Microscopic instructional planning in the context of E-learning

Sofiane Aouag

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Sofiane Aouag
Laboratoire de Recherche sur le Langage
Université Clermont-ferrand II
4 rue ledru 63057
Clermont-ferrand Cedex I
France

aouag@lrl.univ-bpclermont.fr

Abstract: This paper central claim is that there is a need for microscopic Instructional design, which appears to mean the detailed modeling and design of specific components and adaptations for teaching specific material. It will discuss the microscopic instructional planning in the context of E-learning. So it will be concentrated in the design of the last level of E-learning system (the didactic activity). The learning activity, which is regarded as a complex object, must be seen with a microscopic approach where all its components are manifested. The pedagogical instruments constitute its primary matter where theirs molecules are the smallest collection of its components, which retains the properties of that material (according to the teaching intention). The instructional designer must do several projection for each pedagogical instrument to be realized by other actors (pedagogical and didactic model, cognitive model, knowledge objects model and interface model).

Introduction

This paper is the second in a series of articles that looks at specifying new approaches applied into the three levels of E-learning system design. The first and the second level concerned by the processes that govern the management of an e-learning system, (macroscopic and mesoscopic approaches,[1]). E-learning system need to be more focused on the last level of design, which has the higher degree of smoothness,(learning activity level). This paper will be concentrated in this last level where we applied a new approach called "microscopic approach" to design a learning system, it will attempt to demonstrate a first specification of the micro instructional engineering design. In an instructional engineering method, the knowledge engineering processes can help designers define content and objectives, instructional scenarios, instructional materials, as well as the delivery processes of a learning system. [18]. The instructional designer, must do several projections to modeling each pedagogical instruments to be realized by other actors (pedagogical and didactic model, cognitive model, knowledge objects model and interface model). If the use of the TIC brings sometimes a profit in teaching effectiveness, nevertheless it put on the brakes the innovation to go further on the technology [8]. It requires more work to build up effective infrastructure design, so to do that more effort to modeling: the devices of learning and the process implemented by student to learn are required. The questions that we hoped to raise is : why the micro design? And what is the difference between the infrastructure design and the design on the macro scale, Regardless of the learning activities tools used, once the total design, or macro and meso-design, are completed or sufficiently advanced, work can be started on the design of individual materials, pedagogical instrument. Then these materials can be produced, following the requirements of the pedagogical intention model produced at the meso-design stage. These materials will generally be integrated into the system. This paper will preliminary discuss micro-instructional design, we postulate that the design of learning device need to design a complex artifact which supports the adaptative learning, let learner bring into play its knowledge and to carry out the prescribed tasks. This paper will be articulated around the three following fundamental points: the emergence and the nature of knowledge in the activity of design, the didactic activity which is represented as a learning object composed of a list of pedagogical instruments, the nature of the pedagogical instrument and how to design it by the team of design using the microscopic approach ; Initially , the context of the project and its objectives, will be briefly described.

Context of work

The use of new learning technologies such as educational software and multi-media is increasing rapidly in the world. Our work is within the framework AMICAL[1] project, which has the support of a pluridisciplinary team of professors in primary school (experts of domain), linguist, psychologist, cognititien, data processing specialist…. It's a theoretical and development project of a multi-agents and knowledge-based computer for teaching and learning of reading. This project aims to the realization of multimedia intelligent tools likely to contribute the individualization of learning; it is related to the mother tongue (French) and addressed to children in normal schooling on their preparatory course. AMICAL[1] is composed of three types of functional modules: the resource module, the exploration module and the tutorial module. The tutorial module, must lead, in a controlled way, to the acquisition of knowledge by the student to propose session of work. The sessions are the result of a process, " didactic planning" [3], in which the system determines first an objective constructed from the knowledge it has about the student and the knowledge about the domain[4]. Then, the system determines a sequence of didactic activities with corresponds to this objective. It is to be noted that in AMICAL environment, the design of a tutoring module adheres to the current paradigm of multi-agent systems, which offer a good way to model a system to help define the actors, their functions and roles, and also their interactions as a society of agents. The microscopic approach of design is centered on the breakup of the pedagogical instrument into controllable component and micro-component. These micro-components will be specified by actors of design where each one gives one model having detailed of use of this later (pedagogical, cognitive, content to be taught, and the interface), so careful attention is waged to the partitioning process between the actors of design.

Why the micro-design ?

