Educational Adaptive Hypermedia Platform Based on Progressive Assessment and Adapted to the Characteristics and Learning Style of the Student

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Abstract. The aim of this paper is to present an Educational Adaptive Hypermedia Tool, PCMAT, Based on Progressive Assessment and adapted to the student model and learning style. The adaptation of the application is based on progressive self-assessment (exercises, tasks, etc.). The learning platform was already implemented, tested and evaluated in learning processes in Basic Schools. Also, the paper defines and evaluates the characteristic of the User Model to be used in the Student Modeling.

Keywords: Adaptive Hypermedia, Cooperative Learning, Student Modeling.

1. Introduction

The main objective of Adaptive Systems is to adequate its relation with the user (content presentation, navigation, interface, etc.) according to a predefined but updatable model of the user that reflects his objectives, preferences, knowledge and competences [2, 5].

For Educational Adaptive Systems, the emphasis is placed on the student knowledge in the domain application and learning style, to allow him to reach the learning objectives proposed in his training [4].

Although numerous research and already developed systems provided good results, more development, experimentation and implementation are still necessary to conclude about the adequate features and effectiveness of these systems [11].

The application of the constructivist learning theory is more and more used since it suggests that the students do not keep simply the information in a static way, but look for blocks of old knowledge’s related to construct a new and more significant learning process [11].

The OCDE PISA 2006 study [13], concerning Scientific Competence of Portuguese students concluded that the knowledge level about mathematics did not show any
improvements when compared with a similar study undertaken in 2003. The results of this study reveal that students of 7º and 8º grades achieved a low behavior in mathematics [13]. The results show that mathematic knowledge of Portuguese students is lower when compared with the majority of OCDE countries [13].

The aim of this paper is to present the project, PCMAT (Mathematics Collaborative Learning Platform). PCMAT is an Collaborative learning platform with a constructivist approach, assessing the user knowledge and presenting contents and activities adapted to the characteristics and learning style of the student of mathematics in basic schools.

Also, the platform allows the students and teachers to autonomously create and consolidate knowledge, with permanent automatic feedback and support, through instructional methodologies and educational activities explored in a constructivist manner. The capacity of adaptation of these tools in relation to the different necessities and the diversity of the background of each student is necessary for bigger effectiveness and efficiency of the learning process [11].

This paper is organized as follows. Section II provides a general approach to Adaptive Hypermedia Systems (AHS). The section III defines Student Model and section IV Learning Styles concept. Platform Development and Some Results are presented in section V and VI. Finally section VII presents Conclusions.

2. Hypermedia Systems

Adaptive Hypermedia (AH) is generally referred as a crossroad in the research of Hypermedia and User Modeling (UM) [2, 3, 5]. An AHS builds a model of the objectives, preferences and knowledge of each user and uses it, dynamically, through the Domain Model and the Interaction Model, to adapt its contents, navigation and interface to the user needs.

De Bra in 2004 [4] indicates that these systems must present the functionality to change content presentation, links structure or links annotation with the following objectives:

1. Guiding the user to relevant information and keep him away from the irrelevant one, or pages that he still would not be able to understand. This objective is generally known as link adaptation;
2. Supplying, in the content (page), additional or alternative information to certify that the most relevant information is shown. It is generally known as content adaptation.

The global architecture proposed by Benyon [1] and De Bra [5], indicates that AHS must have three essential parts:

1. The User Model, that describes the information, knowledge, preferences, etc., of the user. This component allows extracting and expressing conclusions on the user characteristics;
2. The Domain Model represents a set of domains concepts. In different AHS these concepts can have distinct functions, weights and meanings. Most commonly, each concept is connected/related with other concepts, representing a semantic net;
3. The Interaction Model, which represents and defines the interaction between the user and the application. The data stored in the Interaction Model can be used to infer user characteristics with the objective of updating and validate the User Model. For that purpose, this component includes evaluation, adaptation, and inference mechanisms.

