A formalism of the competency-based approach in adaptive learning systems

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Abstract: - The notion of competence and learner model is the kernel of the Competency-Based Approach (CBA). However, as of today there is not a commonly learner model or ontology for competencies, we have presented in this paper our ontology-based representation in order to define the CBA. This representation provides a baseline for an e-learning adaptive system in which we plan to implement individual learning through individualized learning paths and collaborative learning considering individuals as part of homogeneous groups.
Key-Words: - Individualization, Ontology, Competency-Based Approach, Adaptation, Student modeling, Competency modeling.

1. Introduction

Nowadays, e-learning has seen significant advances taking advantage of the use of information technology and communication (ICT) as well as the progress achieved in the education and training area. Yet, e-learning systems still encounter several problems when compared to traditional face to face learning, due to absence or lack of individualized support that match each case of leaner. Recently, various researches has been conducted around the adaptation of learning and new types of adaptive e-learning systems are emerging and aim to fit the growing need for individualization based on the characteristics of each learner. A glaring fact: since learners proceed with different rhythms, abilities, prerequisites, motivations, it's important to take into account the profile of the learner, and its progress to adapt constantly its learning path, to assist the learner step by step in the acquisition of a competence.

The main sight of this article is to propose an adaptive e-learning system based on individualized paths in a competency-based approach in which we plan to implement individual and collaborative learning. (1)Individual learning to let each learner progress along an optimal path, taking into consideration its characteristics, and (2) collaborative learning to develop cooperation and communication skills, each student belongs to a group of learners whom some characteristics are shared. However, in order to conceive this system, we must consider some several questions: (1) how to adapt the learning path to the specificities of each learner (experiences, skills, prerequisites, rhythms)? (2) How to combine individual and collaborative learning environment? (3) How to subdivide tutor activity into tracking, monitoring and assisting learners. (4) Finally, how to increase learner autonomy, engagement and responsibility in an online e-learning system?

The remainder of this paper is organized as follows: in section 2, we present our research highlights. In section 3, we define the adaptation of learning in a competency-based approach, in which (1) some competency definition, (2) commonly student and competency modeling methods are discussed; also (3) our ontology-based representation is shown. In section 4, we present our operationalization method of the competency-based approach ontology using e-learning standards and xml schema definition. In section 5, we show our vision of an adaptive e-learning system. Section 6 aims to synthesize our work so far. Finally, we draw some conclusions and present new lines of future work.

2. Problem Formulation

Taking individualized paths is worthwhile for learners so they progress according to their educational needs while supporting their interest and motivation [1]. Furthermore, standards learning paths can rarely be optimal for all kind of learners. For these reasons, adaptive e-learning systems aim to propose a specific path for each learner, this led to the idea of static, or dynamic learning paths [10].

Static learning paths are used for limited adaptation, dynamic ones for deep individualization. Still, the individualization supposes a good comprehension of the learner and its performances, compared to a referential [2]. This made of student modeling, and evaluating a priority of our work. We believe that a clear representation of the learner and its level is the way to develop an adaptive e-learning system, capable of understanding its needs and supporting him/her throughout his/her activities. We suppose also that an optimal learning path for a learner is not necessarily for another. Moreover, collaborative learning is essential. Communication skills, sharing efforts to solve problems, increase the learner motivation, engagement and autonomy [19] as well as some skills can only be developed through a collaborative learning. So, the problem is: how to classify or categorize learners in homogeneous groups to receive appropriate learning, combining both individualized and collaborative learning?

We consider that a placement test is important for the initialization of the learner path, which should be refined as possible as the learner progress, based on its actions, evaluations, results, traces, etc. In this sense, the aim of our work is to (1) conceive standard paths for groups of learners (2) initialize the learner profile and its path with an evaluation of its competences (3) assign the learner to an optimal group according to the results of the evaluation (4) individualize the learner path within a group according to its progress, prerequisites and preferences in order to acquire a competence.

3. The Competency-based approach

At present, there is a whole branch of literature that focuses on the notion of competence, which led to various definitions and different approaches. First of all, we try to give a definition of competence, we make also a difference between competency-based approach and goal-based approach, and then we expose some considerable research work about student and competency modeling. Afterwards, we present our ontology-based representation to cover the competency-based approach.

