A Semantic Representation of Online Teaching Business Process Architecture

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Abstract—A Business process architecture (BPA) is one of the significant assets in educational systems as it helps to understand and optimize educational processes by focusing on the key processes rather than the organizational specific details. The semantic, Riva-based business process architecture (srBPA) ontology is an abstract ontology that semantically conceptualizes the business process architecture's components and the relationships between them. This ontology can be instantiated for a specific domain to provide a general semantic-based BPA for organizations working in that domain. This paper instantiates the srBPA ontology for online teaching to provide a general semantic architecture for online teaching process that can be used as a reference by educational systems. This ontology was evaluated for completeness by referring to the national quality standards for online teaching and online courses. The evaluation has revealed that all quality standards were covered in the instantiated ontology through the classes, individuals, attributes and semantic rules that were defined.

Keywords—business process architecture, online teaching, semantic modeling, srBPA ontology, Riva method

1 Introduction

The rapid development of information technology and reliance on internet use in our daily lives has become an urgent necessity in many applications. The covid-19 pandemic has affected many sectors in the world, one the most critical sectors is education. Schools, colleges and universities have been deeply impacted and have directed their efforts to implement online learning and teaching strategies in order to ensure the persistence of the educational process.

The importance of online teaching is growing in all kinds of teaching scenarios. ELearning is an effective learning process that allows for online interaction between learners and their instructors without any face –to –face instruction. It is usually synchronous i.e. real-time, asynchronous i.e. through different ways such as online discussion groups with the instructor and students or learners depending totally on their selves through online materials and videos [1]. Having different online teaching and learning strategies, it is important to have a unified process architecture to represent the main online teaching processes. In addition, providing a semantic representation of the process architecture adds more value where it provides a machine interpretable source of information of online teaching process architecture. This paper provides a semantic online teaching business process architecture that is the result of instantiating Riva-based business process architecture (srBPA) ontology [18].

Section 2 provides background information about the Riva method and the srBPA ontology, and then describe literature related to our research work. Section 3 describes the instantiation of the srBPA ontology for online teaching to generate a Riva-based business process architecture ontology for online teaching. Section 4 evaluates the completeness of the resulting ontology by referring to the national quality standards for online teaching and online courses [19, 20]. Finally, section 5 concludes the paper.

2 Background and literature review

2.1 The Riva method

The Riva method was defined by Ould [15, 16] to derive business process architectures from the essential entities of a business. The main steps of this method are shown in Figure 1.

In order to identify an organization's process architecture in Riva, the boundary of the organization is agreed, then the essential business entities (EBE)s are identified through a brainstorming activity of the organizations' subject matter. The EBEs that have a lifetime which is handled by, or are the responsibility of, members of the organization are classified as Units of Work (UOWs). The next step is to produce a UOW diagram that depicts the dynamic relationships between UOWs. For each UOW, there is: a case process that handles single instances of the UOW; and a case management process for dealing with the flow of instances. The next step is to transform the UOW diagram into a first-cut process architecture; then, to use a number of provided heuristics to generate a second-cut process architecture. The Riva method was shown to be simple and easy to understand and apply [17].

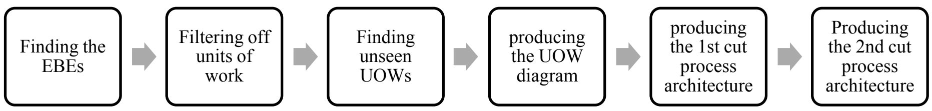

Fig. 1. Riva method steps to derive a BPA from EBEs

2.2 The srBPA ontology [18]

The srBPA ontology is an OWL-DL ontology that was developed to formally represent the Riva BPA elements and relationships between them. This ontology includes the classes that conceptualize the Riva elements as well as the attributes, axioms and rules that set the relationships between classes in order to formally represent the Riva rules. Figure 2 shows a graphical representation of part of the srBPA ontology, and Table 1 describes some of the defined classes and their related attributes.

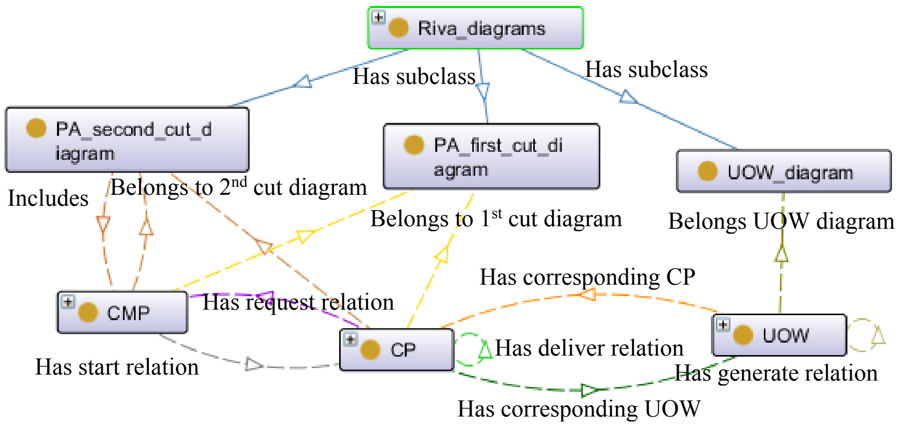

Fig. 2. Part of the srBPA ontology classes and relationships

Table 1. A description for part of the srBPA ontology classes and related attributes

