Towards a Semantic Modeling of Learners for Social Networks

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Abstract. The Friend of a Friend (FOAF) ontology is a vocabulary for mapping social networks. In this paper we propose an extension to FOAF in order to allow it to model learners and their social networks. We analyse FOAF alongside different learner modeling standards and specifications, and based on this analysis we introduce a taxonomy of the different features found in those models. We then compare the learner models and FOAF against the taxonomy to see how their characteristics have been shaped by their purpose. Based on this we propose extensions to FOAF in order to produce a learner model that is capable of forming the basis of a semantic social network.
Keywords: Learner model, taxonomy, social grouping, communities of practice, FOAF.

1 Introduction

The notion of modeling learners in social networks is very useful if applied in distance learning systems and large-scale multi-cultural organizations such as virtual universities, where the learners are physically in different locations and their social life is completely separated from the university's academic life. Students in such as institution will still need friends who share the same interests, preferences or learning experience. As the number of students in these kinds of systems is very large, social groupings must be generated automatically and dynamically

Although developers of learner modeling have introduced a number of standards, none of their models considers describing students for building social networks of learners. Since the FOAF vocabulary is very popular in building social networks and is considered to be a successful way of applying the semantic web techniques for grouping people [1], [2], we turn to FOAF as a possible learner profile, discuss how it fits in with other standards, and how it might be extended to cover the common information presented in other learner models such as preferences and cognitive skills.

In the next section, we discuss the characteristics of several existing (semantic and conventional) learner models. Based on this study, we introduce a taxonomy of the different features that can be presented in a learner model, and we compare the learner models against the taxonomy and analyse the way they relate to each other. Based on this, we discuss the use of FOAF as a learner model and we propose the possible extensions of its vocabulary to include more learner characteristics. The last section concludes the paper and describes our plan for future work.

2 Existing Learner Models

PAPI Learner specification was originally developed within IEEE LTSC as a data interchange specification that describes learner information for communication among cooperating systems [3]. PAPI presents learner's information in six categories: *Personal information* holds general information about the student, e.g. name, address. *Relations information* holds learner's relationships with other persons e.g. classmate, teacherof. *Security information* holds student's security features and access rights, e.g. public and private keys. *Preference information* holds public information about the learner's preferences e.g. learning styles or language. *Performance information* holds record of the learner's measured performance, which may be used for assessment or for identifying the learning experience e.g. grades, interim reports, and certification. *Portfolio information* describes the learners' projects and works, used for accessing their history and previous experience, e.g. accomplishments..

IMS LIP covers information similar to that found in a person's CV [4], focusing more on the learner's history and learning experience. This is due to the fact that LIP was developed to model the lifelong records of learners' achievement and to transfer their records between institutions. Learner's information in LIP is presented in eleven categories: *Identification* presents data about the learner, e.g. name, e-mail. *Goal* provides information about learning, career and other objectives. *Qualification, Certification, Licenses (QCL)* lists qualifications, certifications, and licenses from recognized

authorities. *Activity* contains learning related activities in any state of completion, e.g. a digital representation of a work of art. *Interest* describes hobbies and recreational activities. *Relationship* describes relationships between core data elements. *Competency* describes skills and experience (formal or informal). *Accessibility* describes language capabilities, learning preferences, disabilities, and eligibility. *Transcript* presents an institutionally-based summary of academic achievements. *Affiliation* describes the organisations where the learner has a membership, e.g. work groups. *Securitykey* holds passwords and security keys assigned to a learner.

eduPerson is a specification released jointly by Internet2 (www.internet2.edu) and Educause (www.educause.edu). Similar to PAPI and IMS LIP, eduPerson was designed to facilitate communication between higher education institutions, in particular to move information about people between US universities [5]. The information covered by this standard is similar to the one found in an employee information system, as most of the elements hold data about the person and the organisation they are a member of. Since its main purpose is exchanging data, the descriptions provided are very detailed comparing to other standards. eduPerson associates learner information with forty-three elements classified in two categories: *General attributes,* which holds information about the learner, e.g. name, contacts, security settings, and information about the organisation in which the leaner is a member of, e.g. name or location; it also points to other directories that may contain related data about this directory *(seeAlso).* The second category is *New Attributes,* which is created to facilitate collaboration between institutions, e.g. affiliation, entitlement, person's ID for authentication.

Dolog LP (our term) is a learner profile suggested by Dolog et al that uses RDF (www.w3.org/TR/rdf-primer/) and learner ontologies to enable semantically enhanced learning systems to provide personalisation services [6], [7]. It takes advantage of the flexibility of RDF in encoding user profiles to include attributes from multiple schema, and the ability to add more attributes as necessary depending on how it will be used. Since the aim of Dolog LP is to provide personalisation services, the model was based on the combination of PAPI and IMS LIP [6]. It describes a learner in five categories: *Identification* holds information about the student (name, telephone, address, and email). *Other User Features* describes student *Preferences* (language, proficiency, etc.), and their *Goal* and *Interests*. *Study Performance* describes the student's *Performance*, *Portfolio* and *Certification*. *Human Resource Planning (HRP)* holds information about the organisation in which they are a member. *Calendar* (which is not inherited from PAPI or IMS LIP) holds details about any appointments and events the learner has to attend.