3.1 State of the art

A competence is linked to knowledge because ultimately a competence mobilizes a set of knowledge [7]. It implies that a student can acquire knowledge and skills but can't implement them, in a timely manner and in a specific situation that requires the mobilization of a learned skill. The competence is abstract, broader and intellectual [2]. It's manifested through an action and not invented immediately [6]. In this line of thought, developing a competence is developing a collection of abilities like (1) Learning to know: general knowledge or related to a particular environment (2) Learning to do: operational, relational and cognitive (3) Learning to be: personal qualities. Aggregate them in view of mobilization in a specific context. Boterf[6] perceives competence as a result of combination of (1) knowing how to act: in order to be capable of implementing knowledge, calling for adequate resources in response to a given situation or problem. (2) Wanting to act: to ensure that the person is motivated (3) Being able to act because a competence can only come out in a situation within conditions. Paquette Gilbert [9], defines a competence as association of knowledge and abilities which assure their treatment. Bissonnette and Mario Richard [5] make the difference between, cross-disciplinary competences relative to a discipline and transversal competences such as attitudes, critical thinking, and creativity. Le Boterf distinguishes between individual or collective competences. And Iribarne [20] between imitation competence as the capacity to repeat learned actions in an automatic way, transposition competence to repeat actions in new contexts and situations, and innovation competence to propose new solutions and concepts based on developed knowledge and skills. Each of these definitions depends on the field it is related to.

3.2 Competency-Based Approach versus Goal-Based Approach

The competency-based approach and the goal based approach are two commons ways to structure and organize pedagogical activities. A goal describes an expected result, the purpose of training, and not the process to achieve it [11]. Therefore, a goal-based approach aims to describe observable behaviors in terms of achievements and specifies the desired performance. The knowledge acquired through such an approach does not allow the learner to reuse it in other contexts and situations, because the definition of goals under specific conditions limits the learner to particular learning situations. In this case, the competency-based approach is useful so the learner can mobilize the set of knowledge that he has acquired in new situations with various contexts. For assessments too: the goal-based approach aims to limit learner assessment to the final result compared to the fixed goal. However, the competency-based approach focuses on the learning process, during which the learner is constantly evaluated, to measure the gap between the level of target performance and the current one [2].

We have chosen the first approach which is the competency-based approach for its advantages like acquisition, mobilization and transposition of knowledge in new situations; it's also based on learning process which we plan to use in the learner path: to adjust learner activities towards the desired competence.

3.3 Competency modeling approaches

To design a competence, we propose two models that seem to complete each other: The first of Paquette, G [9] and the second of Elena, G[6]. We present each of these models apart to introduce later our proposal of competence modeling.

3.3.1 Paquette Gilbert's competency modeling [9]

Paquette, G [9] proposes an approach of modeling competence relying on three basic elements: (l) knowledge, (2) ability, and (3) performance [9][2][25].The following table [Table 1] illustrates the concept of ability, knowledge and performance according to Paquette, G[9].

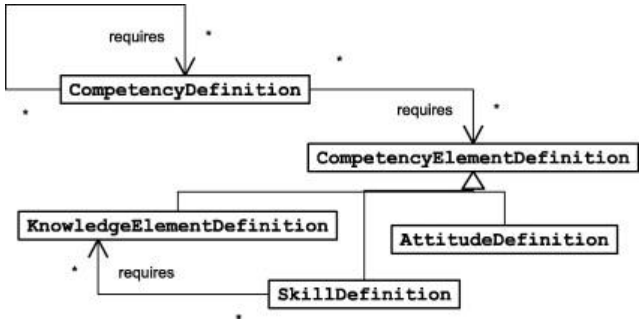
Ability	Knowledge	Performance
Receive: pay attention, remember, identify, locate	Concept	Frequency: On occasion, steadily
Reproduce: Apply (Simulate, use), transpose, translate, instantiate, specify.	Procedure	Cover: partial total individual, collaborative
Produce: analyze (deduct, classify, predict, diagnose), repair, synthesize (induce, plan, design)	Principle	Autonomy: with assistance / without help
Self-management: assess, self-discipline, (influence, initiate, adapt, control)	Fact	Complexity: low, medium, high
Example of competence: Synthesize - the concept of communication - without help.		Context : familiar, new

Table 1: Paquette Gilbert's Competency modeling

Paquette , G[9] defines a competence as the association of knowledge and abilities,(1) knowledge may be concepts, procedures, principles or fact (observations, data, and traces) (2) ability describes the processes that can be applied to domain knowledge and (3) the performance describes some characteristics like the frequency, overlay, degree of autonomy, degree of complexity and context. So, in order to acquire a competence, the learner has to acquire a set of abilities determined by a level and a performance.

