A Generic Approach for Assisting Teachers During Personalization of Learners' Activities

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Abstract. Personalization of learning is a complex task to implement. This task is even more complex if one wants to adopt a generic approach taking into account the many different teaching situations, and the wide variety of pedagogical activities that may exist. In this paper, we describe the GEPPETO approach designed to assist teachers during personalization of pedagogical activities. This approach includes knowledge, models, and processes to adapt pedagogical activities to learners with respect to teachers' pedagogical goals.

Keywords: personalization, pedagogical activity, pedagogical intention of teachers, process, meta-model of knowledge, model of knowledge.

1 Introduction

Personalization of learning consists in modifying activities that are proposed to a learner in order to match a given teaching situation. Personalization is a complex task since there are many different teaching situations and many different pedagogical activities. The heterogeneity of activities is due to the medium on which the activity is provided, e.g. paper activities or exercises to be done on an ILE (Interactive Learning Environment). In addition, pedagogical systems are diverse because they have diverse environments and because these environments offer various contents. Hence, a pedagogical system can take the form of an intelligent tutor, a microworld, a simulator, a hypertext, etc. Each one of these forms is associated with a use mode (free or guided), content (predefined sequence of activities, set of objects that can be manipulated...), but also various educational goals (acquisition of a method, of a set of knowledge, of a practice...).

This paper focuses on how to adapt a learning activity to take into account teaching needs and habits of a teacher, still in a generic context. This adaptation concerns both paper activities and software activities. For paper activities, the issue is to generate an exercise corresponding to the needs of a teacher. For software activities, the issue is to define parameters of an educational system so that both the system's content and its environment suit the needs of the teacher. To make possible this adaptation of pedagogical activities in a generic way, we propose the GEPPETO approach. This approach relies on generic models and generic processes to adapt the activities according to pedagogical intentions of teachers and by using constraints on activities.

We applied this approach to enable the adaptation of paper activities ($GEPPETO_P$) and the adaptation of software activities within ILEs ($GEPPETO_S$).

This paper is organized as follows. Section 2 presents a review of solutions offered to teachers to adapt pedagogical activities to their needs, and shows why these proposals are not usable for providing a generic approach. Section 3 presents the GEPPETO approach to support adaptation of pedagogical activities, and its specifications to adaptation of paper activities and software activities. The paper ends with concluding remarks on research issues opened by this work.

2 Related Work

In order to take into account pedagogical needs and habits of teachers, several solutions have been proposed: using authoring tools, defining pedagogical scenarios or settings up educational systems. **Authoring tools** allow one to create resources (exercises, worksheets of exercises or pedagogical systems) suited to each teacher [1]. For this purpose, the teacher must fully define the educational content. Hence, the use of authoring tools is time consuming. **Pedagogical scenarios** allow one to define activities given to learners [2]. It involves the specification of the context in which they are themselves, the roles of all participants, the actions to do on resources, etc. However tools for defining a scenario do not create resources. They allow one to combine existing resources that are either contained in the application on which the scenario will be implemented, or manually created by the teacher, or created using a specific application. Therefore the adaptation to the teacher needs focuses only on the used educational resources. Only a few educational systems have a **specific part for the teacher** to define the parameters of the learner environment (teaching content and/or interface) [3, 4]. Moreover, these parts are different from one system to another. Thus, a teacher wishing to use multiple systems has to master various tools settings. Whatever the approach chosen, the heterogeneity of the systems is in itself a limit for the teacher. Indeed, to adapt activities from various sources (coming from generators, described in the scenarios, contained in pedagogical systems, etc.) to their educational goals, teachers must learn how to use interfaces of many tools. Moreover, there is no unified approach to assist teachers in their tasks of adaptation of activities.

The approach that we propose consists in giving teachers a unique tool allowing them, among others functionalities, to define parameters of pedagogical activities of various types (on paper or contained in ILE) to match their needs. This tool is then in charge of producing adapted activities.

3 GEPPETO, or How to Adapt Pedagogical Activities According to the Needs of Teachers

To adapt pedagogical activities to the needs of a teacher, it is necessary to constrain the choice or the generation of these activities. To express constraints on activities, it is necessary to have a model of activities to adapt. Obviously, it is not possible to provide a generic model for any existing pedagogical activity. However, it should be possible to define a meta-model that could serve as a basis to guide the establishment of a model for any particular activity. For this purpose, we propose the GEPPETO approach (GEnerics models and processes to Personalize learners' PEdagogical activities according to Teaching Objectives). This approach provides models and processes for adapting the pedagogical activities given to learners with respect to the educational goals of each agent of the personalization. In the context of personalization of learning, adaptation of activities given to learners is done mainly to take into account pedagogical choices of the teacher. However, two different actors can perform effective adaptation: the teacher or the ILE. The teacher may adapt activities directly. The ILE can handle the adaptation task taking into account teacher's requirements. This is the reason why we use the term "agent" to name the actors involved in the personalization process.