FOAF is an RDF vocabulary that provides a set of properties and classes to describe people, documents and organizations [8]. It was developed for building communities and social groupings [9]. FOAF distinguishes five categories for describing a person: *FOAF Basics* includes basic description such as name, e-mail, images, homepage. *Personal Information* includes more personal information such as weblog, interests, publications, and points to people this person '*knows'*. *Online Accounts* holds information about the accounts a person has. *Projects and Groups* holds information about the projects, groups, or organizations the person is a member of.. *Documents and Images* holds information about a document or an image, such as: personal profile document, logo…etc.

3 Learner's Features Taxonomy

In this section we build a taxonomy of the possible features that can describe a learner based on the analysis of the general structures of existing learner models. We classify the characteristics into eight categories, where each is divided into sub categories. The taxonomy is general and captures the types of information modeled in existing standards, rather than defining a canonical set of properties:

1. *Personal data:*
   - *Identification*: metadata that uniquely identifies the person (learner/teacher) within the context of the system, e.g. name, contacts, e-mail.
   - *Description*: holds more details about the person, e.g. homepage, URL, images.
2. *Relations*: information about the student's relations with other people in the university:
   - *Informal*: describes general associations between people and groups, e.g. classmate, teacherof, instructoris, instructorof, belongsto.
   - *Formal:* points to another person's learner profile or to other documents, e.g. knows, seeAlso.
3. Goal: describes the objectives and sub-objectives of a learner.

4. Achievements and Learner history:
   - *Performance:* record of the learner's measured performance, which may be used for assessment or for identifying the learning experience e.g. grades, interim reports, log books.
   - *Certification:* any qualifications, certificates or licenses from recognised authorities.
   - *Competency:* any skills or abilities the learner can perform.
   - *Portfolio*: projects and works of the learner, used for accessing the learner's history and previous experience, e.g. accomplishments and works.
   - *Transcript*: record of academic achievements, usually stored as a file e.g. grades, certification.
   - *Activity*: contains any learning related activity in any state of completion, e.g. education/training work, digital representation of a work of art.
5. *Accessibility and preferences:*
   - *Language:* spoken and written language preferences.
   - *Learning Styles*: preferred learning styles of the learner.
   - *Eligibility*: specifies any eligibility the learner has.
   - *Disability*: specifies any disabilities the learner has.
6. *Interests:* describes hobbies and recreational activities.
7. *Context:*
   - *Affiliation:* describes the relationships of the learner to the institution, e.g. work groups, professional associations' memberships.
   - *Entitlement:* URI that indicates a set of rights to specific resources.
   - *Group/Organisation*: information about the groups or organisations a learner is a member of.
8. *Security:* student's security features and access rights, e.g. keys, credentials, passwords, etc.

4 Comparison of the Learner Models

Table 1 shows a comparison of all five learner models described above by plotting them on the taxonomy. From this we observe that although FOAF was not developed for educational systems, it covers lot of the information that eduPerson describes. Neither of the models hold any description of performance or preferences as they were not developed to support personalization. In the table we insert 'x' in the FOAF column if an extended vocabulary has already been introduced by researchers.

Categories	Sub Categories	PAPI	IMS LIP	EduPerson	Dolog LP	FOAF
Personal data	General	+	+	+	+	+
	Description			+		+
Relations	To others	+				+
	Reference to Others			+		+
Goal			+		+	
Achievement and Learner History	Performance	+	+		+	
	Certification	+	+		+	
	Competency	+	+		+	
	Portfolio	+	+		+	
	Transcript	x	+			
	Activity	p	+		p	
Accessibility and preferences	Language	+	+	+	+	x
	Learning Styles	+	+		+	
	Eligibility	+	+	p	+	
	Disability		+	p	+	x
Interest			+		+	+
Context	Affiliation		+	+	+	+
	Entitlement			+		x
	Group/Organisation description		p	+	p	+
Security		+	+	+	+	x

Table 1. A comparison of the capabilities of Learner Models. We use the following notations: '+' for full support, 'p' for partial support, 'x' for ability to be extended, and a gap for no support

Based on our observations we analyse how the models map the learner's features space (based on the taxonomy) and how they relate to each other. We simplify the representation of our taxonomy to include only its top level (categories) and include the subcategories that are not presented in all the data models in order to highlight their differences and uniqueness. In this representation, we refer to the *Achievement* category as *Performance* and to the *Context* category as *Affiliation.* Figure 1 illustrates how the learner models map the features space. We observe that all the models share the Personal Data, Security and Affiliation presentations, and they all support data portability and interoperability:

- PAPI, IMS LIP and Dolog LP focus on the performance and achievements of the learner. Thus, these models are best used for personalization in adaptive e-learning systems.
- eduPerson is best used in collecting data and transferring it between institutions. IMS LIP, PAPI, and Dolog PL also fit this category; however they do not have as much detail as eduPerson.
- FOAF was not designed for data collection. Although it holds lot of data, it is distributed rather than centralized, so data collection is challenging. However, it can be used for automatic personalization. FOAF is the only model that describes a learner's relations with others by pointing to learner profiles ('*knows*'). eduPerson only points to other documents or managers; and although PAPI records relationships to other learners and teachers, relations are developed mainly for learning management systems to find other members of the team for team learning.

Based on this information, we summarize the possible uses of the models in Table 2 which can be considered as a recommendation for the uses of each learner model.

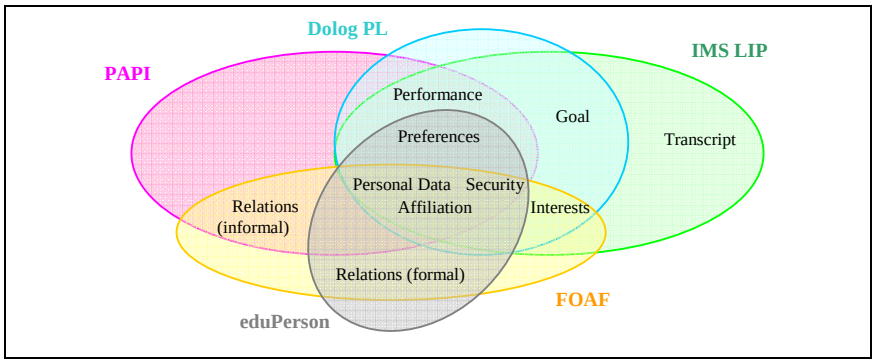

Figure 1. Learner models mapped to the highest levels of the taxonomy

	PAPI	IMS LIP	eduPerson	Dolog LP	FOAF
Info portability	+	+	+	+	+
Personalisation	+	+		+	+
Recording Achievements	+	+		+	
Community building					+

Table 2. What learning models support based on their aim of development. We use the following notations: '+' for full support and we leave a gap for no support

5 Extending FOAF as a Learner Model

FOAF could already be used as a learner model for building and managing social groupings of students. There are many advantages of using FOAF as a learner model:

- It benefits from the advantages of using RDF (extensibility and interoperability) and it is the 2nd most popular ontology after RDF with more than 1.5 millions of FOAF documents generated [1].
- The FOAF vocabulary evolves easily: a number of extension vocabularies have already been developed by different researchers, e.g. the relationship ontology (http://vocab.org/relationship/).
- FOAF files are easy to create using FOAF-a-Matic (www.ldodds.com/foaf/foaf-a-matic.html).
- FOAF makes it possible to locate people with similar interests, which is essential to building communities; moreover, security, privacy and trust issues with FOAF are well covered [10], [11].

In order to bring FOAF into the context of learning, its data model has to be extended to include more features of the learner.

- Although FOAF vocabulary already described a person's interests, preferences such as *spoken and written languages, gender, learning styles* and *preferred modules* should be indicated in order for the student to attract learners with similar preferences.
- Relations with others in the university can be more specified by adding extra vocabulary items such as *classmate of, teacher of,* etc; and information about the learner's academic activities can be extended to include terms like *taking course, taking module, etc*. This will enrich the FOAF *knows* attribute and help generate more efficient groupings.
- Performance information such as the learner's achievements, grades, skills and goal can be also included in the vocabulary, however as publishing most elements in a FOAF file is optional, it is up to the learner to specify this type of information, since many students do not like sharing this level of privacy with colleagues. However, students are to be encouraged to create meaningful FOAF descriptions of themselves with as much details as they can to allow an effective grouping.
- Another issue of considering the application of FOAF concepts to building learners' communities is evaluating the strength of the relationships between learners which the grouping is based on ("friendship" relationships generated from FOAF files through attributes such as *"knows"* and "*seeAlso"*). This paper does not discuss the algorithms of building social networks of learners, our main concern here is the learner model FOAF provides.

6 Conclusion and Future Work

In this paper, we have introduced a taxonomy of the different learner's features that can be presented in a learner model based on the study of different learner's data models. Based on this, we proposed the possible extensions to FOAF to model learners efficiently in order to build learners' social networks.

Further work will involve implementing these extensions and analyzing different algorithms for building communities of learners. Experiments of generating social communities of learners using FOAF will be carried and results from the experiments will be evaluated.

Friend of a Friend is one of the most popular and supported ontologies for the semantic web, if we used it as the basis for our learner models, not only would we gain the advantage of existing tools, extensions and content, but we would also be able to use its personal and community relations to calculate and support social networks for learners.

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