3.3.2 Elena's competency modeling

For Elena G [6], competence modeling requires a detailed description. This leads to the concept of competency definition and competency decomposition. Her conception is based on UML (Unified Modeling Language).
The following figure [Figure 1] illustrates Elena's competency modeling [6]



[figure1]: Elena's competency modeling

- All the characteristics of a competency must be defined: (1) Knowledge Elements, (2) Skills (3) Attitudes.
- A competence may require the acquisition of other competences. For example, programming skills requires skills in algorithms.
- When a competence requires the mastery of more than a competence. It can be divided to several competency elements.

3.4 Learner modeling in a spirit of Competency-Based-Approach

An adaptive system is designed to provide learning paths adapted to each learner. This illustrates the need for an approach of learner modeling, essential and effective for designing individualized activities. In order to establish a complete model, we must identify learner characteristics which the system must adapt. The model of the learner is one of the links required that guides instructional decisions, it can be defined as a process of gathering relevant information to infer the current state of the learner. The representation of the learner has to be understandable and accessible by the system [12]. In

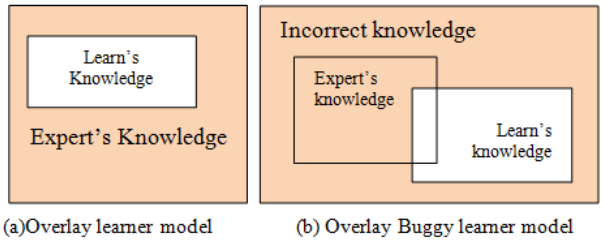
this stage, we must consider an important question about learner modeling which is: what are the characteristics of the learner that should be represented? According to [13] the learner characteristics can take 3 forms: (1) static, such as name, age, address and that are identifiable at the beginning of a learning path, (2) dynamic information extracted from the learner interaction with the system (3) or information relative to domain knowledge or a context. In this sense, the major challenge is to define the dynamic characteristics that are the basis of any adaptation, for example the level of current knowledge and skills, errors and problems, learning styles, etc.

3.4.1 Common learner modeling methods

One of the common methods for learner modeling is to identify, in domain knowledge what he knows from what he does not know. The overlay model aims to assess the state of knowledge and skills of a learner to fill the gap. In this purpose, the overlay model compares the learner state of knowledge to a simulated expert.

The overlay model measures the level of knowledge using Boolean measures (yes, no | 0.1), qualitative measures (good, medium, low) or quantitative as the probability of knowing a concept. However, this method is essentially based on the granularity of domain knowledge and does not support learners' errors. It considers that an error is the result of strategic choices and not caused by the learner, and can't explain the behavior of the learner.

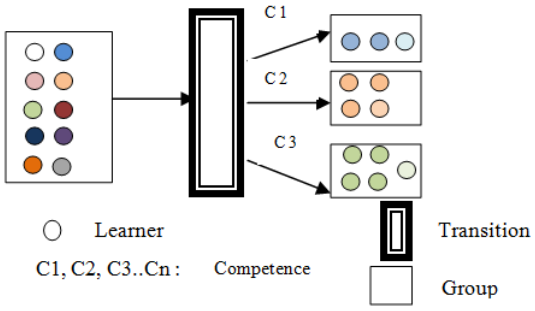
The buggy model (b) complete the recovery model, it uses the most frequently encountered errors considered as incorrect beliefs. Which require a remedial strategy. However, only errors or bugs do not help to determine which types of interventions should be done. The following figure [Figure 2] illustrates the overlay model (a) and the overlay buggy model (b).



[figure2]: overlay model

3.4.2 Stereotypes

The primary concept of using stereotypes is to gather learners who share the same characteristics in a group. In this modeling approach a group contains learners with common skills and knowledge. As illustrated in the figure [figure3],

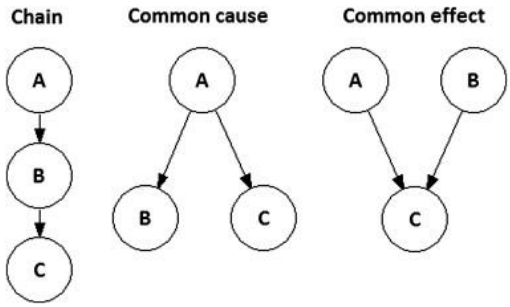


[figure3]: Stereotypes model

Stereotypes are often the solution to the problem of initialization of the learner model, by assigning the learner to an appropriate group and refining its path according to its progresses.