In the GEPPETO approach, a **meta-model of activities** (see ① in Fig. 1) defines the knowledge that an expert must provide in order to describe pedagogical activities. This knowledge once provided by the expert, form either the model of a type of paper activity, or the model of an ILE for adaptation. From such a **model of activities** (see ② in Fig. 1), it is possible to define constraints to guide the choice of activities. These **constraints on activities** (see ③ in Fig. 1) are defined by each agent (teacher or ILE) according to its adaptation needs. Then, these constraints are interpreted by a system implementing GEPPETO to adapt the **pedagogical activities** provided to learners (see ④ in Fig. 1).

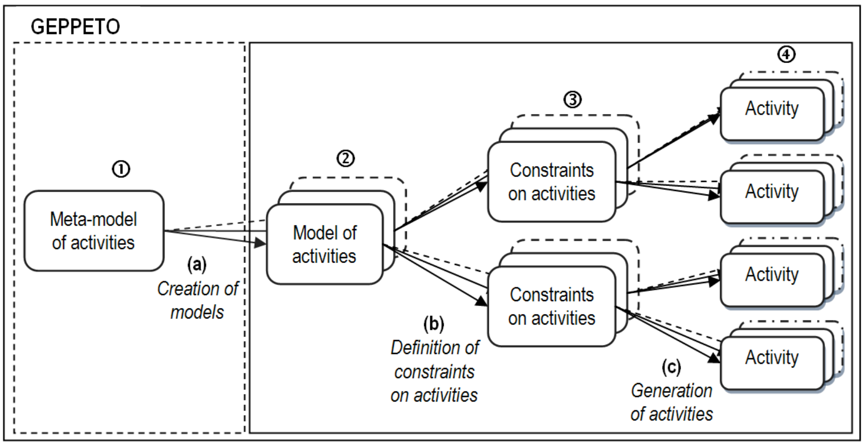

Fig. 1. Graphical representation of the GEPPETO approach.

The GEPPETO processes are made of two phases. The first phase, represented by a dotted frame in Fig. 1, is an initialization phase. It is only done once. In this phase, an expert uses the meta-model of activities to define a model of activities for each paper activity or for each ILE that the agent (teachers or systems) wishes to personalize. This **process of creation of models of activities** is represented by arrows (a) in Fig. 1.

The second phase, represented by a plain frame in Fig. 1, is the normal use of GEPPETO. In this phase, an agent uses a model of activities created by the expert to constrain the personalization of the activities proposed to learners. This **process of definition of constraints on activities** (see (b) in Fig. 1) consists of two steps: in the first one, the system proposes an interface adapted to the model of activities that limits the possibilities when defining constraints on activities and, in the second one, the system records these constraints. Then, constraints on activities are used by the system to personalize the pedagogical activities offered to learners. This **process of generation of activities** (see (c) in Fig. 1) is also decomposed in two steps: use of constraints to create an activity and formatting of this activity either to be printed or to be incorporated into an ILE.

The GEPPETO approach can be used to personalize paper activities or ILEs. The models involved in the specialization of the GEPPETO approach for adaptation of paper activities and relations between these models are shown in Fig. 2. This specialization, called GEPPETO$_P$ (P stands for "Paper"), is based on a typology of paper activities containing eight categories of activities [5]. GEPPETO$_P$ uses a **pattern structure** that describes both the generic structure and all the metadata common to the eight patterns of exercises. Each **pattern of exercises** describes the elements necessary for generating one of the eight categories of activities contained in the previous typology. Each of the patterns of exercises can be used by a generator of exercises to create structures of exercises. Each **structure of exercises** can then be used by the same generator to create a set of **exercises**. Generators of exercises defined in the GEPPETO$_P$ approach are semi-automatic generators. They all have the same generic architecture [5].

