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# DESIGNING LEARNING ACTIVITY TO BE INDIVIDUALIZED

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**Keywords:** Learning activity design, learning object, multimodeling, activity theory, individualized learning, learning to read, Agent.

**Abstract:** The modelling of the learning individualization process is a complex problem which needs multidisciplinary knowledge. The variety of decision problems and of complex domain will never be just one method of model-based decision support. For that making rational decision should be distributed in different levels using various types of knowledge and models. The multi-modelling of the learning activity imply specifying for models of each activity: The didactic model, the knowledge object model, the interface model and the cognitive model given by the actors of design. We propose in this paper a new current of learning activity design based on activity theory where the design of the learning activity means the specification of its specific teaching materials called pedagogical instruments, this material has the mediation role between the learner and the objects presented in the activity.

## 1 INTRODUCTION

Current research in teaching engineering (Paquette G. 2004), (Wiley, David A. 2002) aims at concentrating on the learner's activity and making the learner on the research center. We propose a new formalism for didactic activity representation by using the approach "learning object" which is currently the subject of many works aiming to the standardization of their indexing. 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), the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE), the Advanced Distributed Learning Initiative (ADL) and (IEEE LTSC). Learning objects are elements of a new type of 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, these knowledge are represented in the form of entities < 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). These latter represent the property parts of a learning objects, they 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. We postulate in this paper that the design of the learning activity means the specification of its specific teaching materials called pedagogical instruments; these materials have the mediation roles between the learner and the objects presented in the activity. This paper contains in first the theoretical or conceptual foundations for our work, which is fall under what is called activity theory. In the second part we develop the idea based on the multimodelling approach of the learning activity where we announce that the design of the learning activity need to specify for models: didactic model, knowledge object model, interface model and the cognitive model. Each model comprises the sub models of the pedagogical instruments constituting the learning activity. Initially, the context of the project and its objectives will be briefly described.

## 2 CONTEXT OF WORK

Our work is within the framework AMICAL project (*an interactive learning-to-read environment*

with a multi-agent architecture), which has the support of a pluridisciplinary team of professor 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 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" (Cherkaoui, C. & al. 1997), in which the system determines first an objective constructed from the knowledge it has about the student and the knowledge about the domain (Cleder C. 2002). Then, the system determines a sequence of didactic activities with correspond 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 multimodelling of learning activity 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).

### 3 BASIC PRINCIPLES OF THE FRAMWORK METHODOLOGY

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 dissociated from a new current centred on the pedagogical instrument. The basic theory of this proposition is the activity theory. The originality of the mediation concept is the Activity theory, which reflects that human action is mediated by tools and signs (John-Steiner & Mahn, 1996). This process is depicted in figure 1. The main

problem is to know how learners conduct activity in computer mediated learning environment and how they interact with content using mediating artefact (pedagogical instrument). All the higher psychological processes are mediated through a tool. One of the most important psychological tools is language, which serves as the "prime device for rendering the world intelligible and for communicating our intentions to others" (Säljö, 1996). So the design of the nature of this mediation means the specification of the nature of this mediation by the design of different layers (didactic, cognitive, knowledge objects and interface) layers. (Aouag.s ,2006)

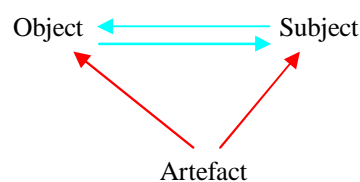


Figure1: Vygotsky's mediating triangle (Vygotsky, 1978)

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, largely inspired by Rob Koper proposition, concentrates today the main part of the research tasks in the E-learning design. IMS LD provides a modelling 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 modelled as an IMS Content Package [IMS] 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 that can be called the scenarisation of learning object. This later is characterized, first of all, by knowledge bring into play for learning. Reusability, adaptation, and composition mechanisms are ,therefore, employed to structure knowledge contents. 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 learner's activity. The instantiation of this parameter represents the first stage for the scenarisation of the learning object. Our proposal lies in the use of the rational agent, which individualizes its parameters according to the student model while being based on rules (didactic, pedagogic and linguistic). The learning activity is represented as learning object, so, it is possible, to reproduce at the same time complex models that one call "scenario of training" for a learning Object, using a significant number of types of declarative knowledge represented in the form of "properties", of procedural knowledge represented in the form of "methods". These methods are regarded as scripts describing the way of use of each pedagogical instrument. The scenarisation is done by the learning object scenarisation agent in three stage (the instantiate the content, find list of the instrument to be used and specify the scenario of each pedagogical instrument)(figure ). It uses its knowledge bases 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).

