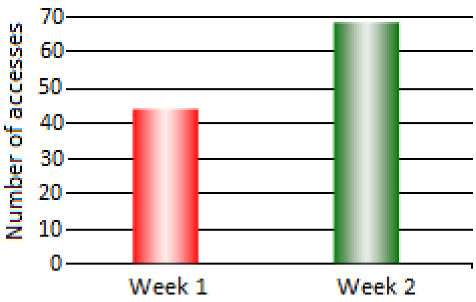


***Fig. 9. Evolution of number of connections to the platform during the experimentation***

The evolution in terms of number of connections is likely due to the fact that the second week of experimentation includes the course ends, period during which teachers are engaged in the pedagogical planning and the preparation of courses for the next quarter.

Besides the number of connections, we have analyzed the distribution of traffic of access to the tools offered by the platform. Thus, we found that teachers have mainly used the tools: "Documents" to manage files which are content resources (transmit, download, consult, etc.), "Forum" to communicate (write, view and reply to messages received), "Wiki" (write and illustrate documents into web pages collaboratively), "Learning path" (create and edit learning path), "Mindmap" (create, send and receive concept maps describing the pedagogical content). Overall statistics found are shown in Fig. 10.

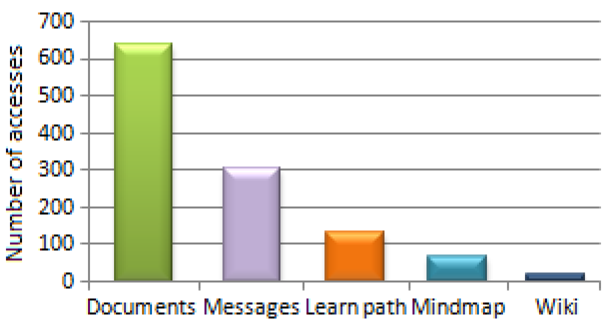


***Fig. 10. Traffic distribution of access to tools consulted***

In the distribution of Fig. 10, an extensive use of the functionalities of document management, of communication and collaboration, compared to other functionalities, is remarkable. This indicates that, in the activity of design/development of contents, teachers have frequently interacted among themselves and with the resources placed at their disposal. In the same context, trace analysis conducted shows that many inter-teacher interactions took place with the communication tool "Chat" native to Dokeos. These statistics can be explained by the fact that teachers had need the tools of communication and collaboration to help each other to understand, design and develop course's contents and resources, but also by the fact that the test period was short for effective use of some tools.

We also note that the testers have not had recourse to communication tools offered by Dokeos only, but they have used other means of communication (social networks, email, etc.). This allows us to affirm that the experimenters did not have a concern about the workspace, but working collaboratively is the main lever for improving practices in design / development of educational contents.

#### 8.1.3.2 SATISFACTION SURVEY

The first survey results obtained among teachers are encouraging and confirm our interpretation of the traces' analysis presented in the previous section. These results show that teachers have appreciated this service that has helped them to develop learning objects collaboratively.

The results obtained show that the teachers involved have never participated in this type of process of collaborative and online design/development of pedagogical contents. For this group of teachers, the proposed method represents a new approach to be tested.

Concerning teacher satisfaction toward the proposed approach, 80% of respondents have expressed their satisfaction: 40% are satisfied and the other 40% have expressed a total satisfaction. Only 20% of respondents have expressed an average satisfaction whereas no response expresses a neutral or unsatisfactory position (Fig. 11).

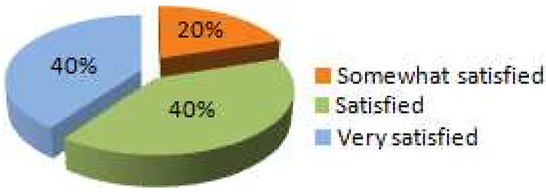


*Fig. 11. Satisfaction of teachers toward the SMC-LD approach*

The high rate of responses who express satisfaction toward SMC-LD is explained by the fact that the online team work, offered by the process of collaborative design and development of contents, has well assured the support of teachers. However, responses expressing an average satisfaction reflect the fact that teachers do have not had (or have not taken) enough time to fully engage in the experimentation.

