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In this paper, we first define the concept of student's profile, necessary to present PERLEA project, theoretical framework of our work. We then present EPROFILEA environment, developed from PERLEA results. We illustrate this paper with a scenario of profiles reuse and an experimental device implementing the different steps of EPROFILEA project.

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1. Introduction

Most of ILE (Interactive Learning Environments) are to be used by the learner to promote his learning. Some of them are aimed at teachers to help them in their teaching task: the ITAS (Intelligent Teaching Assistant Systems) [17]. Our research mainly concerns this last trend, by treating the question of the reuse of existing learners' profiles by the teacher and of the exploitation of these profiles by all actors of the learning situation. This theoretical research is conducted within PERLEA project and is applied through EPROFILEA environment, which proposes a set of tools allowing to reuse and to exploit learners' profiles for all disciplines and all levels.
In this paper, we begin by presenting an example of scenario of learners' profiles reuse by the teacher and by proposing a definition of the learners' profiles concept. We then present PERLEA project, and EPROFILEA environment, by revisiting the proposed scenario from this ILE point of view. We follow by presenting an experimental device tested with 32 ten-year-old learners in a self-assessment framework.

1.1. Scenario of remedying activities in problem solving

A teacher uses in his classroom an ILE for additive word problems with his eight-year-old pupils. This ILE produces at the end of the learning session a profile for each learner. In addition, in order to track the evolution of his pupils' learning, the teacher organizes a set of pencil and paper problem solving activities. So, he has for this domain several profiles from different sources, ILE and pencil and paper, for same pupils. The teacher wants to merge these profiles keeping their content, but reorganizing them, in order to have one profile in problem solving for each pupil. The teacher will also form, from these profiles, a class's

profile gathering all data concerning learners' profiles, in order to identify pupils who have great difficulties in solving problems. The teacher notices seven learners encountering difficulties, two of whom, after discussion with them, need remedying activities. He will so create customized exercises for these both learners.
Currently teachers can't easily complete this scenario successfully. Actually, no tool exists allowing teachers reusing and exploiting data from ILE externalising their learners' profiles, and no tool exists either allowing linking this data to the pencil and paper profiles managed by the teacher. In addition, some tasks (discussion on the profiles between learners and teacher, setting up of class's profiles, creation of customized exercises) are certainly feasible, but requires a great involvement from the teacher.

1.2. Learners' profiles

There are many learners' profiles in the education process, from primary school to university and adult continuing education. These profiles can come from ILE or from paper-pencil source, they concern any subjects and any school levels. We propose here a learners' profile definition, before showing the diversity of this notion.
Learners' profile definition. A learner's profile can be defined as information concerning a learner or a group of learners, collected or deduced from one or several pedagogical activities, computerized or not. Information contained in the learner's profile can concern his knowledge, abilities, conceptions or his behaviour. We prefer to speak of learner's profile than learner's model, because the information contained in the learner's profile are a partial and subjective view of learner's knowledge and not an exact view, as implies the term of model coming from Artificial Intelligence research domain. Learner's profiles can come from different sources, different persons can be at the origin of their creation and these profiles contained various types of information.
Profiles sources. Learners' profiles come from various origins: some of them come from an ILE relying on a learner's model, others are paper-pencil profiles. Some ILE constitute learners' profiles, more or less elaborated, from a set of learners' activities. Among these ILE, several produce open learners' models [16]. Teachers, learners or another ILE can so reuse these learners' models. The learners' profiles coming from a paper-pencil source, result for example from a classical test created by a teacher, in the aim to evaluate their learners' knowledge or gaps.
Persons at the origin of the learners' profiles creation. Learners' profiles can be created at the request of different actors of the learning process. A teacher can want to collect data concerning the learner in the aim to track his learning evolution. He can create a pencil and paper test concerning a specific subject. In addition, the teacher can reuse a profile of this learner coming from an ILE treating a complementary subject. Some school institutions can be at the origin of the learners' profiles creation, in order to track the evolution of all the learners of the institution' learning and to have a general view of the learners' knowledge. Finally, in a context of self-assessment, the learners can be at the origin of their profiles by using an ILE making an assessment of their knowledge and abilities.
Learners' profiles content. First, we can differentiate learners' profiles in two classes. The profiles of use correspond to the learners' behavioural model [18]. They contain information about the learners' use of the software, as the activity achievement time or the trails of the learners' route in the activity. The conceptual profiles correspond to the learners' conceptual model [18] and represent the learners' knowledge. Subsequently, we can differentiate the learners' profiles content by the nature of the concerned information. Some of them concern learners' knowledge; other information concerns their abilities, their know-how or their behaviour. Finally, the form of this information can be a mark associated with an ability, an assessment, a metacognitive commentary, etc.