Concept	Description	Attributes
EBE	The Essential Business Entities of an enterprise.	1) isConsideredUOW: Boolean.
UOW_diagram	The units of work diagram according to the Riva method.	1) hasUOW of type UOW, and 2) hasOutsideWorld of type Outside_world.
PA_first_cut_diagram	The 1st cut process architecture diagram according to the Riva method.	1) hasCP of type CP, 2) hasCMP of type CMP, and 3) hasOutsideWorld of type Outside_world.
PA_second_cut_diagram	The 2nd cut process architecture diagram according to the Riva method.	1) hasCP of type CP, 2) hasCMP of type CMP, and 3) hasOutsideWorld of type Outside_world.
UOW	The units of work in the UOW diagram, according to the Riva method.	1) BelongsToUOWDiagram of type UOW_Diagram, 2) hasCorrespondingCP of type CP, and 3) hasGenerateRelation of type Generate.

2.3 Online teaching

Universities have used different learning techniques to deliver knowledge and to satisfy the needs of their students. Along with the traditional teaching (face –to- face lectures in a class room), online teaching was designed to serve students who cannot attend traditional classes but have access to the internet. The potential of e-learning to improve learning and teaching, has been seen recently when many educational institutions were forced to shift to online mode of teaching.

"Online learning is defined as "learning experiences in synchronous or asynchronous environments using different devices (e.g., mobile phones, laptops, etc.) with internet access". [14]

E-Learning is a computer–assisted teaching, the learning can take place anywhere and anytime and when it is needed. Hence, e-learning can reduce the costs of education and the learning time since it spares the students from travelling long distances to attend the classes. On the other hand, there are some issues and challenges of implementing e-learning facing instructors as well as students. The most important challenge for instructors is to move from offline mode to online mode and to be able to use online tools and infrastructure. Instructors had to focus on well-developed courses where it is necessary to engage students and make the learning process student-centered. Instructors must be effective in responding to student's emails and messages as well as changing their teaching methodologies.

Students lack strong self-motivation and time management skills which may influence the failure or success in online learning. Instructors and students must embrace and bare the shift away from traditional standard classroom teaching to an e-learning approach to education. Understanding the advantages and disadvantages of online learning will help educational institutes in creating strategies to increase the efficiency of distance learning and creating new methods to deliver knowledge to the people who are eager to get.

E-learning technologies have evolved from basic content delivery to rich media based content delivery through the use of learning management systems such as moodle and blackboard. Knowledge construction through the active participation of students become a factor in e-learning. To facilitate the process of knowledge construction, facilities for a collaborative learning environment are provided [10].

Matthew N. O. Sadiku, Philip O. Adebo, and Sarhan M. Musa [5], provided a brief introduction to online teaching and learning. In their research article, they discussed the importance of online learning and teaching in offering opportunities to expand the learning environment for diverse student populations. Online teaching and face- to - face teaching have much in common, except in pace and delivery. On-line learning is suitable for students who have work or other commitments and wish to pursue an internationally recognized degree. Generally, students should have access to a computer system with high internet connections to acquire knowledge. The success or failure of implementing on-line teaching and learning depends on student's self-directed learning and instructors' effectiveness in delivering courses and getting used to online tools and infrastructure.

Fatimah A Albrahim [8], sheds light on the skills and competencies required for teaching online courses in higher education. She did a comprehensive review analyzing the literature concerning the competencies, skills, responsibilities and roles the instructors need to cope with the current standards of learning in higher education. These skills and competencies are classified into six categories: (a) pedagogical skills, (b) content skills, (c) design skills, (d) technological skills, (e) management and institutional skills, and (f) social and communication skills. In her research, she noted that instructors and learners must be educated about different aspects of online learning. Online learning organizations and educational institutions should support online instructors by providing a general framework and guidelines to improve their teaching skills and competencies and to help in designing and creating professional development programs. According to her research, it is difficult for online instructors to execute equally all the skills and roles, so the instructor should determine the priorities of the skills to execute according to his role. The competencies can help online instructors to self-evaluate their teaching skills, qualifications and abilities to teach online.

Ida Panev[6], analyzed the advantages and disadvantages of online teaching in higher education. The author found that online teaching is appropriate for well-organized, mature and motivated students who can manage their time, while it is inappropriate environment for other students who lack the ability of time management and self-discipline. Ida divided online teaching into two types: Asynchronous teaching which can include for example: teaching materials and pre-recorded lectures. Synchronous interactive teaching can include for example: live streaming. Ida discussed the advantages in terms of convenience, less expensive, technology as well as the additional benefits. While there are many advantages to online teaching, the disadvantages of digital learning can't be ignored. The most important issue is that there is no face –to- face interaction between teachers and students. This can cause sociological and psychological problems. Moreover, teachers and students have to make additional efforts. Teachers has to prepare attractive and interactive materials to grab their students' attention. On the other hand, students have to make effort not to be only passive observers of the educational process. The researcher's final goal is to have well educated students regardless whether they got their education in classrooms or online.

2.4 Related work

Semantic web and ontologies technologies influence ELearning systems and applications. A number of papers have been devoted to the study of the importance of semantic web and ontologies in ELearning.

