Information Management Framework for Multilingual Education Management Information Systems

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Abstract

This paper addresses the following problem: Which is a viable approach to semantic modeling of educational institutions based on an information management framework that (1) covers all aspects of educational institutions, (2) can be used for specifying requirements for Education Management Information Systems (EMIS) in a multilingual setting, and (3) leads to an improvement of data integration and data exchange at national and international levels. The solution presented here is the Information Management Framework for Educational Institutions (IMFEI), which aims at covering all aspects of an EMIS. The framework is used for building semantic models of educational institutions, organizational processes and the information needed for the operation. In addition, examples of models are presented with the help of Gellish, a controlled natural language with a standard vocabulary and grammar. This controlled natural language is extensible, and with the help of a use scenario I demonstrate the modeling approach in reasonable detail and discuss its applicability in a multilingual setting. This new approach simplifies data integration and data exchange even in environments with different standards and languages as they exist in the ASEAN Economic Community (AEC), among other regions. A major requirement was to propose an approach appropriate for low-to-medium technology environments.

Keywords: Educational Management Information System, Information Management Framework, multilingual data modeling, data integration, data exchange, Gellish

Introduction

Modern educational institutions are facing new developments by which many professional and social activities will be significantly affected, supported, monitored and even controlled by computer and communication technology, such as information systems. This suggests the immediate need to develop scientific and engineering methodologies for the design, implementation, and analysis of complex systems that center on fundamental forms of human activity supported by information and communication technology (ICT) including management information systems.

This paper concentrates on information modeling of educational institutions and the integration and exchange of education data in a multilingual environment. In the course of increasing economic integration of ASEAN countries, multilinguality is a core requirement for all MIS that provide data for comparison on a national level. In ASEAN, the following official languages are spoken: Burmese (Myanmar), English (Singapore, the Philippines, also working language of ASEAN), Filipino (the Philippines), Indonesian (Indonesia), Khmer (Cambodia), Lao (Laos), Malay (Malaysia, Brunei), Thai (Thailand), and Vietnamese (Vietnam). The ASEAN community is entering a new level of interdependence in 2015 when a single Southeast Asian Market, the Asean Economic Community (AEC), is being launched. The objective of this initiative is to create a single competitive market with a population of over 600

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million and free flow of investment capital, goods and skilled labor force. This has a potential influence on the way national and international bodies will exchange data, not at least in all areas of education. A recent example of such an endeavor has been the European Union and their programs of alignment of standards and data exchange among the 28 member states (Lawn and Segerholm, 2011).

The experiences of the EU have shown that there is a need for data integration on a local, regional, national and international level (Dietze et al., 2014). With data integration, data entered by teachers and administrators into their system can be merged with data of other systems. This integration process is typically not revealed to users, although it leads to transaction processes within Database Management Systems (DBMS). Therefore, users do not need to get training on a new system or to enter data into more than one system to provide and receive mutually usable and useful data. Integration also involves an array of technical design and implementation challenges for an institution, which are not discussed here.

Most systems apply different data formats, vocabularies and procedures, which complicates the exchange of data among educational institutions at all levels. Fortunately, ontologies based on standards and their alignments support the communication of institutional knowledge even if the data formats and languages are different. Ontologies extend taxonomies by applying rules and more sophisticated relations than broad and narrow term, which are called super class and subclass, respectively. Currently, ontologies are mainly used to annotate and markup educational materials (Learning Objects and Reusable Learning Objects), e.g. for curriculum development (Tang, 2011). This enables easier information retrieval of Learning Object Repositories, which is of great help for educators around the world. In this paper the use of ontologies is extended to such organizational data as students' portfolios, educational institutions' assets and time schedules of various educational events. Ontologies can not only be used for retrieving educational materials but also to time schedules, even when based on the lunisolar calendar of Thailand (Snae Namahoot, Brückner, and Panawong, 2015).

The main contributions of this paper are twofold. First, I introduce the Information Management Framework for Educational Institutions (IMFEI) covering all aspects of educational organizations and their various working processes. This framework is used as a basis for eliciting requirements for Educational Management Information Systems, among other applications. IMFEI facilitates the integration and exchange of educational data by harnessing a controlled natural language, Gellish. This part of the paper addresses the needs of stakeholders, managers, and administrative staff of educational institutions. Second, I show semantic representations for typical educational information in a multilingual setting, for which Gellish is well prepared. Regarding the economic situation of typical ASEAN institutions, I considered only low-to-medium technology solutions. This part addresses the requirements for implementing the IMFEI framework for a given educational institution and is directed at developers and technical administrators.