3.4.3 Bayesian networks

Bayesian networks [14][15][16] are directed acyclic graphs (DAG) . The nodes represent random variables, and the structure reflects the conditional dependencies between variables. The figure below [Figure 4] shows an example. The information shown in these graphs facilitates the sequence of actions to take A, B or C [16] the orientation of the arcs is related to the flow of information in the network [15]. The Bayesians networks can be used to conceive learning activities.



[figure4]: Bayesian networks example

3.5 Our proposition of an ontology based-representation for the competency based approach

Ontologies are general representations of a domain mainly based on knowledge extraction [17], which can be easily manipulated by the computer and interpreted by humans. As part of our research, we

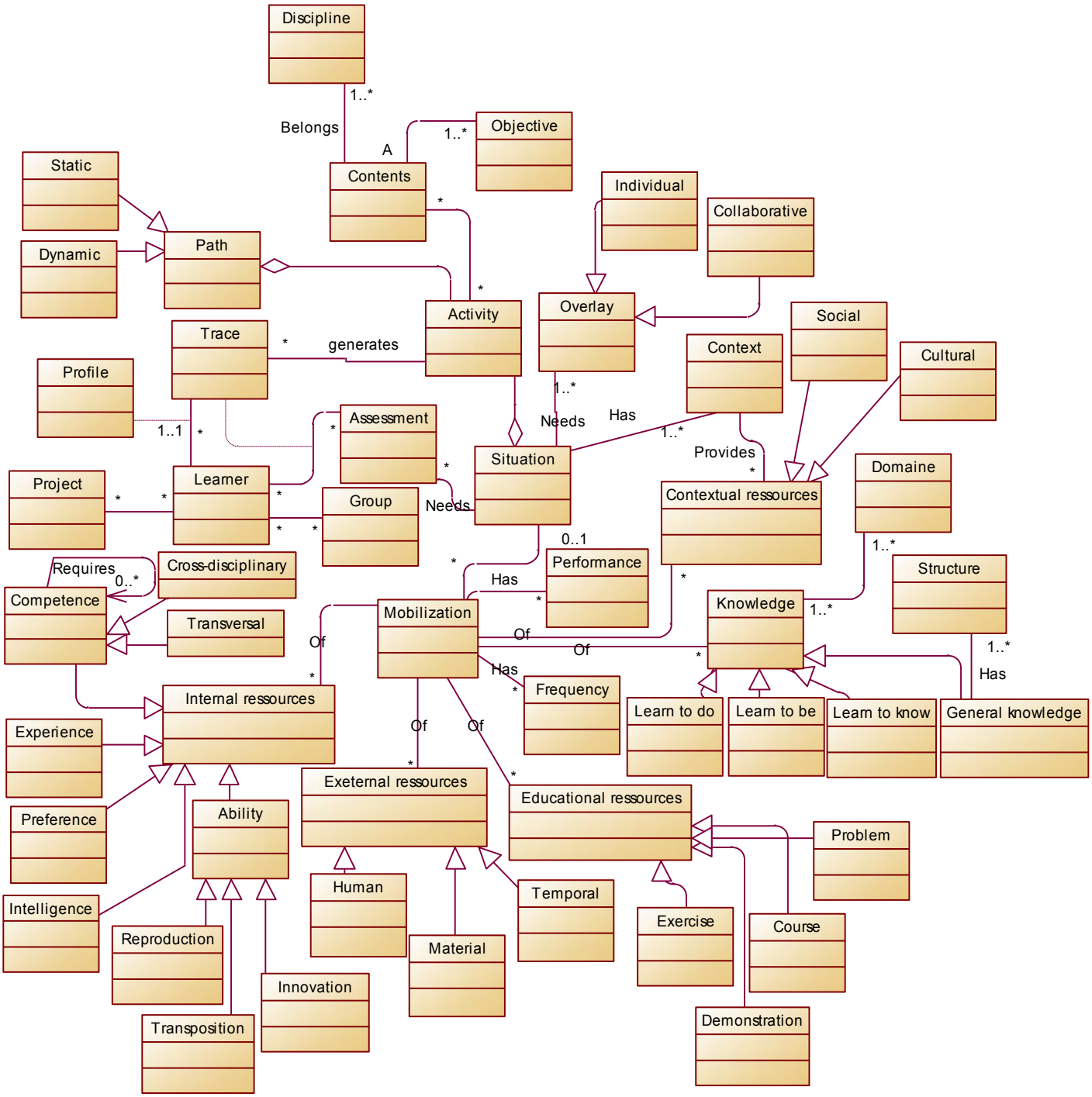
opted for an ontology-based representation (concepts, properties, relations) in order to (1) identify the complexity of competency-based approach, (2) reduce the terminological confusion that applies (3) provide a shared formalism (4) Ensure interoperability and reusability among actors and between systems.