At the level of MISys, teachers are particularly satisfied with the collaborative design space and the means of exploration of contents, thanks to the tools of communication and management available. They consider that the tools of synchronous and asynchronous communication facilitate communication among teachers (80%) and amplify the opportunities for collaboration and exchange between them, which are done rarely or are not done with the traditional means of communication. The opinions of teachers also show that the communication is done with flexibility and suppleness and that this way of working has facilitated the flow of information and updating knowledge in solving problems related to the isolation of teachers working in geographically dispersed areas (100%).

At the level of CESys, teachers have expressed their satisfaction toward the effectiveness of the tool available for achieving the tasks expected. Thus, 60% of teachers are highly satisfied with the authoring tool and the rapid handling of the window "Creation Wizard" that ensures the creation of LO. Only 20% of respondents expressed an average satisfaction toward the developed authoring tool (Fig. 12).

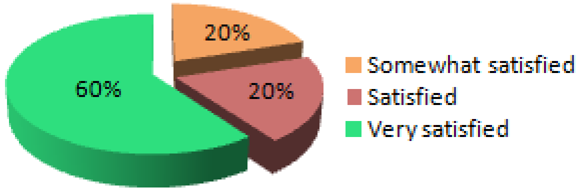


*Fig. 12. Satisfaction of teachers toward the CESys (authoring tool)*

From design point of view, the reactions are not from the same level, but 60% of teachers assume that this is a good compromise between the complexity of pedagogic functions and the richness of the interface by elements associated with these functions.

Concerning the LO produced, most of the actors is totally satisfied with the organization of activities elaborated. They consider that pedagogical contents produced are adapted to socioconstructivist context of learning, which is favored in e-learning practices.

In addition to the results presented above, the free answers to the last question comfort us, but draw our attention to some problems to solve, particularly: add more functions such as the demand to taking control of a session, realize a bank of digital resources useful for course development and productivity of contents, etc.

#### 8.1.4 CONCLUSION

The aim of this first experimentation was to examine the effectiveness of the proposed model. In this experiment, the methodology adopted is based on two techniques of data collection: a survey conducted among teachers (designers) and the observation of their behavior during the experimental sessions.

The results found show that teachers are massively satisfied with this approach. They appreciated the service that has helped them to develop digital documents such as the plans of courses, learning activities, learning situations, pedagogical scenarios, etc. On the other hand, the tracking of teachers in the collaborative design sessions shows that the tools on the platform have well amplified opportunities of communication, exchange and collaboration among teachers.

Teachers involved in this experimentation proved in practice the efficiency of the device that implements the model of collaborative design/development of pedagogical contents. All of the proposed tools can play an important role in designing quality pedagogical content, by reducing the effort, time and distance between teachers.

### 8.2 PRACTICAL TEST OF CONTENTS PRODUCED WITH SMC-LD

This second experimentation, which lasted one month, consists to test, in a real learning situation, contents (learning objects) produced according to the approach proposed by SMC-LD. It aims to measure the impact of the model on learnings.

#### 8.2.1 PARTICIPANTS

The team of learners who participated in this experimentation is composed of 36 learners of the scientific common core in the context of Moroccan secondary education. This team is divided into two groups:

- Control group: the learning situation unfolds in presential with a classroom of learners;
- Experimental group: the learning situation unfolds in presential but it is enriched by the e-learning platform.

Table 1 summarizes the characteristics of learners participating in the testing of contents produced.

