Fostering reflection in ICT-based pedagogical planning

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This paper examines how the idea of pedagogical planning has evolved, both in form and practice, within the research work in educational technology that we have been carrying out over recent years. Specifically, it investigates two initiatives in the field of teachers' professional development in ICT, and another undertaken as part of European research into theoretical and pedagogical frameworks for experimental classroom activities based on innovative digital tools. In the context of this last undertaking, we have adopted the concept of the *pedagogical scenario,* and this is outlined with its chief distinguishing characteristics in terms of pedagogical planning. The paper considers key aspects that have emerged from the reported experiences, especially the importance of pedagogical reflection, and relates these to current efforts being undertaken towards designing the future of learning, with particular reference to the Learning Activity Management System (LAMS).

Keywords: pedagogical planning, pedagogical scenario, pedagogical reflection, learning design, ICT, teaching

Introduction

The idea that the enactment of effective learning processes calls for careful pedagogical planning is certainly not a new one, and indeed such planning continues to play a fundamental role in contemporary education. Those involved in designing and enacting learning processes in some way (teachers, trainers, pedagogical experts, designers, researchers) usually engage in some kind of pedagogical planning to take account of the elements at play and the interactions between them, in an effort to ensure that these form part of a coherent, manageable whole that responds effectively to learners' needs - insofar as this can be determined *a priori* (Jonassen et al, 1997). With the emergence of theories, methods and tools for describing and enacting learning processes using ICT, such planning has become even more crucial for embracing new potential and managing new complexity (Reigeluth 1996, 1997). Researchers and developers in various fields are increasingly looking at how to take account of different pedagogical visions and approaches, expressed through pedagogical planning of some kind (van Es & Koper, 2005; Dalziel, Goodyear & McAndrew, in press). The new opportunities and challenges of technology-enhanced learning have given strong impulse to the formalisation of pedagogical planning and, in a certain sense, have led to conceptually simpler planning processes.

The activity of pedagogical planning has been referred to by different names, and its artefacts have been represented in a variety of ways that in part reflect their relative scope and degree of formalisation. Certainly the most common and well-established form adopted in teaching practice, irrespective of whether ICT is used or not, is the lesson plan. Van Es and Koper (2005) define the lesson plan as a means to:

> describe how learners can achieve a set of learning objectives …[It] usually describes how a series of lessons or a single lesson should take place… which activities learners and teachers must carry out, the order in which the activities should be carried out, the circumstances under which the activities will be carried out, how learners will be grouped and what materials or technology may be used…The whole lesson plan contains an introduction to the problem of the lesson, the tasks a teacher must carry out, a description of the learners' roles, process information indicating how learners should proceed through the lesson, a description of materials that may be used or references to required worksheets and some evaluation guidelines for the teacher. Teachers who are familiar with a certain topic often create lesson plans for their fellow teachers and may make these publicly available.

As well as the lesson plan, the authors also consider the concept of the pedagogical model, which they regard as being very similar but more directly linked to learning theories. Other common pedagogical planning artefacts include teaching modules or units, which generally cover a longer time span than lesson plans and may be broader in scope. For our purposes, we shall refer in general to *pedagogical plans*, considered as tangible proposals aimed at helping a set of learners to reach specific learning goals in a given context.

In this paper we present a review of how the idea of pedagogical planning has evolved, both in form and substance, within the research work we have carried out over the years in the field of educational technology. We examine how, in our efforts to foster teachers' understanding of educational multimedia, we not only documented and described the resources available but also designed teaching modules that provided the motivation and guidance needed for effective integration of those resources in teaching practice in pursuit of specific goals. We then go on to describe how the pedagogical planning efforts of a community of teachers was supported by a more formal structure, one designed to foster reflection on the part of individual authors and also to lend the plans greater coherence and enhance their reusability. Finally, we examine a more wide-ranging concept called the 'pedagogical scenario', in which pedagogical planning assumes a more dynamic and modular nature and is approached as a top-down process that can embrace varying degrees of refinement and hence of complexity. The pedagogical scenario is designed to encompass the viewpoints and concerns of teachers, researchers and computer scientists engaged in educational innovation, opening the way to different forms of enactment.

The brief discussion that concludes the paper explores some key aspects that have emerged from the reported experiences and relates these to current developments being undertaken towards designing the future of learning.