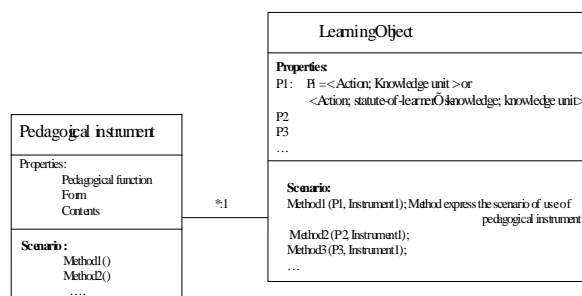


Figure2: Learning object meta model according to the UML Class diagrams formalism

## 4 MULTIMODELING OF THE LEARNING ACTIVITY

The multi-modelling of the learning activity means specifying for model of each activity : The didactic model, the knowledge object model, the interface model and the cognitive model detailed by the actors of design. We consider that the learning activity is a set of pedagogical instrument which has the mediation role between the learner and the knowledge object. So the main idea of this papers is that the learning activity design means the detailed submodels of each pedagogical instrument. The

design of the pedagogical instrument needs to design a complex artefact which supports the adaptive learning, let learner brings into play its knowledge and to carry out the prescribed tasks.

### 4.1 Pedagogical model

The entities manipulated in the pedagogical model have progressive degree of smoothness (macro, meso and micro scale (Aouag S,2005); the entities presented in macro scale are the objective units, in the meso scale we use in our project the didactic situation type which is corresponding to a type of didactic situation. The entities represented in the micro scale are the elements of the individualization of the instantiated didactic situation which is considered as multimedia learning object. The elements of individualization are all variables, which can be used to individualize multimedia learning object starting from the parameters and constraints of individualization: "choice of the topic of the text, choice of the worked words, limitation or not of time, numbers trying, help (natural, a number and moment of the use of the help)". These are incorporated in the models specifying the learning activity. The entities manipulated in this model calculated in the precedence level, these entities are the objective units represented in the form of couples of information: <action; knowledge unit>; or triplets : <action; statute of learner's knowledge; knowledge unit>. The objective units represent the properties part of the knowledge object (Figure 2) For example, we will be able to have the couple < Make acquire; sentence limits> or, < verify; Known; word >.The instantiated parameters of the contents means to instantiate Words. This couples and triplets are reported directly to the evolution of the state of learner's knowledge of reading, but with the assumption that this one is done in correlation with the different pedagogical factors and policy used respecting one learning theory (constructivist). Theses entities are represented under a particular format containing warp details of learning knowledge on various objects of reading (Letter, word, text). The constraints of individualization are calculated starting from knowledge and theirs statutes represented in the student model. Each knowledge has possible statute in the student's model: known, un-known, recognized and possible context where the student has been construct this statute or modified its value. Constraints associated to each value of the variable has the forme of conditional knowledge, which represent the agent's