The rest of this paper is organized as follows: in Section 2 the Information Management Framework for Educational Institutions (IMFEI) is outlined. Section 3 presents the semantic modeling approach (the methodology) I use for implementing applications of IMFEI, for which examples are given in Section 4. The results are discussed in Section 5 followed by the conclusions and an outlook on future work.

Information Management Framework for Educational Institutions (IMFEI)

Information Management Frameworks are reusable application-specific abstractions that enable the development of concrete solutions by guiding appropriate project planning. More specifically, an Information Management Framework defines how to design and create an information management application for a specific domain. It can be used by all people involved in the implementation process of information systems and related applications. In the last two decades, results in many different disciplines have been accomplished and have led to a variety of applications (Rapisardi, Di Franco and Giardino, 2014; Brink, 2014; Namisango and Lubega, 2014).

In this section, I lay out the Information Management Framework for Educational Institutions (IMFEI), which has been designed along the typical lifecycle of educational information management. In Table 1, all the elements are shown that decision makers, designers and developers need to consider when implementing an EMIS. I have identified the following roles occurring in educational information processes: director, organizational head, senior manager of the educational institution (responsible person/board), students, teachers, system architect, system designer, programmer, builder, and the operator or person responsible for processing, administration, and operation.

The rows (A-F) represent the views and activities of the roles, which people can occupy in the working processes of educational institutions. The columns (1-6) show various aspects of the views and activities . In the following, I describe the various activities that roles may have to work through but due to the different organizational environments the names of the roles should merely be seen as labels. Changes of the names and responsibilities of the roles are likely to be made when applying IMFEI to a certain educational organization.

Relating educational institutions, (1) the overseeing body establishes the institution's purpose and defines the scope and boundaries of the institutional activities; (2) the head of the educational organization defines the nature of the organization (structure, processes, management organization among others); (3) the assistant to the head or system architect establishes the conceptual model of the organization and its processes but without reference to a specific technology (also called the blueprint); (4) the system designer analyzes which technologies are appropriate to build solutions for organizational needs; (5) the programmer (or builder) creates the operational components of the organizational information and knowledge that can be manipulated by authorized users and admins; and (6) the operator (or admin) is responsible for the working system, in which users (teachers, staff and students) play a central role.

As far as the aspects are concerned, (A) addresses the data that have to be collected and managed in the educational organization; (B) is about the activities carried out by the institution to support itself; (C) is concerned with the geographical distribution of the institution's operations; (D) covers the people involved in the information processes of the institution; (E) addresses the aspect of time affecting the institution and their knowledge; and (F) addresses the quality aspects of the processes, operation and results of the institution.

With the help of the tabular structure of Table 1, one can describe all informational aspects of an educational organization related to its corresponding views and activities. Some cells in the table contain

more complex ideas than others, so more than one model might be needed there. It is important to understand that IMFEI is a framework and not a single database. When I refer to cells in the following, I do not refer to fields or elements of a database but to information items of Table 1 that must be modelled as a database or list of data. So, all cells of Table 1 need data to be generated, stored, manipulated, and finally transferred in some format. In addition, the data and formats may be described with the help of ontologies and metadata (data about data), which can be used by software for conversion and alignment to make them compatible as input for subsequent steps in the overall data aggregation processes.

For practical reasons I have summarized the 36 cells of the IMFEI framework in short form above and go into more detail for some that I deem important in the following:

A1 is concerned with the concepts, facts and symbols of educational institutions on the local level. Note that the organization would define such concepts as Class Schedule, Library Object and Learning Object, as far as they are significant for the body of knowledge and for the processes of the organization. In A2 the concepts of A1 are used to build classes (concepts), properties (or attributes) and relationships. As an example, the class DVD Image might be specified as Library Object and, at the same time, as Learning Object with further specifications of identification, content and presentation modes. B3 is used to characterize timed processes defined for the educational organization. As an example, the cooperative production process of a curriculum for a tertiary educational institution can be used. Most currently available ontologies do not conceptualize such dynamic processes. B6 is a dynamic overview of current inventory and time related data (log). The educational organization can gain a list of all students or of specified classes of objects, e.g. of all students with a specific class schedule. C4 is concerned with the locations of items that were produced by and for the educational organization, such as information posters, display panels, etc. It should be noted that the locations of such real world objects as buildings are subject to C2. I decided to split C2 and C4 because educational institutions typically do not move C2 objects but may do so for C4 objects. D6 can be basically a table with data on (1) teachers and staff, their responsibilities and functions, and (2) students (as individuals or as a whole) at a location and time. This lets us, e.g., model the individual student as a member of a class of students (the latter being a conceptual item) and as a member of a group of students (being a real item, e.g. the students performing activities for which they need specific instruction). E1 is the master schedule of events that the educational organization is concerned with, e.g. exhibition schedules and their scheduled preparation tasks, periods of absence of staff and students due to various reasons, or the launch date and time of a new venue. In E3 the triggers of process steps within the educational institution are defined. These triggers can be purely timed events (the election of a new supervising board after a fixed time) or more complex ones (the decision basis for the reconstruction of rooms or whole buildings). F1 is the overall Quality Plan for the educational institution. The general rules and practices relating tangible and intangible items in educational processes are core part of this plan. Certain objects or tasks may be deliberately excluded or 'QA outsourced' because of long-term budget constraints. F4 is concerned with the QA information design, which can be built as a formal report. Here, test procedures are

defined to gather data about such items as the staff and student performance as well as related assessment results. These data are used in F5 to make further decisions on how to assure the quality of the educational processes for future operations. In F5 the data of live test procedures are collected and interpreted as well as the students' responses to questionnaires or problem reports turned in by teachers, staff, students and parents.

Table 1 Information Management Framework for Educational Institutions (IMFEI)

		A	B	C	D	E	F
		Data	Activities	Locations	People	Time	Quality
1	Objectives & scope (Planning)	[A1] List of items important for the educational institution	List of functions the educational institution performs	List of locations of educational institutions	Human resource management approaches of organizations and sites	[E1] Educational organization master schedule	[F1] Quality assurance plan
2	Educational institution model (Nature & organiz. of education)	[A2] Language, divergent data model	Organizational process model Organizational strategies, tactics, policies, rules	Logistics network - buildings - Emergency paths - Guided tracks	Organization chart - Teachers - Managers - Gardeners - Students - Support staff	State/transition diagram	Roles in QA, QA standards Security standards
3	Model of fundamental concepts (System architecture)	Convergent E/R model	[B3] Essential data flow model	Locations of roles - Teachers' rooms - Classrooms	The viable system, use scenarios	[E3] Entity life history - 'history'	QA regulations and rules, QA of education
4	Technology model (Design)	Database design	System design, program structure	[C4] HW, SW deployment - Posters - Visual aids	User interface, security design	Event processing	[F4] QA information design
5	Detailed representation (Build)	Physical storage design	Detailed program design Rules specification, program logic	Network architecture, protocols	Screens, security codification	Timing definitions - Calendars	[F5] Internal feedback and test results
6	Functioning service (Operate)	Databases	[B6] Program inventory, logs	Communications facilities	[D6] Trained people, students	Business events - Exhibitions - Special events - Shows - Closing time	Student and teacher feedback Enforced rules

Use of IMFEI

The IMFEI framework will best be exploited in areas where educational information management produces, stores, manipulates and transfers digital data via electronic means. This enables schools, higher education institutions and related organizations to exchange data easily, fast and at the lowest possible cost. Further benefits are improved security of data, increased speed of processing, better manipulation of data (e.g., convert the data according to standards) and the capability to process the data. Regarding higher education, Figure 1 shows the range of information systems in place for a medium-sized country (Croatia) in two levels: the national level and the Higher Education Information level.

The main components of those information systems comprise the educational process management system and the resource management system. Data for both components have to be collected at the source, the educational institution (school, college, university), and continuously aggregated on higher levels (provincial, regional, national and international). This implies that compatible data formats and processes have to be used at the various steps of the aggregation processes themselves, and appropriate means have been outlined by a number of examples in Section 4.