In what follows, we present our proposal of ontology for the competency-based approach. This ontology aims to complete the one previously proposed by our team [16][18] but it is extended to allow us to extract the outline of our adaptive learning system.

In order to propose an ontology-based representation for the competency-based approach, we have synthesized our domain comprehension in a textual form as follows; Figure [Figure 5] will give a graphical representation of it:

- A learning situation is the central node of a competency-based approach, and requires mobilization of different resources in a context with an overlay and requires assessments [4].
- A learning situation is also a set of activities in a given context (which can be familiar or new). Example of learning situations: exploration, research, simulation or teaching situation.
- A learning activity uses contents with objectives; contents are grouped into disciplines [14].
- An activity generates traces that could be exploited to generate individualized learning paths, and often used to update the learner profile
- An assessment identifies the current level of a learner.
- A situation overlay depends on chosen learning modalities: individual or collaborative work, it can also be partial or total, with or without assistance.
- A learning situation requires the mobilization of resources of various kinds:(1) External resources which can be human, material or temporal (2) Contextual resources which depend on the context (3) Educational resources that can be, for example, courses, exercises, demonstrations or problems to solve. (4) Internal resources to represent learner abilities, preferences, experiences and intelligence degree.
- In a learning situation, mobilization has performance and frequency which measure learner ability of reproduction, transposition or innovation. Reproduction to reproduce or repeat actions in an automatic way, transposing to mobilize an acquired skill in an appropriate context, and innovation to propose a new solution by using the knowledge and skills developed.
- A mobilization requires a set of knowledge related to a domain: general knowledge, expertise, skills.
- Knowledge can take 4 forms: General knowledge, learn to know, learn to do, and learn to be.
- Knowledge must have a structure for better interpretation, storage, handling and interoperability in e-Learning system.
- A learner progresses in a learning path individually or collaboratively, can join a group and/or participates to a project.
- The trajectory of a learner is a series of learning activities. It can be static or dynamic.
- A competence may require the acquisition of other competences.
- A competence can be transversal or cross-disciplinary.
- Ability is the capacity to reproduce, transpose or innovate.
- A trace is used to feed the learner profile; it is also the result of a learner assessment.
- Etc.

Our ontology can be used as the core of any production in the domain of competency-based approach; in fact this ontology should reduce or even eliminate the conceptual and terminological confusion and ensure a shared understanding to adopt this approach effectively. It also represents our conception of the environment of our future adaptive e-learning system.



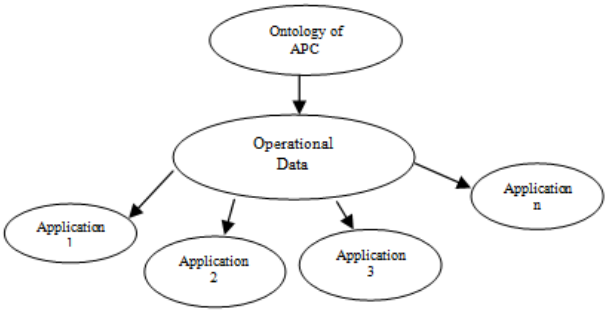
[Figure 5]: Our Ontology-Based Representation for the Competency-Based Approach

4. Operationalization of the competency-based approach ontology

As mentioned in the previous section, ontologies are used to express a certain representation of a domain. In our case, we have designed an ontology in order to (1) translate the key concepts of the competency-based approach, (2) to move towards an understanding of reality and (3) to give a limited interpretation of the CBA. Our purpose is to reduce terminological confusion, and to have a precise design of our adaptive e-Learning system. This section aims to describe the operationalization of the competency-based approach.

4.1 Operationalization of the competency-based approach ontology

Our ontology is a collection of concepts and relations extracted from the literature of the CBA. It includes the necessary elements of our adaptive e-Learning system, such as the definition of the competence, individualized learning path, assessments, etc. In fact, it is built to be reusable by other applications in order to share and exchange common data. In our case, our system has to communicate with (1) a learner trace management application and (2) a leaner assessment application, to update frequently the learner profile. The following figure [Figure 6] explains the benefits of using ontology, to share operational data between applications.