Many e-Learning applications are lacking in knowledge representation technology. To satisfy e-learning requirements to be fast, just-in-time and relevant learning, sematic web with its properties of common-shared-meaning and machine-processable metadata is used. SW enables machines to understand the semantics, or meaning, of information on the World Wide Web. Semantic web is an intuitive web application with the ability to access information which is needed precisely [2].

Semantic web gives learners the ability to search the web and to retrieve information easily by making it possible for learners to find relationships between tagged information using ontologies [13].

The Semantic Web provides a new technology for the web-based information and services that would be understandable and reusable by both humans and machines across different applications. In order to achieve this, it is necessary at the conceptual level to form a consensus in the domain using ontology. Ontology is considered the main component of Semantic web and is defined as the backbone for the Semantic web architecture. It provides a link between the learning material and its conceptualization results in individualized learning paths. Ontology facilitates communication between people and different applications and helps machines to process the meaning and facilitates sharing of information [1, 3, 12, 13].

T.Sheeba S.Hameetha Begum M. Justin Bernard [1], discussed the significance of semantic web in ELearning content and the use of ontology in developing E-Learning content. Tools, languages, steps and approaches for ontology development are also discussed. By focusing on ontology of content infrastructure, e-learning community is realized to have much more effective services than what is currently provided by any of the available computer aided tutoring or learning management systems. ELearning is the use of technology to enable people to learn anytime and anywhere. The semantic web is the emerging technology aiming at web based information and services that would be understandable and reusable by both humans and machines. The semantic web has opened new horizons for internet applications in general and for eLearning in particular.

A similar study is done by Samir A. El-Seoud, Hosam F. El-Sofany and Omar H. Karam [4]. They discussed how the semantic web helps in developing an E-learning platform with a common interface for accessing learning materials. They also discussed how to integrate the semantic web technologies with e-learning systems, taking into consideration the standards and reusable learning objects. In their paper, they proposed an updated e-learning model based on the latest semantic web architecture where the main model for their research is the layered architecture. In their proposed model, the metadata, rules and annotations are stored externally in the ontology and knowledge base. Their model has the advantages of being able to reduce storage space, to retrieve meta-description stored in a database easily and to have different descriptions of the learning material according to the different contexts.

Pankajdeep Kaur, Pallavi Sharma and Nikhil Vohra [3], proposed a platform architecture for e-learning. The proposed a flexible educational system based on ontology technology and semantic web designed to be easy to modify and update. It is an e-learning management system with metadata, where the metadata main components includes system login, learning evaluation, course syllabus, the teaching approach etc. The system architecture of the e-learning system they explained in their paper consists of four components, Learning environment, repository, semantic web and administrator. The interface they designed makes the system easy to access irrespective of user's computer knowledge. The user can search for information using keywords as well as their synonyms. The user interface uses an ontology search engine to search ontology files from database for the keywords. The proposed system is capable of handling 1000 requests simultaneously.

Since the main purpose of education is knowledge sharing, an e-learning system has to be developed based on specific ontologies named educational ontologies. Mihaela Oprea[7] , developed an educational ontology , Univ_Edu_Onto, for teaching university courses. It was implemented in Protégé, a java-based ontology editor. The structure of the ontology has general terms for any university course and specific terms for an undergraduate students Artificial Intelligence course. The general terms may include a curriculum, objectives, pedagogical resource, learning resource, content, exams, problem, application, exercise, solution, lab, project and software. The specific terms are particular to each course and include concepts from the domain of knowledge. For the

Artificial Intelligence course, the researcher include specific terms such as knowledge, inference, heuristic, knowledge base, inference engine, knowledge based system and expert system. Relationships between the terms of the ontology are developed such as has, part of and is-a. The developed ontology can be used in the e-learning platform used for teaching in the universities.

The paper written by Neepa K. Shah focused on e- learning [9], benefits and requirements of e-learning and the uses of semantic web technology in e-learning. According to a study conducted by WR Hambrecht, online learning increased the retention rates of the learning material by 25-60%. It gives the student immediate access to the most current data since instructors are able to update contents instantly. The information delivered can be consistent to all users. In online learning the content is customizable taking into consideration each students strengths and weakness. It is self-paced and learner control. In the paper, the author differentiated between traditional learning and e-learning. The traditional learning has the following characteristics centralized authority, push delivery, lack of personalization and static learning process. On the other hand, e-learning is a distributed, student-oriented, personalized and dynamic learning process. Thus the author concluded that e-learning is replacing traditional learning but there are certain requirements to be achieved such as it needs to be fast and just in time. This needs a suitable content and organized material.

Shabina Dhuria and Sonal Chawls focused on the following points [2]: the use of semantic web and ontologies for realizing e-learning requirements, ontologies applications and the analysis of various ontology tools that are helpful in knowledge retrieval, storage, and sharing. The researchers explained that the purpose of semantic web is to find and access web sites and resources by keywords and definitions of their contents. Ontology, as an important component of semantic web, allows sharing and reusing of information in an organized manner. Both semantic web and ontology provide intelligent access to and management of web content that result in more intelligent e-learning. In the research paper the focus was on ontologies in educational systems. The paper discussed two projects about the usage of ontologies in e-learning. LT4eL project is a multilingual project, where there are nine languages to display the ontology concept. LT4eL enhances search process in LMS. It uses semantic web technology to improve the retrieval of learning material. It also facilitates personalized access to the learning content and defines domain ontology for semantic search. The second project is O4E project [11]. As in many other ontology-based applications, it works on two types of knowledge subject i.e. domain and structure, which leads to two types of ontologies, domain ontology and structure ontology. As a result of their analysis, there exists many ontology tools to apprehend the learning benefits. When compared to other tools, Protégé tool is being used with 68.20%. The percentage of ontology usage in education domain is 31% while it is 69% in other domains.

