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Adapte, a tool for the teacher to personalize activities

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Abstract. In the context of the personalization of learning, we want to provide teachers generic tools enabling them to personalize activities they offer learners. The PERLEA project aims to conceive a system enabling teachers to manage existing learners' profiles. In this system, the Adapte module proposes activities suited to the abilities highlighted by their profiles. These activities are either paper and pencil worksheet or activities on an ILE. This paper presents the principles of the Adapte module, its architecture and the implementation which we have done.

Keywords: Personalization of learning, models of learners, generation of activities, teacher's tool, system architecture, knowledge bases.

1 Introduction

One of the issues of the research on Interactive Learning Environments (ILE) is the personalization of learning. This personalization mostly use learners' profiles assembling information about learner, collected or deduced from one or several pedagogical activities, computerized or not. We consider that these profiles can concern his knowledge, abilities, conceptions and/or his behavior [4].

The personalization of learning, in the context of classic teaching or in the context of the ILE, can concern the interactions between the teacher / the environment and the learner as well as pedagogical activities offered to the learner. We focus on the second point within the research we present here.

In order to personalize pedagogical activities offered to the learner using a learner's profile, we can either use knowledge based systems to generate pedagogical activities the most suited to the profile, or provide to the teacher tools enabling him or her to realize this work himself or herself. We wish to associate these two solutions in Adapte, a module of the PERLEA project.

After the presentation of a utilization *scenario* of Adapte, we will present the PERLEA project and its software environment. Then we will describe more precisely the Adapte module showing that it can help teachers and how. We will detail its architecture and then present the implemented version of the software. We will conclude with our research perspectives on this work and more generally on the PERLEA project.

1.1 Scenario of utilization

A teacher uses in his classroom an ILE on geography with his eight-year-old pupils. This ILE produces at the end of the learning session a profile of each learner. In addition, the teacher has organized for all his students the national assessments of the beginning of the year. These assessments produce a diagnostic on the achievements, mistakes and difficulties of each learner in mathematics and French.

Thus, the teacher has for each pupil several profiles from different sources, ILE and pencil and paper, and for several disciplines. He or she wants to use globally these profiles to provide, for each pupil, personalized exercises sheets. These sheets enable learners to work with autonomy on several disciplines. The teacher also wants to define parameters of the ILE on geography in order that it proposes sessions suited to each learner's profile.

Currently teachers cannot easily complete this scenario successfully. Actually, no tool exist enabling teachers using data from ILE externalizing their learners' profiles, and no tool exists either enabling linking this data to the pencil and paper profiles managed by the teacher. In addition, teachers can produce personalized exercises sheets but teachers have to either create exercises themselves, or take existing exercises and manually adjust to their needs and their working methods. They also have to decide, for each student, exercises to put in his sheets. This work requires a great involvement from the teacher. Finally, ILEs are customizable either through the model of learner they contain [1], [5], [7], [8], or through an administrator interface [3] ,[6]. In the first case, ILE offer sessions suited to learner's profile but the teacher cannot step in the choice of system. In the second case, the teacher defines himself or herself the parameters of sessions proposed to the whole class or to each student. As when creating worksheets, when the teacher personalizes an ILE session, he or she has to decide what kind of activity should be provided to each student. Thus, we observe that according to ILE, either the teacher cannot step in the proposed sessions, or he or she has to provide an important work to personalize it.

1.2 The PERLEA project

The PERLEA project aims at improving the integration of ILEs in education by providing links between the use of ILEs and teachers' everyday practices. In order to do so, we are interested, in a generic way, in the profiles of learners and their utilization *a posteriori* for the management of learners and the personalization of learning [4].

Then, we want to develop an environment that would enable teachers to manipulate existing profiles. This environment has two phases: the integration of existing profiles and the management of these restructured profiles.

In order to explain this mechanism, we take the example of our teacher with profiles from the ILE geography and profiles from national assessments of mathematics and French. Reusing profiles requires knowing their structure. The teacher defines thus a unique frame of profiles describing information contained in the two types of profiles. This profiles frame contains information on the three disciplines. Next, the teacher specifies to the system how to convert automatically

profiles of ILE to get the data of geography, and includes information on the mathematics and French. At the end of the integration phase, the teacher has a unique profile for each of his students.

The second phase of the environment proposes rich utilizations of profiles created. One of these utilizations is made by the Adapte module proposing to learners activities suited to their profiles. These activities can be worksheets generated by the system or computerized activities managed by an external ILE.

