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Dynamic process based on multi- creteria Constraints to personalize multimedia-learning objects

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***Abstract**: Individualized learning is the most important process that need to use individualization constraints to ensure adaptive systems able to support flexible solutions dynamically adapt content as well as interface and the scenario of multimedia learning object to fit pedagogical intentions. Therefore, this various aspect of multimedia learning object have to be supported in a highly personalized manner by the system. Though, tracking and grasping the user behavior remains the most challenging task to retrieve an appropriate teaching plan (sequence of learning activities), which represent in own project the propriety parts of learning objects. This paper will discuss one technique used to personalize learning object based on preferences approach using multicreteria constraints starting from its parameters of contents (propriety part), of its interface which is considered as a set of pedagogical instruments and its scenario of unfolding using the knowledge represented in the student model.*

Key words : Individualized learning, pedagogical instrument, learning activity, learning object.

1. INTRODUCTION

The individualization of learning is situated at the heart of our research framework proceeding in AMICAL[1] project. This project aims at the realization of intelligent tools media likely involve individualization contribution for teaching reading. It concerns a particular training that to learn how to read mother tongue (French) with children in normal schooling at the beginning of there training. AMICAL is composed of three types of functional modules: the resource module, the exploration module and the tutorial module. Our research sticks on this last module, which has a multi-agents architecture, so we wish to integrate agents, which ensure an individual didactic planning by specifying theirs interventions in various levels of individualization. The tutorial module, must lead, in a controlled way, to the acquisition of knowledge by the student. It aims at proposing the student to realize learning sessions of reading, dynamically elaborated and adapted to a particular student at a specific moment of his learning. The sessions are the result of a process, " didactic planning"[5], in which the system determines first an objective constructed from the knowledge it has about the student and the knowledge about the domain. This objective corresponds to a reading lesson in class. This session represents a quite short theoretical time with the student. Then, the system determines a sequence of didactic activities with corresponds to this objective. A sequence of didactic activities represents a whole combination of activities, which are proposed by the system to the student for a particular objective. so the individualization process is situated in

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

three levels : - objective level; the sequence of learning activity types to achieve this objective and the learning activity level. So our proposition in this paper concern in first the three types of individualization constraints starting by the tactic constraints which are related to the objective of working session, the strategic constraints used to calculate the teaching plan, and the operational constraints used in the third level and discuss the importance of the representation of learning activity in the forme of learning object. Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science [11,13,19,22]. We use this latter to represent the learning activity, which is considered as an entity complex multi-faces [4]. We note here that each of these facets refers to many fields of fundamental theoretical research and that the problems arising in each facet have not yet found definitive solutions.(F1) In relation to didactic planning, a didactic situation is a unit of action that the tutoring system has at its disposal in order to achieve the goal of a didactic session. This facet refers to the characterization of the knowledge defining this unit of action and to the research at the present time on the theory of action in AI.(F2) In relation to the student, a didactic situation is a complex problem to be solved. (F3) In relation to the student and to the tutoring system, a didactic situation is a space for interaction between the student and the tutoring module. (F4) In relation to the student and to the tutorial system, a didactic situation is a space for observation of the student whose qualitative interpretation will lead to the update of the student representations. (F5) In relation to the tutorial system, a didactic situation is a knowledge structure taken into account in the decision making process of the tutorial system. These elements are therefore necessary for really individualized student-centred learning to actually take place. So the didactic situation will be considered in this paper as a unit of action (it corresponds to the smallest one and at the same time to the isolable and the significant action which the system carries on for the objective fixed and attained by the student). 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. This knowledge is 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 learning objects. The second stage concernes the interface of the multimedia learning object which is represented in the form of a set of pedagogical instruments and finally the scenario which is considered as the methods associated to each pedagogical instrument.