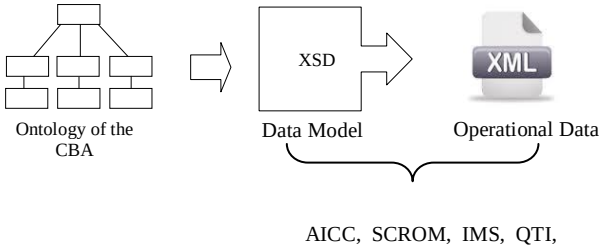


[Figure 6]: Application of CBA ontology

In the following paragraph, we will briefly outline our method of ontology operationnalization; we have used a formal language in order to achieve operational data which could be (1) understandable and interpretable by computer, (2) used by several e-Learning applications.

4.2 Methodology

To operationalize our ontology of CBA, a formal language, understandable by machines was highly recommended**.** This language must ensure communication and data exchange between the different applications. The formal language XML (eXtensible Markup Language) with the XSD (XML Schema Definition) appears to be a good solution. However, XML ensures interoperability between devices, without taking into account the specificities related to pedagogy. In this sense, our idea is to combine between (1) XML to give data a formal, operational and interoperable aspect (2) e-Learning standards and specifications for better operationalization of our ontology, to integrate it into different e-learning systems: existing, current and future. The following figure [Figure 7] illustrates the steps followed:



[Figure 7]: Operationalization of the CBA ontology

4.2.1 The use of e-learning standards

The online learning platforms, educational resources and materials are multiplied. This explains the need for a standards-based approach. Our goal is to (1) produce output formats which are independent from design, implementation and utilization tools (2) create understandable usable and shareable data by different actors, (3) use in a same platform data from different sources and with varied formats (4) Finally, it is to offer means of communication and data sharing based on standards. In this case, the most popular standard for production of XML e-Learning data is IMS [22]. We have chosen this standard to operationalize our ontology of CBA. The choice of XML denotes our intention to use an open format regardless the technical choices to implement.

a. IMS-LIP

IMS-LIP (Learner Information Package) standard of IMS [23][24] produces information about the learner for general purposes. The purpose of this standard is to facilitate the exchange of learner information. In our system, IMS-LIP will allow us to implement several entities of the ontology. For example, we can fill in the information of the learner, its learning path, its educational preferences, the context, its difficulties, its educational activities and objectives, performance,

etc. IMS-LIP includes a set of entities we have identified in the literature of the CBA.

b. IMS-RDCEO

The RDCEO [21][24] (Reusable Definition of Competency or Educational Objective Specification) of IMS proposes a general model for describing competences. Interesting to define the competence once and reuse it as much as needed.

c. IMS-QTI

IMS-Question & Test Interoperability Specification [24] describes assessment methods and content. It defines the structure of a question (item), of a test (assessment) and the expected answers. These elements should allow the exchange of content between e-Learning platforms.

d. IMS-LD

IMS-LD (Learning Design) [24] allows the modeling of learning environments. It defines objects, resources and learning activities.

4.2.2 XML SCHEMA DEFINTION (XSD) to define CBA

Because of the variability in the translation of the CBA, eLearning standards cannot handle all the concepts. Or, sometimes the definitions they offer are limited. So, in order to propose some definitions which meet our needs we have chosen XSD to define some concepts not covered by the standards. But, our choice was inspired from standards using XML to ensure interoperability and reusability, to produce open format without having to take into consideration technical specifications that follow.

4.3 Results

In this section, we give some examples of XML files that we have generated based on e-Learning standards or XSD models that we have conceived. Unfortunately we cannot explain all the xml files but we have chosen the most interesting ones: the xml file containing the competency definition, the xml file containing the evaluation structure and the xml file which define a group of learner.

4.3.1 XML model of the competence

To make the competence we have modeled operational, we have defined a set of properties. The following XML file [figure 8] gives an overview of the competency definition.