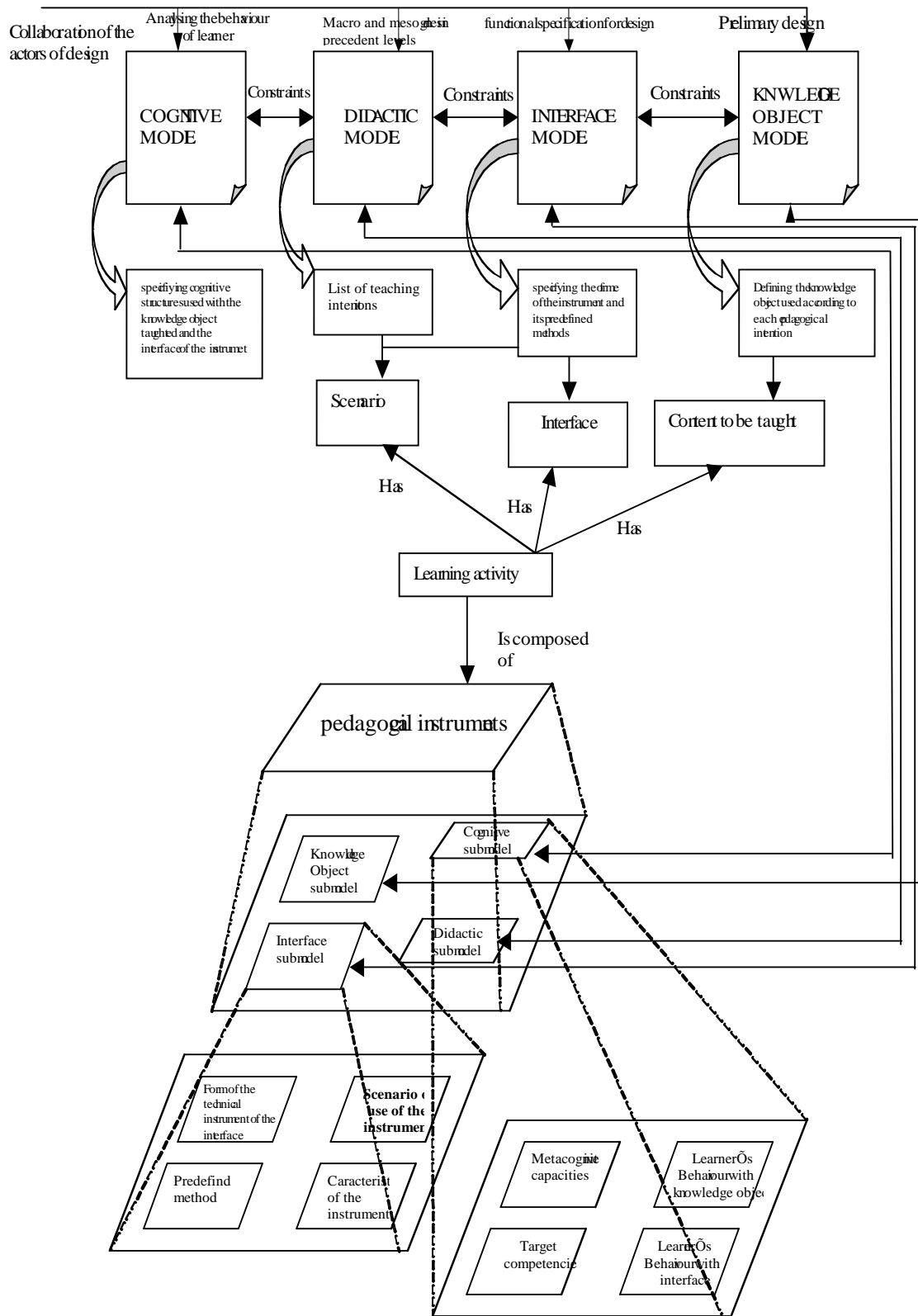


Figure3: Multimodeling of the learning activity

belief about the student's knowledge of the corresponding context. For example if the student has recognized the Word in three different contexts and he has not recognized it in tow other, the agent assign the value (3/5) as believe about its knowledge. Our proposal in this paper concern the use of all this element to be modelled and represented by a pedagogical model. Therefore the pedagogical model is defined as to provide to our system the possibility to adapt pedagogical behaviour to a specific student. In this optic, the choice of pedagogical actions will be more adaptive. Due to the number of input variable and pedagogical rules. We distiguish between two kinds of models (general pedagogical model of the system and sub-model associated to each pedagogical instrument figure 2).

## 4.2 Knowledge Object model

Merrill and his colleagues in the ID2 Research Group proposed a knowledge representation scheme consisting of knowledge components arranged into knowledge objects (Merrill, M. D. & ID2 Research Team 1993), (Merrill, M. D. 1987), (Merrill .D 2000). 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 be realized by the learner during the reading process. 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)