2. LEVELS OF INDIVIDUALIZATION CONSTRAINTS

We will show in this paper how we can use the different aspects of constraints when we individualize the multimedia learning object. These constraints individualization is situated in three levels of individualization -the objective of the next session level, - the sequence of didactic situation types level , and finally, - the Insantiated didactic situation level. So the different types of individualization constraints are associated with a structures of preference represented in the form of conditional knowledge calculated dynamically in each level of individualization. Thus the agents of individualization select dynamically three types of entities (Objective Unit entities, Didactic Situation Type entities, Element of Individualization entities) The selection of these three types of entities which is represented respectively in the (macro, meso and micro [1]) scale requires the collaboration of the agents of the system for making different types of decisions.

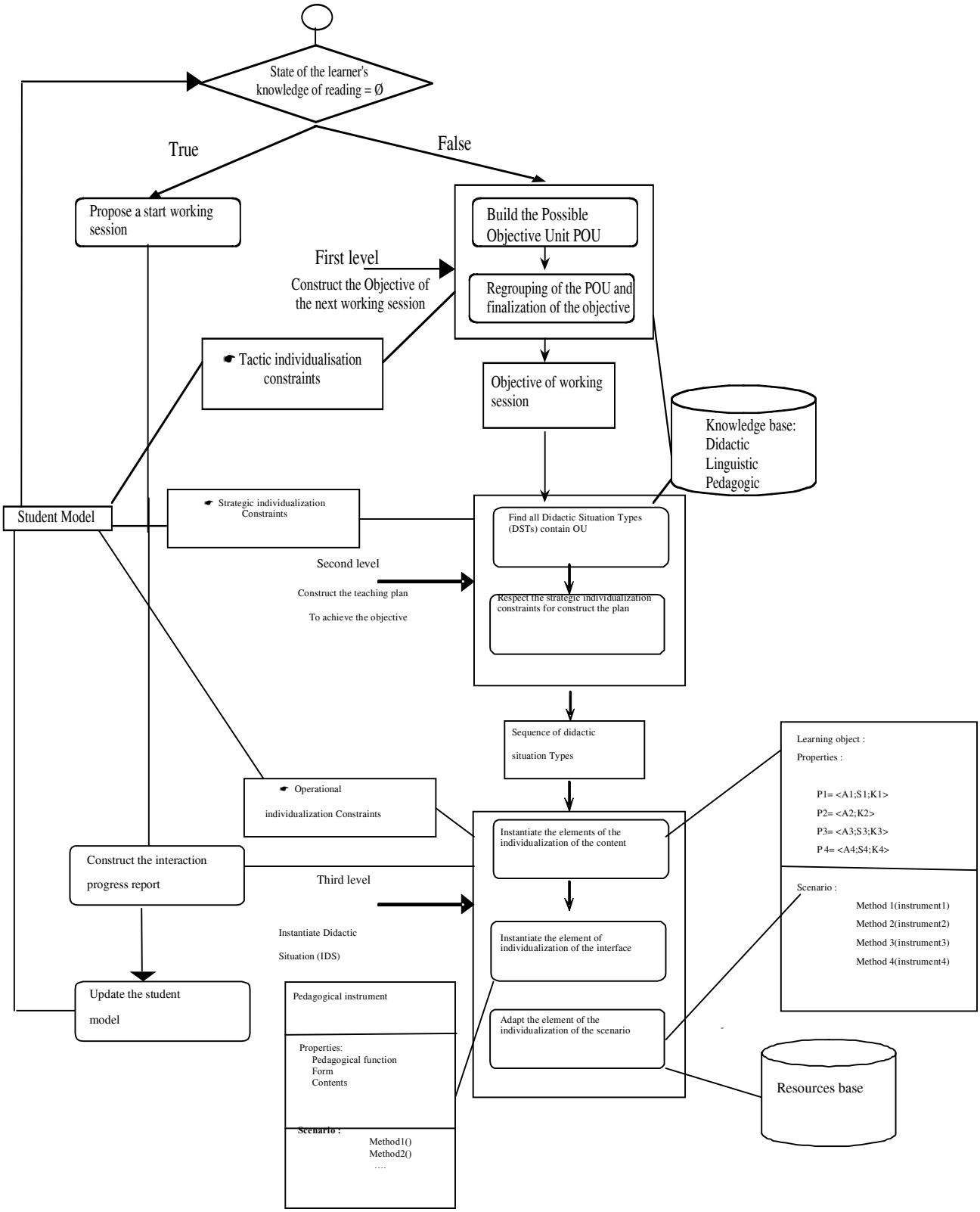


Figure 1 . UML Activity diagram: The three levels of individualization

So the individualization of the learning object signifies specifying, in first, content to be taught, that means find the list of pedagogical intentions constituting its propriety part (learning activity type Figure 2). But before this specification we must find in the first level all objective units to be used. Therefore the individualization of the learning object starts by the specifying of its propriety part using tactic individualization constraints. In (figure 1) the construction of the objective passes by two stages which represent the tactic knowledge (built the possible Objective units; regrouping the possible objective units and finalization of the objective), all rules (or conditional knowledge) which will be used in the first and second stages are considered as tactic individualization constraints. But each used rules corresponding to one of three types of criteria :

- progressiveess of tasck's systeme cretiria
- motivational cretiria (respecting its peferences)
- progressiveess of learner's knowledge criteria

Our proposal in this paper is to include these three types of criteria into the three levels of individualization aiming to specifying the consciousness knowledge of the individualization agent. In [20], the approaches called *DT Tutor*, involves explicitly looking ahead to anticipate how the tutorial action alternatives will influence the student and other aspects of the tutorial state. The innovative idea in this paper is that the preference approach would be applied in the three levels of the system using three types of individualization constraints (tactic, strategic and operational) individualization constraints.

2.1 TACTIC INDIVIDUALIZATION CONSTRAINTS

The tactic knowledge are used in the first level of individualization which is concerned by the processes that govern the management of an e-learning system. In this level the instructional designer should start by transforming the knowledge of a professors in primary school into structured information, (formalization of objective units starting from the reading domain and existing pedagogical material in class). subsequently individualized learning in this level means that we must start by the individualization of the objective of the next session, starting

