EPLANNING:
AN ONTOLOGY-BASED SYSTEM FOR BUILDING INDIVIDUALIZED EDUCATION PLANS FOR STUDENTS WITH SPECIAL EDUCATIONAL NEEDS

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Abstract italiano

Questa articolo presenta i risultati di un progetto di ricerca biennale finalizzato all'adozione di tecnologie basate sul web semantico, allo scopo di creare lo IEP (Piano educativo individualizzato) per bambini con bisogni educativi speciali a scuola. Include una riflessione sulla lezione appresa attraverso la costruzione collaborativa di un'ontologia in un contesto concreto multidisciplinare, come pure attraverso lo sviluppo di un sistema di supporto alla decisione basato su un'ontologia.

Parole chiave

Piano educativo individualizzato, bisogno educative speciali, web semantico, sistema di supporto alla decisione basato su ontologie

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http://riviste.erickson.it/med

English Abstract

This paper presents the results of a two years research project aimed at adopting semantic web technology to draft the IEP (Individualized Education Plan) for pupils with special educational needs in school. It includes a report of lessons learned through the collaborative building of an ontology in a concrete and multidisciplinary context, as well as in developing an ontology-based decision support system.

Keywords

Individualized Education Plan, special educational needs, semantic web technology, ontology-based decision support system

1. ePlanning

The Individualized Education Plan (IEP) is a document that defines academic/life goals, methods and kind of educational intervention (activities, supports and services) to obtain these goals for pupils with special educational needs in the school context (Fogarolo, 2014; Ianes, Cramerotti, 2009; Ianes, Macchia, 2008; Scataglini et al., 2008).

The IEP is the result of a collaborative activity that involves the school special education team, the teachers, the parents, other relevant educational and medical stakeholders, as well as, whenever possible, the student.

This type of plan is required by the Italian Law 104 (year 1992) for students certificated for a disability, in the perspective of full inclusion of all the students with special educational needs, in the regular classes of the public school.

Italy was one of the first few nations in the world, to promote a full inclusion model with a specific law in the year 1977.

In details, an IEP specifies the student academic/life goals and the methods/kind of educational intervention to obtain these goals (long, medium, short term range). Besides the wide employment in the last years, of IEPs in several Italian schools of any educational level (kindergarten, primary school, middle school, high school), the development of a IEP for a given pupil is a manual, complex and time-consuming activity for all the school stakeholders.

To support and facilitate the building of the IEP, we developed a web-based decision support system, called ePlanning where users input relevant aspects of the profile of a pupil (e.g., age, diagnosis, observations about abilities and disabilities in student's functioning) into the system, and based on this content the system guides the users in defining the more appropriate academic/life goals for the pupil, suggesting also activities and educational material that may help in achieving these goals.

Fig. 1 shows the workflow system of IEP construction into the ePlanning application.

Semantic Web technology plays a key role in ePlanning, as well as in its development.

ePlanning (see fig. 2) is an ontology-based application (Rospocher et al., 2014): all the content the system uses to support the construction of an IEP is encoded in an OWL 2 ontology, which formalizes:

1. *processes*, that represent functional abilities;
2. relevant *features* of pupil profiles that have to be taken in consideration in building an IEP, like age, school grade, a diagnosis in terms of a ICD-10[1]

[1] URL: http://www.who.int/classifications/icd/en (Accessed 29.04.2015).

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http://riviste.erickson.it/med

or ICF-CY for Children and You[2] code (two World Health Classifications), as well as the relation of these aspects to functional abilities;
3. proposal of *goals* that can be set in the presence of an impairment of some functional abilities;
4. *activities* and *educational materials* that can be used to achieve the proposed goals.

