Scaffolding pedagogical planning and the design of learning activities: an on-line system

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ABSTRACT

This paper focuses on pedagogical planning as a means to foster the introduction of ICT (Information and Communication Technologies) tools into classroom practices. It illustrates IAMEL, an ICT-enhanced system aimed at supporting teachers in the process of designing, structuring and planning educational activities (including those ICT-based). Pedagogical planning, which is a traditional school practice, is meant as the description, at different level of granularity, of the playing out of a learning situation aimed at the acquisition of a precise body of knowledge through the specification of roles, activities, educational theories and methods. ICT-enhanced pedagogical planners offer a significant added value to the intended scope since they: 1) have a maieutic function in that they help teachers fully express their didactical ideas and finalize the educational approaches and methods to be adopted 2) support the sharing of practices among teachers and communities of teachers 3) provide the ground to foster "a posteriori" reflections on the planned educational experience, once implemented in real school settings.

Keywords: Technology Enhanced Learning, Pedagogical Planning, Net –Technologies, Learning Innovation, Formal Education.

INTRODUCTION

The integration of ICT into ordinary classroom activities is nowadays considered a necessity in the education policies of most of countries, and its positive effects have been showed by a number of research projects carried out in a variety of contexts and age levels. The first effort made by many governments in this direction was the considerable budget invested for equipping schools with hardware and software tools. However, this effort proved to be insufficient and the high expectations put on ICT as vehicles to promote change in education remained unfulfilled (Venezky & Davis, 2002; EC, European Commission, 2004).

The limited impact of the wide ICT use in schools can be ascribed to a variety of different reasons: from those related to the traditional resistance of the school systems to "change", to reasons more deeply related to the fact that technology has often been introduced as an addition to an existing, unchanged classroom setting (De Corte, 1996; Grasha & Yangarber-Hicks, 2000).

For the purpose of this paper, we focus on the teachers and on the difficulties they

encounter in reconsidering and revising their pedagogical practice in order to accommodate a proper and not sporadic use of ICTs (Guzman & Nussbaum, 2009). Often, teachers are induced to look at software tools for education on the basis of very general, ill-defined expectations, and this approach can result in a lack of understanding of the theoretical frameworks, pedagogical practice and conditions under which the educational use of such tools could be genuinely meaningful and productive.

This means that the work towards technological innovation should be developed together with pedagogical innovation. As a matter of fact, from one hand, the use of new tools results in a little pedagogical gain if novel educational strategies and the activities in which teachers and students are involved in are not carefully re-considered and planned. On the other hand, pedagogical innovation should be based on the opportunities offered by technological advances and on the critical examination of how such advances change substantially, in a direct or indirect way, the needs, the modalities and the content themselves of teaching and learning activities.

A relevant role is played by pedagogical planning seen as the description, at different level of granularity, of the playing out of a learning situation (or a unit of learning) aimed at the acquisition of a precise body of knowledge through the specification of roles and activities.

When considering the integration of ICT in school practice, pedagogical planning assumes a particularly important role since it not only helps the single teacher express his/her didactical objectives and approaches but it also serves as a means contributing to the sharing of practices among teachers and communities of teachers; ultimately, it also provides a suitable ground to foster reasoning on encountered difficulties and problems faced. The integration of new technologies in classroom practices, requires that teachers increasingly take into account a variety of different elements (e.g. multiple literacy, changing of roles, timing, contents, etc.) (Robertson & Hughes, 2010), in an effort to ensure that these form part of a coherent, manageable whole able to effectively respond to learners' needs (Jonassen, 1997) and that consents the full attainment of the intended educational objectives. Teachers should, then, be supported in the setting-up of pedagogical plans which both serve the purpose of describing educational itineraries and also help them reflect and make explicit their pedagogical aims, choices and approaches.

Current research in the field of pedagogical planning mainly focuses on defining which instruments and methods better serve the scope since a wide number of different tools and different approaches are available to assist teachers "in the thought processes involved in selecting appropriate methods, tools, student activities and assessments to suit the required learning objectives" (Bailey et Al., 2006).

ICT-based environments and tools aimed at supporting and backing the process of pedagogical planning are widely considered extremely useful resources and, recently, a number of significant attempts to use ICT to describe and share pedagogical ideas have been carried out (Dalziel et Al., 2006; Earp & Pozzi, 2006). The availability of such ICT-based tools has given impulse to the modelization of pedagogical plans. This modelization, on the one hand, increases the possibility of sharing and re-using pedagogical ideas/methods, on the other, makes the process of pedagogical planning conceptually simpler and offers the possibility of better managing complexity.