Learners' profiles representation. Various representations can be used for same information contained in a learner's profile. For example, an information associating marks with abilities can be represented in a textual, a digital, a graphical, a hierarchical form [8], or in a conceptual graph form [19] [5].

2. PERLEA project

ILEs designed in research laboratories are still weakly used in classrooms. Whenever they are used, it is generally punctually; those ILEs concern a small part of the instructional program and teachers only use them for a limited number of sessions. In addition, when ILEs produce learners' profiles, these profiles are not reused in competencies management process into the class, despite the interest they represent. This can be explained more particularly by the difficulty to get and to exploit different information coming from various sources. At last, it can exist a great number of various profiles for a same learner: partial photographs of the learner's learning state, each taken at a specific moment.

From these observations, we propose through PERLEA project a way to improve the integration of ILEs in education by providing links between the use of ILEs and teachers' everyday practices. These links take shape of tools helping teachers to merge profiles coming from teachers' practices and profiles produced by ILEs, in order to exploit them together in the classroom. This leads us to treat the question of the reuse of existing digital documents, learners' profiles of our research, and more generally the question of interoperability in ILE. Interoperability is actually concerned on three counts in PERLEA: from one hand with the reuse of digital documents coming from ILE, the learners' profiles, from the other hand the environment we want to propose can redirect the learner to an ILE suited to the difficulties highlighted during his profile presentation. In addition, some ILEs can delegate the exploitation of their profiles to the environment developed in PERLEA project framework. We actually think that it is necessary to dissociate in ILE the diagnosis step from the use of learners' profile step; only the second step is treated in PERLEA.

In PERLEA project, we aim to model the pupils' tracking processes, in particular through the study of profiles use by different actors of the learning situation[1]. We make the hypothesis that an environment based on such a model, offering tools enabling the teacher to reuse learners' profiles and allowing the different actors of the pedagogical situation to exploit these profiles, answers to teachers' needs concerning individualization of teaching and is profitable to these actors. We think indeed that the exploitation of learners' profiles can improve learning, more particularly by proposing metacognitive activities and activities (pencil and paper or computerized) suited to learners' profiles. To complete our project successfully, we work regularly with teachers and pedagogical experts following a suited design method [10]. That is the way we for example identify teachers' practice and needs concerning the use of profiles in their classroom. We will naturally carefully evaluate the pertinence of our model and the real benefits for each type of actors of the developed environment following evaluation methods suited to ILE [14].

This research leads us to study different questions apart from any computerized environment. First we study the use practices and expectations of teachers as regards to profiles and their reuse. We also identify the concerned audience and the benefits of the reuse and the exploitation of learners' profiles for each audience. Then, we have to determine different possible exploitations of learners' profiles allowing integrating in the best way information contained in the profiles in the learning process. The main exploitation consists of a visualization of the information adapted to the target public,

[1] This is one of the issues of Carole Eyssautier's phD Thesis, began in 2003 in Arcade CLIPS-IMAG team in Grenoble, in cooperation with LIRIS in Lyon.

supplemented by activities promoting their appropriation of the profiles. But in the case of the profile presentation to the learner himself, it is interesting to also propose him to negotiate his profile [3][1]. Furthermore, for each public, we will study the specificities of the proposed profiles visualisations: we can't actually propose same information to a teacher and to a learner, or to his parents, as we can't formulate and present it in the same manner. Within our project framework, we study other exploitations of the profiles: the creation of a class' profile from each learner's profile, in order to propose a view of a group of learners' knowledge, the proposition of activities suited to the profiles, the reuse of information contained in the profiles into pedagogical scenarios, or else the share of practices between teachers concerning learners' tracking.

3. EPROFILEA environment

PERLEA project leads to the implementation of an ILE: EPROFILEA (Exploitation of PROFILes by tEachers and leArners) [9]. From one hand this environment aimed at assisting the teacher in his profiles management, whatever the concerned domain, the level and the origin of the profiles (created by the teacher himself or by an ILE). From the other hand, EPROFILEA have to allow the exploitation of these profiles by the different actors of the learning situation. Actors who are most concerned by our environment are teachers who have different profiles for each of their pupils and want to reuse and exploit them. But it is also interesting to allow the learners themselves to view, to manipulate and even to negotiate their profile [15] in order to allow them to know what do the teacher or the system knows or thinks about them [11], in order to become aware of the state of their knowledge, of their weak or strong points [2], what fit into a metacognitive approach [13]. In addition, several institutions, as schools or the Ministry of Education, are concerned by the exploitation of learners' profiles. Learners' profiles can also help families to track their child's learning and to establish a dialogue with the learner as the portfolio encourages to do [6].