In Educational Adaptive Hypermedia Systems (EAHS), the emphasis is placed on students’ knowledge in the domain application and learning style, in order to allow them to reach the learning objectives proposed in their training [12].

The application of the learning theory constructivist in AHS is more and more used. The learning process is more efficient when it is built in a base of a knowledge learnt previously and it will be still more useful if the student will be actively implicated in the process [11, 12].

3. Student Model

The beginning of User Modeling (UM) is dated to 1978/1979 with the first work by Allen, Cohen, Perrault and Rich [8]. In the following 10 years, numerous applications or systems were developed to store different types of user information to allow distinct adaptation models. Morik, Kobsa, Wahlster and McTear present an extensive survey of these systems [8]. In these initial systems, user modeling was embedded and there was not a clear distinction from other components of the system [8].

In 1990, Kobsa was the first author to use the term "User Modeling Shell System". Since then, different systems have been developed with the ability to reuse User Models [8, 11, 12].

In generic AHS, the User Model allows changing several aspects of the system, in reply to certain characteristics (given or inferred) of the user [2]. These characteristics represent the knowledge and preferences that the system assumes that the user (individual, group of users or no human user) has [11, 12].

In EAHS, the UM (or Student Model) has increased relevance: when the student reaches the objectives of the course, the system must be able to re-adapt, for example, to his knowledge [2, 11, 12].

A Student Model (SM) includes information referring to the specific knowledge that the system judges that the user possesses on the domain, known as the Domain Dependent Data (DDD). The components of the Domain Dependent Data correspond to the Domain Model with three-level functionality [1, 11]:

1. Task level, with the objectives/competences of the domain that the user will have to master. In this case, the objectives or intermediate objectives can be altered according to the evolution of the learning process;
2. Logical Level, which describes the user knowledge of the domain and is updated during the student’s learning process;
3. Physical Level that registers and infers the profile of the user knowledge.

The Domain Independent Data (DID) are composed of two elements: the Psychological Model and the Generic Model of the Student Profile, with an explicit representation [8]. The psychological data are related with the cognitive and affective aspects of the student. Some studies have demonstrated that the difference between
the cognitive capacities and personality aspects affects the quality of some models or styles of interaction [8]. These data are more permanent which allows the system to know beforehand which the characteristics are that it must adapt to. [1, 16]. The data related to the user interests, common knowledge and background are kept in the Generic Model of the Student Profile.

The DID include following aspects [1, 8, 12]: Initial user knowledge; Objective and plans; Cognitive capacities; Learning styles; Preferences; Academic profile (technological studies versus economical studies and management, knowledge of literature, artistic capacities, etc.); Age and type of student; Cognitive style (affective, impulsive, etc.) personality aspects (introverted, extroverted, etc.).

As expressed before, some of these characteristics are relevant for a determined type of UM and not for others [2, 3]. Therefore, for each AHS, it will be necessary to define which are the characteristics and relevant parameters of the user to be kept [11, 12].

The following list tries to address the most common aspects that support adaptation [11, 12]:

1. Domain Independent Data:
   a. Generic profile: Personal information (name, email, password, etc.); demographic data (age, etc.); academic background; qualifications; background knowledge; deficiencies: visual or others; the Domain of Application; inheritance of characteristics (creation of user stereotypes).
   b. Psychological profile: Learning style (taxonomy); cognitive capacities; personality; inheritance of characteristics.

2. Domain Dependent Data:
   a. Objectives; plan; complete description of the navigation; knowledge acquired; results of evaluations; context model; aptitude; interests (Definition of the interests of the individual with the objective to adapt the navigation and contents); deadline extend (Long, short or normal stated period).

Different approaches to implement UM in some AHS will be presented in Table 1. Next, systems that use overlay model will be described and then; the systems that use a combination of different techniques will be presented.