This paper aims at giving a contribution to this research field by presenting an on line environment devoted to pedagogical planning. This environment was designed and implemented in the framework of the research project IAMEL, supported by the Italian Ministry of Education and Research

under the PRIN 2007 (Research Projects of National Interest) programme. Main aim of the IAMEL project was that of supporting the teaching/learning of mathematics by means of enhanced e-learning platforms. In the project the need emerged for a system able to describe fully innovative learning plans encompassing a wide variety of detailed learning activities. The envisaged system had to feature considerable expressiveness, via a suitable descriptor schema, and at the same time a high degree of structural flexibility.

In the following, before providing a description of the IAMEL system, we first discuss the existing relationships between the work done and the broad field of learning design; the overall methodology adopted by the IAMEL System is then discussed and starting from the first results of the experimentations some preliminary conclusions on the system effectiveness and usability are drawn.

Learning design & Pedagogical planning

When considering the area of pedagogical planning, we first surveyed the broad area of learning design.

Although learning design is intended in a variety of manners in the literature, one general unifying characteristic is the presence of an artefact as a focal point of the design process. This artefact can be defined as "a description of the playing out of a learning situation or a unit of learning aimed at the acquisition of a precise body of knowledge through the specification of roles and activities, as well as knowledge handling resources, tools, services and results associated with the implementation of the activities" (Pernin & Lejeune, 2006).

Definitions of this kind are sufficiently broad to accommodate a wide range of interpretations and approaches. Indeed researchers in the field adopt a variety of terms to denote such artefacts (learning design, learning scenario, pedagogical plans, didactical scenario, etc.), which differ greatly as far as both the nature of the meaning invested in them and, consequently, in the design and in the implementation of artefacts implemented to express them (Bottino et Al., 2010).

The work conducted in the framework of the IAMEL project focused on pedagogical planning with the specific aim to support teachers in the process of ideating, structuring and planning educational activities for their classes. Such tool has to provide teachers with a mean to make explicit not only the educational activities to be carried out but also the pedagogical rationale underlying their design choices. According to this approach, in the following the term "pedagogical plan" refers not only to the description of a learning situation planned by the teachers but also to the the explicitation of critical pedagogical and contextual aspects entailed in the design and enactment of a planned learning activity.

In recent years, modelling languages have been studied and implemented with the aim to formalize, in a machine-readable form, educational activities and, in particular, units of learning, by making explicit the relations between actors, activities, resources, tools and services. IMS LD (Koper & Olivier, 2003) is the most widely adopted of these languages. New artefacts aimed at implementing this specification are beginning to appear and will eventually give rise to new teaching and learning design practices. However, "the knowledge of the learning designer himself is not captured by the IMS-LD Learning Design, which only represents the result" (Koper, 2006). Since the "learning designer" (both teachers and researchers) were exactly at the core of the IAMEL project, the adoption of specific design languages such as IMS-LD were considered to be inappropriate for the specific objectives of the project at hand. Analogous considerations can be done also for systems like LAMS whose focus is on the production and management of machine-