2 Principles of the Adapte module

2.1 What help for the teacher?

The role of the Adapte module is to provide to learners activities suited to their profiles. These activities can be paper and pencil exercises or computerized activities managed by an external ILE.

In the case of paper and pencil activities, Adapte produces a worksheet corresponding to the profile of each learner. For this purpose, it generates exercises contained in the sheet and determines the size and/or duration of the worksheet. It also provides to the teacher answers of exercises contained in the sheet.

In the case of computerized activities, there are three *scenari* depending on how the ILE is customizable: definition of the parameters of ILE by Adapte if it is possible; definition of an instruction sheet by Adapte, for the teacher, to set ILE thanks to an administrator interface; definition of an instruction sheet by Adapte, containing a list of exercises that the student will have to do on the ILE, if this ILE is not customizable. In all cases, Adapte sets personalized sessions on the ILE according to the learner's profile. It uses exercises generators of the ILE or chooses exercises in the database of the ILE. It also determines the order of exercises, their number and the duration of the session.

2.2 What sort of expertise the teacher provides to Adapte?

In order to assign worksheets to a student, we have to help the teacher in his pedagogical work and then to acquire his expertise to integrate it into the system, but without taking his place as a teacher in the classroom. So we worked with teachers to know their teaching practices and we identified with them the rules they use to assign a type of exercise to an element of the profile.

Thus, in Adapte, the teacher specifies its own teaching strategies. For this purpose, the teacher creates activities frames containing a set of constraints to generate or to select an activity (paper and pencil activity or computerized activity). After creating an activities frame, the teacher defines constraints on part of the learner's profile. The link between a part of the profile and one or more activities frame is called assignment *criterion*. The teacher defines a teaching strategy for a teaching situation by organizing these assignment *criteria* into a hierarchy according to their importance.

Let us go back to our teacher example. The teaching strategy, that he or she will define for creating paper and pencil worksheets, will contain all the assignment *criteria* on the three sections of learners' profile (mathematics, French, geography). Thus, the teacher specifies, in mathematics for example, that if a student has difficulties with additive word problems, then he or she will have to solve additive word problems with small numbers and short sentences. However, if a student has good results with additive word problems, then he or she will have to solve exercises with large numbers, with calculations which requires the use of carry over and with phrases unnecessary to the resolution of the exercise. These *criteria* really do a link between the learners' profiles (mastery of such competence) and an activities frame (all the constraints to generate exercises on the additive word problems). The assignment *criteria* enabling to personalizing the ILE on geography will contain activities frames. Constraints on these activities frames will enable to choose, within the exercises database of ILE, what exercise to propose to pupils. These activities frames can as well contain constraints to generate new exercises with the generator integrated to the ILE on geography. These assignment *criteria* concern, in the profile, data on geography, but also data on mathematics and French in order to consider, for example, difficulties for some students to read or to calculate.

After defining his teaching strategies, the teacher specifies his teaching situation by defining constraints which enable having worksheets corresponding to his needs for the whole class. He or she can, for example, specify to the system that he or she wishes worksheets for an hour study, or that he or she wants sheets containing three exercises.

Finally, when Adapte has generated worksheets, the teacher can modify it either requesting a new version of an exercise, if the proposed values do not satisfy him or her, or deleting or adding exercises. Likewise, he or she can change the personalization proposed for the ILE.

2.3 What are the theoretical and technical needs of Adapte?

Adapte must be able to create or select activities appropriated to each learner to be added in the worksheet or in the session proposed by an ILE.

Concerning paper and pencil activities, it is necessary to generate them rather than to choose them in a database, in order to have enough variety of problems and to have questions specifically thought for each learner. So we listed the exercises that teachers from primary and secondary schools give to learners, for all disciplines, and identified a typology of exercises. From this typology, we proposed a set of semi-automatic generators that can generate exercises with or without intervention of the teacher [2].

To personalize an ILE, Adapte requires a set of didactic knowledge (discipline, level, competences involved ...), as well as a set of technical knowledge (position of files, existence and use of a generator exercises...) on this ILE. This knowledge is specific to each ILE and must be provided by an expert or by the ILE designer.