The question that we propose to raise is to know what is the profit attained from the infrastructures design. In light of this question, we formulate the definition of instructional engineering as it is specified in [18]. So instructional engineering is what designers do as they build and maintain global learning systems that focus on engaging learners in two main processes:

1. Knowledge extraction, the process of transforming the knowledge of an expert in a given field into structured information, which is sub-sequently made available to the whole organization
2. Knowledge dissemination, the process of transforming information into knowledge that is internalized by the learner as new competencies, typically ones useful to the learner's organization.

Micro instructional design is concerned by the learning activity, which is represented as a whole of pedagogical instruments. Thus a microscopic approach of design is based on the principles of projection applied at the pedagogical instrument which is considered as the key of E-learning design. The projection means that the designer explicit the differences features of the pedagogical materials (all models able to represent the various aspects of the pedagogical instrument). (Kota S. & Ward in [11]) has defined three types of design, which are commonly accepted: *creative* designs, *innovative* and *routine* design. Our proposition is focused in a hybrid case between the two last, today, it seems necessary to renew the instructional design methodology to support the creation of reused artificial object for learning systems in order to operationalize the theoretical foundation. The case of applicability is resolutely innovating design and it has routine nature. In this article, we consider that the design of the learning system is to specify a complex artifact which supports the training, allows learner to carry out the prescribed tasks corresponding to the pedagogical intensions, and, finally, compensates for the difficulties which implied by autonomy. The problem of E-learning design is that knowledge has different kinds and touched very wide fields: cognition, Linguistics, Psychological... Only one person cannot have this precise knowledge in all domains. Especially he cannot control all the processes implemented by learner to acquire knowledge according to its favorites (its learning style). When learner starts learning, he implements certain cognitive processes, some of these processes are known today [5,11,12,13]. In view of the fact that each learner has a cognitive structure which depends on his experiments and his capacities, each one should have a particular mode of access and of interaction with knowledge. An interesting solution is

[1] Architecture Multi-agents Interactive Compagnon pour l'Apprentissage de la Lecture (an interactive learning-to-read environment with a multi-agent architecture

to create more elaborate models for learning taking into account all aspect of acquisition of knowledge by the learner. These models will concern the pedagogical instruments constituting learning object; such a system can be described in terms of four models: a knowledge object model describing the contents; a pedagogical and didactic model defining the proprieties of the pedagogical instrument, in the form of pedagogical intention necessary to the progressiveness of learners knowledge; a cognitive model establishing the design of process to be used by learner to bring into play it's knowledge for each material used (it's cognitive structures) and target competencies, regardless of its format; and finally, a delivery model describing the interface of each pedagogical instrument. The realization of this models need to share pluridisciplinary knowledge between the various actors of design to arrive at the specification of the pedagogical instrument.

Various actors of the process of design:

Competences needed to have an overall glance as well as near to the technological realization too vast and are varied to be held by only one person, the designer. The main role of the team is to Allow a progression of learner's knowledge according to its favorites, identification of knowledge used indeed by learner: how to manage to activate certain learner strategy and the translation of the collected results in terms of effectiveness of the techniques used. The stake is in the distribution and collaboration consequently the teamwork is required. The various actors who make the team of design are as follows:

- **The instructional designer:** He defines the general characteristics of the pedagogical instrument; his role is to specify the shells for the other specialists to integrate the various standard specifications.
- **The specialist Linguist** (various sub-field: semantics, psycholinguist,..): The specialist linguist fixes the specifications of each knowledge object and it's micro-component within his field of expertise.
- **The expert of domain:** is the teacher who is in contacts with reality (children) they fix the limits of acceptance of tests. They return to the team of design as well critical report, which contain a lot of rejections.
- **The cogniticien:** There is thus much communication between different actors of design, the cogniticien and the expert of domain even if this one in certain cases could take care itself of the final specifications. Its role is to identify the individual knowledge, strategies implemented by learner and the various stimulus according to its learning style envisaged.
- **The ergonomist:** The role of ergonomics in the project is to design the pedagogical instrument as being support of knowledge and as interface tool. This articulation should allow: a better comprehension of the effects of object knowledge to be taught and other type of knowledge used by learner (logic use of the interface…) , for this reason, "knowledge effectively used must be specified by including facts or learner's behavior which could be characterized by other models.

finally does the Ontological Engineer exist? And is he a manager of knowledge projects? In all the cases he must has a high technicality in order to be able to dialogue with all actors of design. In reality, where we located ourselves still much in the research, many actors of the process of design can take several caps.