Some experiences in pedagogical planning

SD2: from selecting resources to integrating them in teaching practice

Servizio Documentazione Software Didattico (SD2)[1] is an online service established in 1999 by the *Istituto per le Tecnologie Didattiche* (ITD)[2], in conjunction with Italy's Ministry for Education, to help teachers learn about ICT-based tools and resources suitable for their particular teaching requirements: it is the main service of its kind in Italy. As well as general information about available ICT products, teachers using SD2[3] seek guidance in integrating these resources effectively into their teaching practice. Consequently, the SD2 site features a repository of detailed teaching units with comprehensively described learning activities, including computer-based ones, as well as any attendant digital content for enactment.

Beyond the immediate purpose of responding to users' specific teaching needs, the plans have a more general aim of encouraging teachers intending to implement ICT-based activities of their own to bear in mind fundamental questions such as the overall structure and sequence of proposed activities, the prerequisites and learning goals entailed in each phase, the role and suitability of the tools and resources employed, classroom orchestration and management, etc – fundamental considerations that underpin truly effective teaching and learning using ICT.

[1] For more details, see the SD2 web site at http://www.sd2.itd.cnr.it/.
[2] ITD is a research institute belonging to the Italian Research Council.
[3] Approximately 40,000, including both trainee and in-service school teachers.

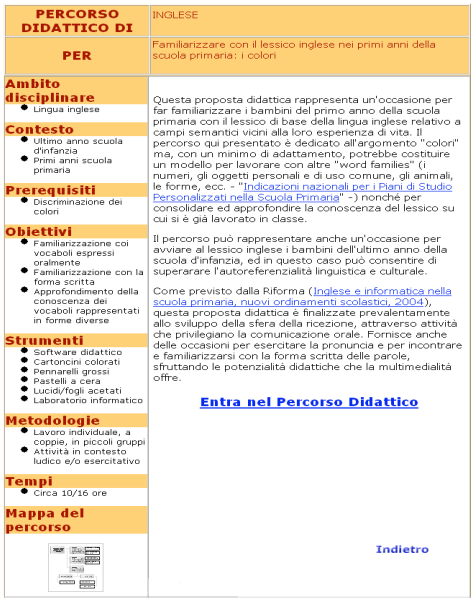

Figure 1: 'Home page' of example SD2 plan

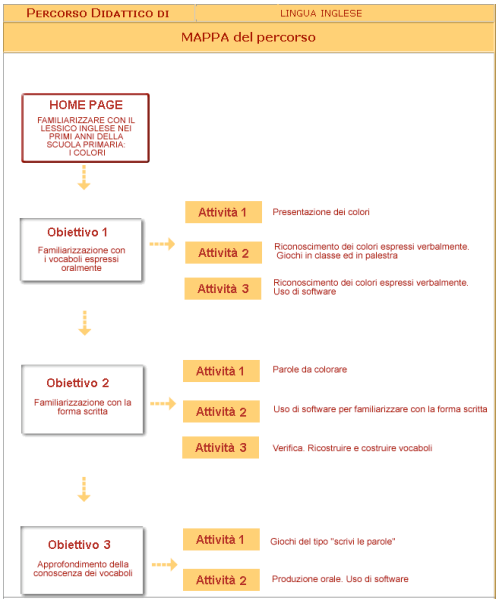

Figure 2: Interactive map of plan structure

The pedagogical plans are in hypertext form and were created using a structured series of HTML template shells. To view a plan in SD2, teachers simply select one from the list of titles, which are also coded by school level and subject area. Figure 1 shows the home page of an example plan containing a description and a list of top-level specifications (the left-hand frame), which may include subject area, subject topics, context, prerequisites, goals, tools and resources, methodology, duration. Entering the plan proper (see interactive map in Figure 2), the user is presented with a certain number of learning goals (described in full on the relevant page) that can be attained by enacting the suggested sequence of learning activities. Structuring and presenting the whole pedagogical plan in terms of learning goals puts the focus firmly on what, for teachers, represents the core of a pedagogical plan, and in SD2 a conscious effort was made to 'bring the core to the fore', as it were.

