Supporting the Design of Pilot Learning Activities with the Pedagogical Plan Manager

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Abstract. Pilot actions for introducing ICT-based innovation in school education generally involve a multitude of elements and a range of different actors. Accounting for and grasping this complexity calls for systematic pedagogical planning efforts that provide a solid basis for accommodating the different perspectives, for analysing the factors at play and also for casting light on the initial assumptions and theoretical framework adopted. These are the issues currently being addressed in a European project called ReMath, in which the authors are developing and testing a prototype ICT-based tool called the Pedagogical Plan Manager (PPM). The system supports the construction and sharing of pedagogical plans within a community of different actors operating in different contexts with different visions. This paper briefly describes some of the requirements that have shaped the PPM and outlines the conceptual model on which it is based. The system is described in the light of two vital characteristics it presents for the design of learning activities, namely expressiveness and flexibility.

1 Introduction

Pilot actions aimed at bringing innovation to school education through ICT are potentially complex endeavours involving a multitude of elements and a range of different actors such as teachers, researchers, pedagogical experts, designers, etc. So when it comes to the design of experimental learning activities, adequate account needs to be taken of the various factors and perspectives involved. A well articulated pedagogical plan can provide a solid basis for pilot analysis and help in gaining understanding of the dynamics at play. In addition, such a plan can cast light on the conceptual framework of the pilot action and on the assumptions underpinning the design of learning activities, areas that have a strong bearing on the outcome and can thus prove critical in the eventual take-up of the innovation in question.

In recent times, pedagogical questions involved in ICT-based educational actions have been attracting increasing interest. In the field of learning design, much attention is currently being focused on how different pedagogical visions can be accommodated and expressed in the authoring of learning actions, invoking pedagogical planning of some kind [1,2]. This is the direction of the work reported in this paper, which is based on the conviction that, as well as supporting the preparation of "units of learning" (UoL) [3] and suchlike, ICT can also be a support for critical reflection, helping to clarify, crystallize and capture pedagogical aspects which often remain implicit or hidden in the design process.

These concerns are an integral part of the authors' present activities within the EC ReMath project[1], where a strong need exists to address the specific requirements of researchers in the design of pedagogical plans. The project involves cross-experimentation of innovative ICT-based learning activities at European level and entails collective exploration of design issues, pilot activities and comparison of results in the light of multiple approaches and contexts. This has led to the definition of the "pedagogical scenario", seen as a description of aspects deemed relevant for the design of innovative ICT-based learning activities. The conceptual model of the pedagogical scenario has provided the basis for the development of a web-based tool called the Pedagogical Plan Manager (PPM). This tool is designed for the production and sharing of instantiated pedagogical scenarios, henceforth called "pedagogical plans". As reported in the following sections, the PPM's specific mission is to support reflective and documented pedagogical design in experimental piloting. The authors believe, however, that the approach and solutions adopted are applicable to the wider educational context, and they do not exclude future integration of capabilities for enacting learner-oriented activities online.

2 The Context and Specific Requirements

The ReMath project has the aim of building an integrated theoretical and operative framework for mathematics learning through ICT-based representation of mathematical meanings. In efforts towards achieving and demonstrating this integration, research teams based in different European countries have each developed a digital maths learning tool that reifies the particular theoretical framework/s inspiring their work. These teams are carrying out cross-experimentation to compare and relate the theoretical frameworks adopted in the development of the tools. As the project's basic assumptions stress the importance of the learning process, exploration does not occur at tool level, but rather is based on exchange among researchers about the learning processes mediated by the use of the developed tools. Furthermore, collaboration involves both researchers specialized in the mathematics domain as well as those in the field of education technology, so as

[1] ReMath: Representing Mathematics with digital technologies (IST4-26751).

to enhance dialogue not only on a content and epistemological level, but also at a pedagogical and didactical level.

In this context, the authors identified a number of key project requirements that were deemed important for the development of both the pedagogical scenario model and the prototype tool which was to concretize that model. The main requirements identified were to:

- help researchers make explicit the theoretical assumptions that are implicit in their educational software tool and in the learning activities based on the different software;
- give teams in different countries and settings the means to express their particular design ideas for pilots without forcing them to conform to a preset structural format reflecting a single (external) cultural vision of teaching/learning;
- support cross-experimentation of innovative mathematics software in order to explore how a team (a) approaches the design of learning activities based on a tool that it has not itself developed, and (b) how it adapts these to its specific pedagogical aims, research objectives and experimental context;
- support reflection, discussion and comparison within the ReMath community, whose mission is to explore the basis for integrating disparate theoretical frameworks.