*Table 1. Characteristics of learners participants in testing of produced contents*

| Elements | Modalities | Experimental group | Control group | Total |
|---|---|---|---|---|
| **Learners** | M/F | 18 | 18 | 36 |
| **Sex** | Male | 10 | 11 | 21 |
| | Female | 8 | 7 | 15 |
| **Study level** | Scientific common core | 18 | 18 | 36 |
| **Frequency of computer use** | Several times per day | 11 | 13 | 24 |
| | Once per day | 7 | 4 | 11 |
| | Several times per week | 0 | 1 | 1 |
| **Computer science prerequisites** | Yes | 15 | 13 | 28 |
| | No | 3 | 5 | 8 |

In an experimentation session, a group of nine learners were present in the classroom equipped with 9 computers. Learners had about 16 years and were more or less familiar with the use of computer science. In the two groups chosen, there was an almost even split between boys and girls because specific gender aspects must be taken into account [26].

#### 8.2.2 Methodology

To test the LO produced according to the SMC-LD model, the adopted approach is based on a very simple method of experimental class and control class that, on the basis of a comparison between the results of evaluations relating to targeted skills, allows measurement of the impact of the model on learnings. The comparison of evaluation results of the two groups allows to distinguishing possible differences, from which we will show the influence of the model on learnings. For this, we chose to address two situations:

- "presential situation": devoted to control group that received a traditional presential teaching. Each session is divided into two parts: a first part of theoretical course devoted to one or more concepts, and a second part devoted to a series of practical exercises. The teacher relies on visual support using a "data show" for better visibility, especially when it comes to examples of computer programs to run.
- "enriched presential situation": devoted to experimental group. The learning sessions are made in a hybrid way (in presential and at a distance). Each learner has had access, through his workstation, to the learning environment in which it can start a learning path. The recommendations on how to use tools (communicate, exchange, share, etc.) integrated to the platform were provided. Learning is done in socioconstructivist way through the learner-teacher and learner-learner interactions.

#### 8.2.3 Evaluation process

The evaluation process is prolonged over the entire period of contents testing. Evaluation consists to a common summative test at the end of each session for the two groups. The choice fell on "multiple choice questions". This type of evaluation measures the sum of the knowledge acquired during the session, errors are then sanctioned as weaknesses. This evaluation is sanctioned by a note that will account for the average or the successful of learning. This evaluation is based on an evolved synthesis of exercises realized at various stages of course, a principle to help to avoid simple memorizations.

#### 8.2.4 Results and interpretations

The comparison of the success rate was performed on the basis of evaluations results of two groups for all experimentation sessions. Generally, results show that, for the two groups, there is a significant difference in terms of number of learners having the average. Statistics obtained in the eight evaluations/tests are shown in Table 2.

*Table 2. Recapitulative of tests results of the two groups*

| N° Test/ Evaluation | Experimental group | | Control group | |
|---|---|---|---|---|
| | Number of learners whose average is: | | | |
| | <10 | >10 | <10 | >10 |
| **1** | 10 | 8 | 8 | 10 |
| **2** | 9 | 9 | 9 | 9 |
| **3** | 7 | 11 | 10 | 8 |
| **4** | 6 | 12 | 9 | 9 |
| **5** | 5 | 13 | 8 | 10 |
| **6** | 6 | 12 | 10 | 8 |
| **7** | 8 | 10 | 9 | 9 |
| **8** | 5 | 13 | 7 | 11 |

The data in Table 2 show that, for the group of online learners (with SMC-LD), an average of 11 learners out of 18 have obtained an average or more, which means that the success rate for this group has reached 61.11%. For group of learners in presential (without SMC-LD), an average of 9.25 out of 18 have obtained an average or more. This means that the success rate for this group has decreased to 51.39%. Fig. 13 illustrates to best the success and failure rates for the two groups.