Clearly, this early effort to support teachers' planning was strongly grounded in one-to-many communication: teachers had access to a set of ready-made plans, chose a suitable one and then adopted or adapted it to their specific requirements. This emphasis on providing information to as wide an audience as possible was very much the prevailing trend on the web back in the 1990s when the initiative was envisaged. However, with the increasing prominence of ideas and technologies emphasising social involvement in the construction of knowledge and learning – the cornerstones of the Web 2.0 era – a strong impetus emerged to go beyond the provision of ready-made plans, however comprehensive and well conceived, and towards giving teachers the means to design, share, (re)use, refine and personalise plans within a community of practice. This was the thinking behind the Netform 2 project.

NETFORM2: from off-the-shelf to do-it-yourself

Netform2[4] was a project launched in 2002 to help teachers create and share their own pedagogical plans containing learning activities that feature the use of both traditional and ICT-based resources for reaching specific learning objectives. The aim was to empower teachers so that they could take on a more proactive role in the design and personalisation of pedagogical plans and to foster sharing and reuse of those plans by teachers in different settings. This involved the establishment of a self-sustaining online peer network of teachers which would also help novice teachers and those with little experience in using ICT in teaching to engage constructively with more experienced colleagues within a virtual online community so as to foster the transfer of expertise and best practices (Benigno, Ott & Tavella, 2003).

[4] Netform2 was a joint ITD/Ministry of Education undertaking. The project web site can be visited at http://www.netform2.itd.cnr.it/.

One of the main outcomes of Netform2 was the design and implementation of a system comprising two distinct but interrelated environments:

- a java-based authoring environment with restricted access rights for creating, editing and publishing plans;
- an open repository of published plans, which are listed by title, school subject and level, with a brief description to aid selection.

As with SD2, authors can provide direct access to any digital content and documentation they deem necessary for enactment.

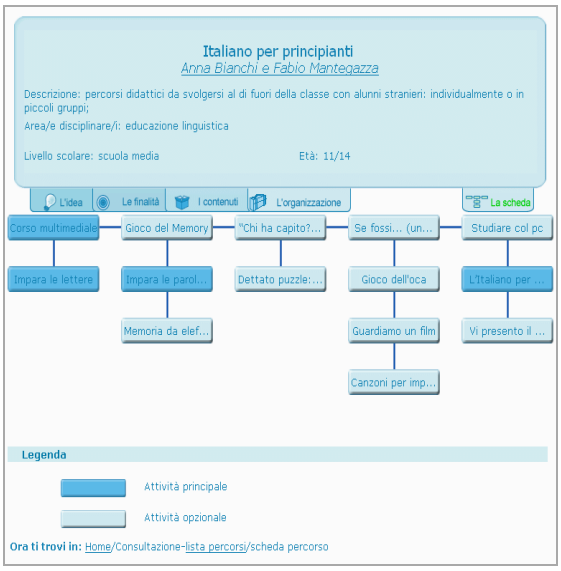

Figure 3: Example plan published in Netform2

Figure 4: Netform2 authoring environment

Figure 3 shows an example teaching plan published in the repository. The main section at the top gives general plan information (title, authors, subject area, school and age level) with further top-level description available via the four tabs immediately underneath (left to right: Idea, Goals, Subject Contents, and Organization). The Idea descriptor explains the plan's point of departure, namely the educational problem addressed (the need for intervening) and the proposal, i.e. how the author proposes to tackle that problem, describing any innovation this might entail. Organisation outlines the method used, the tools adopted and the time required to complete all the plan's mandatory activities. Top-level description of Goals and Subject Contents is provided via the respective tabs. Taken together, these top-level descriptors give a basic idea of the plan's features, constraints and overall feasibility, the aim being to stimulate interest and curiosity, and, at the same time, to give the user a fairly immediate grasp of whether the plan is suitable for their needs.

The array of cells in the central area of Figure 3 represents the organised structure of proposed activities. Those linked vertically share common intermediate learning goals, while the horizontal links express the suggested sequence to follow for working towards the plan's overall objectives. Provision is made for both mandatory (dark coloured) and optional (light coloured) activities. Building and modifying this structure in the authoring view (see Figure 4) simply entails activating/deactivating cells in the 5 x 5 grid: the blank cells do not appear in the published structure.