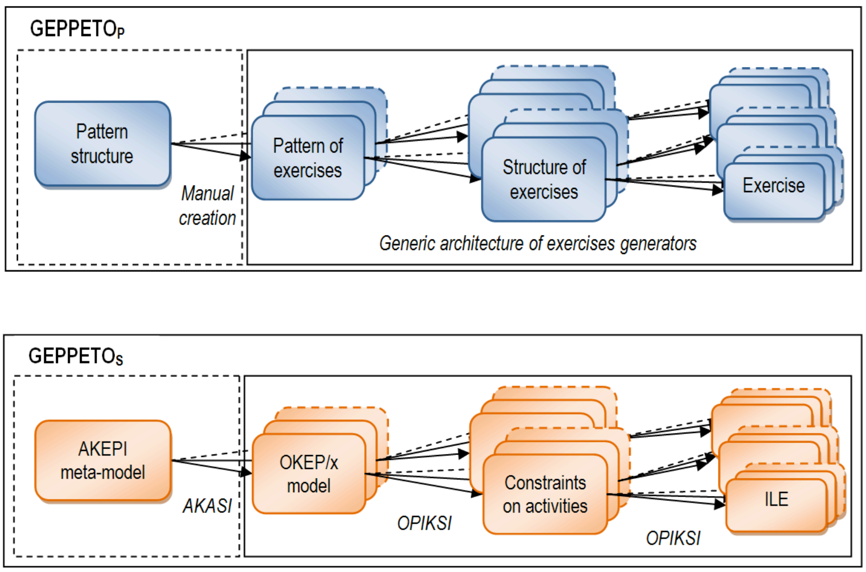

Fig. 2. Graphical representation of the GEPPETO$_P$ and GEPPETO$_S$ approach.

The models involved in the specialization of the GEPPETO approach for adapting software activities and relations between these models are shown in Fig. 2. This specialization, called $GEPPETO_S$ (S stands for "Software") allows adapting software activities. A software activity is defined as a sequence of activities on a pedagogical system. Therefore adapting software activities consists in defining parameters on the content of the sequence and on the system. These parameters ensure that the system will be well suited to the learner.

We have studied thirty educational systems having various types, origins, target publics and domains. This study allows us to say that [6]: the personalization of an ILE can cover five facets: selection or creation of activities, organization of these activities to form sequences of work, functionality available for the learner, interface and feedback provided by the ILE; the parameters influencing these facets can be represented in configuration files or modified through the interface of the ILE; and each of these parameters can be described using a common formalism to be presented uniformly to a teacher. This homogenization makes easier the customization of heterogeneous ILEs. Therefore, the customization of an ILE requires having a description of all the parameters related to activities, sequences of activities, functions and/or interface of the ILE. In addition, to be able to act on an ILE, we must be able to modify configuration files. Therefore it is necessary to have technical information on the ILE such as the presence or absence of an exercises generator, the location and the content of configuration files. The study of existing norms and standards [7, 8, 9, 10] led us to observe that they do not allow an expert to describe an ILE with such granularity.

In the approach $GEPPETO_S$, we describe the **AKEPI meta-model** (Acquisition of Knowledge Enabling Personalization of Interactive learning environments), a meta-model for the acquisition of knowledge for personalization of ILEs [6]. We combine this meta-model with two processes. First, the **AKASI process** allows an expert to instantiate the AKEPI meta-model with knowledge specific to an ILE x in order to create the **OKEP/x model** (Operational Knowledge Enabling Personalization of the ILE x), a model of operational knowledge for customizing the ILE x. Second, the **OPIKSI process** allows a system to use the OKEP/x model to propose to the teacher an interface enabling him to customize the ILE x (see Fig. 2).

4 Concluding Remarks

In this paper, we presented the GEPPETO approach. This approach relies on generic models and generic processes to adapt activities according to pedagogical intentions of teachers, by making use of constraints on activities. We applied this approach to enable the adaptation of paper activities ($GEPPETO_P$) and the adaptation of software activities within ILEs ($GEPPETO_S$). Both specializations of the approach have been implemented in Adapte [11], a system that provides each learner with activities suited to his profile, while respecting the pedagogical choices of their teacher. This implementation allowed us to demonstrate the technical feasibility of our proposals, and to evaluate them by practical experiments involving teachers [12].

The evaluations of the GEPPETO approach allowed us to validate the principle and feasibility of the implementation of the approach. However, the typology of paper activities used by the $GEPPETO_P$ specialization [5] must still be validated by experts in Education Sciences. For software activities, we defined the application framework of the AKEPI meta-model to allow an expert to describe an ILE in the $GEPPETO_S$ specialization. This application framework limits the use of the approach to the adaptation of pedagogical system providing individual learning activities. However, the AKEPI meta-model is open and can be extended to take into account ILEs offering collective and/or collaborative learning situations.

Hence, an immediate issue of this work is to describe this new class of ILEs with our AKEPI meta-model. It will then be necessary to adapt the activities of these types of collaborative systems according to our methodology, in order to verify that the models and tools that we propose can overcome new obstacles inherent to the specificity of these systems.

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