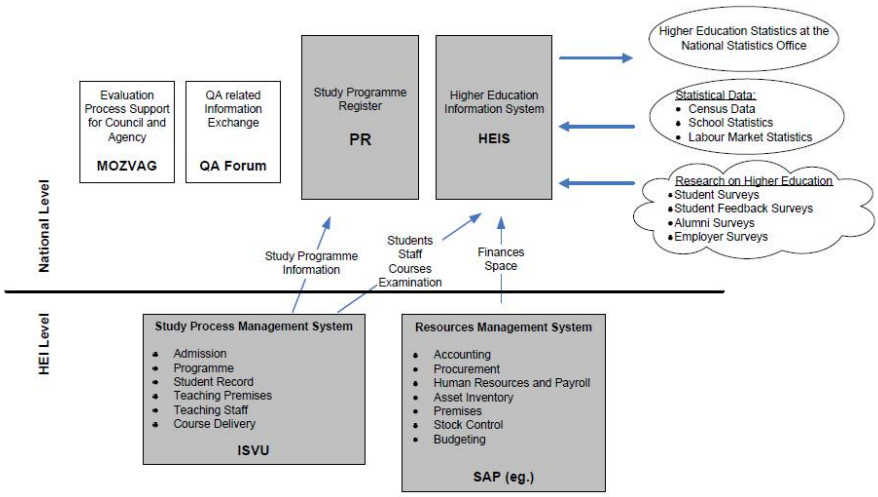

Figure 1 Information Systems in Higher Education of Croatia (Frackmann, 2003)

Electronic Data Interchange (EDI) among educational institutions

Electronic Data Interchange has been used for a long time in commercial and financial services. EDI was pushed by the setting of an international standard (EDIFACT) provided by the United Nations and adopted by the International Organization for Standardization (ISO). EDIFACT is the only international standard for EDI and mainly used outside the USA, which uses a national standard for the exchange of data.

There is no generally accepted standard for data exchange of educational information. However, a recent initiative in the United States has led to the Education Data Interchange Network, for which some standards are provided . For ASEAN, on the other hand, such a standard has to be carved out and adopted by the partners. This does not imply substantial change of data processing and manipulation across the educational institutions and organizations of ASEAN member states. Indeed, they still can use their regional and national educational information standards and working systems rather these data will be converted into an international standard, which has to be defined. The conversion process and system needs a thorough semantic basis, which is usually implemented as an ontology or a set of ontologies.

Semantic modeling with Gellish

In this section I summarize our approach to the implementation of semantic models on the basis of IMFEI (Section 2) harnessing a 4D model. This means, it covers models of educational institutions, processes and results as they evolve over time. Because those may be changed over time and require adapted schemes or processes, IMFEI and the related semantic models do not only focus on static modeling but also on dynamic (evolving) concepts. In the last part of this section, the querying and qualifying of educational data are discussed.

Implementation approach

The implementation of semantic models for educational institutions uses Gellish, a controlled natural language environment harnessing a grammar that enables simple multilingual semantic constructs for dictionaries, taxonomies and ontologies. The inclusion of a grammar is a major step forward to improving the construction of multilingual information systems. For the implementation of semantic models the following approach has been used:

1. Identification of concepts building the nomenclature, dictionary and taxonomy (assuming that most of them are already available and a little extension is needed),

1.1 concepts relating educational institutions and processes,

1.2 concepts about measurements and units (for calculations), and

1.3 concepts required for calculations

2. Description of the items relating educational institutions and processes

3. Description of restrictions of classes and properties

As an example for calculations within an ontology a model of a guided tour through a museum is used. For the description of the path of the guided tour, it is necessary to include concepts in the taxonomy for the description of

4. the physical components of the topology of the tour, the entries, exits, aisles, exhibition items, starting and end points,

5. the structure of the floor plan of a building, and

6. the streams of traffic in the aisles and around the points of interest.

Of course, for a complete description of the floor plan other components are also required, such as rest rooms, vending machines and cafeterias.

In Gellish any concept is added to the Gellish Smart Dictionary by

1. the specification of a unique identifier (UID) and a name and its possible synonyms; this forms the nomenclature,

2. the specification of a specialization relation, being a subtype-supertype relation (also called Broader Term and Narrower Term), with the direct supertype of the concept; this forms the taxonomy, and

3. the specification of a textual definition; this forms the dictionary.

Obviously, with the help of the unique identifier we can comfortably create a multilingual dictionary (and ontology, as is described below) within a single table. In addition to definitions of concepts, it is also possible to include knowledge about the concepts. For this we can define specific relations between concepts, such as an explicitly modeled definition (specifying the value of the discriminating property of a subtype) as well as the specification of possible elements of a complex of buildings, possible properties of concepts, and possible roles that concepts can play in relation to other concepts.