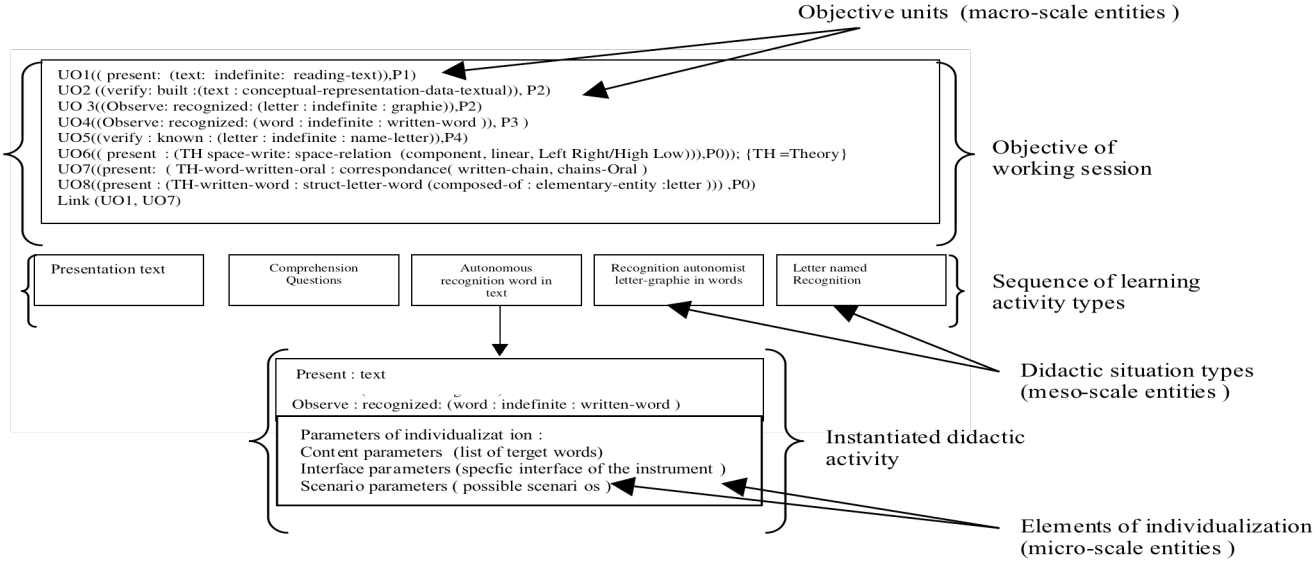


Figure2 The three types of manipulated entities in the system

a student model that used to collect all useful knowledge concerning its learning. The entities manipulated in this level are in macro scale, this 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> . For example, we will be able to have the couple < Make acquire; sentence limits> or, < verify; Known; word >. The objective of didactic session is defined as a set of objective units which 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). The tactic knowledge are represented under a particular format containing warp details of learning knowledge on various objects of reading (Letter, word, text). We concur with an constructivist approach of the teaching theorizing that the objective is represented in the way of a structure of couples "objective units". The construction of the objective is done dynamically in two stages: - the construction of the possible objective units POU and the construction of the objective starting from these POU [6]. The whole of the POU is determined from the state of the learner's knowledge of reading and organizing knowledge from the linguistic, didactic and teaching domains.
Linguistic knowledge is related to the French language (the description of the writing example: High - Low, Left right ; entities of the reading: letter, word, sentence...); didactic knowledge relate to the rules which determine the objective according to the state of the learner's knowledge, permitted to acquire a new knowledge through learning; or to modify the statute of knowledge. Pedagogical knowledge concern all didactic knowledge, which are not dependent of the reading domain. We can mention the pedagogical knowledge items as actions : they represent the actions the teacher tries to carry out and these actions correspond to a particular type of work. This definition comes onto the notion of pedagogical action. Among these actions, we can distinguish a first group characterized by the intention it corresponds to : the diagnostic actions such as 'to observe', 'to verify' correspond to the teacher's intention to refine his knowledge about the learner ; as to the actions such as 'put in presence of', 'to make aware of' , they correspond to the teacher's intention to have the learner improve his or her own knowledge. Another group of actions could be defined depending on the sort of domain knowledge items they can be associated with : 'to make the learner use' can be associated with domain knowledge items of procedural type, like a word identification strategy for example. By contrast, 'to make acquire' represents an action which could not be associated with a strategy but rather with knowledge items of declarative type, like 'the recognition of different written forms of the A letter '. These teaching actions are found in the couples that appear in an objective. Didactic knowledge constitutes another sort of pedagogical knowledge closely related with the learning domain. The didactic knowledge items are essentially used to pick the domain knowledge items within the first phase of the objective construction called "construction of the possible couples set" [6]. Among these didactic knowledge items, we can find for example an item like 'the word is central in reading learning' and so, the word should be the central element in a session, as a coherence factor. The second level concerned by the strategic knowledge using to achieve the objective of the next session.

2.2 STRATEGIC INDIVIDUALIZATION CONSTRAINTS

There are many strategies likely to be used to personalize learning. Nevertheless, like the terms learning styles motivation, personalization require to be more specified according to this level of individualization. In this level**,** the entities manipulated are in the meso scale (didactic situation types represented in the form couples < action, knowledge unit > or triplets <Action; statute-of-learner's-knowledge; knowledge unit> (figure 2)). The strategic knowledge represent the structures of preference which are constructed dynamically by the

agent where it uses heuristic values according to the pedagogical factors (teaching strategy). So the professor of primary school describes different strategies used for example to achieve objectives using strategic knowledge, which engage students in the learning process stimulate critical thinking and a greater awareness of other perspectives [15]. Thus he should communicate this knowledge to the instructional designer clearly articulating course expectations and explicates other factors to be used in different situations. But the problem that we have meted is that the learning face to face is not the same in E-learning. So we can not use all the strategies applied in the class then we use only transferable methods used for moderation and facilitation in face-to-face situations to be transferred into media-based interaction and be adapted respective modified within learning environments. In order to be more specific, personalization is described in this level with five strategies with increasing sophistication, each strategy describing a specific personalization technique applied in this level. From the simplest to most complex, the five strategies are:

(a) Take the didactic situation type (DST) which contains more than one couple or triplet figured in the objective of working session;
(b) Keep DSTs which propose preferred tasks by the learner (for example: evaluation tasks); Human tutors consider the student's emotional or motivational state in deciding how to respond [15], so the statistic analysis used by the student representation agent about the time of response and number of trying means that the tasks are preferred by the learner (high degree of preference).
(c) Keep the DST which has precedence relation with the DST selected before. we can define static relation between didactic situation types for example the DST of presentation of the text should precede the didactic situation about comprehension of the text. But the didactic situation autonomous recognition word in the text should not have been preceded by the didactic situation presentation of the text for learners who have a high degree of familiarization with the text.
(d) Eliminate all the sequence of DSTs that contains redundancy tasks or difficult tasks for learners; the progressiveness of the system task's should be done stapes by stapes (identification words in text seen before, or identification words in new text, that depends to the cognition state of the learner about reading).
(e) Keep only coherent sequence of DST.

These strategies could be used separately but to ensure coherent graph the set of strategies must be used collectively. So the agent use the algorithm depth-first to calculate the sequence of DSTs with respecting all strategic constraints defined in this level.

2.3 OPERATIONAL INDIVIDUALIZATION CONSTRAINTS

After the second level of individualization or the determination of strategic knowledge to plan the objective; we use other type of knowledge, which will concern the operational knowledge. So we will be focused in this paper on this third level. The operational knowledge concerned by, in first, the interface which will be proposed to the learner and how can it adapted to it's learning style. 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 [3] or if it presents materials which the user is not yet prepared to understand [12]. 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 [7,8]. 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. This different conduct can be seen as teaching strategies (in this third level) starting the student model (figure 3). 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-by-word; sentence by sentences global reading of the text). This different ways of reading of the text explicit the tack's progress of the system which are associated with constraints calculated starting from the student model. These constraints are associated to the criteria of the text and the cognition's state of the learner about reading text. For example we start by (Word by Word) for text with a high degree of difficulty or global reading of known text by leaner.

3 PARAMETERS OF IDIVIDUALIZATION, CRITERIA AND CONSTRAINTS

The parameters of individualization are all variables, which can be used to individualize multimedia learning object starting from the elements and constraints of individualization: choice of the topic of the text, choice of the words, limitation of time, numbers of trying, help (natural, a number and moment of the use of the help). "Graphical models" combine graph theory and probability theory to provide a general framework for representing models in which a number of variables interact. Graphical models trace their origins to many different fields and have been applied in wide variety of settings: [16].

Learning strategy	**Related teaching strategy**	**Parameters**
St1- Visual comparison strategy	Present text without reading ; display the word in the screen ; suggest help	The specific interface of the instrument Text : T ; Target Word , number of the target word, leanrer's statute of the word to be known; Help (reading text proposed or imposed) ; number of trying.
St2- using contextual indices strategy (spatio-semantic localization)	Present text without reading ; give set of word which has the same order appeared in the text ; suggest help	The specific interface of the instrument, Text : T ; set of ordered target Word , number of the target word, leanrer's statute of the word to be known; Help (reading text proposed or imposed) ; number of trying.
St3- partial graphical location strategy (locate initial capital letter)	Present text without reading ; the learner identify words which start by capital letter and don't situated in the beginning of the sentence, suggest help	The specific interface of the instrument Text : T ; set of target Word starting by capital letters , number of the target word, leanrer's statute of the word to be known; Help (reading text proposed or imposed) ; number of trying.
St4- using location initial syllables (locate initial syllables)	present text without reading ; the learner identify words which start by the same syllable, suggest help	The specific interface of the instrument Text : T ; set of target Word starting by the same syllable, number of the target word, leanrer's statute of the word to be