EPROFILEA consists in two stages: the setting up of profiles compatible with the environment and their exploitation (cf. Figure 1). Reusing profiles first requires the description of their structure. This description, that we call profiles frame, is done by the teacher in the profiles frames building module, called Bâtisseur (for builder). This module makes operational the profiles description language defined in PERLEA project. This language must allow describing the existing profiles, whether they come from an ILE or they are pencil and paper profiles, whatever the type of information they contain. A first prototype of this module has been developed and is at the moment tested. To fill in the profiles frame built in Bâtisseur in order to make up learners' profiles, can be done in two different manners depending on whether data are coming from pencil and paper profiles or from an ILE. In the case of pencil and paper profiles, EPROFILEA includes an assistant, PROSE (PROfileS keyboarded by the tEacher), helping the teacher to keyboard data of each of his pupils according to the profiles structure defined within BÂTISSEUR. This requires the representation of the keyboarding progression by learner and by profile element. The first developed prototype is at present in a test step. In the case of profiles coming from ILEs, EPROFILEA proposes profiles conversion modules (the "TOURBILLONS", for whirl): interfaces between the ILE and EPROFILEA. At the present time, when a teacher wants to use profiles coming from a new ILE (not already known by EPROFILEA), computer scientists of our team have to develop a new conversion module to be used later by the teacher. To make this step easier, we are developing a module helping an expert teacher to build a new TOURBILLON adapted to the ILE the profiles of which he wants to reuse.

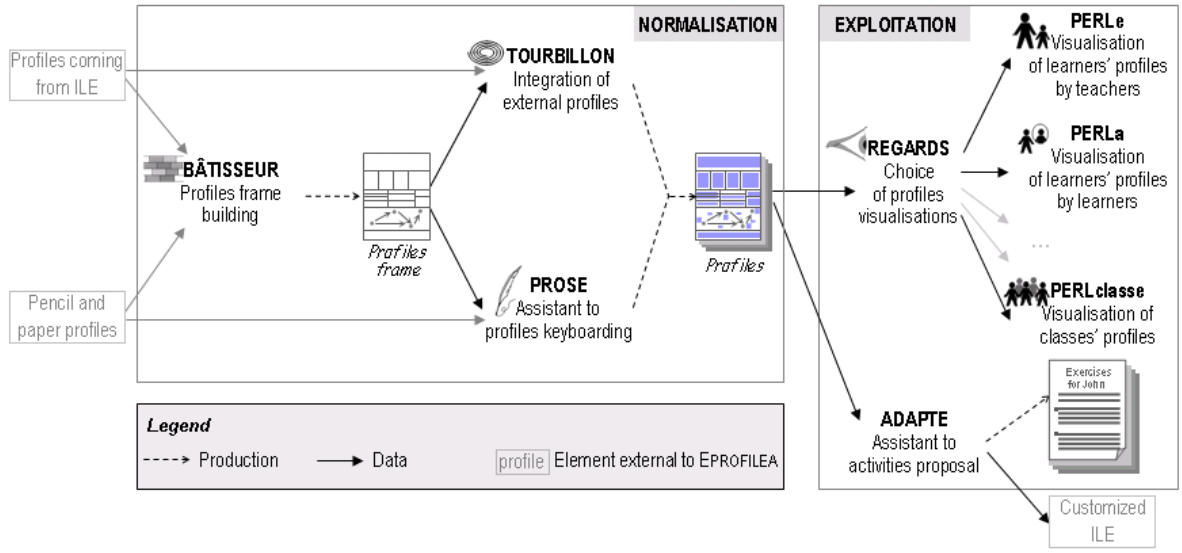

Figure 1: EPROFILEA architecture.