The implementation of an ontology with Gellish is typically carried out by creating a table (the Gellish Table), a single table with an object – relation – object structure that can express all sorts of facts about the domain of interest.

A short hand and very simple example may illustrate the use of Gellish for identifying objects in Gellish. In Table 1 concepts are shown with unique IDs from standard Gellish (reserved UID 0-30.000.000) and user defined extensions (UIDs >30.000.000, shaded). The latter are proprietary to the educational institution and cannot be used automatically by other institutions. These extensional facts must be approved by the international Gellish Board if they are intended to be used globally; another way to ensure compatibility of the representation of concepts is to make the table(s) available to the participants of the aggregation processes.

Table 1 Standard and extended (shaded) Gellish concepts

UID	Relation/ fact
1.110	is name of
1.225	is classified as a
31.000.110	has a ground area
927.838	489
570.097	square meter
40.100.201	private school K-12
31.100.763	all girls' school
5.138	is located in
700.046	province
2.700.330	Thailand

The general approach is to relate two concepts, or as the Gellish manual states: 'Every fact can be built from elementary or atomic facts and each elementary or atomic fact is expressed as a relation between two things.' This relation is sometimes called a binary fact as expressed in Table using the standard and extended Gellish concepts of Table 1.

Note: binary facts do not consist necessarily of two facts only but can be modeled with additional, so called auxiliary, facts about the two main objects.

The Gellish expressions of Table 2 tell the software agent and human readers that Udomdarunee School is a public school in Sukhothai Province, which is located in Thailand. The UIDs of objects and relations are unique once and for all, which enables software agents to use synonyms, homonyms and translated terms in a meaningful way. For semantic modeling of real world objects it is important to distinguish between superclasses, subclasses, individual objects and their qualitative or quantitative characteristics. In Gellish, the respective relation types are as follows:

1. Individual object: indicated by the relation type "is classified as a" (UID 1.225),
2. Superclass/Subclass: indicated by the relation type "is a specialization of" (UID 1.146),
3. Qualitative/quantitative characteristic: indicated by the relation type "is a qualification of" (UID 1.726)

Table 2 Example of Gellish binary facts with standard and extended (shaded cells) concepts

UID of left hand object	Name of left hand object	UID of relation type	Name of relation type	UID of right hand object	Name of right hand object
40.100.451	school grade 1	1.225	is classified as a	850.039	level in a hierarchy
40.100.451	school grade 1	1.981	is a synonym of	40.100.451	grade 1 (school)
60.000.221	Udomdarunee School	1.225	is classified as a	40.100.200	public school
60.000.221	Udomdarunee School	5.138	is located in	40.050.057	Sukhothai Province
60.000.221	Udomdarunee School	1.225	is classified as a	40.100.200	K-12 school
40.050.057	Sukhothai Province	1.225	is classified as a	700.046	province
40.050.058	Sukhothai Province	5.138	is located in	2.700.330	Thailand

In addition to the relationship of the two main objects (e.g. school grade 1 and level in a hierarchy in Table 3), Gellish allows the specification of a significant number of auxiliary facts in a single row, which then builds a standard n-tuple. These auxiliary facts may cover such characteristics as the language, in which the elementary fact are stated or the topic (also called namespace), to which the elementary fact is related. As an example, Table 4 shows an extended Gellish implementation of Table 3, to which language information is added. With the language fact and the Unique IDs all facts stated in English (as above) can be derived automatically for the Thai and Malay languages (and any other languages) with the help of a dictionary or appropriate translation tool. Moreover, topics can be included as auxiliary facts in a new column, e.g. the topic 'IMFEI' to show the scope of all facts relating the framework presented in this paper.

Table 3 Gellish implementation with auxiliary fact 'Language'

Language	UID of left object	Name of left hand object	UID of fact	UID of relation type	Name of relation type	UID of right hand object	Name of right hand object
English	60.000.221	Udomdarunee School	61.000.234	1.225	is classified as a	40.100.200	public school
Thai	60.000.221	โรงเรียนอุดมดรุณี	61.000.234	1.225	จัดเป็น	40.100.200	โรงเรียนเทศบาล
English	60.000.221	Udom Darunee School	61.000.235	1.981	is a synonym of	60.000.221	Udomdarunee School
Malay	60.000.221	Udomdarunee Sekolah	61.000.234	1.225	diklasifikasikan sebagai	40.100.200	sekolah awam

The hierarchy of concepts used in IMFEI modelling is outlined in the following. The base concepts are stated in the Gellish Dictionary. I have enriched the base concepts by concepts derived from educational institution standard models. National, regional educational organizations are encouraged to extend the concepts according to their needs regarding content and language.