Competence is defined through the following properties:

- <identifier> identifies the competence through a unique identifier, to retrieve it during the learning.
- <title> a competence must have a title.
- <description> contains a detailed description of the competence.
- <level> the current level of the competence.
- <scale> defines a scale for assessing a competence .
- <statement> the competence may be elementary, but can contain multiple competences. In this case, they must be entered in this tag.
- <statementtoken> the competence must be evaluated, that is why we use the tag that points to the assessments that support the competence.

```
<?xml version="1.0" encoding="UTF-8"?>
<rdceo xmlns="http://www.imsglobal.org/xsd/imsrdceo_rootv1p0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.imsglobal.org/xsd/imsrdceo_rootv1
p0_rootv1p0.xsd">
<identifier>Ar0001</identifier>
<title>
    <langstring xml:lang="en">Arithmetic Competency </langstring>
</title>
<description>
            <value> this competency include: Add </value>
             <level>
                    <langstring>Level 1</langstring>
            </level>
<scale>
 <minvalue>0</minvalue>
<maxvalue>20</maxvalue>
</scale>
</description>
<definition>
<statement Statementid="A1" Statementname="Addition">
<statementtext>
<langstring>Calculate the sum of two  integers</langstring>
</statementtext>
              <statementtoken>Q_AD_0001</statementtoken>
            </statement>
</definition>
</rdceo>
```

[Figure 8]: XML Model of the competence

In this example, we define a competence in arithmetic. More specifically, "the addition of two numbers, «It is about the level « level1 », the assessment scale is « between 0 and 20 ». The competence of addition can be evaluated using the question which id is « **Q_AD_0001** ».

4.3.2 XML model of the assessment

The competency assessment is about asking a series of questions to the learner. The XML file of assessment allows the modeling of the question to ask. It contains the following properties:

- <ResponseDeclaration> used to uniquely identify the question.
- <CorrectResponse> contains the correct response to compare with the response of the learner.

- <outcomeDeclaration > select the given score according to the response of the learner.
- <itemBody> define the question to ask.
- <choiceInteraction> serves to present a set of choices in the case of a qcm.

The following figure [Figure 9] shows an example of a question, the property « identifier="Q_AD_0001" » is used in the xml file which define the competence to determine the best question to ask to evaluate the learner.

```
<assessmentItem xmlns="http://www.imsglobal.org/xsd/imsqti_v2p0" x
mlns:xsi="http://www.w3.org/2001/XMLSchema
instance" xsi:schemaLocation="http://www.imsglobal.org/xsd/imsqti_v
2p0 imsqti_v2p0.xsd"identifier="choice" title="Unattended
Luggage" adaptive="false" timeDependent="false">
<responseDeclaration identifier="Q_AD_0001" cardinality="single" ba
seType="identifier">
<CorrectResponse>
        <value>Choice A</value>
</correctResponse>
</responseDeclaration>
<outcomeDeclaration identifier="SCORE" cardinality="single" baseTy
pe="integer">
        <defaultValue>
                <value>0</value>
        </defaultValue>
</outcomeDeclaration>
<itemBody>
<p> Calculez la somme des deux nombre</p>
<p>3+15</p>
<choiceInteraction responseIdentifier="Q_AD_0001_response" shuffle
="false" maxChoices="1">
<simpleChoice identifier="ChoiceA">18</simpleChoice>
<simpleChoice identifier="ChoiceB">19</simpleChoice>
<simpleChoice identifier="ChoiceC">20</simpleChoice>
</choiceInteraction>
</itemBody>
</assessmentItem>
```

[Figure 9]: XML model of assessment

This example shows a question which asks the learner to calculate the sum of two numbers and to choose the best answer from three choices (A, B, C). This xml file specifies the correct answer, the answer is "A" and used to calculate the score.

4.3.3 XML model of the assessment

There is no standard in e-learning which cover the definition of group of learners with degrees of homogeneity. So, we have conceived an XSD model to define the concept of a group of learner. The following figure [Figure 10] shows an example.

In order to define a group, we have implemented these properties:

- <identifier> used to uniquely identify the group of learners.
- <title> : gives a title to the group.
- <description> describe the group.
- <homogeneity> defines a degrees of homogeneity which allow learners to join or leave the group .
- <learners> a list of learners of the group.

```
<xs:schema attributeFormDefault = "unqualified"
elementFormDefault = "qualified" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" >
 <xs:element name = "Learnergroup" >
  <xs:complexType>
   <xs:sequence>
    <xs:element type = "xs:byte" name = "identifier" />
    <xs:element type = "xs:string" name = "title" />
    <xs:element type = "xs:string" name = "description" />
    <xs:element name = "homogeneity" >
     <xs:complexType>
      <xs:sequence>
       <xs:element type = "xs:byte" name = "minvalue" />
       <xs:element type = "xs:byte" name = "maxvalue" />
      </xs:sequence>
     </xs:complexType>
    </xs:element>
    <xs:element name = "learners" >
     <xs:complexType>
      <xs:sequence>
       <xs:element name = "learnerinformation" >
        <xs:complexType>
         <xs:sequence>
          <xs:element type = "xs:byte" name = "id" />
          <xs:element type = "xs:string" name = "name" />
          <xs:element type = "xs:byte" name =
"homogoneitydegree" />
         </xs:sequence>
        </xs:complexType>
       </xs:element>
      </xs:sequence>
     </xs:complexType>
    </xs:element>
   </xs:sequence>
  </xs:complexType>
```