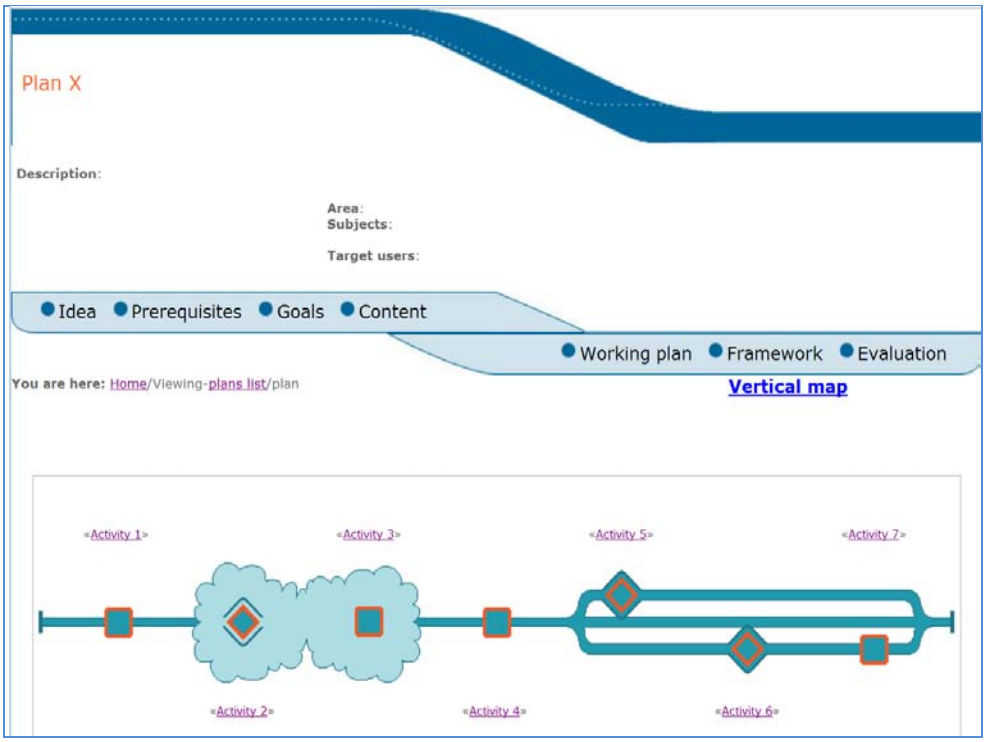
interpretable design artefacts (Dalziel, 2003). LAMS is, actually, an integrated system that seeks to support rapid, "teacher-friendly" generation, customisation and running of learning sequences (Dalziel &Philip, 2004). As to the scope of the IAMEL project, LAMS was discarded as it is not primarily intended to support critical pedagogical and contextual reflections. As a matter of fact, LAMS sequences, and those generated with IMS-LD based tools, can generally be classified as "runnable" design artefacts, as opposed to "inspirational" ones, to use the distinction adopted by (Falconer et Al, 2007). Inspirational designs tend to be more educator - than learner-oriented, and, as such, are closer to the pedagogical plan concept we aim to in the IAMEL project, where we defend the idea of providing teachers with means to build high-level models rather than proposing them a modelling language to prepare ready-to-use lesson plans. In the following, an overall description of the IAMEL system is provided and its main features are illustrated by focusing on key innovative aspects.

THE RESEARCH CONTEXT: THE IAMEL PROJECT

This research was conducted in the framework of the research project IAMEL, supported by the Italian Ministry of Education and Research under the PRIN 2007 (Research Projects of National Interest) programme, the main aim of which was that of supporting the teaching/learning of mathematics by enhancing the potential of e-learning platforms at these ends.

As said above, in this project pedagogical planning was broadly felt as a key aspect and a specific ICT-based tool was produced, following previous experiences (Earp & Pozzi, 2006) carried out by the authors, who were partners of the consortium.

Fig 1 Main screenshot of an exemplary IAMEL Pedagogical Plan



METHODOLOGY: THE IAMEL SYSTEM AND THE APPROACH TO PEDAGOGICAL PLANNING

The IAMEL system was designed and implemented with the main aim of allowing the production and sharing of structured pedagogical plans; although it was conceived and created to address the needs of researchers and teachers working in the field of mathematics, it can be considered fully content and subject-independent. It is grounded on a well-defined but open structure and foresees a detailed description of learning activities.

Structuring pedagogical plans

Fig. 1 shows the main screen of an exemplary pedagogical plan, called PLAN X; it gives a global idea of the overall structure and contents of the IAMEL System.

The main upper part of the screen contains some basic data (description, authors, target population…) aimed at providing key information about the plan; the map at the bottom of the screen shows, instead, the sequence of the different activities to be carried out. Each activity is then further described in detail in a separate section where its relevant functional aspects are highlighted.

Key information in the upper part of the screen (Fig.1) mainly aim at providing a general overview of the plan by giving a basic idea of its features, constraints and overall feasibility.

On the top of the screen, after the title of the plan and the names of the authors, a very basic description of the plan is provided encompassing the educational area (discipline), the subject matter and the target population addressed (school level, age range, further specific and detailed features such as disability, learning difficulties etc...).

The underneath ribbon gives further general details on the plan at hand by means of seven small tabs that can be expanded thus providing access to a text box containing detailed information about:

- The underpinning *idea* or, in other words, the main reasons why the author(s) has chosen to implement such an educational plan, the need for it, its importance and value in the educational context.
- The *prerequisites* (cognitive, physical, related to specific knowledge and know how etc..) demanded to the students in order to perform the required activities.
- The *goals* to be achieved by the learner population (curricular, content-epistemological, cognitive, social-affective, instrumental goals).
- The *content* addressed, in terms of specific issues, subjects, topics, matters…
- The *working plan* or, rather, the overall organization underpinning the plan enactment. This section is meant to indicate how to manage the overall process and to cover details about setting, duration and process documentation.
- The theoretical *framework* that has informed the process of the plan design.
- The methods, parameters and specific tools adopted to carry out the *evaluation* of the envisaged activities.