As can be seen from reviewing the literature, most research work has focused on using semantic web to provide better methodologies and tools for online teaching, however, our work focuses on providing a business process architecture that helps identify the main processes of online teaching without having to worry about organizational-dependent details.

3 Instantiation of srBPA ontology for online teaching

In this section, we first show how the Riva method is used to generate a BPA for online teaching then we show how it is semantically represented using srBPA ontology.

3.1 Online teaching BPA

In this section we show how to generate a Riva based business process architecture for online teaching

Finding the EBEs. The first step in to identify the essential business entities (EBE) for the online teaching process, this is a brainstorming activity that should be conducted by people working in the domain, since the authors of this paper are well experienced in the online teaching process, they had two sessions to brainstorm the list of EBEs, the questions suggested by Ould [16] were used to help identify them.

Three simple filters should be applied to the list of EBEs to ensure that each entity is truly essential to the business; the first one is to discard any entity that doesn't make sense to add the word 'a' or 'an' in front of it, the second one is to discard any designed entity, which is there because of the way the business runs, rather than because they fundamentally characterize the business. The third filter is to discard entities that are roles and are not of the essence of the business.

Table 2 shows the questions that were used to prompt suggestions and the essential entities that were identified as answers to those questions.

Table 2. Questions used to identify the list of EBEs

Questions to prompt suggestion of candidate EBEs	Candidate EBEs
What do we make?	**Online courses, Online courses syllabus**, **courses material,** online lectures, handouts – videos – booklets – course files – **Assignments** – **Exams** – **projects** – conferencing – Lecture notes - Books
What services do we offer?	Teaching –**multiple class coordination - grading – students' evaluation** counseling – **online office hours** – guiding – giving references- **projects online supervision** – **students' performance monitoring**
What things can we simply not get away from?	exams reviews - accreditation requirements – **exit surveys**, **stakeholder involvement** – **continuous improvement** – **course evaluation** – instructor evaluation – **course regulations**
Who are our external customers?	External examiners – External researchers – external teachers – external students – accreditation employees – maintenance employees – service providers
Who are our internal customers?	Students– Instructors – teaching assistants – administrative staff – lab supervisors – e-learning staff members – committee members
Are there things that our customers have, or want, or do that are EBEs for us?	**Disabled students management** - complaints – asking questions – submitting answers – uploading files and videos – downloading files and videos –requesting grades review – requesting to update grades – **exit surveys** – **absent students management**
What things do we think differentiate our organization from others in the same business?	**Online courses – continuous improvement**

What sorts of things do we deal with day in, day out?	**Teaching platform**, **exams platform**, **grading platform**, Complaints – students questions – system failure —time management
What events in the 'outside world', the world outside our organization, do we need to respond to?	**Stakeholder involvement**, **university regulations- quality standards**
What business entities are listed in our corporate data model?	Grades – students' information – instructors' information
What things do our information systems keep information on?	Labs – computers - library – rooms (Lectures or offices – staff members – instructors and students – Research information Lectures, **students absence**, students grades

Filtering off units of work. The resulting list of EBEs in the previous step describes the subject matter of the online teaching process. The next step is to find the units of work (UOW) from the list of EBEs, these units of work are entities that have lifetime during which we must look after them. So each UOW starts, proceeds and stops during the process, and some actions must be taken to handle it.

Accordingly, the list of EBEs will be examined to filter out any entity that is not a unit of work, a role that only plays part in the process, and any entity that is part of EBE and doesn't have a separate lifetime. The units of work appear in bold face in Table 2.

Finding unseen UOWs. This step tries to find UOWs that could've been missed through examining the names of the departments, putting the words "change to" and "collection of" in front of each UOW to see if it creates another UOW. After examining this step, no unseen units of work were found.

Producing the UOW diagram: Finding the dynamic relationships between UOW. There are possible relationships between UOWs, especially when one UOW requires information from another, a neutral word 'generates' could be used to describe the dynamic relationship between units of work. Accordingly, if two UOWs A and B have the relationship 'A generates B', then this means that "during the lifetime of a case of UOW A, cases of UOW B are required/needed/activated/called for".

Figure 3 shows the UOW diagram which represents all units of work identified for online teaching and the dynamic relationships between them.