[Figure 10]: XSD model of learners group

```
<Learnergroup>
<identifier>0022</identifier>
<title>Groupe1</title>
<description>
Group1
</description>
<homogeneity>
        <minvalue>1</minvalue>
        <maxvalue>5</maxvalue>
</homogeneity>
<learners>
<learnerinformation>
<id>001</id>
<name> learner1 </name>
<homogoneitydegree>3</homogoneitydegree>
</learnerinformation>
</learners>
</Learnergroup>
```

[Figure 11]: XML model of learners group

The following example is an implementation of the XSD model. For example, we have defined a group « group1 » with a degree of homogeneity between « 1 » et « 5 ». The XML file of learners group [Figure11] contains the list of learner

belonging to the group: example « learner1 » with a degree of homogeneity equal to « 3 ».

5. Towards an adaptive e-learning system based on individualized paths in a competency-based approach

5.1 Adaptation, individualization and personalization

The suffix "tion" in adaptation, individualization and personalization expresses an "action or the result of an action" [8]. In one hand, individualization and personalization are relative to an individual or a person, while the adaptation reflects the action "to adapt or adjust something» regardless the person characteristics or preferences [8]. From this, we can say that the adaptation takes often the form of individualization or personalization. The individualization can be associated to one or more learner, while personalization is directly focused on one and only one learner. For example, an individualized learning path involves only one learner but designed to be used for other learners at the same time but a personalization can cover a single case of learner at a single time and can't be used for another learner.

5.2 System presentation

We propose an adaptive e-learning system in which the learner can acquire a competence via multiple ways: we plan to conceive a set of optimal and standard paths for groups of learners (classes) (1) Beginner (2) Elementary, (3) Intermediate, (4) Advanced, (5) Very advanced. From theses paths the system would choose the optimal one based on the evaluation of the learner, the paths will be refined as the learner progresses based on actions, evaluations, results, traces. according to (1) its prerequisites: previously measured at the entrance of the system, (2) its current level periodically compared to the competence it should acquire and oriented towards the next learning step forward.

5.2.1 Positioning test step:

Check up the learner pre-requisites. For example, in the medical field, a treatment will have no effect in the absence of a relevant diagnosis [3]. In education, individualized paths will have no effect in the absence of assessments, to put the learner in a most appropriate activity relative to its current level.

5.2.2 Adaptation step

From an initial path, the adaptive learning system must orchestrate learner activities in order to achieve the desired competence. In this sense, we distinguish two learner situations:

(1) Learners in the same group whom learning trajectories are progressively adapted.

(2) Learners whose competence level allows them to join other groups, weaker or advanced; we call it migration to a suitable group.

5.2.3 Summative evaluation step:

Optional step for understanding the learner advancement in the acquisition of a competence.

6. Discussion

We divided our work into two main parts: the first discuss the learner and competence modeling and the second presents our perception of an adaptive e-Learning system. In the first part of this paper, we have asked the following question: how to design a learner and its competences in the spirit of the competency-based approach? And how to design the learner to facilitate the generation of individualized paths? First of all, the methods previously shown do not take into account the internal resources of the learner. However, to individualize the learning path, learner capacities, characteristics and the context are crucial. That's why we have combined in the same representation (1) the characteristics of the learner, static ones as general information (2) dynamic ones as information extracted from the learner and the system interaction, and (3) characteristics related to a domain such as knowledge, skills, or context [13]. We believe that our ontology-based presentation contains the important elements of the competency-based approach as well as the principle of individualization and will form the basis of our adaptive e-learning system.

The second part of this paper, defines the aim of our future system, in which the learner can acquire a competence individually, taking into account its needs, but also in the context of a homogeneous group: as the individual learning is not enough: the course adapts the learner path without isolating him of a group.

7. Conclusion

In this paper, we have discussed the competency-based approach and the concept of individualization; we have chosen to reduce its complexity through an ontology, which represents the learner as central element, the competence as the result of the e-learning system and the individualized path as a

means to achieve it. In the future, we will focus on the assessment of the learner because there is no competence without assessments, in order to put the learner into the most adequate path.

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