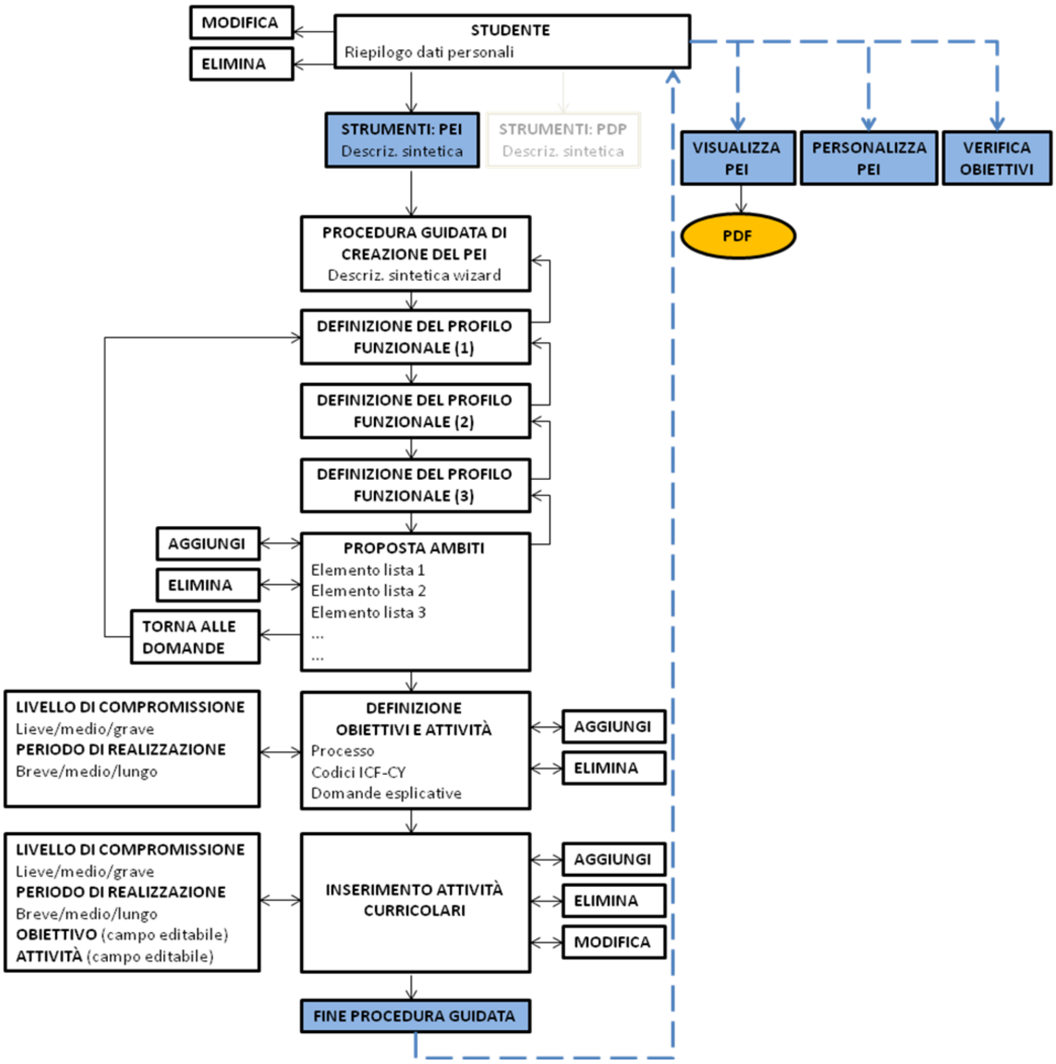

Fig. 1 Workflow system of IEP construction into the ePlanning application.

[2] URL: http://www.who.int/classifications/icf/en/ (Accessed 29.04.2015).

These screenshots show the flow of the system in creating a IEP.

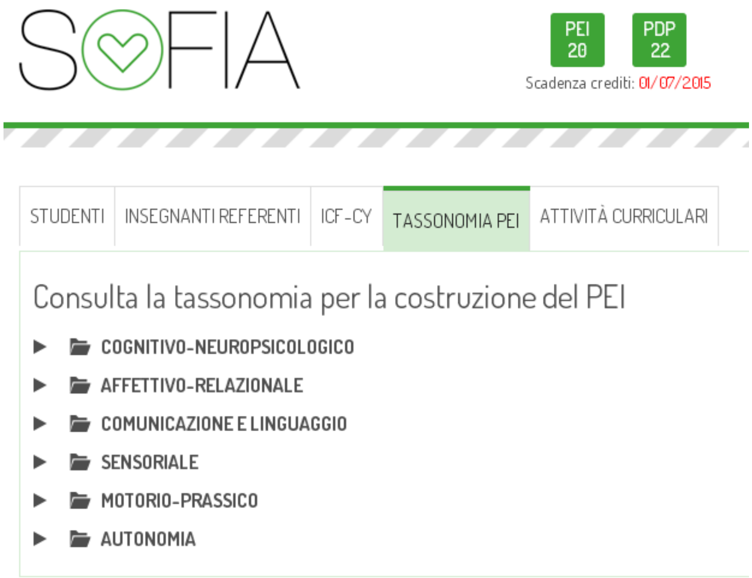

Fig. 2 Screenshot of the main areas of ePlanning application.