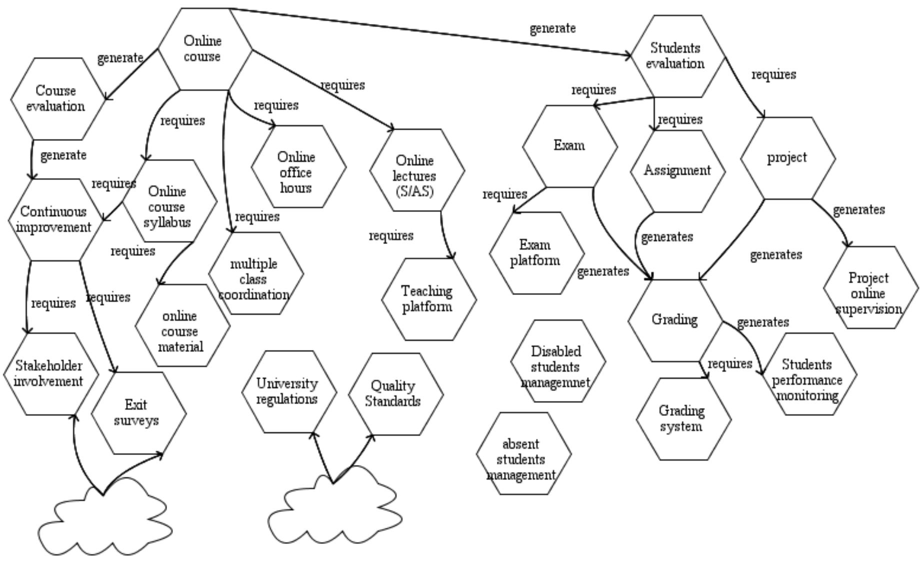

Fig. 3. Unit of work diagram for online teaching

Producing the first cut process architecture. This is a mechanical step where it is hypothesized that for each UOW in the UOW diagram, there are three processes; a case process, a case management process and a case strategy process. The "generate" relationship between units of work are represented as different relationships between the corresponding processes as shown in Figure 4.

The first cut process architecture diagram was generated automatically using the RPage tool [21], Figure 5 shows part of this architecture, the full diagram was not included because of the large number of relationships between case processes and case management processes that makes the diagram difficult to read.

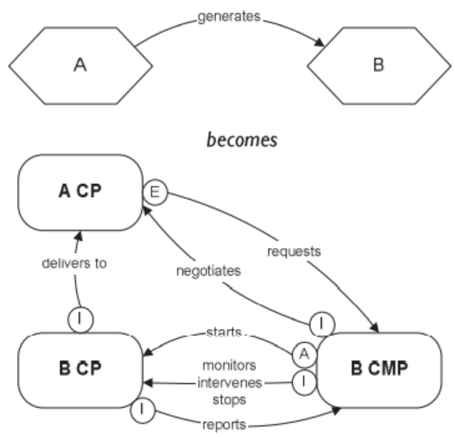

Fig. 4. Rule to generate case processes and case management processes

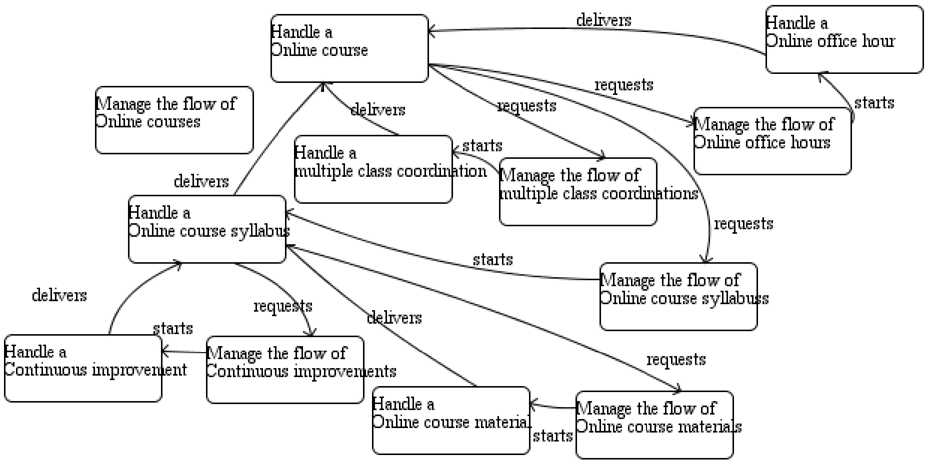

Fig. 5. Part of the 1st cut business process architecture for online teaching

Producing the second cut process architecture. The first cut process architecture involves more information that is actually present in a process architecture. In this step a domain expert is required to validate the first cut process architecture to decide on which processes and relationships should remain and which should be removed. For example, some case management processes can be encapsulated in the requesting case processes, so these should be folded into the requesting case processes. Another validation is to check each "deliver" relationship if it really happens, because some "request" relationship doesn't hold in reality. The domain expert should also check if the case management process is not empty, because sometimes there is no process to handle the flow of certain cases, if this applies then the case management process should be removed. One final validation is to check chains of requests, for example if A request B and B request C then instead of making C delivers to B and B delivers to A, the "deliver" relationship can be short-circuited where C delivers immediately to A.

Having validated the first cut process architecture by a domain expert and removed unrealistic processes and relationships, the second cut process architecture provides the target process architecture. This architecture is more realistic and represent the main processes of the system and the relationships between them, to provide an abstract view of the system. Figure 6 shows the second cut process architecture.