Some AHS that use the overlay model for UM are the following [3, 12]:

1. The Adaptive Hypermedia Architecture (AHA) System is Educational AHS. The purpose of this system is to deliver courses over the web. The UM is based on concepts knowledge that the user acquires by solving tests and reading the hypermedia pages of the course.
2. The AHM and XAHM system, in which the adaptation depends on the user’s level of expertise about the know concepts of the system domain (which is a subset of all domain concepts).
3. The ISIS-TUTOR, which is a system, intended for learning the print formatting language of an information retrieval system CDS/ISIS/M which uses the overlay model with a set of integer counters.
4. The HYPERFLEX, which is an adaptive hypertext browser. This system asks the user to specify his objectives and plans and uses a connected semantic network.
Table 1. UM Characteristics of Some AHS [12]

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Some Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Knowledge represented by layers, a net of concepts, thus forming a semantics net (Overlay Model)</td>
<td>INTERBOOK, KBS HYPERBOOK, INSPIRE, HYPADAPTER, HYPERFLEX, AHA, ISIS-TUTOR, KN-AHS, ELM-ARTII, ANATOM-TUTOR, METADOC</td>
</tr>
<tr>
<td>Stereotypes of two classification dimensions</td>
<td>METADOC, AVANTI, C-BOOK5</td>
</tr>
<tr>
<td>User Objectives</td>
<td>INSPIRE, HYPLAN, HYPERCASE5, HYPERFLEX, AVANTI, AHA, INTERBOOK, KBS HYPERBOOK</td>
</tr>
<tr>
<td>Prerequisite and experience</td>
<td>AHA, ADAPTWEB, NETCOACH, INTERBOOK</td>
</tr>
<tr>
<td>Preferences</td>
<td>HYPERFLEX, HYPADAPTER, INTERBOOK</td>
</tr>
<tr>
<td>User Interests</td>
<td>INSPIRE, AHA, ADAPTWEB, NETCOACH, INTERBOOK, KBS HYPERBOOK</td>
</tr>
<tr>
<td>History</td>
<td>ADAPTWEB, NETCOACH, INTERBOOK</td>
</tr>
</tbody>
</table>

Many systems use stereotypes for describing the user, for example HYPERTUTOR is a system that only uses stereotypes for describing the user. This system employs exercises to obtain information about the users and uses stereotypes for UM. The student can belong to one of three groups: novice, medium or expert [7, 12].

Many times one method alone does not allow the modeling needs of the system and the combination of diverse methods has to be chosen [12]:

1. ANATOM-TUTOR is a system to teach anatomy. It contains a rule-based user modeling component with operates with stereotypes and weighted rules.

2. ELM-ART – Adaptive Remote Tutor is a system to support learning of Lisp programming language. It uses two UM Techniques: simple overlay.

References:

1. http://www2.sis.pitt.edu/~peterb/InterBook.html
2. http://www.kbs.uni-hannover.de/hyperbook/
model and complex Episodic Learner model. The user’s knowledge is represented by episodes that represent user individual learning history and his behavior and former problem solving situations.

3. INTERBOOK is a tool for authoring and delivering adaptive electronic textbooks on the web. This AHS uses a concept based on the overlay model, but the UM is initialized using stereotypes.

4. AVANTI is a system about metropolitan areas for a variety of users with different needs. This system combines an initial interview, stereotypes and the overlay method to create initial assumptions and then to maintain the knowledge of the user.

UM creation is also be achieved in [8, 12]:

1. UMT: it allows the hierarchical definition of the user type through stereotypes, the definition of rules to infer the UM and the detection of contradictions. The user information received can be classified as invariable or assumptions.
2. BGP-MS: it allows suppositions, represented by logical predicates, on the stereotype of the user or groups of users. Inference is achieved through different types of suppositions to define the user knowledge.
3. DOPPELGÄNGER: a server it accepts user information through hardware and software sensors. Several techniques to collect the sensor data are available. The users can visualize and edit their UM.
4. TAGUS: it allows the definition of a stereotype hierarchy and contains an inference mechanism.
5. UM: a UM toolkit, tries to represent suppositions of the user knowledge, preferences and others. The information is accompanied by a value that represents the confidence level.

