BPM4ED: A Research Project for Designing 21st-Century Schools

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***Abstract*— Schools and teaching are quickly changing due to the continuous evolution of the world and society, and thus new forms of education are required: on the one side, the emergence of smart cities and smart communities demands for active citizens interacting with institutions, and on the other side ICT is modifying both the learning environments and the training models. The so-called "21st century schools" differ from the current ones in almost all the aspects: building architecture, furniture, teaching and learning methods. This new kind of school is spreading all over the world, and governments recognizing the importance of an efficient, modern and up-to-date education system are committed in the design and implementation of these new schools. But some problems make this scenario confusing, preventing an ordered development of this new kind of schools: first, the lack of theoretical models able to represent the "21st century school" features; second, tools to manage and design these schools and their services and activities are, when they exist, based on the old paradigms (i.e., the traditional school with classrooms, etc.) and are not still integrated in an unique toolbox able to support the whole school operations and management.**

In this paper, the ongoing BPM4ED (Business Process Management for EDucation) research project is described: schools are seen as organizations and business process management techniques are used to analyze and classify them; the final and ambitious goals of the project are the development of a design methodology for "21st century schools" and the definition, design and implementation of a new class of integrated tools, possibly including the existing ones, to manage all the school activities and services.

***Index Terms*—business process management; design methodology; theory of organizations; 21st century school.**

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I. Introduction

The current schools (or the most of the existing ones), which we will refer as "traditional", are characterized by fixed and invariable elements. These involve architectural infrastructures (classrooms, gyms, laboratories, etc.), as well as functions, roles, rights, and responsibilities of teachers, students, and parents, which are clear, distinguished and determined (for instance, the teacher teaches classes of pupils, parents and students participate in class councils, including the choice of textbooks, teachers plan their own activities, etc.).

In recent years, the integration of ICT in the educational process is fostering the development of new learning environments [10,15] and teaching models [9,10], up to, in the most successful cases, the design of completely new schools, in which the concepts of classroom and class do not exist anymore; these schools are referred to as "21st century schools".

Moreover, the "21st century schools" have to be a part of modern societies, playing a central role in them, as required by emerging concept of smart cities.

In Europe, and all over the world, there are different "types" of "21st century schools" [9,10,11,12,13,14], which differ significantly from traditional schools in both the teaching methods that they use and in the services provided to students, as well as in the architecture they adopt.

Also in Italy, a process of modernization of the education system is undergoing. It comprehends the creation of models of new schools called "schools 2.0", which, supported by ICT, have to significantly change not only the learning environments but also the entire organization and structure of schools.

However, if traditional school scheme and structural characteristics are consolidated and recognizable, new schools lack a characterization and prototypes, to which to refer to.

Two problems arise: the realization and the diffusion of these new schools within a country. A typical policy to cope with this problem is the so-called *dissemination* (see, for example, [9,10,11]), according to which *new schools* are first designed and realized and then they are taken as *models* and

"*replicated*". The replication usually requires the teachers to visit these new schools, appreciating their learning paradigm, environment, organization and management; therefore, they decide to import the new model in their own school. A net of private and public institutions that fund its realization assists this process.

We argue that, although this policy may represent an effective way to avoid impositions in changing the model, it implies difficulties when importing it. In fact, schools are complex organizations, and designing them involves many variables, so that enormous difficulties have to be faced in designing a "21st century school". *Importing* not always means *copying*, but it means adapting the model to the characteristics and needs of the community and the place where the school is located.

A design methodology is therefore needed to help schools in being involved in the modernization process. This is also strongly motivated by the more and more complex management of the activities to be accomplished in the schools, especially when they offer services to all citizens, not only to students, and when they make use of a lot of technological tools, as it happens in new schools. Thus, the instructional design methods have to take in account both individual learning processes and collaborative ones, as well as problem solving activities, and activities related to the specialization of the smart communities to which the school provides services.