Mapping the learning activities

The core of the whole plan are the activities to be carried out; as shown in Fig.1, the map containing the flow of the activities appears in the main screen shot of the plan: it gives a basic idea of number and of type the envisaged activities.

As to the nature of the activities, the IAMEL system distinguishes among “mandatory /obligatory activities”, namely those that are considered necessary to fulfil the intended educational objectives and “optional activities”: those that should not necessarily be carried out by all students since they are not essential to achieve the intended learning/teaching objective.

Fig 2 Map of the activities (flow: obligatory-optional-obligatory-optional)

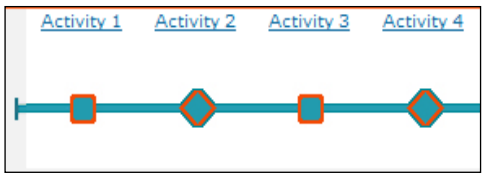
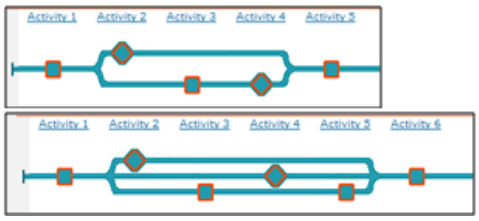


Figure 2 shows an exemplary simple map of activities. The represented sequence is composed by obligatory activities (squares) and optional activities (rhombuses). The actual flow is linear and sequential: an initial obligatory activity is followed by an optional one, subsequently the third activity is again obligatory while the last one is, once more, optional.

IAMEL, nevertheless, allows the building up of very complex and articulated plans where the sequence of the activities can be far more variegated and diversified.

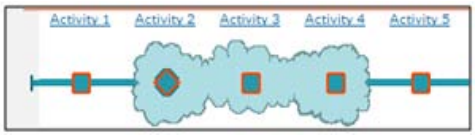
Fig 3 Map of the activities: "two routes" and "three routes" flow



For instance, as shown in Fig. 3, it offers the possibility of setting up “two routes” (Fig.3, upper part) or even “three routes” paths (Fig.3, lower part), where the user can autonomously choose among different alternatives.

As an example, the flow represented in the left part of Fig.3 envisages that after performing the mandatory “Activity 1” and before performing the mandatory “Activity 5” the users have the possibility to follow the upper route (where only one optional activity is foreseen) or to follow the lower route where one mandatory activity and an optional one (to be performed in a linear sequence) are foreseen.

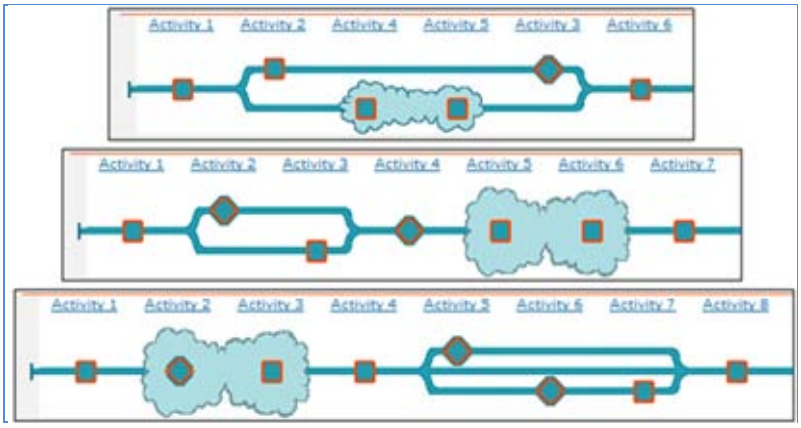
Fig 4 Map of the activities including random-order activities



As a consequence of these facilities, the IAMEL maps can represent a huge number of different links /relations among the entailed activities, as it is shown in Fig.5, where the maps of three different learning plans are represented.

As a further opportunity, the map also encompasses the possibility of defining a set of activities to be carried out in a random, not strictly sequential order. Fig.4 represents a situation where, after performing the mandatory “Activity 1” and before performing the mandatory “Activity 5” the users have to carry out two obligatory activities (“Activity 3” and “Activity 4”) and

Fig 5 Three different activity maps instantiating different possible learning paths



possibly an optional one ("Activity 2") but the order of these activities, therefore represented in a "cloud", is not established *a priori*.