When users click on a cell in a published plan, they get a comprehensive view of the proposed activity, expressed via a series of descriptors that includes specific objectives, teacher and student prerequisites, the tools and resources required, suggested working method, preparation notes, indication of technology to be employed, etc. The author provides these and other plan data by completing the related fields in the authoring environment, saving the modified plan and then publishing it for viewing in the user environment.

Applying a set of descriptors to all plan levels, including the activities themselves, rather than more or less open-ended textual narrative as in SD2 reflects a more structured and formalised approach, one that presents a number of advantages:

- plans are more readily accessible and comprehensible to users, especially when the same – or similar – descriptors are used both at upper levels for the plan as a whole and for the single activities;
- authors are encouraged to focus and reflect systematically on the individual elements of their plans, on the structure of proposed activities, and on how these elements fit together to make a whole;
- authors can check overall coherence of that whole more easily;
- the plans themselves are easier to modify and to manage, both by authors and by system administrators;
- there is greater scope for exploiting technological functionalities, for example the possibility to search for and access plans via specific parameters.

It is worth pointing out that the conceptual scheme adopted for representing pedagogical plans in Netform2 was not preconceived by the project researchers and then proposed *fait accompli* to the teachers, but rather was the fruit of a collaborative decision-making and verification process driven by the project's core group of expert teachers during the early stages of the project. The resulting scheme has proved to be functional and responsive to teachers' needs, aspects that were crucial to effective take-up and plan reuse. The scheme represented a solid foundation which could easily be extended to meet requirements emerging outside the project's confines.

One such area of action is e-inclusion and the need to provide adequate educational opportunities for *all* learners, including those with Special Education Needs, issues that are gaining serious attention worldwide[5]. In this context ITD has been called on by Italy's Ministry of Education to lend its expertise in ICT for disability and learning difficulties to new initiatives regarding e-inclusion and accessibility, one of which is called *Accessibilità del Software Didattico* (ASD). This involves the development of a system for the creation and sharing of pedagogical plans expressly designed to foster inclusive learning by exploiting the potential of accessible educational software. Devising such plans is by no means an easy undertaking: it entails delicate decision making at a number of levels (personal, technical, didactical. etc.) and designing for reuse is a complex task. This is where the experience gained in Netform2 comes in good stead.

The community of specialised practitioners brought together in ASD will create and test inclusive plans using an online system similar in many ways to the one adopted in Netform2 but revised to meet mission requirements. A key feature of ASD is that the set of proposed activities in each plan will include one or more activities designed to address specific SEN issues, with the aim of facilitating inclusion in the learning group. As well as providing a narrative description of each activity that they proposed in their plans, authors will make use of a set of descriptors that comprises subject area, subject topics, context, prerequisites, goals, tools and resources, methodology, duration.

REMATH: from pedagogical plans to pedagogical scenarios

Fostering ICT-based innovation in teaching practice often entails quite close encounters between the worlds of teaching and of research. In experimental activities, teachers commonly work directly with research teams to ascertain the potential of ICT-based tools in teaching and to define meaningful contexts and methods of use. Our experience in this regard suggests that much can be gained by broadening the scope of pedagogical plans so that, as well as responding to immediate didactical needs, they also incorporate more long ranging aspects of change and innovation brought about by the use of ICT in education. Embracing classroom experience and theoretical conceptions means accounting for very

[5] Recent e-inclusion legislation in Italy stipulates that all public software procurements and utilisation will henceforth have to comply with accessibility specifications http://www.pubbliaccesso.gov.it/normative/law_20040109_n4.htm (in English). This law is based on Section 508 of the US Rehabilitation Act: http://www.section508.gov. A serious of such e-inclusion measures has recently been endorsed by Ministerial Agreement at European level: see http://europa.eu.int/information_society/events/ict_riga_2006/index_en.htm.

different visions and points of view. This mediating role might be played by the 'pedagogical scenario' (also called the learning scenario[6]), a concept that Pernin and Lejeune (2006) define as:

> the description, carried out *a priori* or *a posteriori,* 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. This broad definition covers diverse circumstances: for example it could apply to a traditional or computerised learning situation or to a UoL lasting just a few seconds or a course spanning a number of years.