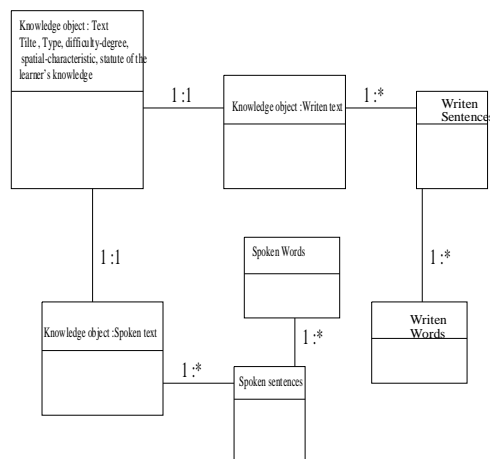


Figure4: UML Class diagram of the knowledge object text

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. The knowledge object model is represented also by network of concepts like Spoken text ; written text , written-word, spoken word, written-sentences, spoken sentences, Tilte , Type, difficulty-degree, spatial-characteristic; and edge which represent links: is composed of, component of, corresponding to, structured-as, type of, is characterized by.

## 4.3 Interface Model

The interface model contains the description of the interface of the pedagogical instruments which constitute the didactic activity : Colors, Policies of text , Screen organisation , Scenario of use of each instrument. The interfacing of the didactic activity relates to the adaptation of its interface to learner. It is a question of specifying the pedagogical instruments to be used for turning on actions of the system illustrated in the properties of the learning object (figure 1). The determination of the pedagogical instrument is based on the knowledge first collected from the student model and those illustrated in the properties of learning object(its contents). An example of a pedagogical instrument is " the field of the text" that one regards as a support of these contents associated to its

scenario of use. The pedagogical instrument is characterized by four criteria:

- Pedagogical Function: it can answer a pedagogical intention represented as: < action, knowledge unit > or <Action; statute-of-learner's-knowledge; knowledge unit>.
- Scenario of use: the life cycle, number of tests and imposed or proposal help...
- Form: the shape of the instrument (Button defines; Fields of text; Word; letter, an image), colors, dimensions space...
- Contents: (the text, the word, the contents of button...)

We distinguish between the model of use of the interface which is sub-model of cognitive model and the interface model. The model of use of the interface can be considered as a set of function, it allows communication and finalizes the form by which the system wants to transmit information. This model is in co-operation with the pedagogical, cognitive, knowledge object model of the system. It transforms the internal representation of the system into comprehensible information for the learner. This model can transmit the same knowledge more or less clearly. Indeed, even if the pedagogical model decides pedagogical function and contents, the interface model deals with suitable pedagogical instrument to be used to propose the final form to the learner taking into account its learning style and its preferences. The most popular technologies are *Hiding* for adaptive navigation support. The idea of navigation support by hiding is to restrict the navigation space by hiding links to irrelevant pages (Brusilovsky, P. and Pesin, L. (1994)) or if it presents materials which the user is not yet prepared to understand. For example if we can detect starting from the behavior of the learner that he has impulsive character (we must hid the Next button until the finish of the tasks proposed by the system) the other type of learner can be called reflexive learner according to research about variables of psychological variables of the functionality of human mind Del Soldato, T., & du Boulay, B. (1995). Dunn, Rita, Dunn, Kenneth, Price, Garry E. (1979). Barbe, Swassing & Milone (1979) 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. The visual style is characterised by the more effectiveness fore learner's memory by using the vision, the auditory style is related to auditory and the Kinesthetic style

concerned by all what we touche (in learning to read domain 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 behaviour. This stylistic dimension is also presented in the mixed models of Hill (Nunney and Hill, 1972)

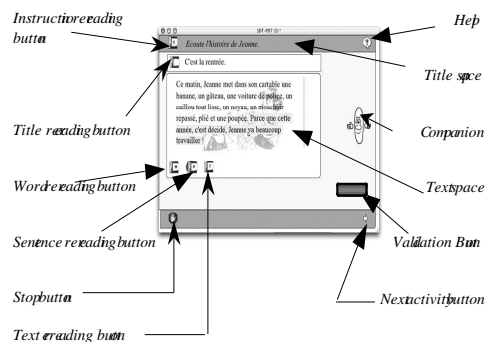


Figure5: The set of technical instruments of the interface

So the pedagogical instrument is the tool that activate this stimuli and allow the learner to do its most to utilize its capacities to understand and to learn. . Thus elements of the individualization are considered as variables of the specification of the instrument (The button next which is considered in our case as the instrument tools used by the agent). Others types of parameters can be used to individualize the scenario of use of the instrument. The different ways of the use of the instrument can be considered as methods through the paradigm object-oriented. For example if we have the text field in the didactic situation (presentation of the text). The different ways of presentation of this latter can be considered as the possible scenarios to be presented to the learner (reading-Word-byword; sentence by sentences global reading of the text).