From the resulting profiles, the teacher establishes within REGARDS (for views) module the profiles visualisations that will be proposed to each actor of the learning situation. This module allows establishing different views for one profile: the teacher view, the learner view, the family view… To build these different views, the teacher chooses the parts of the profile that will be available for consultation by the different actors, the vocabulary used, suitable for these actors, and the representation mode (for example graphical, textual or numerical). PERL modules (Profiles of the lEarneRs expLoited) allow an interactive visualisation of the profiles by the different actors of the learning situation according to the view determined by the teacher in REGARDS module. There are several versions of these modules depending on whether the visualisation concerns learners' profiles or class' profiles, and depending on the actors: the teacher him-self (PERLe: PERL teacher), the learners (PERLa: PERL learners), or even the institutions. The design of these modules asks various questions: how to facilitate the taking over of the profiles by the target public? How to represent the different profiles parts corresponding to the different elements of the profiles description language? How to represent the profiles evolution as time goes? How to organise a support to the profile negotiation between the learner and the teacher? In addition, we are planning to conceive and develop a last module, ADAPTE, allowing proposing to learners activities suited to their competencies and suited to knowledge highlighted in their profiles: pencil and paper activities proposed by the system, or computerised activities managed by an other ILE. For this module, we must find a balance between genericity of EPROFILEA environment and disciplinary specificities or depending on the age, the scholar or academic level. We have to identify how far it is from one hand possible and from the other hand desirable to automate the activities creation. This module is from our point of view essential, insofar as it gives means to the teacher to include his work on the learners' profiles with EPROFILEA environment in his class practice into activities suited to the profiles. If first simple prototypes of REGARDS and PERLe have been proposed and are currently been revised, ADAPTE is not treated for now.

Finally, there is a question transverse to all EPROFILEA modules: how to conceive, fill-in and exploit hybrid and progressive profiles including information coming from different sources (pencil and paper or from ILEs), the structure and the contain of which can evolve as time goes (addition of a part to the profiles frame by the teacher or taking into account of the evolution of the learners' competencies during the school year).

4. EPROFILEA THROUGHOUT A SCENARIO OF PROFILES REUSE

4.1. Scenario of remedying activities in problem solving

The scenario of personalisation of solving problems activities in class with eight-year-old pupils permits a new reading of EPROFILEA architecture. First, the teacher describes within Bâtisseur as a profiles frame the profiles he wants to create from the information coming from his everyday class practice from one hand, and coming from the used ILE from the other hand. Supposing that the Tourbillon for additive word problem already exists, the teacher just has to use this module: he supplies it with the profiles coming from the problem solving ILE used by the learners, in order to obtain a version of these profiles compatible with the structure described in the profiles frame. In addition, the teacher assisted by the Prose module fill-in the part of the learners' profiles corresponding to the classical problem solving activities done in class. The teacher chooses the visualisation modes within Regards before to consult the class's profile within PERLclasse. During this consultation the teacher observes for each studied piece of knowledge, not only the class's average mastery, but also the learners list depending on their mastery level. The teacher identifies seven learners for whom he has a doubt concerning their solving problem mastery. He makes more precise observations of these learners' competencies by studying their profile within PERLe and proposes to these pupils to negotiate their profile within PERLa. This further information allows the teacher to conclude that it is still necessary for two among these learners to work in detail problem solving. The teacher finally uses Adapte module to conceive exercises suited to these learners.

4.2. Presentation of a device helping learners to self-assess themselves

We developed and tested in real situation with 32 ten-year-old pupils a device helping learners to self-assess themselves in mathematics [7][2]. This device based on EPROFILEA architecture treats the profiles reuse question, from the profiles description up to their negotiation by learners. The reuse of learners' profiles coming from self-assessment is a very specific case of profiles reuse, but it allows us to verify the feasibility of the project, even in such a specific case.

We set apart two kinds of self-assessments: self-assessments from a knowledge-point of view, or positioning test, and self-assessments from an exercise-point of view, or self-assessment. A positioning test refers to a set of questions concerning knowledge (for example "I know the multiplication technique for decimal numbers"). In that case, the link between the exercises and the content is not obvious for most of learners. A self-assessment refers to a set of questions concerning what the learner managed to do in the exercises (for example, "I managed to do the multiplication in my exercise"). As a statement for this specific work, we postulated that it is easier for ten-year-old learners to self-assess themselves than to do a positioning test. Since learners encountering more difficulties in doing a positioning test are low-level ones, we designed a device helping these learners to learn to master this task. Our device allows the learner to self-assess himself and turns the learner's self-assessment into a positioning report, which is submitted to the learner himself.

[2] This work results from a research conducted cooperatively between CLIPS-IMAG and LIRIS, involving in particular the authors of this paper as well as J.-P. David.