We are currently exploring the potential of the pedagogical scenario as partners in the EU Remath project[7], which gathers research teams throughout Europe who are working in the field of technology-enhanced learning applied to mathematics, often from quite different theoretical perspectives. The general aim of the project is for these teams to share their know-how and ideas in a collaborative effort to define a theoretical and operative framework, ie a common means for framing and positioning the different theories on, and approaches to, technology-enhanced maths learning that inspire each group. More specifically, this effort will entail experimentation and cross-testing in European classrooms of activities based on the use of experimental maths software developed by different teams involved in the project. Key to this effort, and to the definition of the shared framework, is the 'pedagogical scenario', whose conceptual design, development and implementation is the responsibility of ITD.

In response to the particular demands of the Remath project, the pedagogical scenario has been designed as an extremely flexible, modular entity capable of embracing both simple plans for single activities and very complex structures with activities of different type arranged into different levels. This flexibility is achieved by defining a scenario as a tree-like hierarchy made up of simpler, elementary scenarios (the leaves of the tree - see Fig. 5) and expressing these using a common set of descriptors[8].

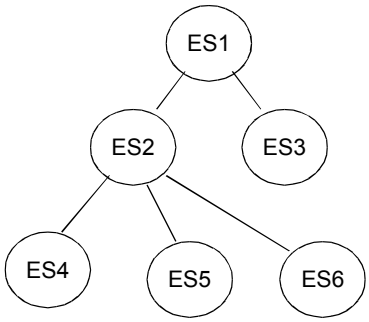

Figure 5: Tree structure of a Remath pedagogical scenario

[6] The former term tends to be favoured by authors from French-speaking contexts, possibly because *scénario pedagogique* is also used in the wider education field to denote pedagogical plans and designs in general**.**

[7] The Remath Project is co-funded by the European Commission within the Sixth Framework Programme (2002-2006) http://remath.cti.gr/default_remath.asp.

[8] The hierarchically organized descriptor set comprises Identity (general meta-data for identification and system management), Target (Population, Context, Goals), Specifications (Tools, Resources, Work-plan), and Rationale (including theoretical framework), a descriptor which is proposed at different levels. Some descriptors cluster elements of similar type, for example Goals comprises the descriptors Curricular, Cognitive, Content-Epistemological, Social-Affective, and Instrumental Goals.

Each node of the tree (for instance ES2 in Fig.5) may be interpreted either as an elementary scenario or as a sub-tree having that node as a root (in the example the leaves are ES4, ES5 and ES6). As both interpretations can be useful, we need to label them with different names; accordingly, we refer to the first case as 'the elementary scenario ES2' and to the second case as 'the scenario ES2'. Rules of order and optionality can be applied to the nodes within a scenario so as to allow for complex activity structures.

The design of the pedagogical scenario model attributes high priority to the concerns of actors who perform in various capacities (research, software design, scenario design, scenario enactment) within different educational and national settings: this is reflected both in the choice and arrangement of descriptors and in the modular, hierarchical schema. These actors should be able to use scenarios in a way that befits their different requirements. For example, authors can propose *full scenarios* - complete with activities designed and structured to meet certain goals within a certain context - that others can draw on to different degrees and personalise for reuse in the way they see fit. However, *elementary scenarios* can also encapsulate nascent ideas which will subsequently be fleshed out into full scenarios by those that have (greater) familiarity with a particular learning context, and its particular requirements and restraints. An instance of such 'germination' might be, say, a description of an interesting didactical 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.

In the field of learning design, a variety of approaches have been (and are being) explored to support the sharing and reuse of design artefacts: these include the elaboration of generalised models and patterns, the instantiation of templates, the tailoring/reworking of exemplars, the abstraction of suitable exemplars to produce templates, etc (Bailey, Zalfan, Davis, Conole, 2006; Martel, Vignollet, Ferraris, David, Lejeune, 2006; Pernin & Lejeune, 2006; Buzza et al, 2005, Griffiths & Blat, 2005; Harper, Oliver, Hedberg, Wills, 2003). Allowing the flexibility to work with pedagogical scenarios in a variety of ways (abstract/concrete, general/detailed) is crucial both to their reuse and to fostering wider involvement of various actors in the pedagogical planning process. As Dalziel, Goodyear & McAndrew (in press) state:

> The exchange of ideas in a community needs to provide flexibility…Completely specified exchangeable elements…will certainly be of value, but may not provide significant support for exchange of understanding and reuse in a way that recognises adjustment to context and draws on the skills of both the original designer and those of the teacher involved in the reuse.