#### 4.4 Cognitive model

Cognitive psychologists have proposed a diversity of theories of how knowledge is represented in memory Wiley, David A. (2002):. 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 Merrill .D (2000). 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 Wiley, David A. (2002). 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 predict, 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 (Fry and all, 1993).

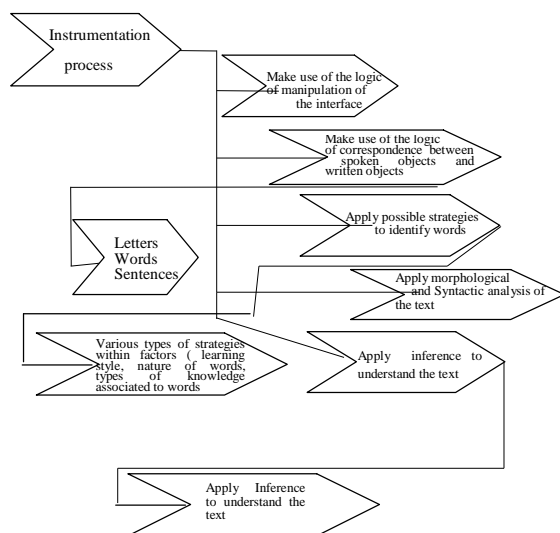


Figure6: General graph of event process implemented by learner (ARIS formalism)

All these knowledge must appear in the **cognitive model** specified by the cognition. So the pedagogical instrument is designed to be able to conduit of the learner’s strategies (metacognition within the constructivism approach). An example of this conduit is to let the learner identifying word by using syntactic analysis of sequences of words to be identified ( without ambiguous syntactic structures);

the second stage is to let him/her acquires the development of the syntactic structure of the various components starting from various indices (morphological, morpho-syntactic, sets of themes and pragmatic) and finely is to establish the coherence between the proposals inference starting from its knowledge bases stored in memory. This approach is concerned with building cognitive models of the user based on the view that people, just like computers, are some sort of information processing device. The cognitive model contain all process that used by learner to manipulate the interface and to learn for example : Use logic of reading : (left to right ; high-low), apply logic of corresponding : (spoken word/ written word , spoken sentence/written sentences), make use of Logic of the use of the interface, make use of pre-required knowledge, apply inference to understand the text, utilize strategies, Bring into play emotional situation. More generally, this model takes care of communications between the student and the system remainder. We have find the most model which can represent the process implemented by learner is “General graphe of event process implemented by learner (ARIS formalism ) Figure 4“ in which, we consider that the learner mind has a great number of process with interaction like a machine, so ARIS (analysis representation information system) IDS Sheer Academy (2001) formalism can be used to represent all process to be used; more research in cognitive psychology are required to complete this model (process of human mind); the process which we have represented is considered as instrumentation process (one of the process which can be implemented by learner). In reality the use of the instrument is interpreted by a logic implemented by learner for familiarizing with it. This process is called instrumentation of the learner (in the sense of Rabardel Rabardel, P 1995.)

## 5 CONCLUSION AND PERSPECTIVES

Research challenges for managing the complexity of future E-learning system claim are not in the development or use of any one type of model. Instead, research is urgently needed in the multimodeling area. All components of the systems and solutions rely on multiple models for their design and operation. Successful complexity management, however, requires that all modeling



activities be viewed within a multi formalism perspective. Some of the important research issues that stand in the way of practical multimodeling for complex systems have not been satisfactorily solved even for unitary models. The challenge posed by these issues cannot be underestimated, but there are hopeful signs, most notably the difficulty of the domain related to the individualization of learning. In fact, the history of progress in technology is also the history of progress in active multimodels. The earliest model-based decision systems incorporated unitary models; today's systems are able to control aircraft, refineries, paper mills, commercial buildings, and innumerable other engineering systems by employing several models (Murray-Smith, R. and Johansen, T.A.1997). For that we have found that the design of the learning activity need to be more focused on different fields. Nevertheless, the multi modelling method requires more design by the team-work to find all the elements of individualization.

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