In this scenario, the BPM4ED (Business Process Management for EDucation) [25] research project was conceived and is currently ongoing. In BPM4ED, schools are seen as organizations and Business Processes Management techniques (BPM for short) are used to analyze and classify them. The final and ambitious goals of the project are the development of a design methodology for "21st century schools" and the definition, design, and implementation of a new class of integrated tools, possibly including the existing ones, to manage all the school activities and services. The stages of the project and the related activities are described in the rest of this paper (each section is devoted to a stage, from the idea underlying the project to the final goals) and summarized by the UML activity diagram in Fig. 1.

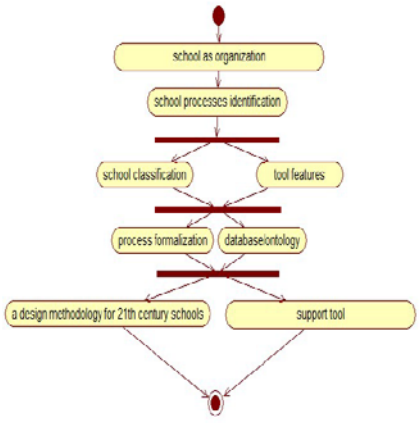

Fig. 1. The activity diagram of the research activities in BPM4ED

II. The Idea: Framing the School Organization within Theory of Organization and its Working within Business Process Management (BPM)

A. Schools as organizations

The basic idea underlying the project consists in framing the school structure within the organization theory [1], and in modeling the school way of working through the Business Process Management approach [2].

According to this view, the school structure has the following components: ***mission*** (the main goal of the school); ***processes*** (describing the services provided by the school and the activities performed); ***resources*** (needed by processes to work).

The resources can be classified according to the ***organizational and*** the ***technical environments***. The ***organizational environment*** consists of:

- roles and their social structure: used to define the role(s) of people working in the school and the relations among each others;
- physical environment: both the internal environment (classrooms, laboratories, etc.) and external environment (in which the school is located).

The ***technical environment*** consists of:

- tools: software, hardware and other ones to accomplish the activities of the organization (e.g., broadband lines for the Internet connection, cloud computing, IWB, etc.);
- an information system: "An integrated man/machine system for providing information to support the operations, management and decision making functions in an organization. The system uses computer hardware, software, manual procedures, management and decision models and a database" [5].

B. Classification of schools

The first partial outcomes allowing a broad assessment of the validity of the idea are described in [3,4]. In [4], a new instructional design methodology based on eXtreme Programming [16,17,18] is proposed to guarantee transparency and community participation to the school life. In [3], using the classification of Venkatraman [7] and the results from Sims et al. [6], it is discussed how it is possible to classify schools in six levels:

Level 1 – *Localized exploitation of ICT to improve school services efficiency and transparency*

Example 1 (technologized traditional school): a school with a wireless infrastructure, where classes are given by presentations using IWBs; the school has a Web site with all the information about its activities and organization, the taught subjects, the timetables of classes and parents' meeting, enrollment forms, etc.

Level 2 – *ICT for the internal process integration*

Example 2 (school provided with an Internet connection,

intranet and an e-learning platform): the e-learning platform serves to integrate some teaching processes.

Level 3 – ***School process redesign (ICT for new process realization)***

Example 3 (school provided with an Internet connection, intranet, an e-learning platform, communication and cooperation tools as e-mail, chat, videoconference): this kind of schools allows for new teaching activities, new relations among students, between students and teachers, parents and the school, etc. From the point of view of processes, schools belonging to this level have automated some processes and have redesigned processes concerning the relations among stakeholders and actors.

Level 4 – ***Redesign of processes concerning the relations between the school and the other participants***

Example 4 (school provided with an Internet connection, intranet, an e-learning platform, communication and cooperation tools): the school provides a set of online interactive services for all the stakeholders; moreover new relations with external stakeholders can be undertaken (the network management is entrusted to an external provider). It is worth to notice that the schools of this level need specialized (e-learning) platforms to allow the previous relations.

Level 5 – ***Redefinition of the school goals***

Example 5 (school provided with an Internet connection, intranet, an e-learning platform, communication and cooperation tools): the school tries to personalize as much as possible the teaching/learning processes; moreover, the school can realize processes that are usually performed by external stakeholders (e.g., e-book publishing activities).