4. Learning Styles

The key of constructivism theory is that student must be actively involved in the learning process. It is important that teachers understands that the construction of knowledge acquisition occurs from knowledge that student already possess and differs from Student to Student. The role of the Teachers is now to be a guide for the student [6, 11].

Students learn in different ways and depend upon many different and personal factors [15].

The emphasis in student individual differences is also important in a context to recognize, design and support students activities (tasks). In constructivism learning theory, Students have different Learning Styles (LS). Also, the capacity of adaptation in different social contexts and the constructive social aspect of knowledge must be taken in consideration [6, 11].

Generally, Learning Styles is understood as something that intent to define models of how a person learns. Generally it is understood that each person has a Learning Style different and preferred with the goal to achieve better results. Some case studies
have been proposed that teachers should assess the learning styles of their students and adapt their classroom and methods to best fit each student's learning style [9, 14].

There are different Learning Styles models (based on different psychological theories) such as for example [15]:

1. Models based on personality (Witkin’s and Myers-Briggs Type Indicator);
2. Models based on information processing approach (Schmeck’s and Kolb’s);
3. Models based on Social Interaction (Reichmann and Grasha);
4. Models based on multidimensional factors (Keefe and Dun & Dun).

VARK Strategies is a questionnaire that provides users with a profile of their learning preferences. These preferences are about the ways that they want to access and select information. These models/strategies describe three basic Learning Styles: Visual learning (learn by seeing); Auditory learning (learn by hearing) and Kinesthetic learning or practical (learn by doing) [11].

The model proposed by Kolb is the most commonly used inventory and is based on Piaget’s model on cognitive and learning development [15].

Kolb Learning Styles Model are based on the four stages of the learning cycle: Concrete Experience - (CE), Reflective Observation - (RO), Abstract Conceptualization - (AC) and Active Experimentation - (AE) [9, 14].

From these levels are defined the matrix to allow the classification of the Student Learning Styles (Table 2).

**Table 2. Kolb Learning Styles Matrix [9]**

<table>
<thead>
<tr>
<th>Feeling (Concrete Experience - CE)</th>
<th>doing (Active Experimentation - AE)</th>
<th>watching (Reflective Observation - RO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking (Abstract Conceptualization – AC)</td>
<td>accommodating (CE/AE)</td>
<td>Diverging (CE/RO)</td>
</tr>
<tr>
<td></td>
<td>Converging (AC/AE)</td>
<td>assimilating (AC/RO)</td>
</tr>
</tbody>
</table>

The learning process must take into consideration the individual cognitive and emotional parts of the student. In summary each Student is unique. Student personal progress must be adapted and not generalized and repetitive [6, 12].
5. Platform Development

The platform, PCMAT (Mathematics Collaborative Learning Platform), is a Collaborative Adaptive Learning Tool Based on Progressive Assessment for Mathematics in Basic Schools.

PCMAT is based on AHA! (Adaptive Hypermedia Architecture). AHA is a Web-based adaptive hypermedia system and is able to perform adaptation that is based on the user’s browsing actions. AHA! is an Open Source project built on Java Servlet technology, use XML and XSLT and the database support is mySQL. AHA! provides some adaptation features like for example adaptive content by conditionally including fragments, and adaptive navigation supported by annotating links [17].

The User Model of AHA! is defined through concepts with attributes. The User Model is stored in the mySQL database or in the form of XML files. The authors can influence the possible updates to the UM through the concept structure and the associated adaptation rules.

AHA! Domain Model consists of a set of concepts, with associated attributes and adaptation rules. Most concepts are associated with pages.