Learning activity is represented as whole of pedagogical instruments :

Current research in the field of teaching engineering [18,19,20,23] aims at concentrating on the learner's activity and hopes to be based on the scenario of training and to put it at the research center [9,10,20]. We propose a new formalism for didactic activity representation by using the approach "learning object" which is currently the subject of many work aiming to the standardization of their indexing[9,15,16,23]. Their goal has been to define open technical standards for computer supported learning environments and education products. The most important initiative of standardization are the Instructional Management Systems Project (IMS)[1], the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE)[2], the Advanced Distributed Learning Initiative (ADL)[3] and (IEEE LTSC)[4]. Learning objects are elements of a new type of

[1] http://www.imsproject.org
[2] http://www.ariadne-eu.org
[3] http://www.adlnet.org
[4] http://www.ieee.org

computer-based instruction grounded in the object-oriented paradigm of computer science. So the learning object is characterized, first of all, by knowledge bring into play for learning. Reusability, adaptation, and composition mechanisms are ,therefore, employed to structure knowledge contents. In our case, this knowledge is represented in the form of entity < action, knowledge unit > or <Action; statute-of-learner's-knowledge; knowledge unit> such a knowledge units is regarded as parameters of individualization of the contents of didactic activity type (figure1) . This latter represents the property part of a learning object, it represent the contents no instantiated yet. We consider in this paper that the individualization of the learning activity is interpreted by the scenarisation of the learning object.

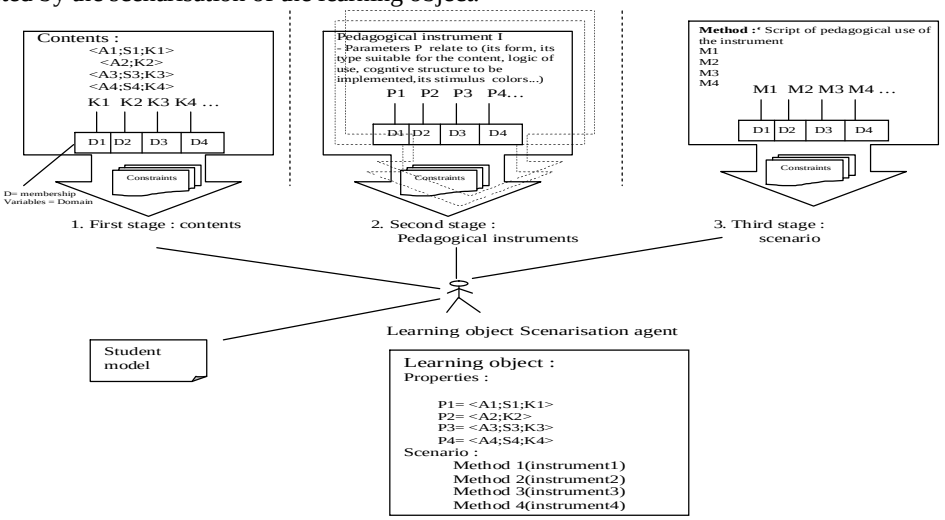

Figure 1 *Three stages for scenarisation of Learning Object*

In our point of view the learning activity scenario will be specified by dynamic process that can be called the scenarisation of learning object. So the scenarisation of learning object reveals the various aspects of learning activity : - it's contents which represent the primary teaching matter, - its interface which is represented in the form of a whole pedagogical instruments constituting the teaching equipment and finally - the scenario of use of each teaching instrument. The scenarisation is done by the learning object scenarisation agent. It uses its base of knowledge built dynamically starting from the agents of the environment and the knowledge defined on the contents for scenarisation of each pedagogical instrument (find all suitable methods constituting the scenario of unfolding) It uses its base of knowledge built dynamically starting from the agents of the environment and the knowledge defined on the contents for scenarisation of each pedagogical instrument (find all suitable methods constituting the scenario of unfolding). (Figure1)

Pedagogical instrument is the key of E-learning design

The pedagogical instrument is a complex artificial object that must undertake the design and the evaluation as a didactic artefact suited to bring into play the learner's knowledge. We propose in this article a new point of view which is dissociated from a new current which will be centred on the pedagogical instrument, so we announce that the pedagogical instruments which will constituting the key of E-learning design. Rob Koper of Open University of the Netherlands proposes a point of view which dissociates the current centred on the resources affirming that the learning activities which represent the key of E-learning design and not the knowledge objects. He proposes to describe the learning activity using a first version of the language EML, Educational Modelling Language. The specification IMS Learning Design [9], largely inspired by Rob Koper prposition, concentrates today the main part of the research tasks in the E-learning design. IMS LD provides a modeling conceptual framework in which the scenario of the unit of training rests on a theatrical metaphor. A *unit of learning* is an abstract term used to refer to any delimited piece of education or training, such as a course, a module, a lesson, etc. It can be modeled as an IMS Content Package [9] where the organization part is replaced by an IMS Learning Design. In our point of view the learning activity scenario will be specified by dynamic process (figure1) that can be called the scenarisation of learning object