Meeting such requirements and accounting for the diverse perspectives and concerns that the project brings together clearly called for a design solution offering considerable expressiveness and a high degree of structural flexibility. These two fundamental characteristics of the Pedagogical Plan Manager are described in greater detail in the following section.

3 Expressiveness and Flexibility of the Pedagogical Plan Manager

As mentioned above, the Pedagogical Plan Manager is based on a pedagogical scenario model. The model is seen as a dynamic, flexible and modular basis for the production of pedagogical plans. While the pedagogical scenario does share some characteristics with other learning design artefacts such as the “unit of learning”, it differs from these in several important ways, one of which is the explicit and concerted effort to accommodate the perspective of the researcher. Accordingly, the model features a number of attributes for expressing (among other things) the reason why an educational action is proposed, the theoretical and didactical framework in which it is positioned, the innovation it is intended to introduce and the way it is to be implemented. The aim is to bring to light key (often submerged) issues involved in the designing process and in the resulting design artefact, as well as to foster reflection on the adopted solutions. [2,4]

The attributes of the pedagogical scenario are organized in a schema of descriptors which, when instantiated with data (open text and multimedia), form a pedagogical plan. These descriptors are grouped into four major categories - Identity, Target, Rationale, Specifications - each of which is further refined into more detailed descriptor sets and single descriptors, as follows.

- IDENTITY - identifies and classifies a plan , also for storing and retrieving it in the PPM system;
- TARGET - indicates the population addressed, the context in which that population is embedded, the educational goals to be achieved;
- RATIONALE - expresses plan rationale and the theoretical framework that has informed the design process;
- SPECIFICATIONS – indicates the tools and resources to be used by students, how these are be used, and a work plan.

The nature and organization of this descriptor schema are key factors in ensuring that the pedagogical scenario instance, the pedagogical plan, is capable of a high degree of expressiveness. The adopted model supports and enhances this capability by treating the pedagogical scenario as a tree-like hierarchical structure whose different levels are to be instantiated using the same descriptor schema, populated at appropriate degrees of abstraction. This not only allows authors to express and explore their concerns at considerable depth, it is also crucial for encouraging them to consider and reflect on how they articulate their pedagogical ideas through(out) the design, from high-level "vision statement" to the operational details of learning activities. As Beetham [5] puts it, "(authors') priorities may only emerge as they reflect on the (design) decisions they have taken". To foster this emergence, in the PPM it is the authors themselves who determine the exact organization and granularity they wish to adopt when expressing their design ideas, rather than having to conform to a fixed structure and/or adopt predetermined entities (*activity*, *lesson*, *unit*, *module*, etc.) that reflect a single, possibly unfamiliar cultural/pedagogical vision. The need for such flexibility emerged in previous ITD experiences [6] in pedagogical planning and is considered essential in experimental piloting contexts like ReMath, which foresees cross-experimentation and collaborative development of plans. For example, various degrees of adaptation will be required in order to permit a comprehensive, instantiated plan (one proposing detailed experimental activities for meeting certain goals within a certain context) to be reused in a variety of different settings. Likewise, when building plans in a collaborative framework, authors need to have the means to capture and exchange nascent ideas, possibly expressed at a fairly high level of abstraction, which are then fleshed out with the particulars of the learning context, its specific requirements and restraints. An instance of such "germination" might be a description of an interesting educational "affordance" of a software program considered useful for tackling a problematic area of learning, or perhaps, at a more abstract level, a proposal for the adoption of a specific theoretical approach to subject teaching.

As with expressiveness, the quality of flexibility is firmly rooted in the conceptual model underpinning the PPM, whereby the pedagogical plan is treated as a tree-like hierarchical structure comprising multiple levels of abstraction (see Fig.1. below). This approach offers a number of advantages. It makes it easier to manage the potential complexity of plans by allowing top-down *representation*, which is helpful irrespective of how the authoring *process* is actually carried out: top-down, bottom-up, middle-out, or zigzag fashion. Each node of the hierarchy is a complete pedagogical scenario in itself, populated with data at an appropriate level of abstraction using the same descriptor schema (though not all fields will necessarily need populating at all levels). Top-down representation acts as a stimulus for recognizing and making explicit structural aspects of the plan that are conceptually meaningful but often “hidden” or overlooked in the design. In addition, it allows those in experimental contexts to express and investigate research concerns at different degrees of granularity. It facilitates collaborative development by allowing authors to decide in what direction, and how far, to take the refinement. It supports reuse through modularity, i.e. by proposing a set of loosely coupled elementary components that have strong internal (conceptual) coherence.