AHA! can grant mechanisms for inferring the learner’s preferences corresponding to an specific learning styles.

The Adaptation Model of AHA! describes how to update the user model and how to generate the adaptation based on User Model and the Domain Model. This Adaptation Model is the base for the adaptation rules.

5.1. Definition of our Platform

The learning platform developed is based on a constructivist approach, assessing the user knowledge and presenting contents and activities adapted to the characteristics and learning style of the student (Fig. 1).

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**Fig. 1. Framework Initial Page [11]**
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Also, the platform allows the students and teachers to autonomously create and consolidate knowledge, with permanent automatic feedback and support, through instructional methodologies and educational activities explored in a constructivist manner [11].

The adaptation of the application is based on progressive self-assessment (exercises, tasks, etc.). The scheme is set by the teacher but is individualized to each student’s level of knowledge, competences, abilities and learning path. The platform is also connected to tutorials that are contextually accessed by the students when they fail a progression step.

One of the goals of the project is to define and to evaluate the characteristic of the User Model to be used in the Student Model. For the definition of the student characteristics to be stored, the application takes into account the Domain Model and the constructivist approach.

With the objective to consolidate the knowledge of the student, our system is able to make permanent automatic feedback and support, through instructional methodologies and educational activities explored in a constructivist manner.

In addition, the platform can adapt the use of learning objects in accordance to the constructivist analysis of the student and his performance. The use of user profile is very important to do not generate questions, tasks, etc. related to knowledge that has not yet been presented to the learner. The constructivist approach is also used to suggest some references to the student according to the response of the progressive self-assessment (exercises, tasks, etc.) [11].

For the definition of the Adaptation Model, we are using the student characteristics in the User Model. With these features, it is possible to define the concept graph by each user in order to use the Adaptation Model. The path used in the graph is defined from the interaction with the student using an progressive assessment, from the representation of the student knowledge defined by the Overlay Model and from the user characteristics store in the UM.

In order to evaluate the system, one Basic School was used. The course chosen was “Direct Proportionality” (mathematics) (Fig. 2) [11].
The student must access the platform in a classroom adapted for this effect two sessions for week with the duration of two hours each. During the sessions, teacher provides guidance to students. Additionally, the students have more four hours for week from any local with access to Internet.

All the privacy aspects are considered in account in the application.

5.2. System Architecture Definition

The system architecture is based on some strategies already used for the implementation of Adaptive Hypermedia System (AHS), like for example the [17]:

1. Dexter Model;
2. Amsterdam Hypermedia Model (AHM);
3. Adaptive Hypermedia Application Model (AHAM) or;

The architecture used for the implementation of the system is almost the same referred by De Bra [5] and the architecture used to build the UM is the same used by Benyon [1] (Fig. 3).

Therefore, in our system, the user requests an assessment by clicking on a link in a Web page (Fig. 4). Every assessment/page corresponds to a "concept" in the domain model and the user model (which is an overlay model). The system checks the suitability of the requested page for the current user. The adaptation rules used to check if the page is suitable are defined in the adaptation model. Updates to the User Model are inferred from the interaction between the user and the application. The correct or wrong answers of the user allow the system to estimate the user’s knowledge level about the concept related with the requested content.
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Fig. 3. Architecture of the System

Fig. 4. Link Interaction
5.3. Student Model Implementation

Two different types of techniques can be used to implement the Student Model: Knowledge and Behavioral based [8, 11]. The Knowledge-Based adaptation typically results for data collected through questionnaires and studies of the user, with the purpose to produce a set of initial heuristics. The Behavioral adaptation results from monitoring of the user during his activity [12].

The use of stereotypes allows to classify users in groups and generalizes student characteristics to that group [11, 12]. The definition of the necessary characteristics for the classification in stereotypes must take into consideration the granularity degree wished [12].

The Behavioral adaptation can be implemented in two forms: the Overlay and the Perturbation methods [12]. These methods relate the level of the student knowledge with the learning objectives/competences that the student is supposed/intended to reach [12].

