STUDENT ADMINISTRATION SYSTEMS, A NEW APPROACH FOR UNIVERSITIES

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Abstract. *Improving the work and interface with students in a university is a feature of professionalism of the management team, or the knowledge, skills and abilities of its members however, the information system that supports them is also essential. A semantic Student Administration System can help the managers from universities, professors, students and administrative staff with integrating information across the higher education organization. This asset can be part of a strategy to improve students' management to meet the nowadays challenges and requirements for data integration. The paper motivates and presents an ontology adapted to the needs of educational data management. This new system based on Semantic Web helps students and members of the management team of universities. The presented work describes the components and system architecture underlying its implementation in a real platform and proposes an early stage ontology design for the presented application area.*

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1. Introduction

A semantic Student Administration System (SAS) is a next-generation system for universities that combines the latest semantic technology with existing data management experience of education institutions.

We propose to design an application that simplifies and reduces the system costs, provides students with an intuitive mobile experience, integrated in a knowledge graph model based on Semantic Web. The system must be sufficiently complete and robust to serve as an effective template for future research.

Starting from these considerations, the article has the following structure. In section 2 we analyze the problem of our research and the background, in section 3 we offer a literature review and key achievements for our research. Section 4 describes the new proposal and key modelling decisions and section 5 presents the case study. The paper ends with the Conclusions section.

2. Problem statement, background and state of the art

Applications currently implemented in Romania's universities are mostly based on relational databases [1], isolated and lacking interoperability mechanisms with external systems or available open data sources. That is why our proposal is to migrate the existing relational databases to semantic technology and to integrate all these applications according to the integration patterns of RDF Graphs and Linked Enterprise Data.

We want to build a new ontology and suggest a way to design a new model of such an ontology for our university, however the proposal should be generalizable for other institutions as well.

The actors affected are all those working in a university (professors, staff or students) but students are the main beneficiaries of the system. The university's employees can perceive a variety of benefits (stronger collaboration, automated operations, web of information, retrieval of connected data), which are now administered by different offices, both inside and outside the university.

In paper (Zhao et al.in 2004 [2]), the authors explore the use of Semantic Web technologies such as RDF and ontologies to support the representation of information. Also they study existing initiatives such as Jena and LSID, to generate and store knowledge repositories.

The authors of paper [3], Lima, F. and Schwabe, D. argue the need for flexible models capable of representing semi-structured data processed in Web applications and also give the requirements for query languages that allow the specification of navigational aspects of Web applications.

The project presented in [4] describes the research methodological approach of a work in progress project. It is a Semantic Web related project that presents an architecture with several layers, one of them is Data Interchange based on RDF.

Gruber in 1993 [5] describes the role of ontologies in supporting knowledge sharing activities and then presents a set of criteria to guide the development of ontologies for these purposes. Paper [6] presents an ontology-based approach to e-learning system adapted to the needs of training human resource in a hospital. Also presents the components and system architecture underlying its implementation in a real platform, be a useful guide to how to build an ontology. The study described in the paper of Saarsen [7] shows that models in which the ordering relations between tasks are captured in diagrammatic form, while the details of each task are captured in textual form, are more likely to be used on a sustained basis. Another paper that supports this thesis from a Knowledge Management perspective is [14].

In [8] the author state that "the design of a symbol influences whether it is easy to spot in a model and is correctly associated with the concept it represents".

By providing an ontology for representing risks and mitigation measures, the information can be represented through annotations in arbitrary types of enterprise models [9].

Studying the literature we can conclude that an infrastructure based on Semantic Web for SAS doesn't exist, there are only some synergetic structures. We want to build a new architecture with semantic data services built upon existing sources – an earlier stage of this research was reported in [16], where we focused on semantic data links rather than the ontological aspect.

3. The workflow of the proposal

A large number of universities around the world design their individual database on a relational model for a variety of application domains. Our proposal is to replace the existing applications - see the AcademicInfo Application existing at the level of the Romanian universities, implemented in relational database (<https://academicinfo.ubbcluj.ro/Info/CadreDidactice.aspx> or <https://www.amgd.ro/>) with a D2RQ-lifted semantic database connected to the website of the university. The construction of such an applicable model is complex especially when considering the entire spectrum of data and persons who interact with the platform. Figure 1 presents the underlying recommended development process.

Modelling decisions

Protégé, an ontology editor based on Java (<http://protege.stanford.edu/>), is a standalone application, open source with an extensible architecture. The languages for the ontologies began to be created in the early 1990s, usually as an evolution of existing knowledge representation languages. Among the most relevant languages include: Resource Description

Framework and the Web Ontology Language (OWL), with the Extensible Markup Language (XML) as an early choice for serialization format.