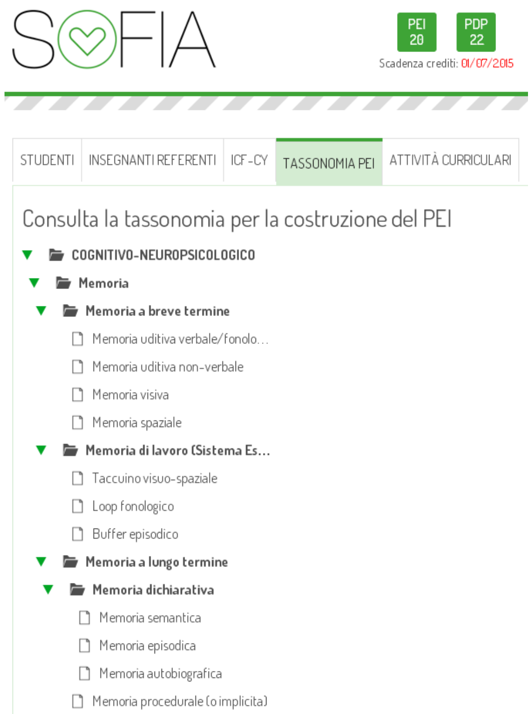

Fig. 3 Screenshot of the main area
“Cognitive – neuropsychological” – Process “Memory” and related sub-processes.

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Fig. 4 A proposal of relevant areas, processes and sub-processes of pupil profiles that have to be taken in consideration in building his/her IEP (an example).

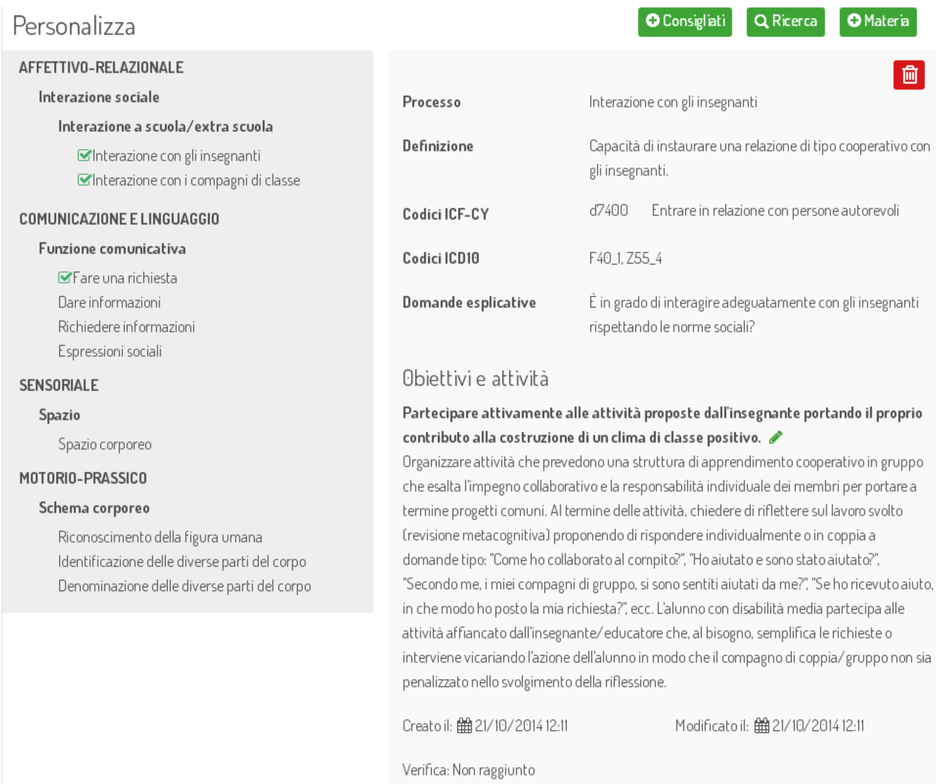

Fig. 5 A proposal of goals, activities and educational materials (an example).

ISSN 2038-3002 - Vol. 6, n. 1, anno 2015, pp. 101-110

The system iteratively accesses the ontology during each session of construction of an IEP by dynamically querying the content of the ontology according to the functional diagnosis of the pupil for which the IEP has to be developed.

OWL-DL reasoning power is also exploited in this phase.

An important example of query is the one that returns all the information of a given functional ability. Given the Uniform Resource Identifier (URI) of a functional ability the system connects to the data store containing the ontology, it performs the query with SPARQL language and retrieves all the relevant information. Such information are the parent (the URI of) and the children of that functional ability (according to the taxonomy of processes and sub-processes), its label, description and clarifying questions in natural language, the sex compatible to that functional ability, some possible ICF-CY or ICD10 codes, an order and a weight representing its relevance in the taxonomy. Another query is the one that, given the URI of a process representing a functional ability, returns the information of its sub-processes. First the query retrieves all the sub-processes, and then the query above is executed for extracting the information of every single functional ability. The power of the semantic technologies is that the URIs of the individuals in the ontology univocally identifies them, so potentially (if the ontology would be public) a single functional ability could be retrieved by whatever application in the world.