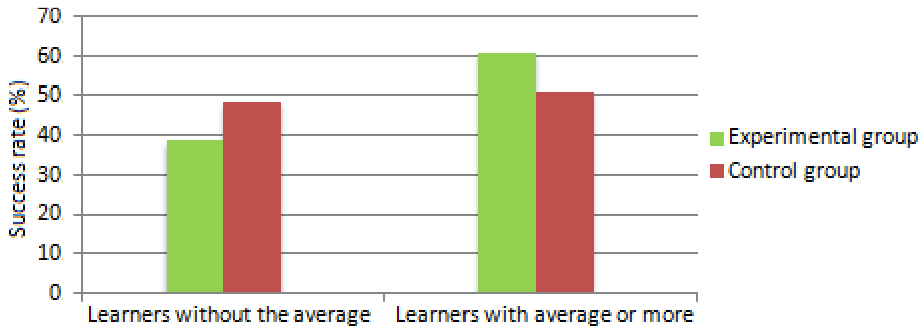


*Fig. 13. Success and failure rates for the two groups*

Test results show that there is a quantitative and qualitative difference between learners of experimental group and those in the control group. From the quantitative point of view, the use of SMC-LD model has allowed to learners, initially weaker, to enhance their implication in learning , what has led to a significant increase in success rate from 51.39% (for the control group) to 61.11% (for the experimental group).

From a qualitative point of view, we found that, in terms of skills development, the proposed educational model has contributed to the perfection of students' learnings. The model places learner at the heart of the learning process. It promotes the emergence of an interactive educational approach in which learning is built in a socioconstructivist way, through a relation of mediation of teacher with learner.

The results of this second experimentation can thus constitute a starting point to address the needs (of teachers or learners) formulated in the framework of this research work. Thus, adopting a collaborative approach in the design and development of pedagogical contents leads to the production of quality contents, adapted to the current context of e-learning which fits into socioconstructivist approach. The use of these contents in collaborative learning activities then brings important educational benefits and allows obtaining a higher success rate.

In addition to the results of evaluations carried, the possibility of access to traces of various working sessions of learners on the platform allowed us to found a very dense activity at the level of use of tools: "Chat", "Learning path" and "Quiz". This allows us to visualize also the progression, the success rate and the number of attempts for each learner.

#### 8.2.5 CONCLUSION

The aim of this second experimentation was to evaluate the pedagogical contribution of e-learning contents designed collaboratively according to the SMC-LD model. The evaluation was conducted according to an experimental study methodology, based on comparison of results of tests performed for two groups: experimental group and control group.

Based on this methodology, we have compared the performance of learners in the online environment, which offers contents designed collaboratively, with learners who followed a presential and traditional situation. The results show that the contents designed collaboratively according to SMC-LD model have provided significant pedagogical benefits at the level of learners' performance. This confirms the effectiveness of the proposed model in terms of skills development.

On the other hand, analysis of the use of collaboration and communication tools, offered by the online learning environment, also shows that these tools have been fully exploited. This confirms the hypothesis of the necessity to integrate these tools within these interfaces for increased collaboration and effective learners tracking.

## 9 GENERAL CONCLUSION AND PERSPECTIVES

This article has presented design, implementation and experimentation of a generic model adapted to collaborative design and development of e-learning pedagogical contents. The introduction of such a model seeks to assist and guide teachers in implementing pedagogical contents best suited to the current e-learning context (socioconstructivist, collaborative, etc.).

The establishment of SMC-LD is focused on two main aspects: (1) “Contents design”, where SMC-LD proposes to establish a collaborative design process of e-learning contents. (2) “Contents development”, which is confronted to the problem of the relevance of norms and standards of educational modeling. Thus, SMC-LD proposes a method for modeling LO upstream of SCORM and IMS-LD standards.

To validate its applicability, SMC-LD is implemented through a representative prototype and then experimented in real teaching conditions. The experimentation was conducted in two phases: an experimentation of SMC-LD on field, with a team of teachers, and a practical testing of contents (produced with SMC-LD) with a group of learners. The results found are satisfactory and encourage us to pursue this research. Teachers have appreciated the collaborative learning design approach. On the other hand, the model has brought significant pedagogical benefits at the performance of learners.

As a teacher, we could confirm the relevance of the SMC-LD model. In the future, experimentation of SMC-LD continues well as its development. The different returns resulting from the experimental study will be considered in order to improve efficiency of the model on the technical, ergonomic and pedagogical plan. On the other hand, in short and in medium term, deployment of our approach in other contexts of learning and other disciplines will contribute also to the validation of our generic proposals.

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