Top-down representation is implemented in the PPM by introducing the notions of the Hierarchical Pedagogical Plan (HIPP) and the Single Node Pedagogical Plan, or SNiPP. The HIPP and SNiPP are the fundamental entities that users work with in the PPM for shaping pedagogical plans and displaying their contents. As Fig.1 shows, the HIPP is a structure comprising a set of one or more SNiPPs which, as stated above, are complete pedagogical scenarios in themselves; so potentially each entity may be interpreted - as required - either as an individual node (SNiPP) or as a tree/sub-tree with that node as its root (HIPP).

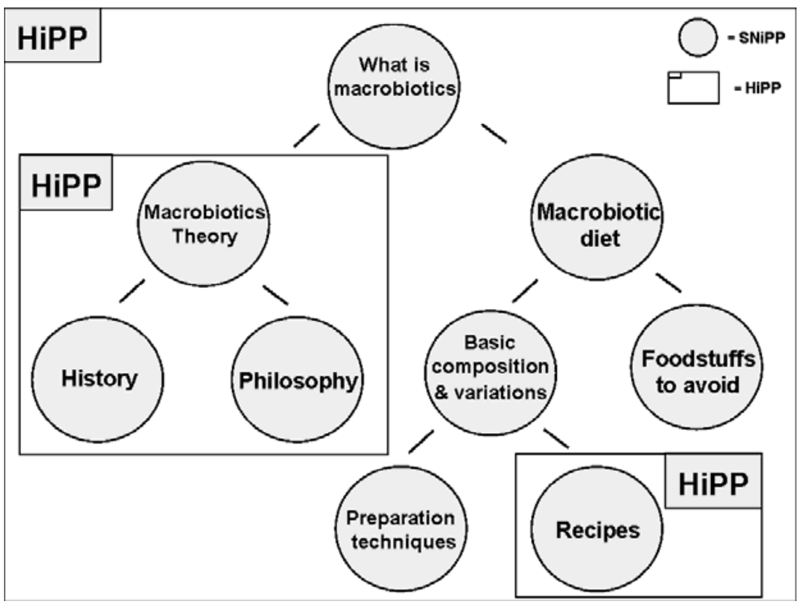

Fig. 1. an example structure (organised by topic) showing the two main entities represented in the PPM: HiPP and SNiPP

4. Prototype of the Pedagogical Plan Manager

The prototype version of the PPM (http://ppm.itd.cnr.it/) that the authors have developed is currently being used in the ReMath project for collaborative creation, sharing and reuse of pedagogical plans. As already mentioned, the basic idea underpinning the PPM is to represent pedagogical plans as hierarchical entities which can be built and read at different levels of detail. This structure should support both "authors" (providing them with the possibility to work with a top-down structure) and "readers", who in top-down organization have a facilitating factor for understanding complex plans, i.e. grasping the general structure, relating rationales with concrete details, etc.

The PPM interface has been designed so as to allow both authors and readers to deal easily and naturally with the hierarchical structure, to navigate from the general to the particular and vice versa, and to explicitly select the fields they want to focus on.