So that Adapte can propose activities adapted to the learners' profile, we have just seen that the system needs to know teaching strategies, specific to each teacher, on a profile with a given structure and to know how to generate or to choose activities to propose to learners. We also have to define the mechanism enabling Adapte to apply

these teaching strategies to each profile. So we have given it a set of knowledge to evaluate the assignment *criteria* contained in the strategies according to each profile. These knowledge enable to create consistent paper and pencil worksheets i.e. to create worksheets, from generated or selected exercises, respecting the constraints of time, page setting... Finally, this knowledge enables to personalize an ILE in creating valid sessions. All of this knowledge is independent from the domain of the work provided to the learner and is also independent from the ILE the teacher wishes to personalize.

3 Architecture of Adapte

Now that we have clarified what Adapte needs to run, we will present its architecture (cf. Fig. 1). Adapte has several knowledge bases that we present to explain their contents.

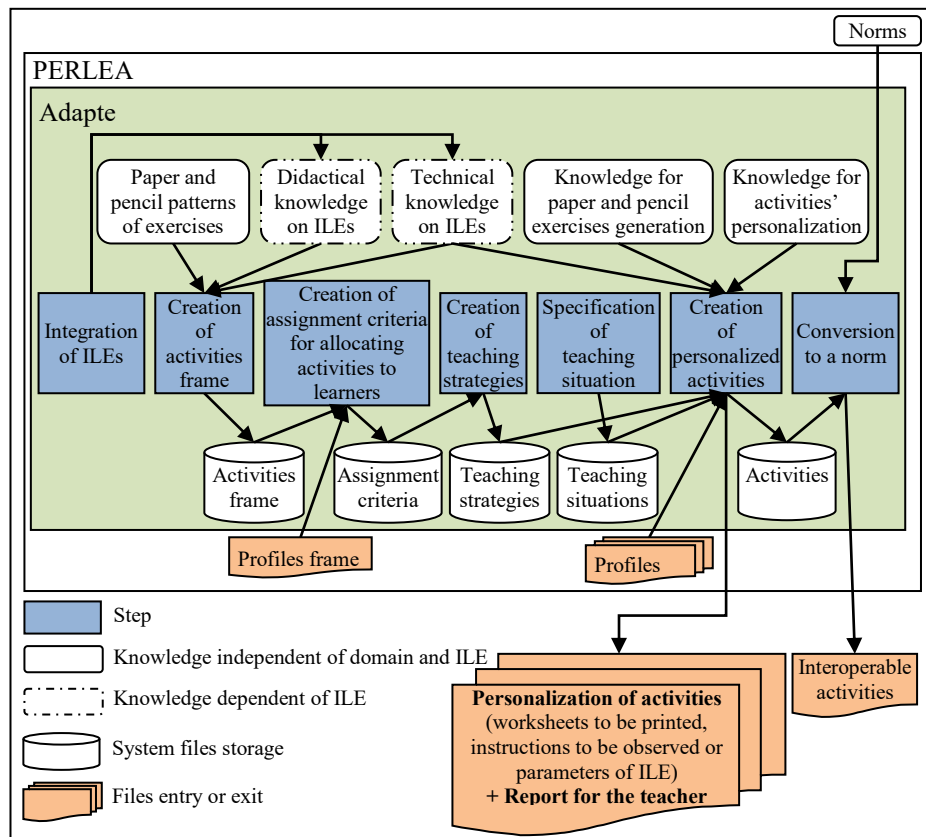


Fig. 1. Architecture of the Adapte module.

Paper and pencil patterns of exercises. An exercises pattern contains a theoretical definition of a class of exercises frame. An exercises frame contains all the constraints to create an exercise of a particular type. Currently, we have identified eight exercises patterns. These exercises patterns are independent of the domain for which we want to generate an exercise. They will be used to generate exercises frames that are dependent of the domain.

Knowledge for paper and pencil exercises generation. This knowledge includes the eight semi-automatic generators to create paper and pencil exercises. These generators use exercises patterns in order to know the structure of exercises that can be generated. Each generator contains knowledge of the domain of the generated exercise (e.g. knowledge of calculation for the exercises of mathematics) and general knowledge independent from the exercise domain (e.g. a dictionary of synonyms for varying exercises or grammatical rules to generate exercises with natural language).