Querying and qualifying the Gellish database

Two types of questions can be asked about the semantic model based on Gellish: (1) requests for unknown information, and (2) asking for a response, e.g. a confirmation. Gellish users do not require a specific query language because Gellish queries are of the same structure as ordinary propositions. The result of a Gellish query is a Gellish expression, i.e. an expression in form of a row as has been presented in Tables 1-4.

Requests for unknown information are of the form: Which objects have a particular relation with another object (including additional constraints with specific values for characteristics of the resulting objects)? As an example, the user asks 'Which objects are classified as a palm leaf manuscript?' In Gellish, we can pose this question as if it were a proposition but replacing the unknown object by

'What'. We then get an expression as in Table 1 (the answers are in the shaded rows). Note that 'What' is a reserved term for asking this kind of question and that there other such terms, which can be used for querying the database (who, which object, which aspect, which person, where, when).

Table 1 Gellish query for unknown object (short form)

Name of left hand object	Name of relation type	Name of right hand object
what	is classified as	public school
what	is classified as	K-12 school
Udomdarunee School	is classified as	public school
Udomdarunee School	is classified as	K-12 school

Results and discussion

With the help of the IMF appropriate concepts from Standard Gellish English and customized concepts in Extended Gellish English, a semantic model of a secondary school as a proof-of-concept has been built. Due to limited space, this section can present only an extract of the whole model; nevertheless, it shows the application of the method as has been laid out in Section 3. As mentioned above, UIDs < 30.000.000 are concepts of Standard Gellish and can be used as standard concepts straight away. In Table 6, I also provide examples of multilingual representations of appropriate relations for modeling characteristics and processes of educational institutions.

For the semantic modeling of a secondary school, we need the following concepts, which are not part of the Standard Gellish English but are subject to specification by proprietary facts and relationships as follows:

- school type
- teacher qualification
- teacher specialization
- teaching level (class grade)
- educational route
- teachers'specialization
- curriculum
- course syllabus
- teaching resource

Table 2 Potential relations for semantic modelling of educational processes from Standard Gellish with some Thai translations as examples in the context of a school

No.	UID of left hand object	left hand object	UID of relation type	Name of relation	UID of right hand object	right hand object
1	10.000.020.034	Teerawat	5.144	is scheduler of	31.405.200	teachers' schedule
2	10.000.020.034	ธีรวัฒน์	5.144	เป็นกำหนดการของ	31.405.200	ตารางเวลาของครู
3	31.405.200	teachers' schedule	1.187	is approved by	31.405.203	schedule committee
4	31.405.200	ตารางเวลาของครู	1.187	รับการอนุมัติจาก	31.405.203	คณะกรรมการกำหนดเวลา
5	30.522.007	2004	5.190	year of renovation of	60.000.221	Udomdarunee School, Sukhothai
6	30.522.007	2547	5.190	ปีของการปรับปรุง	60.000.221	โรงเรียนอุดมดรุณี

No.	UID of left hand object	left hand object	UID of relation type	Name of relation	UID of right hand object	right hand object
7	10.000.020.031	Kraisak	4.912	is manager of *	60.000.221	Udomdarunee School, Sukhothai
8	2.120.402.300	K-12	1.146	is a specialization of	2.120.400.530	school
9	2.120.402.300	K-12	1.146	เป็นความเชี่ยวชาญของ	2.120.400.530	โรงเรียน
10	31.405.200	teachers' timetable	1.981	is a synonym of	31.405.200	teachers' schedule
11	33.501.625	PhD	1.982	is an abbreviation for	33.501.625	Doctor of Philosophy
12	2.120.402.300	K-12	1.983	code for a term for an object	2.120.402.300	kindergarten to grade 12
13	2.120.400.530	school	4.691	is a translation of	2.120.400.530	โรงเรียน
14	1.230.342.677	T077	5.352	is an identifier of	10.000.020.034	Teerawat
15	10.000.020.034	Teerawat	5.284	is a parent of	10.100.010.329	Amporn
16	10.000.020.034	ธีรวัฒน์	5.284	เป็นผู้ปกครองของ	10.100.010.329	อัมพร
17	10.056.201.066	Udomdarunee School, Sukhothai	1.225	is classified as a	2.120.402.300	K-12
18	10.056.201.066	โรงเรียนอุดมดรุณีสุโขทัย	1.225	จัดเป็น	2.120.402.300	K-12
19	30.010.300	class (at educational institution)	2.076	conceptually required role by a relation	31.020.533	teacher and student

