EMPLOYEES' UPSKILLING THROUGH SERVICE-ORIENTED LEARNING ENVIRONMENTS

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Abstract: Aiming to increase their competitiveness, many companies are turning to new learning concepts and strategies that stress collaboration among employees. Both individual learning and organizational learning should be considered in relation to create a synergetic effect when introducing and maintaining skills among employees, and as well when it is necessary to train personnel in non-core competences. Regarding such kind of training, the possibility to collaborate with third parties is advantageous, especially in co-creating and/or using learning content. In this paper, we propose ICT-related solution directions concerning an adaptable, flexible, and collaborative upskilling of employees. We consider, in particular, two underlying objectives, namely adjustability of content+process and collaborative content co-creation. The mentioned adjustability of content+process is about the specialization of generic content+process, driven by the user (employee), and it is also about individualism. The mentioned collaborative content co-creation is about a (cross-border) dynamic creation of content by several persons. Our proposed solution directions (introduced and motivated in this paper) envision an approach that is used to integrate ideas pointing to some computing paradigms that concern SOA – Service-Oriented Architecture. It is expected that such an approach can contribute to the upskilling of employees that is done in an effective and user-friendly way.

1 INTRODUCTION

Competences of personnel as well as the related skills and their adequate adaptation are important with regard to the competitiveness of companies. Hence, aiming to increase their competitiveness, many companies are turning to new learning concepts and strategies that stress collaboration among employees within and beyond organizational boundaries. Such collaboration concerns individual learning and organizational learning. They both should be considered in relation to create a synergetic effect when introducing and maintaining skills among employees, and as well when it is necessary to train personnel in non-core competences (IBM Global Business Services, 2006). Regarding such kind of training, the possibility to collaborate with third parties is advantageous, especially in co-creating and/or using learning content. What is nevertheless necessary for this is a proper integration of both the content (the knowledge transferred) and the process (the way of transferring the knowledge).

In the current paper, we propose ICT-related solution directions concerning an adaptable, flexible, and collaborative upskilling of employees. We consider, in particular, two underlying objectives, namely adjustability of content+process and collaborative content co-creation. The mentioned adjustability of content+process is about the specialization of generic content+process, driven by the user (employee), and it is also about

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individualism. An example of the former is the requirements for different extensions of a knowledge core, driven by different cultures (concerning employees); and example of the latter are possible personality-driven preferences with respect to the content – one employee would prefer more explanations, another employee would prefer more pictures, and so on. The mentioned collaborative content co-creation is about a (cross-border) dynamic creation of content by several persons. The proposed solution directions (introduced and motivated in this paper) envision an approach that is used to integrate ideas pointing to some computing paradigms that concern SOA – Service-Oriented Architecture (Luthria & Rabhi, 2009). It is expected that such an approach can contribute to the upskilling of employees that is done in an effective and user-friendly way.

The remaining of the current paper is structured as follows: Section 2 will further delimit and elaborate the problem, as a basis for Section 3 in which our proposed solution directions are briefly outlined. Section 4 discusses then these solution directions in more detail, following three perspectives, namely requirements, architecture, and implementation. Section 5 outlines some further challenges and discusses related work. Finally, Section 6 presents the conclusions.

2 PROBLEM ELABORATION

To elaborate further the problem statement, we introduce our main learning/training-related perspectives (illustrated in Figure 1).

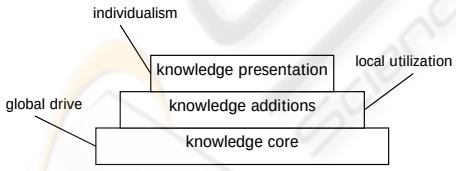

Figure 1: Knowledge perspectives.

As the figure suggests:

- There is a 'global' drive first of all for disseminating a knowledge core, pushed either by Society or by legislation or by the global management of a distributed company, to just mention several possibilities.

- There is a 'local' utilization (on top of the global drive) that concerns the way the knowledge is introduced in a particular societal segment or organization.

- There is finally a personal issue that concerns the way the knowledge is actually delivered to a particular person having his/her own personal peculiarities.

The knowledge core is (often) of global concern, the knowledge additions are driven usually by the need for a local (knowledge) utilization, while the knowledge presentation is about the way the knowledge is actually delivered and this should be driven by individualism – making the user in control of how (s)he would be learning and or being trained – with more figures, more examples, less explanations, for instance.

Each of these knowledge perspectives would need to be architecturally reflected in a learning environment, to guarantee that the global, local, and individual demands will be satisfied.

We claim that this can be possible with service-oriented solutions that allow for a proper consideration of the situation of each entity in the learning/training process. Hence, we would get inspiration from a computing paradigm, namely SOA which is not introduced in this paper for the sake of brevity. We nevertheless refer interested readers to (Alonso, 2004; Erl, 2007; Papazoglou, 2008).

3 SOLUTION DIRECTIONS

In our furthering previous work (Shishkov & Van Sinderen, 2009), we will define briefly our proposed solution directions in this section.

We would base our model on several key services, considered in the mentioned work, as exhibited in Figure 2:

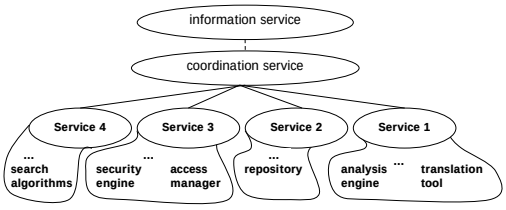

Figure 2: Key services and their relations.