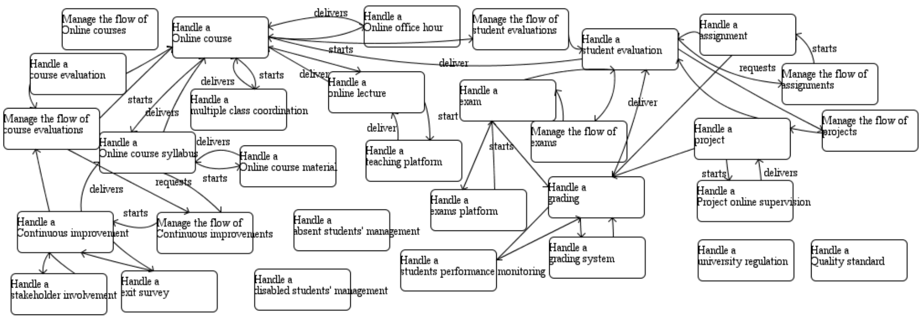

Fig. 6. 2nd cut process architecture for online teaching

3.2 Semantic representation

In this step, we semantically represent the BPA and all its elements using the srBPA ontology [18]. The following algorithm describes the steps used to instantiate the srBPA ontology for online teaching process. Figures 7, 8 and 9 shows snapshots from the protégé tool which was used to instantiate the srBPA ontology for online teaching.

```
  Algorithm I: instatiating srBPA ontology for online
teaching
  Input: SrBPA ontology, the set of essential business
entities for the online teaching process OT_EBEs = {ebe1,
ebe2, …, eben} where n is the number of EBEs.
  Output: OT_srBPA ontolog: the instantiated srBPA onol-
ogy for the online teaching process
  Begin
  1. Create the individual OT_UOW_Diagram as an instance
     of the class UOW_Diagram
  2. Create the individual OT_PA1_Diagram as an instance
     of the class PA1_Diagram
  3. Create the individual OT_PA2_Diagram as an instance
     of the class PA2_Diagram
  4. For each eben ∊ OT_EBEs:
      Create an individual for the class "EBE"
      If eben is considered a UoW, then Set the relation
"isConsideredUoW" as true
      End for
  5. Run the following SWRL rule to create corresponding
     UoWs individual
      EBE(?x) ^ isConsideredUOW(?x, True) -> UOW(?x)
  6. Run the following SWRL rule to set all UOWs to be-
     long to OT_UOW_Diagram:
      UOW(?u) -> belongsToUOWDiagram(?u, OT_UOW_Diagram)
```

7. Run the following Jess rule to create the corresponding CP of each UOW and set hasCorrespondingUOW:
   (defrule create_CP ?f <- (object (is-a UOW)) =>
   (make-instance (str-cat (instance-name ?f) "__Handling") of CP (hasCorrespondingUOW ?f)))
8. Run the following Jess rule to create the corresponding CMP of each UOW and set hasManaging CP:
   (defrule create_CMP ?f <- (object (is-a UOW) (hasCorrespondingCP ?cp)) =>
   (make-instance (str-cat (instance-name ?f) "__flowManaging") of CMP (hasManagingCP ?cp)))
9. Run the following SWRL rules to assert that each CP belongs to both the 1st and 2nd cut diagrams
   CP(?cp) -> belongsTo1stCutDiagram(?cp, OT_PA1_Diagram) ^ belongsTo2ndCutDiagram(?cp, OT_PA2_Diagram)
   CMP(?cmp) -> belongsTo1stCutDiagram(?cmp, OT_PA1_Diagram)
10. Run the following jess rule to perform the translation of the relationships present in the UOW diagram into relationships between the corresponding CPs and CMPs in the 1st cut PA diagram:
    (defrule translate_relations
    (object (is-a Generate) (OBJECT ?f) (hasUOWSource ?a) (hasUOWDestination ?b))
    (object (is-a CP)(OBJECT ?acp) (hasCorrespondingUOW ?a)) (object (is-a CP) (OBJECT ?bcp) (hasCorrespondingUOW ?b))
    (object (is-a CMP) (OBJECT ?bcmp) (hasManagingCP ?bcp))
    =>
    (make-instance (str-cat (instance-name ?f) "_d") of Deliver (hasCPSource ?bcp) (hasCPDestination ?acp))
    (make-instance (str-cat (instance-name ?f) "_r") of Request (hasCPSource ?acp) (hasCMPDestination ?bcmp))
    (make-instance (str-cat (instance-name ?f) "_s") of Start (hasCMPSource ?bcmp) (hasCPDestination ?bcp)))
11. Delete irrelevant CMPs by setting the Boolean property isActive as false
12. Run the following SWRL rule to delete all relevant "Request" relations to it (if exists)
    CMP (?cmp) ^ isActive (?cmp, false) ^ Request (?r) ^ hasCMPDestination (?r, ?cmp) -> isActive(?r, false)
13. Modify The "Start" relations to the managed CP by changing the source from the CMP to the CP that should have requested it.

14. Run the following SWRL rule to identify those CMPs that belong to the 2nd cut diagram

```
CMP(?cmp) ^ isActive(?cmp, True) ^ belongsTo1stCutDiagram (?cmp, OT_PA1_Diagram) -> belongsTo2ndCutDiagram (?cmp, OT_PA2_Diagram)
```