* meaning in this case head of school

Table 6 represents an extract of the semantic model in the context of a specific school, and similar tables can be provided for other schools of a school district, other school districts, other provinces, or finally the whole country. All those tables would use the same relations between individual objects (expressed by UID 1.225 is classified as a) or concepts (UID 1.146 is a specialization of) as appropriate for the individual schools. If a school needs more concepts or individuals, the data managers can easily attach appropriate items to the tables of the particular school. The order of facts in the table does not affect the outcome of queries or reasoning processes. On the higher levels of the school administration, the data can be merged, reconciled, or synchronized as deemed appropriate.

As has been laid out by Thailand's former Foreign Minister Thanat Khoman (1992) and by Brückner (2015), ASEAN countries have a rich history and vibrant culture of education. Both can be shared among members of the community in a way that is not only effective but also multicultural.

Conclusions and further work

This study has been undertaken to answer the following questions: which is a viable approach to semantic modeling of educational institutions based on an information management framework that

1. covers all aspects of educational institutions,
2. can be used for specifying requirements for Educational Management Systems (EMIS) in a multilingual setting, and
3. improves data integration and data exchange at an international level.

The research resulted in two main contributions: (1) the development of IMFEI, the Information Management Framework for Educational Institutions, and (2) an example model to partially implement an EMIS with Standard and Extended Gellish for multilingual educational data modeling, collection, storage, manipulation and transfer.

Much work has to be done to implement such a system, which is currently non-existent, although the need is felt by many institutions worldwide (Turner, 2008). The ideas outlined in this paper have to be conveyed to the authorities responsible for the effective exchange of education data.

References

Brink, Roelien (2014). An Information Management Framework for the Work-Integrated Learning Process. Diss., University of Johannesburg, South Africa. Online at http://ujdigispace.uj.ac.za/handle/10210/11269.

Brückner, M. (2015). Education in ASEAN. Berlin: ResearchGate.DOI:10.13140/RG.2.1.1002.8961.

Chakkrit Snae Namahoot, Michael Brückner and Naruepon Panawong (2015): CAT-TOURS.

Dietze, S.; H. Drachsler; D. Giordano (2014). A survey on linked data and the social web as facilitators for TEL recommender systems. In: Recommender Systems for Technology Enhanced Learning. Berlin: Springer, 47–75.

Lawn, Martin and Christina Segerholm (2011). Europe through experts and technologies. In: Jenny Ozga, Peter Dahler-Larsen, Christina Segerholm, and Hannu Simola (eds.): Fabricating Quality in Education: Data and Governance in Europe. Routledge, ISBN 9781136824470.

Namisango, F., and T. J. Lubega (2014). A theoretical framework for improving information management in small and medium-sized enterprises: The case of Uganda. International Journal of e-Education, e-Business, e-Management and e-Learning, Vol. 4, No. 2, April 2014.

Rapisardi, Elena, Sabina Di Franco and Marco Giardino (2014). Italian civil protection 2.0: Towards a resilient information management framework. Lollino et al. (eds.), Conference: IAEG 2014, Turin, Volume: G. Engineering Geology for Society and Territory – Volume 7.

Tang A, Rahman AA. (2011). Proof-of-Concept Design of an Ontology-Based Computing Curricula Management System. In: Cherifi H, Zain JM, El-Qawasmeh E., editors. Digital Information and Communication Technology and Its Applications. Heidelberg: Springer, 280–292.

Thanat Khoman (1992). ASEAN Conception and Evolution. ASEAN Reader. Singapore: Institute of Southeast Asian Studies.Available online at http://www.asean.org/news/item/asean-conception-and-evolution-by-thanat-khoman.

Turner, M. L. (2008). High marks for e-transcripts: delivering academic records electronically offers substantial convenience, time, and cost advantages over paper-based exchange. The Journal, 2(1).