4.2.1. Device's architecture

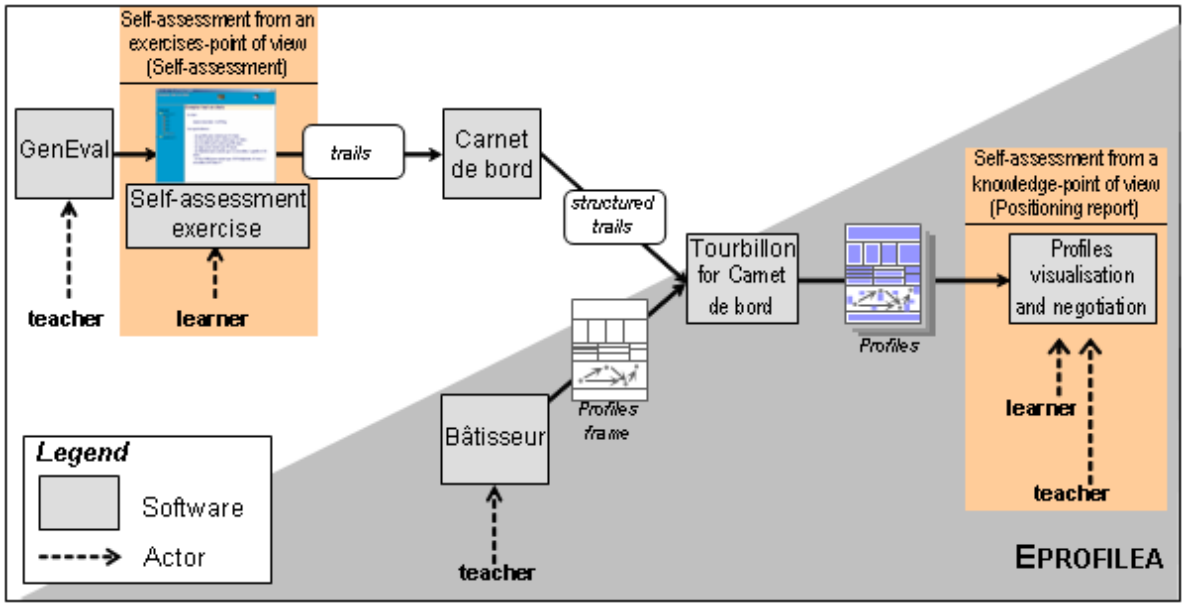

Figure 2: Experimental device architecture based on EPROFILEA environment.

The experimental device uses GenEval [4], an authoring tool allowing teachers to create self-assessment activities. For EPROFILEA, GenEval is an external ILE providing learners' profiles. The device comprises several steps (cf. Figure 2). First, through GenEval, the teacher creates the self-assessment exercise. The learner does the exercise, compares his answer to the answer proposed in the system and self-assesses himself from an exercise point of view. The self-assessment data, structured by Carnet de bord[3] software, constitutes learners' profiles resulting from an ILE and is reusable by EPROFILEA environment. The fourth step of the device consists in describing the profiles structure in BÂTISSEUR. The resulting profiles frame describes the knowledge corresponding to the exercise proposed to the learners. The fifth step consists in filling automatically the profiles frame through TOURBILLON-Carnet de bord for each learner with his data. The link between self-assessments and learner positioning report is made at this step. Indeed, students' self-assessments refer to the exercises, whereas the profiles frame refers to knowledge. TOURBILLON-Carnet de bord contains the links between the exercises and the knowledge, given that two self-assessment criterions from an exercise-point of view can concern the same piece of knowledge. After this step, there are as many profiles as learners. The last step of the device is the profile presentation to the learner himself and this positioning report negotiation between learner and teacher.

5. Conclusion

In this paper, we presented PERLEA project which aim at modelling the students' tracking process involving teachers, learners, parents or school institutions. This research is linked with researches on interoperability between ILE, because EPROFILEA environment can be used by different ILE as a module specialized in profiles exploitation. This environment can be connected upstream with an ILE creating learners' profiles without allow their exploitation by the actors and downstream with other ILE allowing a personalized course according to a specific profile.

We have described EPROFILEA architecture helping actors to reuse and exploit learners' profiles of all disciplines, whatever their level, by teacher and different actors of the

[3] Carnet de bord project is supervised by J.-P. David from Arcade team at CLIPS.

learning situation. This ILE is aimed at answering teachers' needs by proposing them a set of tools, support for profiles management and their reinvestment within classes' practices. We have already developed some prototypes of these tools [7], even if the current research work isn't finished. These prototypes are for us a support for reflection and a communication means particularly with the teachers involved in the project. Finally, we have presented a specific implementation of EPROFILEA, showing the feasibility of the project.

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