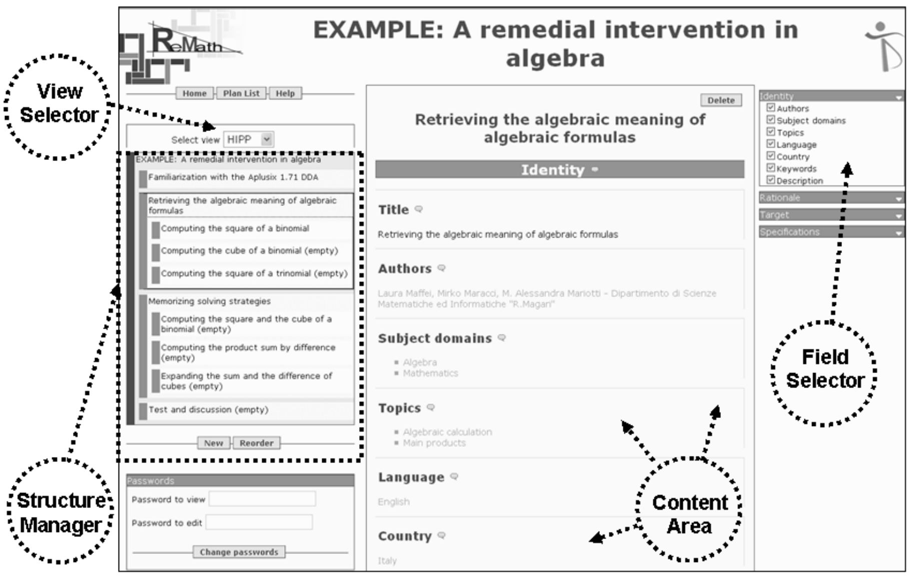

Fig. 2 - Interface of the editing environment

In order to do this, the prototype PPM provides three basic functionalities: management of pedagogical plans (Manager); building/modifying plans (Editor); and viewing/navigating existing plans (Viewer). The Manager is a simple repository for browsing and selecting from the list of existing plans. The Editor and the Viewer share a set of common facilities (see Fig.2), including: a *Structure Manager*, an interactive map of the plan hierarchy for viewing and shaping plan structure; a *View Selector*, which allows the user to work either with SNiPPs or with HiPPs, switching from one to the other as required; and a *Field Selector*, for selecting exactly the type and number of descriptors the user wishes to work with at any given moment.

Using the Field Selector in conjunction with the View Selector, the user can input/display on a single web page the data for a single descriptor (e.g. curriculum goals) or to a set thereof (e.g. goals) at different levels of the hierarchy. In this way both authors and readers can “drill down” through a plan as desired [4], a possibility which helps in reaping the aforementioned benefits of top-down representation.

To further facilitate plan construction via top-down representation, authors can populate a given field in a given SNiPP automatically by electing to inherit the data that is contained in the corresponding field within the immediate parent SNiPP.

The descriptive fields in the content area can be completed with data of various kind (free text, images, hyperlinks, html code), and it is also possible to upload attached files: guidance for completing each field is available in a pop-up. As well as inserting data for identification and description purposes, authors can include links to any web-based tools to be used in learning activities and can also integrate any digital learning resources to be used in enactment. In the PPM, the term “resources” refers both to: (1) “input” artefacts needed *a priori* for carrying out activities with students (worksheets to fill out, web sites to visit, etc.); and (2) runtime-generated artefacts that result from enacted activities, whether these be elaborations of a given “input” resource (a completed worksheet, a filled-out table) or something produced from scratch, like student reports. So a plan can include a resource, in the form of either a concrete instance or a description, which is to be progressively elaborated across a sequence of learning activities.

In response to the demands of the ReMath project, the PPM has been designed as a wholly web-based tool accessible via standard web browser. This, combined with real-time online editing via Ajax permits collaborative development of plans online, an essential function in experimental piloting of learning activities, which almost invariably involve a team design effort. To further support collaboration, fields in the PPM Editor feature a “Comment” window for appending remarks in the plan authoring process. This is currently being used in ReMath as a space for exchange and collaboration about plan contents, and has been earmarked for further development in the next version of the tool.

5 Conclusions

This paper has presented a conceptual model and related ICT-based tool that were conceived and developed to support the pedagogical design of experimental learning initiatives engaging different actors, contexts and visions. Particular attention has been devoted to key criteria that have guided the development of the Pedagogical Plan Manager, namely expressiveness and flexibility. These are supported and enhanced by the adoption of top-down representation of pedagogical plans, which helps in mastering the potential complexity of a plan design (and of plan designing) and in recognizing and making explicit significant structural aspects.

While the authors are keen to explore this potential, they are also keenly aware of possible drawbacks. With top-down representation, particular care is required to ensure manageability (especially in terms of interface design) and to avoid the attendant risk of information overload [4]. Likewise, the benefits derived from a high degree of flexibility need to be considered in the light of the increased effort and engagement that may be required of both authors and readers.

In order to strike a suitable balance between these factors, it is necessary to have a clear idea of how effectively the PPM has actually satisfied different users' needs in the ReMath project. To this purpose the authors have developed and implemented an evaluation strategy intended to verify the soundness of the "pedagogical scenario" both as a conceptual model and as a concrete entity implemented via the PPM tool. Preliminary results from pedagogical plan authors indicate that they appreciate the PPM's qualities of expressiveness and flexibility; useful feedback has also been collected for determining areas of priority for further development. As the evaluation effort continues over the remaining stages of the ReMath project, it is expected that other valuable indications will emerge.

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