Figure 4. The steps in building a new system

OWL is designed to represent knowledge semantically enriched and complex representations about things, groups of things and relations between things.

Structural units for our proposal are represented in Figure 2. We start with the definition of system environment, we continue with the modelling of entities and we finalize with step 3, Knowledge Domain Modelling.

Figure 2. Structural units for modelling

For this purpose, ontologies are used in modelling the domain of interest and to build, organize and update specific learning resources (student profiles, learning pathways, learning objects). Pragmatic considerations (e.g., cost, effort of implementation, which may limit the number of artefacts) are also taken into account [14].

The design aims to provide a comprehensive and systematic knowledge about the target group, data and knowledge assets to support educational processes depending on the student profile and objectives. It implements the concept of personalization and demonstrates that personalization of learning requires new solutions to several issues such as identification profile, knowledge users, learning style, the aim of learning, educational attainment, purpose and context. We must define the domain and objectives of ontology, taking into consideration the activities to be supported, the main beneficiaries of ontology, those who will use and maintain it. We define a list of classes using a mixed top-down and bottom-up approach. Then we define properties of classes, cardinality and domain and finally we create the instances of classes.

4. Case Study

The implementation of a semantic SAS is done starting with the *Student* concept, for determining the current level of knowledge and training objectives. In Figure 3 we can see the model of Student repository and the graph representation. The basic structure is built on four interconnected graphs: *Student*, *Hour*, *Mark* and *Scholarship*. The inter-table links are based on the primary-keys from relational database (see Figure 3) which are transformed by D2RQ into RDF object properties.

Figure 5. The graph model of application repository

The model is built incrementally, using data source from the forms offered by the system, structured in two directions: determining the real level of knowledge of the student and the objectives of the student. The knowledge domain is the management of student's data from the university. The concepts are organized in an ontology representing the domain to be managed. In describing such a model we start by using **Mind Mapping**. This is a useful technique that helps us to structure and record information which will later be refined in the schema of the RDF knowledge graph. It also supports and enhances creative problem solving, in our case, and generates new ideas. The mind mapping applications help us to build the relationships graphically, between concepts *Student*, *Scholarship*, *Hour* and *Marks*. In this way our repository is organized into idea clusters that are centered on the main topic, in our case *Student* (see Figure 4).

Figure 6. Mind-map diagram in a Student Class concept

The implementation of our ontology is performed with the help of Protégé (<http://protege.stanford.edu/>), as we see in Figure 5. Protégé is an ontology editor and a specialized platform for developing applications based on knowledge.

Figure 7. The modelling of Student SAS Graph represented in Protégé

The class hierarchy is described within the entities: *Mark*, *Timeslot*, *NaryRelationTeachRoomSlotCourse*, *Room*, *Courses*, *Scholarship* and *Person*. Some of classes have sub-classes and can be developed later.

TopObjectProperty subsumes the relationships used in graphs.

We implemented eight properties: *attendst timetable*, *duringtimeslot*, *hasintimetablerrm*, *has timetablecourse*, *studies*, *teaches*, *hasMark*, *hasScholarship* (see Figure 6).

Figure 8. Relationships between graphs represented by ObjectPropties

Domain modelling involves decomposing a body of knowledge in a set of elements called concepts that are basic pieces of knowledge or information. Domain knowledge modelling allows the use of these structures to personalize learning by building, organizing and updating learning resources based on information from the student profile and the educational content provided by learning objects stored in the system. The proposed ontological structure is a starting point that can potentially bridge data schema derived from legacy systems storing current data assets pertaining to educational activities.

5. Conclusions

The main contribution of our research is to provide a novel approach to Student Management Information Systems design. As we see in Figure 2, the three steps of the process (system environment, entities modelling and knowledge domain modelling) help researchers, reviewers, editors, to find the template for a Student Information System based on Semantic Web. We hope that many researchers in IS will try to use the process and ontological model, thereby testing their viability. The case study we have provided with this paper demonstrates its use in technical details, but only within the scope of two research problems.

First, further use will tell us whether there are problem domains where it requires extension or where it just doesn't work well, and second, is that of the research entry point. We made a point of suggesting that there might be multiple possible entry points for such a system.

We hope that our proposal will inspire researchers to build student management ontologies based on existing relational databases, via their conversion to multigraphs (or distributed graphs) that can be processed with SPARQL semantic queries.

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