Indeed, authors in Remath are not compelled to work with a preconceived structure with predefined levels, as in Netform2. A useful analogy is that of a potter who is working at the wheel, shaping and modelling the clay as the pot takes form, rather than filling it into a ready-made mould that has been fashioned to produce a given result.

Discussion

The experiences described in this paper have been driven by the fundamental requirement that they should respond directly to the manifold needs of the actors involved, and this is reflected in the approaches adopted to pedagogical planning. SD2 and Netform2 addressed the need (albeit using quite different strategies) to encourage and foster the spread of know-how to less experienced teachers and to those with limited experience in using ICT in their teaching practice, something that is acutely felt in countries such as Italy where ICT use is still not a consolidated part of the average teacher's professional practice. Accordingly, attention was focused on teachers' professional (and personal) development, on heightening awareness of and sensitivity to the issues entailed in using ICT effectively in teaching practice, on the planning process as a means for *pedagogical reflection* (Hatton & Smith, 1994; Diezmann & Watters, 2006). This emphasis on reflection is a characteristic that is also shared by the pedagogical scenario in the Remath project, which has the additional ambition of broadening and intensifying that reflection by embracing the concerns of other actors such as pedagogical experts, researchers and computer scientists, whose contributions in areas like theoretical frameworks and ICT-based innovation can greatly enhance and enrich learning processes.

Exploration in fields such as instructional design, learning design, and learning patterns is currently resulting in the development and testing of ICT-based tools that approach pedagogical planning from different directions and capitalise on its fruits in different ways. For example, the IMS-LD specification, one of the most significant initiatives in this area, 'aims to represent the learning design of units of learning in a semantic, formal and machine interpretable way' (Koper 2006). This formalisation is providing the basis for a continuing research effort that is seeing the emergence of systems both for testing the validity of the specification and for exploring its pedagogical potential, especially within e-learning. One of the most well-established learning design-inspired applications is the Learning Activity Management System (LAMS), a system for designing and building activity sequences that can be enacted online with direct learner participation (Dalziel, 2003). This enactment capability clearly distinguishes LAMS from the undertakings described above, which, as explained, have focused 'upstream' on pedagogical reflection.

A key to exploiting the educational potential of systems like LAMS, Netform2, Remath and the like is undoubtedly the extent to which individual practitioners can access and reuse, in one form or another, proposals resulting from the pedagogical planning process in order to reach learning goals within their specific contexts. Teacher-authors in particular stand to gain from greater socialisation of pedagogical planning as, for a number of reasons, they have traditionally 'plied their trade' in relative isolation, often leading to a sort of professional tunnel vision (Midoro et al, 2005; UNESCO, 2003).

LAMS mainly seeks to facilitate reuse through degrees of abstraction, whereby sequences can be seen as more or less content- and context-independent templates, skeletal structures that can be rapidly contextualised and customised to suit different domains and settings (Dalziel, 2003; Dalziel & Philip, 2004). A driving ambition of LAMS is to support busy practitioners by making instantiation as quick and effortless as possible, technically achievable in no less than 5 minutes. Another significant example of abstraction applicable to learning design is design patterns (Alexander et al, 1977). Here the emphasis is on identifying an appropriate type of (collaborative) learning structure such as brainstorming, jigsaw etc, that might be suitably adopted for meeting specific goals, and on using this as a sort of basic building block for constructing an instantiated learning design (Hernández-Leo, D. et al, 2006; Strijbos, 2004).

The instantiation of a pedagogical scenario, on the other hand, aspires more towards a constructive effort of reflection, which is underpinned by its potential for expressiveness – bringing the core to the fore. By the same token, however, the modular approach of pedagogical scenarios also endeavours to support and foster the 'germination' of ideas – as well as facilitate personalisation and reuse – through minimal elementary scenarios that can be organised and developed into fully structured scenarios. Ensuring that both needs are catered for in an effective manner is one of the major challenges that lie ahead. Another key priority will be to explore opportunities for web-based enactment of pedagogical plans/scenarios, which could open up new possibilities for bringing the benefits of *pedagogical reflection* to fruition in learning processes and thus, it is hoped, make a positive contribution to designing the future of learning.

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