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century schools**

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Abstract— The ways of schooling and teaching is quickly changing for the continuous evolution of the surrounding world: new forms of education are required; in fact, on the one side the birth of the smart cities and the smart community ask for active citizens interacting with institutions and on the other side the enormous potentiality of 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 and so on. This new kind of school are spreading all over Europe and the world and governments, which recognize the importance of an efficient, modern and up to date education system, are committed in the design and implementation of these new schools. Two 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 tool to support the overall school working and management.

In this paper, the ongoing BPM4ED (Business Process Management for EDucation) research project is described: schools are seen as organizations and the business processes 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.

1. Introduction

The current schools (or the most of the existing ones), which we will call from now on “traditional”, are characterized by fixed and invariable elements from both the structural point of view (classrooms, gyms, laboratories, etc.), and function, 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, so as required by the smart city concept.

In Europe and in the world there are different “types” of “21st century school” [9,10,11,12,13,14], which differ significantly from traditional schools in both the teaching methods that they use in services provided to students, and in the architecture/building concepts.

Even in Italy, a process of modernization of the education system is undergoing and it comprehends the creation of models of new school called “schools 2.0” which, through ICT, have to significantly change not only the learning environments, but the entire school complex in its organization and structure. However, if traditional schools scheme and structural characteristics are consolidated and recognizable, new schools lack a characterization and prototypes to which to refer to.

Schools are complex organizations and their design involve many variables and this yields an enormous difficulty in designing a “21st century school”.

A design methodology is therefore necessary to help school in being involved in the modernization process. Moreover, being more and more complex, also the management of the activities to be accomplished in the schools is quite complex, especially in these new schools (i) which offer services to all citizens, not only to students, (ii) where are a lot of technological tools need to be managed, (iii) where 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 smart specialization of the smart communities to which the school provides services.

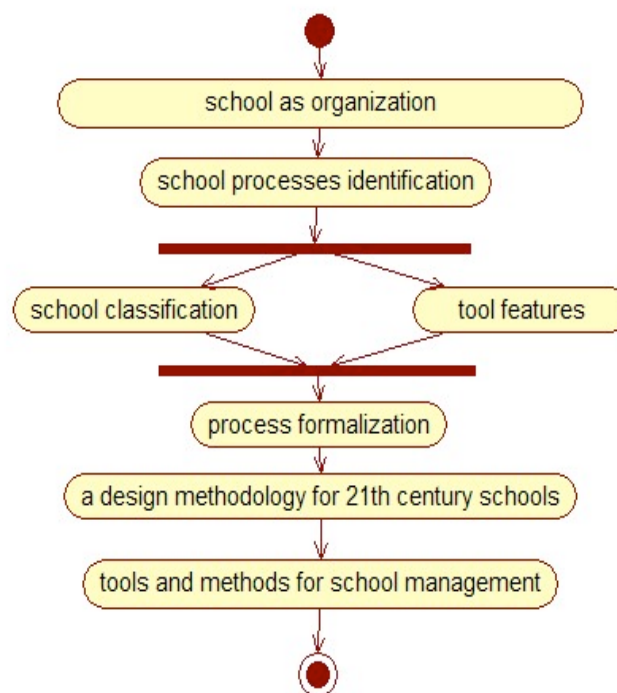


Fig. 1. The research activity diagram of the BPM4ED project

In this scenario, the ongoing BPM4ED (Business Process Management for EDucation) research project was born. In BPM4ED, schools are seen as organizations and the 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 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 Figure 1.

2. The idea: framing the school organization within theory of organization and its working within Business Process Management (BPM)

2.1 School as organization

The basic ideas underlying the project consist in framing school structure within the organization theory [1] and in modeling the school working through the Business Process Management concepts [2].

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

The resources can be classified as **organizational** and the **technical environment**. The **organizational environment** is constituted by

- 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** is constituted by

- tools: software, hardware and other ones to accomplish the activities of the organization (e.g., broadband connections, cloud computing, personal computer, IWB, etc.);
- 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 data base”* [5].

2.2 School classification

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 the eXtreme Programming [16,17,18] is proposed to guarantee transparency and community participation to the school life. In the technical report [3], using the classification of Venkatraman [7] and the results from Sims et al. [6], it is outlined how it is possible to classify schools by the following six levels summarized in the following:

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

Example 1 (technologized traditional school): a school with wireless infrastructure, where classes are given through presentations using IWBs; the school has a web site with all the information about the school, the subjects taught, the classes timetable, parents meeting timetable, enrollment forms, etc.

Level 2 – ITC exploitation for the internal process integration

Example 2 (school provided with Internet connection, intranet and an e-learning platform): the e-learning platform serves to integrate some teaching processes.

Level 3 – School process redesign (ITC exploitation for new process realization)

Example 3 (school provided with Internet connection, intranet, e-learning platform, communication and cooperation tools like e-mail, chat, videoconference): this kind of school allows for new teaching activities, new relation among students, between students and teachers,

parents and school, etc. From the point of view of processes, school belonging to this level have automated some processes and have redesigned processes concerning the relations among school actors.

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

Example 4 (school provided with Internet connection, intranet, e-learning platform, communication and cooperation tools like e-mail, chat, videoconference): 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 goal

Example 5 (school provided with Internet connection, intranet, e-learning platform, communication and cooperation tools like e-mail, chat, videoconference): 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 actors (e.g., publishing).

Level 6 –No school/ Network of schools

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

3. Stage 2: Feasibility Analysis

The goal of this stage is to identify in detail the school process in order to improve the previous classification. An initial analysis and classification of school processes has been made in [8].

First of all, a notion of school process is needed; this is possible modifying the 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 function [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 of the school; 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 (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* (process name: student enrollment; activities: registration; access; find school by school-code; choose the curriculum; form compilation about personal data; chose other schools; send data; obtain receipt) which, finally, are realized by the *implemented school processes* (e.g. online enrollment software).

4. Stage 3: Applying Processes to School Analysis

This stage is devoted to an 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 and classify them.

4.1 School classification

This task could be also called “School from the point of view of working”; to classify school in a precise way is an important task because it contributes to the devising of a design methodology for schools; in addition, school classification can make clearer and precise the concept of “modern school” or “21st century school”.

4.2 Tool feature

Similarly to what is done before, this task could be also called “School from the point of view of resources”; understanding the kind of tools and of devices, the contexts where they are used, the effects on the school working and, as a consequence, being able to classify tools and devices from different perspectives also contributes to the devising of a design methodology.

5. 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 (iii) finally 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.

6. Final stages: designing the tool and the school design methodology

This is the final stage of the project realization, in which it is the design methodology (or methodologies depending on the kind of school) will be devised and the management tool will be designed and realized. Here, software engineering methodologies as in [4], will be considered.

7. Conclusions

We hope to experiment or validate the project results on real schools, stage by stage. In order to monitor the project, we are selecting a number of schools to be truly representative of various aspects so that they can be considered as testbeds / living labs.

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