Describing the learning activities

Each activity encompassed in a plan is described in details in a separate section, where its relevant aspects are highlighted.
By clicking any one of the activities showed in a map (e.g.: those in Fig.5) we "enter" into a specific sheet, that fully describes the activity at hand.
Fig.6 shows the available fields, which actually encompass:

- A detailed *description* of the activity to be performed
- The listing and the explanation of the *prerequisites* needed to perform the activity; such prerequisites, once again, are expected not to be fully coincident with those of the general the plan; Specifying the prerequisites of each activity of a plan appears to be particularly important for instance when the plan allows choosing among different alternative activities (alternative routes represented in Fig. 5). As a matter of fact the choice among the alternatives can also be done by taking into account the actual possession by the students of the needed prerequisites.
- The specification of its main specific learning goals (which not necessarily coincide with those of the overall plan being often a specific subset or even middle-stage objectives, necessary to fulfil the more general ones)
- The description of the tools and resources required (or even suggested) to perform the activity. In this section the actual tools and resource needed/adopted are also made available if and when possible. This is true, as an example, for software

Fig 6 Activity description and fields

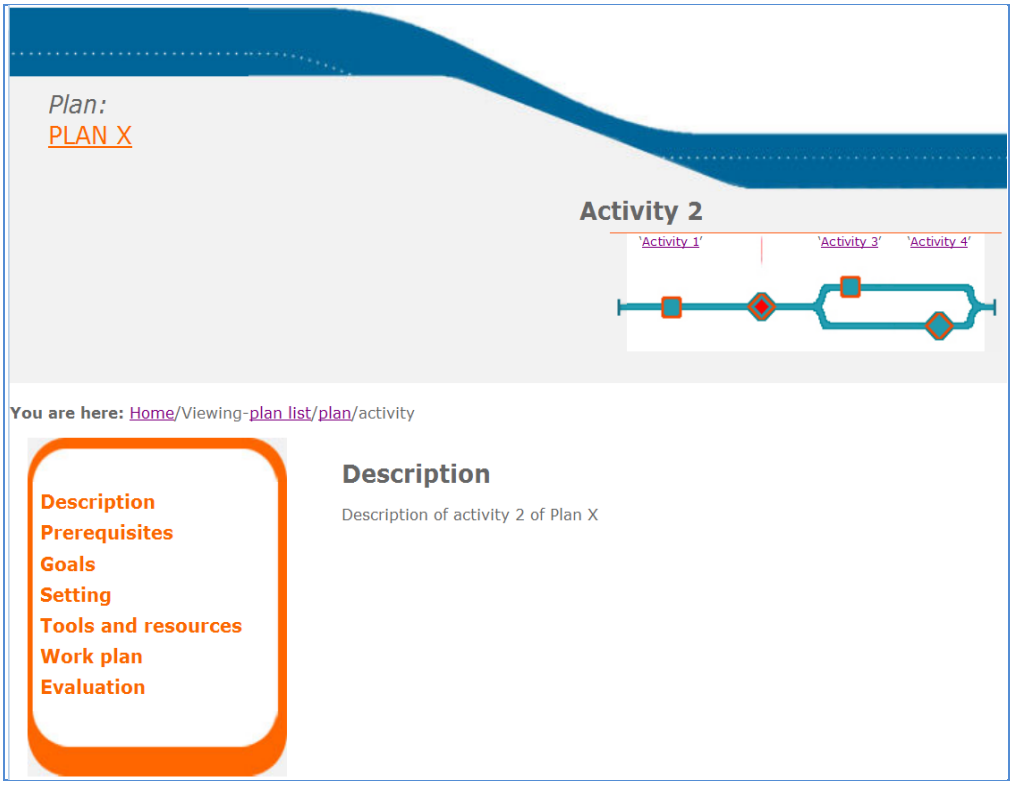


Fig 7 Activity 1 tools and resources: availability and/or download

tools classified as OER (Open Educational Resources) (Petrides et al., 2008); in this case the tool itself is linked or provided for downloading, as shown in Fig.7.

- A detailed work plan of the activity, including an accurate description of the teaching methodology, the recommended educational setting, the overall and specific work organization (e.g.: individual, groups...), the teaching/learning strategy adopted, the overall time required etc...
- Specific attention to the *evaluation* methods, tools and measures to be used with specific reference to all relevant documents and reports available.

MAIN RESULTS

The first results of the in-field experimentations of the IAMEL system, carried out in the framework of the PRIN research project, should be considered by tacking two different perspectives: the pedagogical and the technological perspective.

From a pedagogical viewpoint, the conducted experience suggested that pedagogical planning, which is actually a traditional practice for educators, when is mediated by new technologies and in particular by net-technologies, acquires new potentialities for the propagation of innovation among teachers.