Figure 3 : parameters of individuaization associated to each teaching strategy used il the didactic situation "Autonomous recogntion words in text "

Each node in the graph symbolize vector represented in N dimension space, each one has a set of random variables. The pattern of edges in the graph represents the qualitative dependencies between the variables; the absence of an edge between two nodes means that any statistical dependency between these two variables is mediated via some other variable or set of variables in student knowledge 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 it's value. Constraints associated to each node has the forme of conditional knowledge, which represent the agent's belief about the student's knowledge of the corresponding context. For example if the student have recognize 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 it's knowledge. At the beginning of a problem, the nodes representing the givens and conditional knowledge, since these are given in the problem statement to calculate the probability value of each node. The student's strategy required to do task's system according to the criterion defined by the instructional designer. Quite often criteria are referred to as macro-objective of the agent, and in this article these two terms will be used interchangeably. Such a set of macro-objectives is typically modified during model analysis. In other words, it is easy to determine for each criteria separately, which solution (represented by vectors X) is the best one, such as the narrative text competing with the minimization of degree of difficulty to learning more. So if the text is preferred by the learner that means it reponse to th motivational criterion, consequently the solution is to propose the narrative text (which is preferred by the learner) or easy text to facilitate it's learning. accordingly a preference approach based on methods used actually in decision theory[20,21,14] to specify criteria. We consider that there are three criteria to be supposed to make decision.

- progressiveess of tasck's systeme cretiria
- motivational cretiria (respecting its peferences)
- progressiveess of learner's knowledge criteria

Obviously, the solution based on the criteria that support the progressiveness of it's knowledge is preferred over any dominated solution (assuming, that the selected criteria correspond well to the preferential structure which have the forme of conditional knowledge) . It is a commonly known fact that decision making is not a point event, even in situations where Here one should distinguish two groups of problems which are related to the two related but distinct issues, namely: - Model development, where some parameters of the model can hardly be precisely determined and -The model analysis, where a classical approach forces to treat one actual criterion as constraint. There is also a great variation in the use of models, which depends on various factors (like the pedagogical factor, the affective factor , the background and experience of student) However, the modelling process (composed of problem formulation, model specification, analysis and management) has many similarities also when the model are very different (knowledge object model, cognitive model and interface model), given by the multidisciplinary team. 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. 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. The interface model contains the description of the interface of the

instrument : Colors, Policies of text , Screen organisation , Scenario of use of each instrument.

3.1 DECISION VARIABLES

In model-based decision support it is assumed that decisions have quantitative characters and therefore can be represented by a set of the model variables, hereafter referred to as decisions $X \in D$, where D denotes a space of decisions or the possible values of X. In most cases X is a vector composed of various types of variables and other vectors. Sometimes some of the decision variables X are used as criteria, but for the sake of consistency we assume that such a variable is simply represented by one of the outcomes y. So vectors used to improve student leaning is related to the variables like (conditional knowledge, statute of learner's knowledge and statute of learners affects which are related to the relationship between the didactic situation and the preferences of learner). Let us illustrate this by specification of the decision variables of our illustrative models. In the knowledge object model (Text model) we can find the vector : T(Tilte , Type, difficulty-degree, spatial-caracteristic, number-of-time-of-reading); the type of text can be related to the account text, dialogue texte, descriptif texte… In the pedagogical model the decision variables are the variables associated with each type of text, for example the pedagogical intention : (present text : narrative text ; statute : new). So the knowledge object model contains variables which are specified in the pedagogical model. In the Learning style model, the main decision variables are related to the preferences elements by the learner either teaching or learning strategy (maitrized). The learning style model let the designer take into account all factors that make the students learn more so we know that the students learn more when they are engaged actively during an instructional task, Increased opportunity to learn content is correlated positively with increased student achievement [9]. 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. The visual style is caracterised by the more effectiveness for learner's memory by using the vision [18], the auditory style is related to auditory and the Kinesthetic style concerned by all what we touch (in learning to read domain that stimuli concerned by pronunciation).