End

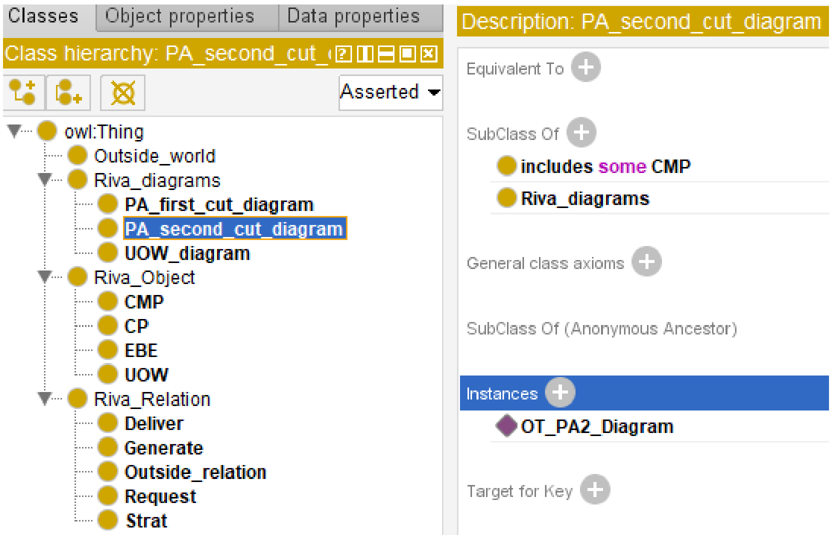

Fig. 7. A screenshot from the protégé tool that shows the main classes of the srBPA ontology

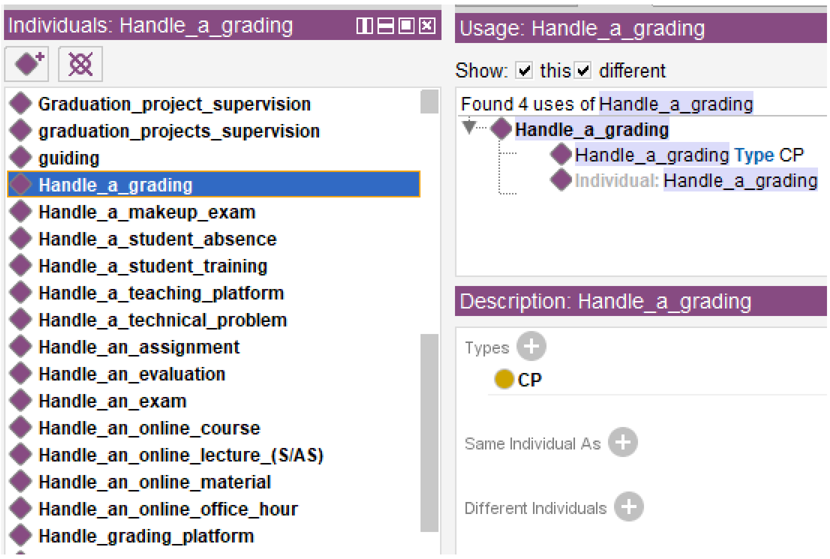

Fig. 8. A screenshot from the protégé tool that shows part of the instances created for the CP class

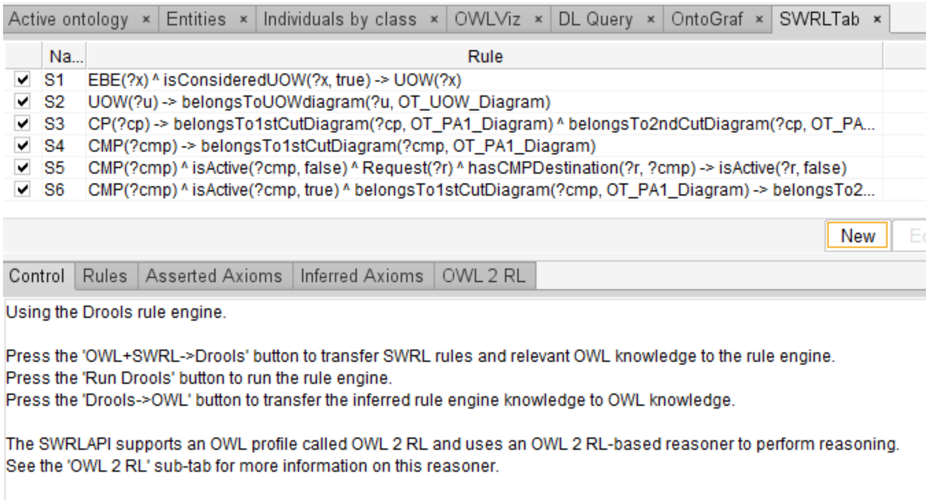

Fig. 9. A screenshot from the protégé tool that shows part of the SWRL rules

4 Discussion

Online teaching methods and best practices are constantly evolving and in order to keep teachers up to date, experts from Quality Matters (QM) and the Virtual Learning Leadership Alliance (VLLA) released a revised version of the National Standards for Quality Online learning, which previously had been updated in 2011 by iNACOL.

This aligns to our main goal of providing a semantic representation of the online teaching process architecture which is to provide a standard source of information of the high-level activities present in any online teaching process. Our added value here is the semantic representation of information to make it machine interpretable.

In this section we explain the value of instantiating srBPA ontology and providing a semantic representation of the online teaching process architecture through the comparison with the National Standards for Quality Online Teaching [19] and the National Standards for Quality Online course [20]. Tables 3 and 4.