The approach used to build the User Model (UM) is the Stereotype Model with the overlay model for the knowledge representation of the student.

The user modeling process starts with the identification of the user subgroup (using for example questionnaires and Learning Styles), then the identification of key characteristics (which one to identify the members of a user-subgroup), and finally the representation in hierarchical ordered stereotypes with inheritance.

The user plan is a sequence of user actions that allows him to achieve a certain goal. The System observes the user actions and tries to infer all possible user plans. This goal is possible because our system has a library of all possible user actions and the preconditions of those actions.

A large number of criteria can be established in the Stereotype definition depending on the adaptation goals [11].

The definition of the characteristics of the student will take into account the Domain Model and the constructivist approach of the application. For example, table 3 presents a generic profile which includes the name, age, knowledge, academics background, deficiencies and the domain of the application. In the psychological profile, the learning style, cognitive capacity and traces of the personality of the student will be stored. In the Domain Dependent Data, the objectives, result of assessments and aptitude of the user will be followed.
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Table 3. Characteristic Used in the SM

<table>
<thead>
<tr>
<th>Model</th>
<th>Profile</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Independent Data</td>
<td>Generic Profile</td>
<td>Personal information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demographic data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academics background</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qualifications</td>
</tr>
<tr>
<td></td>
<td>Psychological profile</td>
<td>Knowledge (background knowledge)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deficiencies: visual or others</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Application Domain</td>
</tr>
<tr>
<td>Domain Dependent Data</td>
<td>Objectives</td>
<td>Learning style</td>
</tr>
<tr>
<td></td>
<td>Planning / Plan</td>
<td>Cognitive capacities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traces of the personality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inheritance of characteristics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A context model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aptitude</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deadline extend</td>
</tr>
</tbody>
</table>

The tools used to collect data are:
1. For the Domain Independent data: Questionnaires, certificates and C.V.;
   Learning Styles, questionnaires and Psychological exams;
2. For the Domain Dependent Data: Questionnaires and exams;
3. For the definition of the Learning Styles of the student we are using the

5.4. Overlay

In this method, the user knowledge is related, layer to layer, to the Domain Model,
producing the user knowledge model [12]. The expression of the knowledge level of
each concept is dependent on the Domain Model itself: this value can be binary
(knows or ignores), qualitative (good, average, weak, etc.) or quantitative (the
probability of knowing or not, a real value between 0 and 1, etc.). In the platform the
value used is binary.

The student knowledge is a subset of the system knowledge. The system does not
allow representing the incorrect knowledge that the student acquired or might have
acquired. This solution demands great flexibility in the student knowledge model for
each topic [2].

In addition, this method requires that the Domain Model represents individual
topics and concepts. Its complexity depends on the granularity of the Domain Model
structure and on the estimate of the student knowledge, acquired through the analysis
of the student’s readings and assessments. This type of model is very flexible and capable of representing different domains.

5.5. Domain and Adaptation Models Development

The Domain Model represents concept hierarchies and the related structure for the representation of the user knowledge level (quantitative value).

The Domain and Adaptation Model use the student characteristics from the User Model (UM). The knowledge about the user, represented in the User Model, is used by the Adaptation Model to define a specific domain concept graph, adapted from the Domain Model, in order to address the current user needs.

The path used in the graph is defined by:
1. The interaction with the student using a progressive assessment;
2. The student knowledge representation defined by the Overlay Model;
3. The user characteristics in the UM.

The system adaptation (adaptation to content or links) to the user can produce user model updates as well.

The results of Domain and Adaptation Models achieve are:
1. The development of the concept graph by each user to use in the Adaptation rules;
2. The Definition of the Adaptation Model using the characteristics of the student in the User Model.

5.6. Interaction Model

The Interaction Model represents and defines the interaction between the user and the application [11].