3.2 EXTERNAL DECISIONS

Figure 4 illustrates the different aspects of decision, which can be considered as external decision made by the agents of the environment. In practice the vectors may include representations of various type of variables that substantially influence the values of outcomes y but are not controlled by the agent, for example: variables x controlled by the agent, and external decisions denoted by z which is suggested by other agent, this one can be represented as recommendation of the Student Representation agent to propose the Task : T1 or knowledge : K1 will be included in the vector supported this type of variable. Other case is considered where the agent of construction of the objective of next session can share some conditional knowledge, which can influence the variables instantiation process. While the external decisions are beyond control of the agent, it can analyse the scenarios with various representations of external decisions in order to find out not only a solution which will best respond to a most likely representation of external inputs z but also a solution that will be robust, i.e. will be good also for various other compositions of z that should be considered. The quantitative dependencies between variables which are connected via edges are specified via parameterised conditional distributions. The pattern of edges specify a joint criteria and

conditional knowledge over all the variables in the graph (figure 4). We refer to the pattern of edges as the structure of the graph, while the parameters of the graph simply as the parameters of the vectors, which constitute the nodes of the graph.

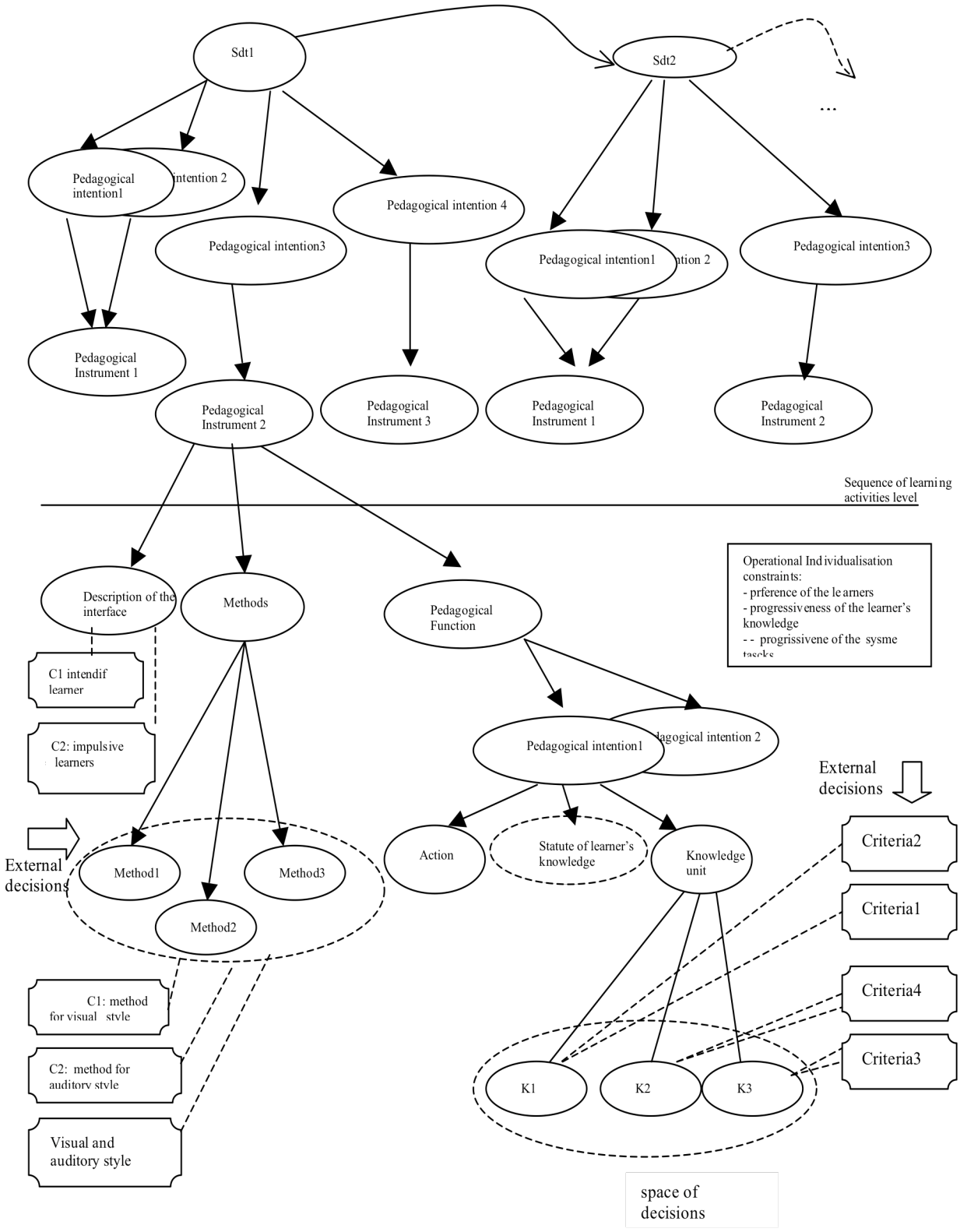


Figure 4 . Meta model for theoretic preferences approach

3.3 POSTERIOR DECISION

Contribution of the elements of adaptation in the process of didactic planning has dependence relation with components of the system (The Objective of working session, the sequence of the activities and the interaction progress report). These elements can modify these components in the case of passive help system. Following Gerhard Fischer [10], Adaptive hypermedia system AHS are traditionally divided into two classes: active and passive AHS. In a passive AHS, it is the user who initiates the help session by asking for help. An active help system initiates the help session itself. For example if the learner asks for help which is considered as an element of the individualization. So the use of this element can modify the pedagogical Intention descript in the Instantiated Didactic Situation (after execution); this pedagogical intention are specified in the objective component, thus this modification has an incidence to