Pedagogical instrument as a didactic artefact:

The didactic characteristic of the pedagogical instrument are related to teaching intentions calculated in precedence levels. Pedagogical knowledge concerns all didactic knowledge, which are not dependent of the reading domain. The pedagogical characteristic of the instrument concern the pedagogical material aspect of the instrument, so it holds the information about the didactic usage and quality of the entities belonging to the other domains. Its elements are entities which include a reference to objective unites which have a number of didactic attributes to those entities. There are two kinds of didactic entities, related to either the conceptual or the instructional entities. each entity have a priority depending whether it's importance (a measure of the importance of the entity, as a part of the learning process, to the student).

Micro-components of knowledge object:

Merrill and his colleagues in the ID2 Research Group proposed a knowledge representation scheme consisting of knowledge components arranged into knowledge objects [13,14,15,16]. This knowledge object framework is the same for a wide variety of different topics within a subject matter domain, or for knowledge in different subject matter domains. knowledge object of “learning to read domain” are letters, words, sentences and texts; the micro-component of a knowledge object sentences are the components of words (letters). It would be necessary to characterize the differences between knowledge object as entity and its proprieties, for example: The knowledge objects sentences have 2 types of knowledge:

- Knowledge associated with properties of the object “sentence” as theoretical space (example: "The association between written/spoken sentences”: association grapheme/phoneme, the noun indicates letters, the grapheme representing the word, Structure of word, the correspondence written/spoken words), So it’s highlighted systematically each time that a written sentences, texts is spoken.
- Knowledge associated with an entity as a unit of sense, which need to put into practice knowledge of learner to reason about the object itself (conceptual representation of the sentences)

The text is the most complex knowledge object related to learning to read domain, it acts of a complex work to realize by the learner during the reading of the text. Learning made as a syntactic analysis from sequences of identified words. Development of the proposals and their significance Combination and integration of the proposals starting from various indices (morphological, morpho-syntactic and pragmatic)
The statute of knowledge for learning, could be regarded as a combination of other statute of knowledge at the same time as it can be elementary; this statute would be given according to the various statutes of different micro-component from the knowledge objects.

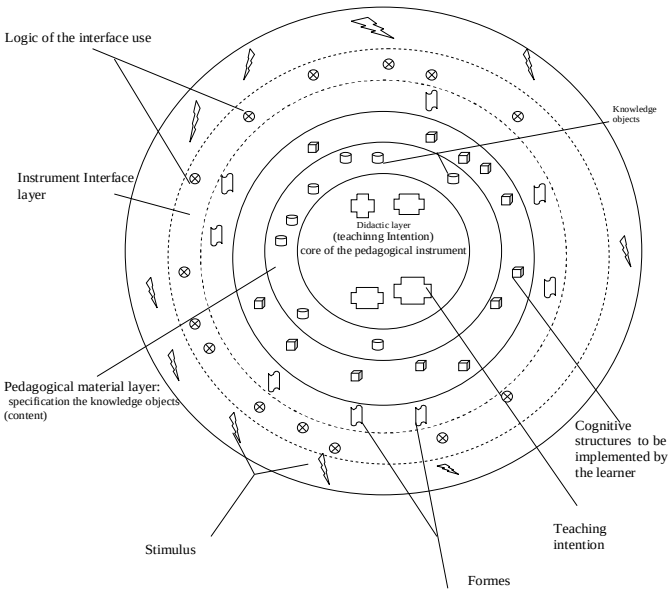

Figure 2. Pedagogical instrument structure

Pedagogical instrument and cognitive structures:

Cognitive psychologists have proposed a diversity of theories of how knowledge is represented in memory [12]. Schema theory postulates that learners represent knowledge in memory as some form of cognitive structure. A knowledge structure has a form of a schema representing the information that is required by a learner to be able to solve complex problems. If the required information (knowledge components) and the relationships among these knowledge components are incomplete, then the learner will not be able to efficiently and effectively solve problems requiring this knowledge[15]. So solving a problem requires the learner to not only have the appropriate knowledge representation (schema or knowledge structure) but he or she must also have algorithms or heuristics for manipulating these knowledge components in order to solve problems [14]. The process of activation of a cognitive process for learner could be defined as a complex knowledge based on the other knowledge to acquire and the cognitive structure implemented at the time of learning. The use of this schema require a high level of treatment by learner: **: to understand, to predect, to reason, to judge, to interpret, to criticize, to determine** the main idea, **to summarize, to re-read** and self-monitoring, **to make** connections between their reading and what they already know, and **to identify** what they need to know about a topic before reading about it; prefixes, and suffixes of words for comprehension; and **to use** information from their reading to increase vocabulary and enhance language usage [7]. All this knowledge must appear in the **cognitive model** specified by the congnitien. So the pedagogical instrument is designed to be able to Conduit of the strategies (metacognition within the constructivism approach). An example of this conduit is to let the learner to identify word by Syntactic analysis of sequences of identified words (simple and no ambiguous syntactic structures); Development of the syntactic structure of the various components by the use of the contextual and semantic resources starting from various indices (morphological, morpho-syntactic, sets of themes and pragmatic) and finely Establishment of coherence between the proposals inference starting from the knowledge bases stored in memory.

Pedagogical instrument and the scenario of use:

The interface model of the instrument describes its shape and different way of its use, which can be described as methods in the paradigm object-oriented where the pedagogical instrument is an object and the predefined methods for this object can be regarded as possible scenarios for its use. The use of the instrument is interpreted by a logic implemented by learner to arrive at the familiarisation with the instrument. This process is called instrumentation of the learner (in the sense of Rabardel [21]).

Pedagogical instrument surrounded by different types of stimulus::

Barbe, Swassing & Milone (1979, 1988) [2] have developed the *Swassing-Barbe Perceptual Modality Instrument to* identify different learning styles visual, auditory and Kinesthetic. It is significant to understand the basic underpinnings of how individuals learn and retain knowledge. We learn using a combination of Visual Stimuli, Auditory Stimuli, Kinesthetic Stimuli.

Instrument	**Pedagogical intention**	**Knowledge object**	**Cogntive structure**	**Formes**	**scenario of use (logic of use for learner)**	**Stimulus**
Text-field	Let learner implement process to activate the strategy « comparison-discrimination »	Word :instance Text :new	Use logic of reading : left to right apply logic of corresponding : spoken word/ written word ; spoken sentence/written sentences Learner Ability to reason in this text starting from its knowledge.	Form text-field (description of its interface)	Text-Field (follow the reader)	**Visual ;**
Multiple-choice	Verify the memorisation of knowledge object.	Representation of the relationship between each proposal sentences and its related sentences in the text	Make use of Logic of the use of the interface ; Make use of prerequired knowledge Inferring about sense to determine the main idea	QMC	Reading the proposals sentences and using memory to answer.	Auditotry and visual

Word in list	Let learner develope the ability to recognise the **logo graphe of words**	Word : instance	Utilize strategies : the **logo-graphe** Using memory to recognize the word	Word in list	The Image of word to be recognised in the list of rwords	Visual

Figure 3. Some examples of pedagogical instruments

The visual style is caracterised by the more effectivenesse fore learner's memory by using the vision, the auditory style is related to auditory and the Kinesthetic style concerned by all what we touché (in learning to read domaine that stimuli concerned by pronunciation). The originality of this model is to rather measure the styles starting from the relationship between scores of performance to tests of memorizing than starting from perceptions of learner from its behavior. This stylistic dimension is also present in the mixed models of Hill (Nunney and Hill, 1972) [17] So the pedagogical instrument is the tool that activate this stimuli and allow the learner to make the most to utilize its capacities to understand and to learn.

Conclusion :

We have tried to take retreat to prepare a new form of practice of research in E-learning design to put into practice the different models that we refer. The goal that we are fixed is to arrive at the first specification of the microscopic approach of E-learning design. This specification aim at the micro pedagogical technology which need a various types of competencies, the structure of the team of design poses problems of communication for the cooperation between researchers having different approaches, but wanting to collaborate, for that, it is necessary to clarify and argue, for each partner, the practical aspect of the specified model and the bonds of the latter with all the component of the system. The activity of design is all the way through the actors, the constraints, the standards required to describe the tools allowing the integration of the ITC (Information and Communication technology), for that we have been concentrate in the formalization of the pedagogical instruments and all the hierarchy of it's components including its knowledge object to be taught. It is probable that for the moment, all our respective waiting are not realised yet, even if for us such a bet can let the E-learning community more advance, while making it possible to better describe the elements which contribute effectively to implement the process of individualization of the learning, which is in the heart of our practices of research. So today the microscope used to visualise all the component of the learning activity is not capable to show unknown elements yet, hence more research in various domains is required to arrive at higher technology able to illustrate all micro-components of the key of E-learning design, the pedagogical instrument.

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