In detail the IAMEL system proved to be able:

- To provide a flexible model where it is possible to make explicit and to structure not only the concrete activities to be carried out but also the theoretical and pedagogical assumptions that have motivated the setting up of such activities.
- To offer the possibility to provide descriptions at different levels of granularity and scope.
- To support the teacher in gaining greater awareness on the pedagogical rationale underlying his/her own design choices making explicit relevant pedagogical issues at play.
- To foster the sharing among teachers of pedagogical reasoning and knowledge connected with concrete activities and itineraries thus, fostering, at different degrees of abstraction, its reuse.
- To support the integration of ICT tools in school practice through the development of plans where crucial issues related with its integration in practice are explicitly addressed.
- To provide a model which is content and subject-independent.

From a more technological standpoint, a number of significant aspects emerged.

Indeed the system is endowed with a number of significant features that contribute to make it a widely usable and accessible tool, namely:

Customizable Data-Base Features

IAMEL is powered by PHP and based on a MySQL database whose structure is the result of the common work of the researchers involved in the project.
Increased flexibility and augmented search facilities are some of the key added values provided by the fact that the pedagogical plans are in a database compatible format. The fields of the database can be filled both with text and XHTML code; XHTML is required if the author needs to implement simple editing features, to insert images, to add links to documents in the repository and to external sites (in the system guide a few examples of the use of XHTML code are available, and some specific tags are suggested). When the use of XHTML code is required, some specific and very simple rules have been defined in order to maintain a homogeneous layout (e.g.: it's forbidden to use the tag FONT).
The system also offers easy access to external material. The uploading of external resources (software as well as articles or working sheet) is, in fact, accepted; in particular it is possible to upload a wide amount of resources directly from a special repository which is part of the system itself.
The IAMEL system encompasses two different environments: the "authoring environment" and "viewing environment".
They are oriented to fulfil the different needs of two different types of users: readers and authors.

Multi-Environment Features

The formers can only view the existing published plans, while the others can both create new plans and edit/modify existing plans. Readers have limited access permissions (and are therefore only admitted to use the "viewing environment") while authors, through a rigorous authentication procedure, have access to both the environments (Petrides et al, 2008).
In addition, while the readers can only access the "published" plans (those plans that the authors have decided to share with others) those users that are authenticated as authors,

Fig 8 Commuting from the authoring to the viewing enviroment and vice versa

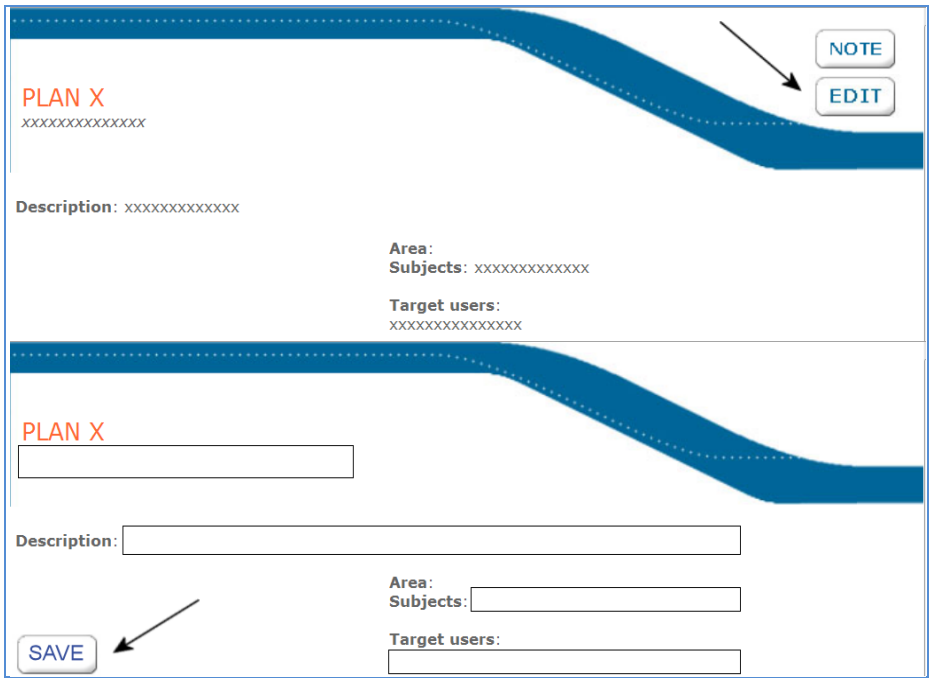
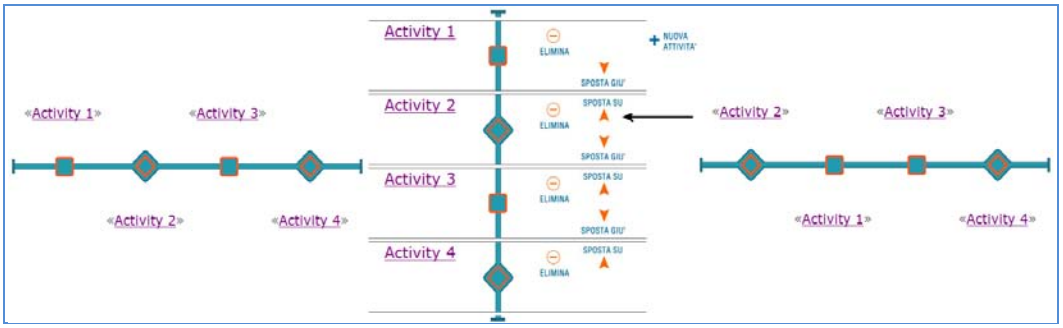