the student model starting from the interaction progress report and consequently on the determination of the following objective. Therefore the parameters of individualization which intervene on the didactic activity level have two various natures: The parameters which can't modifying the objective unit (Title of text, number of trying…) and the parameters which can change the unit of objective. For example if the pedagogical intention (display-in-the-screen: text: known) with help suggested. So the use of help by learn (reading text) is considered as the execution of other action consequently that modify this objective unit by (display-in-the-screen, reading-text, known). Which mean that the precedence objective unit is not reached. The new objective unit is considered as posterior decision made by the agent of execution of the interface.

4 CONCLUSION AND PERSPECTIVES

We have presented in this paper preference approach to personalize multimedia-learning object taking into account the variety of decision problems and of complex domain, which will never be just one method of model-based decision support. In fact, no single modelling paradigm alone is sufficiently good enough to identify and analyze various enough strategies for any complex decision problems. Thus making rational decision should be distributed in different levels using various types of knowledge; rather, an integration of various modelling methods and tools is needed to provide the best available support possible to analyze complex problems to calculate the preference structure associated to each learning situation. In reality the preference structure construct dynamically by the individualization agent using the student model, which should be descript by the instructional designer in the form of conditional knowledge. Nevertheless, this method requires more design by the team-work to find all the elements of individualization, more research is required in the cognition domain to find process implemented by learner, in user intelligent interface to explicit logic used by the learner and to focus attention of learner and in the structure of the individualisation agent, does it needed consciousness mechanism to ensure adaptive agent able to have adaptive behaviour according to learners? Is it a structure of preference about effect of the decision variables associated to the mental model [17] of knowledge object used implicitly by the agent ? Our research orientations are to find aspectual agent which use preference approach and more complex mechanism able to reproduce different mechanism of artificial mind which would be based in different domains.

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