The architecture of the ePlanning system is divided into three tiers:

1. the *Presentation Tier*
2. the *Business Logic Tier*
3. the *Data Tier*.

The Presentation Tier is the interface the user interacts with for building the IEP. It is the application oriented layer and it communicates its requests to the Business Logic Tier. The requests are handled by this latter layer through methods exposed by a web service implemented with a REST (REpresentational State Transfer) architecture. Every method semantically queries the ontology from the Data Tier in order to satisfy the application logic. The Data Tier physically retrieves the data from the ontology with the logical inferences already computed. The ontology is stored in an openRDF Sesame triple store.

To favour the construction of a high-quality ontology, to be used at the core of the ePlanning application, an heterogeneous team of 20 users having complementary competencies and skills was involved in its development:

ISSN 2038-3002 - Vol. 6, n. 1, anno 2015, pp. 101-110
http://riviste.erickson.it/med

- *Psychologists and Educators*: helped to define the taxonomy of processes and sub-processes (more than 400) referring to different functioning areas of the students:
  - Cognitive – neuropsychological
  - Communication – language
  - Affective – relational
  - Motor skills
  - Sensory
  - Autonomy (personal and social)
  - Learning.

- *Teachers* (kindergarten, primary school, middle school, high school): helped to define goals (long, medium, short term range) and related activities established on the basis of the level of impairment. The ontology contains more than 9000 goals on three different levels of complexity.
- *Knowledge Engineers*: helped to provide the modelling expertise to properly model the rich content to be represented.
- *Application Engineers*: helped to bring in the application perspective, in particular for the requirements of application-specific content to be modelled in the ontology.

The modelling was performed with a customized version of MoKI,[3] the Modelling Wiki, a collaboratively mediawiki-based tool to model ontological and procedural knowledge (Ghidini, 2012).

The customization consisted in defining ad-hoc forms to guide users in contributing to the ontology, as well as in developing specific features to browse the ontology content.

The tool was extensively used by the modellers: in over a one-year modelling period, we tracked more than 6500 editing operations.

Building an application and its ontology in the concrete setting of the development of an application as ePlanning, let emerge certain aspects that are worth mentioning.

1. Regarding the collaborative development we remark on the importance of having a flexible, ad-hoc, online, and collaborative modelling tool such as MoKI, which allowed us to avoid the proliferation of “latest versions” of documents by domain experts, familiar with spreadsheet before this experience, and consequently considerably reducing human effort.
2. A second aspect worth mentioning is the importance of early deploying the application ontology in its corresponding system, already during the modelling activities. This favoured the improvement of the ontology quality and the early detection of modelling mistakes and assumptions.

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[3] URL: http://moki.fbk.eu (Accessed 29.04.2015).

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3. The importance of adopting an hybrid ontological representation (i.e. representing each core element both as a class and as an individual) to ensure a multipurpose ontology, to be used as a traditional classification ontology on the one hand, and as the main data component of an application system on the other hand.
4. Regarding the application, to allow for its rapid development, to access to the ontology was provided by a we-services exposing pre-canned SPARQL queries through API methods. The web service was implemented by the knowledge engineers, while the application engineers concentrated only on the application perspective without any efforts of interfacing with semantic data and without altering their usual development processes. This work methodology has allowed for a rapid development of ePlanning system.

2. Conclusion

ePlanning has been released in September 2014 as a commercial tool, commercially released as "SOFIA" edited by Edizioni Centro Studi Erickson, having as target audience the schools of all the national territory.

This transition from "research" (ePlanning) to "an operative tool" (SOFIA) has been crucial.

By themselves, the school special education team and the teachers observations would not be sufficient to address the complex needs of many students with special educational needs. However, implemented as part of the services that the IEP team develops, this tool can contribute to a systemic, complete and functional plan for student success.

Encouragement, acknowledgement and support through appropriate tools may help the school special education team feel more comfortable in joining IEP teams and increase their expertise. So they will be able to offer greater contributions for students with whom they are working every day in the school context and view student needs more comprehensively.

Students with special educational needs can benefit directly from these increased expertise and skills, as well as from the constructive collaboration of all the members if the IEP team.

We hope that our ePlanning/SOFIA research project/tool and other lessons learned may be beneficial in this way, for similar modelling initiatives, regarding the development of ontology-based application in practical case, in particular in the psycho-educational field.

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http://riviste.erickson.it/med

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