Fig 9 Using the graphical interface to change the order of the activities



can view all the plans they themselves have created, and can both create new plans and make adjustments and amendments to existing plans.

What's more, the authors are allowed to directly shift from the "viewing environment" to the "authoring environment" and vice versa, thus getting an immediate feedback of their actions (new content / changes).

The fact that IAMEL allows "commuting" between the authoring and the viewing environment, thus *de facto* functioning as a multi-environment system, represents a relevant novelty with respect to other systems where the environments are not directly linked one to the other (Benigno et al, 2006).

Fig.8 shows a part of the same page as it appears in the authoring environment (upper part of Fig.8) and in the viewing environment (lower part of Fig.8); in the former enacting the saving procedure (SAVE button) takes directly to the viewing environment while from the second the "commuting" to the authoring part happens by simply clicking on the EDIT button.

Graphical Interface Assistance

The system includes a graphical interface which greatly enhances the system usability. Thanks to this feature the users, as shown in Fig.9, in a few steps can modify the map of the activities of a plan (flow of the activities) and, as mentioned above, immediately after they also have the possibility to visualize the new map.

Fig 9 in the left part shows the starting situation where the map comprises four activities in the sequence *obligatory-optional-obligatory-optional*; the central part shows the authoring environment where the second optional activity (Activity 2) is moved upwards (the move is underlined by the black arrow); in the right part of the figure the result of the move are shown; actually following the performed changes, "Activity 2" is placed at the first place of the sequence and the order of the activity has been changed into *optional- obligatory-obligatory-optional*.

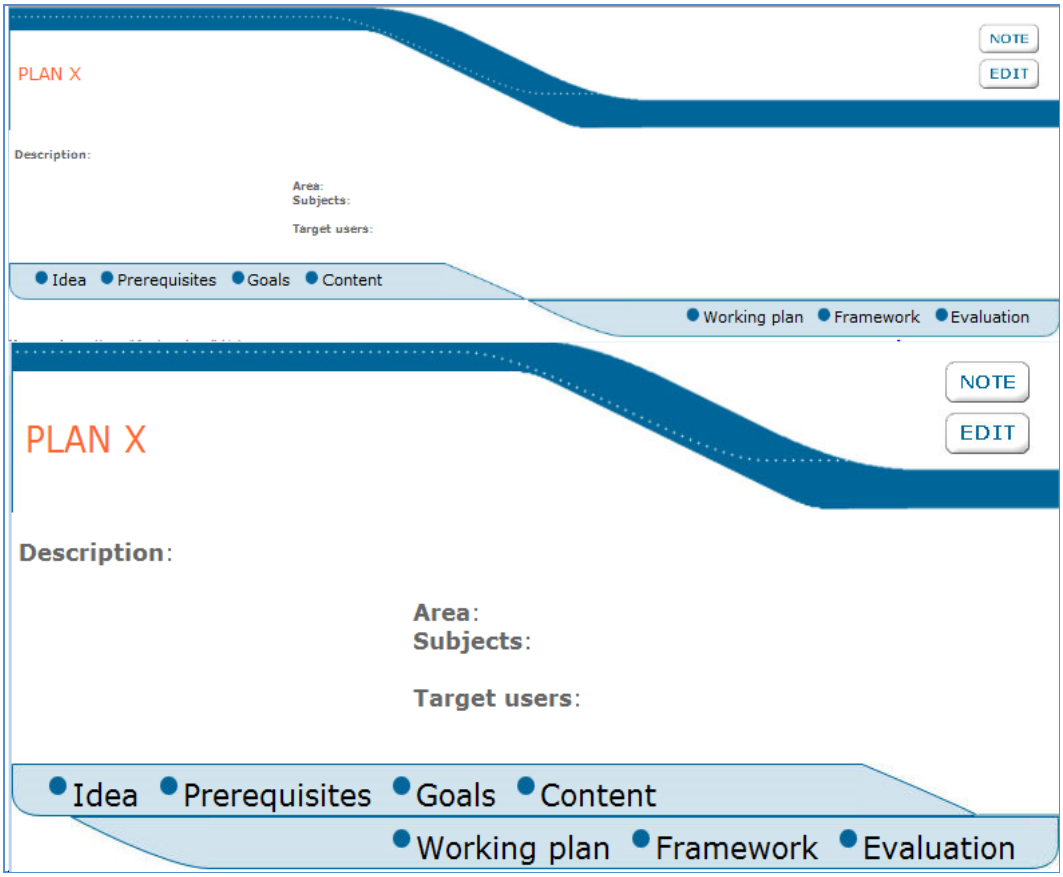
Of course, by acting on the map by means of the graphical interface not only the map changes but the whole activity (including its detailed description) is moved to the new position