Didactical and technical knowledge on ILEs. This knowledge is different for each ILE and thus for each domain. The didactic knowledge contains anything related to what is taught in the ILE (discipline, competences worked ...). The technical knowledge specifies how to act on the ILE to personalize it (position of files, generators available, exercises bases...). There is a link between these two types of knowledge for linking, for example, an exercise of a database to competences that this exercise needs. All the knowledge about the ILE to personalize should be provided to Adapte by an expert or by the designer of the ILE.

Knowledge for activities' personalization. A personalization of activities contains, depending on the use of Adapte, either the worksheet to be printed, or parameters that enable the personalization of an ILE. It contains, in addition, a report for the teacher saying him or her what is proposed to the learner (the exercises, working time planned...). The knowledge to create a personalization of activities contains the rules for creating a paper and pencil worksheet based on exercises generated or for creating personalized sessions on an ILE. This knowledge is independent of the domain and independent of the ILE that we want to personalize.

From this knowledge, Adapte, with the help of the teacher, can propose activities adapted to the learners' profiles. For this purpose, the teacher defines its teaching strategies by creating a set of assignment *criteria*. These assignment *criteria* use the activities frames contained in the system or defined by the teacher. Then the teacher specifies his teaching situation and the system creates personalized activities. We will now go back on every step of Adapte enabling this mechanism.

Integration of ILEs. This step is made by an expert or by the designer of the ILE to personalize. It enables, for each ILE, to integrate the necessary technical and didactical knowledge. It is required so that Adapte can personalize an ILE but it is done only once.

Creation of activities frame. This step is made by the teacher to define exercises corresponding to his working habits. For paper and pencil part of Adapte, the teacher chooses an exercises pattern (i.e. a type of exercise) and defines the constraints he or she wishes so that the system generates exercises that satisfy him or her. For the personalization of ILE, the teacher defines the constraints of exercises generation when ILE to personalize contains a generator, or defines the constraints to select an exercise in the system databases. All these constraints are saved in an activities frame.

Creation of assignment *criteria* for allocating activities to learners. This step is made by the teacher and enables him or her to make a link between parts of learners' profiles and activities frames. The parts of profile are selected and are constrained in order to choose students with a particular problem or competence. For example, the teacher will choose in the learner's profile the competence "Mastering the rules of punctuation," and will provide a type of exercise for students with a success rate between 0 and 25%, another type of exercise for those with a rate between 25 and 75%, and nothing for students with a rate higher than 75%.

Creation of teaching strategies. This step is made by the teacher and enables him or her to choose the assignment *criteria* he or she wishes to use. It also enables him or her to order these *criteria* by providing a level of importance. This level of importance is used in cases where the system cannot choose between two exercises to provide to the learner. The system will provide in priority activities associated to the *criteria* with a high level of importance.

Specification of teaching situation. This step is made by the teacher and composes two parts. First, the teacher specifies the learners' profiles for which he or she wishes to obtain personalized activities. Secondly, the teacher defines the constraints enabling to "limit" the worksheets or the ILE's sessions. In our situation, "to limit" means to specify the duration of the working session, a maximum number of exercise, etc.

Creation of personalized activities. This step is made by the system from learners' profiles, teaching strategies defined by the teacher and knowledge relating to either the creation of a paper and pencil worksheet, or the creation of a session on an ILE. After Adapte has proposed its selection of personalized activities, the teacher can validate or modify the choice of the system.

Conversion to a norm. This step is optional in the mechanism of Adapte. It enables converting paper and pencil exercises, generated by Adapte, to a given norm, to enable their exchange with other systems.

All these steps were defined to enable Adapte to provide paper and pencil worksheets or to personalize an ILE. We will in the next section illustrate them introducing the part of Adapte enabling creating personalized paper and pencil activities.

4 Implementation and evaluation of the Adapte software

A first part of the software has been developed to enable teachers to fully apply the desired approach of Adapte. This part implements the results proposed for the part of paper and pencil software i.e. the part which propose worksheets for learners.

When using the software, the teacher defines its teaching strategies specifying his assignment *criteria* for allocating an exercise to one or several competences of the learner's profile. Let us go back to our teacher example. He or she defined a profiles frame containing knowledge on French, mathematics and geography. Now, he or she defines in Adapte assignment *criteria* so his students can work on their weaknesses. We can seen on the *criterion* of Fig. 2 that the teacher has selected the knowledge "France – Its main cities" and that he or she has specified that he or she wishes to make work the students whose values for this knowledge are "not mastered". He or she associated with this constraint on the learners' profiles the exercises frame "D14_Put_cities_in_France.xml". To do that, he or she had chosen an exercises pattern, "Work on illustration", from the eight patterns of Adapte and defined constraints to generate an exercise corresponding to his wishes. These constraints indicate that the illustration is a map of France, that the fields to be filled are the cities of France, that the exercise must contain at least ten fields necessarily Paris, Lyon and Marseille, etc.