Level 6 –*No school/ Network of schools*

Example 6 (distance and mobile devices, a cloud computing platform, software to share services): in this case, decentralization is the main feature and the goal is to realize the Web 2.0 idea of "multiple sources, more services".

III. Stage 2: Feasibility Analysis

The goal of this stage is to identify in detail the school processes in order to improve the previous classification. We sketch below our approach. A more detailed analysis, and the complete classification of school processes we have carried out, can be found in [8].

First of all, a notion of school process is needed; this is possible by modifying the classical definition of business process [1] to make it suitable for schools.

Definition (*School process*). *A school process consists of a set of activities that are performed in coordination in the organizational and technical environment of the school. These activities jointly realize a school goal. Each school process is enacted by a single school, but it may interact with processes performed by other schools or organizations.*

In an analogous way, it is possible to redefine the classification of processes on the ground of their functions [2]:

- **school strategy processes:** they describe the strategy of the school, to develop a long-term sustainable formative plan;
- **organizational school processes:** the school strategy is decomposed by goals; each organizational process serves to reach one of these goals;
- **operational school processes:** these processes are a further specification of the ones in the previous category and they include the activities and their relationships;
- **implemented school processes:** these are the school processes that are implemented; they contain information on the execution of processes and activities other than the technical and organizational environment in which they have to be executed.

For instance, the main process in a school (e.g., an Italian school) is the *training plan process* which originates the school goals on the ground of analysis of the external environment of the school (the smart community features and needs) and the constraints (school building features, laws, teachers' visions and skills, etc.). The school goals are fulfilled by the *organizational school processes* (e.g., PROCESS NAME: student enrollment; input: student data; output: class and section), which, in turn, are more precisely described by the *operational school processes* (e.g., PROCESS NAME: student enrollment; activities: registration, access, find school by school-code, choose the curriculum, compile the form with personal data, choose other schools, send data, obtain receipt) which, finally, are realized by the *implemented school processes* (e.g., an online enrollment software).

IV. Stage 3: Applying Processes to School Analysis

This stage is devoted to the application of BPM to school analysis; this means both to classify schools (i.e., to provide a precise and detailed classification) and to study the features of tools and devices used in schools.

A. School classification

Classifying schools in a precise way, according to their way of operating, is an important task as it contributes to devising the new design methodology for schools; in addition, school classification can make clearer and precise the concept of "modern school" or "21st century school".

B. Tools features

Tools have to support the application of the methodology and this task serves to define the main feature of the tools.

V. Stage 4: Process formalization

Different process modeling tool and notation have been proposed in the literature over the years: *(i)* those ones adopting an activity/control-flow view, as BPMN – Business Process Model & Notation [19] or YAWL [20], *(ii)* those ones

adopting a more declarative view, i.e., focused on expressing constraints on what is allowed/not allowed in the process more than prescribing a rigid sequence of activities, as Declare [21], and finally *(iii)* the more recent ones following the so-called adaptive case management view, aiming at adding flexibility in the management of the processes as well as more attention to precise data modeling [22][23]. In the project, also on the basis of previous research focused on artifact-centric modeling of processes [24], we envision the development of a process modeling notation, routed on the above notations, but specifically tailored to school process modeling, which require a certain amount of flexibility in the process models themselves.

VI. Final Stages: Designing The Tool and The School Design Methodology

This will be the final stage of the project, in which the design methodology (or methodologies, depending on the kinds of schools) will be devised, and the management tool(s) will be designed and realized.

To these aims, advanced software engineering methodologies, as those in [4], will considered.

VII. Conclusions

The BPM4ED (Business Process Management for EDucation) project is currently ongoing and is supposed to still run for a few years. We aim at experimenting and validating the project results, as soon as they are conceived, on real schools, stage by stage.

To this aim, we are currently selecting a number of Italian schools to be truly representative of various aspects, so that they can be considered as testbeds and living labs.

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