Customization Feature

The system comprises a number of features allowing a high degree of customization and personalization. This aspect is particularly important to sustain and improve the software accessibility by persons with special needs

Fig. 10 provides an example of one of the accessibility features of the system; it shows how the viewing of the main screenshot of Plan X can be fully customized by reducing and/or enlarging the content to meet the needs of low vision users. This facility is

Fig 10 Customization features: enlarging facilities



evident if we focus on the graphical image of the ribbon containing the idea, prerequisites etc...; if we enlarge it as shown in the two subsequent images (upper and lower part of Fig.10) we see that, although the dimension of the image is sensibly increased in the lower part, the general aspect of the page remains almost the same and reading is easier.

This is of course only one of the customization feature the system is equipped with; the architecture of the entire system is, in fact, fully compliant with the required accessibility standard (use of validated XHTML and CSS) and meets the requirements of the Italian law in force (law 4/2004 or Stanca Act[1]).

The system also allows that the author works in a random, not sequential way by filling in the data base fields in the order he/she prefers, by acting on the map structure and on the data base fields in a relatively independent way.

CONCLUSIONS

Main objective of the research carried out in the framework of the IAMEL project was to provide a conceptual model for pedagogical planning able to represent both teaching and learning processes to be enacted in concrete classroom settings and also able to make

[1] Italian Law 4/2004 Provisions to support the access to Information Technologies for the disabled http://www.pubbliaccesso.gov.it/normative/law_20040109_n4.htm

explicit the underpinning motivations and choices. Pedagogical plans and wider learning scenarios of different levels of granularity and scope can be designed, modelled and retrieved by means of the IAMEL tool: e.g. scenarios modelling the specific articulation of a learning activity, scenarios modelling a set of learning activities, scenarios modelling the orchestration of different learning activities or sets of activities, etc.

Since the success of tools of such kind depends not only on their ergonomic quality but also on the appropriateness of underlying concepts of users practice and representation, the IAMEL system has been designed by taking into account pre-existing practices (Earp, Pozzi, 2006) but it is also a flexible system that can be adapted to users' specific needs.

In this light, the IAMEL provides different kinds of users with different facilities; it is actually based on advanced database technologies and exploits the potential of a powered graphical interface; it also allows customized access by the users and was designed and implemented in accordance with the "Design for All" (Klironomos et al, 2004) principles.

Actually, the approach adopted to build up the IAMEL system differs from the standard approach adopted for instance by the IMS-LD main stream movement (Koper, 2006) which offers a ready-to-use modelling language explicitly oriented to support the students' learning activities.

IAMEL, instead, is meant to provide teachers with means to instantiate their pedagogical ideas by offering them an ICT enhanced environment aimed at fully describing pedagogical plans that can be further "reused and shared".

The two research lines are not antithetical but complementary in that they serve two different objectives that, both, concur to support teachers' efforts towards a more effective learning.

The IAMEL experience supports the idea that the research line on Pedagogical Planning is productive and opens perspectives related to the introduction of intention-based modelling. In particular in the TEL field it appears to be crucial since the actual introduction of new technological tools in the classroom still requires that teachers are supported and provided with specific information on how these tools are to be integrated in the teaching and learning processes.

The IAMEL system, on the one hand, offers a more systematic approach to the design of pedagogical plans, an activity often suffering of a low degree of formalization, and, on the other hand, it also supports the spreading of new educational ideas and methods by allowing the "reuse" of previously developed plans. This also can support the evolution of the "knowledge society" (Sharma et al 2010) by contributing to build up a wider "knowledge culture" (Bakry, & Alfantookh, 2010) and, hopefully, to concretely improve and foster "knowledge sharing" (Benigno et al., 2004) in the educational field.

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