Table 3. Mapping between the standards for quality online teaching and the semantic representation in SrBPA ontology

Standard	Description	Semantic implementation in SrBPA ontology
Standard A: professional responsibilities	The online teacher demonstrates professional responsibilities in keeping with the best practices of online instruction.	The following case process instance was defined: *Handle continuous improvement*. The following case management process was defined: *Manage the flow of continuous improvements*
Standard B: Digital pedagogy	The online teacher supports learning and facilitates presence (teacher, social, and learner) with digital pedagogy.	The following case process instances were defined: *Handle teaching platform, handle grading platform, handle online lecture, handle online material and handle online office hours*

Standard C: Community building	The online teacher facilitates interactions and collaboration to build a supportive online community that fosters active learning.	The following case process instances were defined: *Handle online lecture, handle online assignment, handle project online supervision*
Standard D: Learner engagement	The online teacher promotes learner success through interactions with learners and other stakeholders and by facilitating meaningful learner engagement in learning activities.	The following case process instances were defined: *Handle an exit survey, handle stakeholder involvement* The following case management process instance was defined: *Manage the flow of exit surveys*
Standard E: Digital citizenship	The online teacher models, guides, and encourages legal, ethical, and safe behavior related to technology use	The following case process instances were defined: *Handle course regulations, handle university regulations*
Standard F: Diverse instruction	The online teacher personalizes instruction based on the learner's diverse academic, social, and emotional needs.	The following case process instances were defined: *Handle disabled students, Handle student performance monitoring, handle continuous improvement*
Standard G: Assessment and measurement	The online teacher creates and/or implements assessments in online learning environments in ways that ensure the validity and reliability of the instruments and procedures. The teacher measures learner progress through assessments, projects, and assignments that meet standards-based learning goals, and evaluates learner understanding of how these assessments measure achievement of the learning objectives.	The following case process instances were defined: *Handle course evaluation, handle students evaluation, handle an assignment, handle an exam, handle project online supervision, handle continuous improvement* The following case management processes were defined: *manage the flow of students evaluations, manage the flow of assignments, manage the flow of exams, manage the flow of continuous improvements.*
Standard H: Instructional Design	The online teacher curates and creates instructional materials, tools, strategies, and resources to engage all learners and ensure achievement of academic goals.	The following case process instances were defined: *Handle a teaching platform, handle grading platform*

Table 4. Mapping between the standards for quality online courses and the semantic representation in SrBPA ontology

Standard	Description	Semantic implementation in srBPA ontology
Standard A: Course Overview and Support	The overall design of the course is made clear to the learner at the beginning of the course.	The following case process instance was defined: *Handle online course syllabus*
Standard B: Content	The online course provides learners with various content options that promote their mastery of content and are aligned with state or national content standards	The following case process instance was defined: *Handle online material*
Standard C: Instructional design	The online course incorporates instructional materials, activities, resources, and assessments that are aligned to standards, engage all learners, and support the achievement of academic goals.	The following case process instance was defined: *Handle an online course*

Standard D: Learner Assessment	A variety of assessment strategies are used throughout the course geared toward learning and engagement and learners are provided with feedback on their progress	The following case process instances were defined: *Handle course evaluation, handle students evaluation, handle an assignment, handle an exam, handle project online supervision* The following case management processes were defined: *manage the flow of students evaluations, manage the flow of assignments, manage the flow of exams,*
Standard E: Accessibility and usability	The course design reflects a commitment to accessibility so that all learners can access all content and activities and to usability so that all learners can easily navigate and interact with all course components	The following case process instances were defined: *Handle a teaching platform, handle grading platform, handle an exam platform*
Standard F: Technology	The technologies enabling the various course components facilitate active learning and do not impede the learning process.	The following case process instances were defined: *Handle a teaching platform, handle grading platform, handle an exam platform*
Standard G: Course evaluation	The online course is evaluated regularly for effectiveness, using a variety of assessment strategies, and the findings are used as a basis for improvement	The following case process instances were defined: *Handle a course evaluation, handle continuous improvement.* The following case management processes were defined: *manage the flow of course improvements*

As can be seen from the mapping tables, the srBPA ontology has included all quality standards for online teaching and online courses. For example, the case processes: "Handle teaching platform" and "Handle grading platform" satisfy standard B of quality standards for online teaching as well as standard F for quality standards of online courses where the activities include how teachers use digital pedagogical tools for teaching, interaction and communication.

The ontology presents abstract and general case process instances whose activities can be different from one organization to another, and this is the essence of presenting business process architectures rather than business process models. Accordingly, having a semantic representation for online teaching process architecture helps understand the main processes that should be present to have successful outcomes, without having to concern about process details as it could be variant according to organizations and strategies.

5 Conclusion

In this paper, the srBPA ontology was instantiated for online teaching, with the aim to provide a semantic representation of the online teaching business process architecture. The BPA method used is based on the Riva method, where the essential business entities were identified and the units of work were extracted and used to generate a unit of work diagram that shows the relationships between UOWs. The first cut BPA can be generated automatically, and then the second cut BPA is generated after applying a number of heuristics. All components of the Riva-based BPA are represented semantically in srBPA ontology as well as the relationships between them, in addition to the rules that makes the Riva method. In order to instantiate the ontology, individuals are created for each class, so instances were either defined or generated automatically through the rules to conceptualize EBEs, UoWs, CPs, CMPs, diagrams and relationships.

The instantiated srBPA ontology was evaluated for completeness by referring to the national quality standards for online teaching and online courses [19, 20]. Each standard was examined to check its availability in the instantiated ontology, mapping resulted in all quality standards covered through multiple case process and case management process instances.

Adapting this semantic representation in educational systems will be beneficial as it provides a single source of information that is machine interpretable and can be used as a core component in systems that aim to monitor and optimize the online teaching process.

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