In the Interaction Model, the system presents the functionalities to change the content presentation, the structure of the links or the links annotation with the objective to allow the student to reach the learning goals proposed in their training [5]. To guide the user to the relevant information and keep him away from the irrelevant information or pages that he still would not be able to understand, it is used the technique generally known by link adaptation (Hiding, disabling, removal, etc.). Also, the platform supplies, in the content (page), additional or alternative information to certify that the most relevant information is shown. The technique that is used for this task it is generally known by content adaptation.

Next, one example of a content adaptation code is presented:

```xml
<p>Seja Bem vindo <b><variable name="personal.name" /></b> </p>
<if expr="PROPDIREC.historiasedatas.knowledge&gt;15"> <block>de volta</block> </if>
ao Curso de Proporcionalidade Directa.
</p>
</p>
```
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The constructivist approach is also in the sense to suggest references and activities to the student according with the response of the progressive self-assessment exercises, tasks, etc. [11].

6. Some Results

The first version of the framework presented in previous section, was already implemented, tested and evaluated in learning processes in mathematics basic schools. The collected evaluation data has showed a very high degree of interest and motivation from students and teachers alike, resulting from its use. Students also perceive this tool as very relevant for their learning, as a self-operating application to be integrated in a more global learning strategy that includes also tutoring (direct contact with the teacher) and peer learning. Teachers agree with these definitions of the platform, as well [11].

Another result is the definition of a new strategy and architecture for the implementation of an Educational Adaptive Hypermedia platform in basic schools in Portugal [11].

The capacity of adaptation of these tools in relation to the different needs and the diversity of the background of each student is necessary for bigger effectiveness and efficiency of the learning process. The increased responsibility of the student in the education process, is in accordance with the individualization and adaptability of learning process proposed in. It will be also possible to introduce more responsibility to the student in his learning process, namely in the individualization and adaptability of learning.

The main result of the present development is the validation of a reference picture for the user model that will support new adaptive functionalities based on the use of learning objects to truly support a constructivist learning and cognitive path [11].

The definition of the characteristics of the student to be stored and the selection of the techniques of the Overlay Model and stereotype for the representation of the user knowledge’s in the UM and the Adaptation Model were defined. The number and type of characteristics to use depend on the finality of each system, but some relevance is in the cognitive part, learning styles and student knowledge [12].
At present, our research of the Student Model and AHS, goes in the direction to make possible the reuse of each student model in different systems. The standards are more and more relevant for this effect, allowing the systems to communicate and to share data, components and structures, at syntax and semantic level [4], even if most of them still only allow syntax integration [3, 5, 11].

Also in the next year, the system will be evaluated in others courses.

7. Conclusion

In the scientific area of User Modeling, numerous research and developed systems already seem to promise good results [10, 12], but yet some experimentation and implementation are still necessary to conclude about the utility of the UM. That is, the experimentation and implementation of these systems are still very scarce to determine the utility of some of the referred applications.

In the educational AHS, emphasis is put on the student knowledge related with the domain application, in the sense of making the most effective adaptation and allowing the student to reach his objectives [4].

The analysis, application, implementation, integration and evaluation of techniques used to adapt the presentation and navigation in educational AHS, using metadata for the learning objects and user modeling, etc, will contribute to improve the value and implementation of e-learning in Basic Schools, in a way to make possible the educational process more adaptive to the student learning style.

The capacity of the adaptation of these tools, considering the different necessities and the diversity of individual information source of each student will be necessary, namely for more and more efficiency learning process. It will be also possible to introduce more responsibility to the student in his learning process, namely in the individualization and adaptability of learning.

Also, the application of diverse adaptive techniques in an integrated way for the development of learning tools with constructivists characteristics, will be not only an important alternative, but also a new solution/innovation for the learning systems development.

References

Educational Adaptive Hypermedia Platform Based on Progressive Assessment and Adapted to the Characteristics and Learning Style of the Student

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