The teacher defines several constraints illustrating his pedagogical objectives. These constraints compose its teaching strategy. A part of his strategy is provided in Fig. 2.

<i>Criterion 1: No mastery of French cities</i>
<ul style="list-style-type: none"> - Knowledge: Geography - France - Its main cities - Values: not mastered - Exercises frame: D14_Put_cities_in_France.xml
<i>Criterion 2: No mastery of additive word problems</i>
<ul style="list-style-type: none"> - Knowledge: Mathematics - Exploitation of numeric data - Additive word problems - Values: X between 0% and 50% - Exercises frame: F18_Additive_word_problems_Low_level.xml
<i>Criterion 3: Mastery of additive word problems</i>
<ul style="list-style-type: none"> - Knowledge: Mathematics - Exploitation of numeric data - Additive word problems - Values: X between 50% and 100% - Exercises frame: F19_Additive_word_problems_Hard_level.xml

Fig. 2. Teaching strategy defined in Adapte

Then, the teacher chooses a set of learners' profiles, and specifies that he or she wants for each student a worksheet containing two exercises. The system produces as many

personalized worksheets that there are profiles. In order to do so, the system will evaluate the assignment *criteria* functions of profile's data of each student. For example, look at the case of Boris and Charles whose profiles are provided in Fig. 3. We can see that Boris does not master the placement of main cities in France on a map and has a success rate of 45% to additive word problems. According to the teaching strategy in Fig. 2, we will provide a worksheet containing a exercise generated through the exercises frame "D14_Put_cities_in_France.xml" and a exercise generated through the exercises frame "F18_Additive_word_problems_Low_level.xml". We can also see that Charles knows the cities of France and has a success rate of 95% to additive word problems. Its worksheet will contain two different exercises generated through the same exercises frame "F19_Additive_word_problems_Hard_level.xml".

<pre> <profile name="Boris"> <brick name="Geography"> <component name="France"> <under_component name="Its situation in a map"> <value>Mastered</value> </under_component > <under_component nom="Its main cities"> <value>Not mastered</value> </under_component> </ component > ... </brick> < brick name="Mathematics"> < component name="Exploitation of numeric data"> <under_component name="Additive word problems"> <value>45</value> </under_component> ... </ component > ... </ brick > </profile> </pre>	<pre> <profile name="Charles"> <brick name="Geography"> <component name="France"> <under_component name="Its situation in a map"> <value>Mastered</value> </under_component > <under_component nom="Its main cities"> <value>Mastered</value> </under_component> </ component > ... </brick> < brick name="Mathematics"> < component name="Exploitation of numeric data"> <under_component name="Additive word problems"> <value>95</value> </under_component> ... </ component > ... </ brick > </profile> </pre>
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Fig. 3. Profiles of Boris and Charles.

Finally Adapte shows to the teacher the worksheets assigned to each of his students. The teacher can modify them either deleting or adding exercises, or requesting another version of one of the exercises. Then, he or she can print it to provide it to his students.

The conception of the Adapte module has been made in partnership with teachers and as the software is now usable, we have submitted it to these teachers. Then a teacher outside of the PERLEA project has tried the software. Their feedbacks seem to validate the software and the architecture defined.

5 Prospects

We presented in this paper the conception work that we have undertaken on the Adapte module. This module offers to learners activities suited to their profiles. A first version of the software implements the results suggested for the generation and assignment of paper and pencil activities. This software enables teachers to realize the full approach proposed by Adapte. However, it includes only three generators fully developed. Before finishing its implementation, we want to work with experts from education sciences to validate our typology of exercises and therefore all the exercises generators.

Currently, we have focused our work on the part of Adapte suggesting sessions adapted to the competences of the learner on an external ILE.

When Adapte will be fully implemented, we will put in place most rigorous evaluations of our results. These will be done by experiments with many teachers unrelated to the conception of the module. These experiments will involve all concerned modules of the PERLEA project's environment, and from the definition of a profiles frame by the teacher to the effective use of personalized activities by learners.

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