As it is seen from the Figure, a coordination service is considered and information service as well as several more services.

The *coordination service* orchestrates the overall work of the system, invoking other services at the right moment and offering them also the right input.

Hence, this service would need a supporting *information service* that takes care of all data delivered at the right moment to the right entity.

The other services are: Service 1 (Educational Mediation Service), Service 2 (Educational Broker Service), Service 3 (Educational User Agent Service), and Service 4 (Educational Resource Discovery Service).

Service 1 concerns the delivery of an advise that is to be helpful for the user, by directing him or her for adequately making the next steps in his or her using the learning environment.

Service 2 concerns match-making, for example between a user and a course or between a content-creator and a course, which match-making is to be based on strictly-defined criteria.

Service 3 concerns request processing issues, such as what is required (by the user), to what course(s) he or she can qualify, and so on.

Service 4 concerns searching which in tern concerns users, courses, and so on.

This service model has already been justified in previous related work as it has been already mentioned in this section. Hence, for the sake of brevity, we will not consider the justification of this model.

This model is however adapted with regard to the problem considered in this paper (see Section 2) and to our considered background, namely service-oriented computing (Section 3).

In the following section, we will go in more detail, by considering the development of a system that can implement the introduced service model.

4 DEVELOPMENT PERSPECTIVES

We will address in this section the development perspectives concerning the proposed solution directions, by addressing firstly requirements perspectives, secondly - architectural perspectives and finally, implementation perspectives.

Requirements. We start here, by discussing the most important requirements on the IT environment from the end-user perspective.

With respect to this, we distinguish between two main categories of end-users. One category is that of company employees, who are the consumers of training and learning material. Experienced and educated company employees may also act as producers of training and learning material, and assume a teacher role to transfer their knowledge to novices. Furthermore, company employees, including inexperienced employees, may engage in collaborative learning, in order to transfer and co-create knowledge and skills through social interaction rather than through content media. The second category is that of company managers, who set and manage the learning targets in accordance to the goals of the company. The company goals, in turn, will depend on the nature of the business and on market developments, competition and opportunities. Learning targets may include what, when and how certain skill/knowledge levels should be attained. Such targets are set for function categories rather than for individual employees. In addition, remuneration policies and other measures may be agreed upon to stimulate company employees to engage in training/learning tracks.

The IT environment must be capable of enabling and facilitating an innovative methodology on how to conduct education and training of employees of companies. From this objective, some generic requirements can be derived from the perspective of the identified end-user categories:

- It should be possible to mix and match learning modules offered by different organizations on geographically distributed nodes using diverse technologies;
- The mixing and matching is typically prepared and constrained by a company, by defining learning profiles, learning paths and learning policies that are generally useful given the mission and strategy of (organizational units within) the company;
- The mixing and matching should be completed by the employee, such that (s)he can tailor the learning content, method and plan according to personal needs and preferences given the constraints imposed by the company;
- It should be easy to add, remove and update learning modules, so as to keep pace with changes in knowledge/skill demands of the company and to profit from the availability of new or improved learning modules;
- It should be possible for employees to transfer their experience and expertise to other employees by contributing to or co-creating the content of certain learning modules;
- The delivery of learning content may be automatically adapted to personal conditions, such as availability, place and device

characteristics, using context sensors and context reasoning;
- A company should have the possibility to be informed about the learning modules that are successfully completed by their employees, so as to compare realized and required knowledge/skill levels relevant for the business goals of the company;
- Employees should have the possibility to be informed about their knowledge/skill level (based on learning modules successfully completed), how to improve it, and what personal opportunities within the company are created by knowledge/skill improvements.

In addition, the IT environment should support case-specific requirements on functional and non-functional aspects, such as:

- Provide learning modules relevant for the domain or company;
- Provide learning profiles, paths and policies relevant for the domain or company;
- Provide life-cycle management, monitoring, control and information extraction mechanisms relevant for the domain or company;
- Satisfy non-functional properties, such as response time, availability, reliability, security and privacy, which are considered relevant for the domain or company.

Architecture. A definition of a service-oriented architecture is envisioned, for an employee upskilling system in which employer and employee objectives can be flexibly supported and third-party learning services can be added on demand.

Based on the previously mentioned requirements, we recognize a few components/tools that play a crucial role in our architecture:

- Policy-maker: definition and enforcement of business-constrained learning policies;
- Match-maker: matching employee learning objectives with (composite) learning services;
- Planning-dashboard: providing overviews and details on leaning achievements and opportunities; has two specializations, viz. one for the employer (business-level) and one for the employee (individual-level);
- Delivery-dashboard: provides facilities to the employee to modify previously agreed delivery of learning services;
- Monitoring-dashboard: provides overviews and details on the usage and performance of the system to the employer;
- Orchestrator: controls and coordinates the execution of service instances for the delivery of a (composite) learning service, possibly using information on the context of the employee to which the service is delivered

These are the basic issues that concern the architectural perspective with regard to the proposed solution directions. What has not been discussed in the current section for the sake of brevity nevertheless is the platform (with a service-oriented architecture) that is to flexibly use the introduced application components together with company-developed and third party services. This will be addressed in further related research.

Implementation. Being consistent with the architectural decisions already mentioned, the envisioned implementation would be characterized by the following: (i) User-centric composition. A user agent that adapts to the knowledge and skill level of the end-user, and mediates between the end-user and the composition engine. (ii) Rich service composition. A composition engine that can cope with richer services, and apply more criteria beyond simple input-output matching will be developed. (iii) Flexible business alignment: the employer will be able to establish policies at run-time that will adapt by context-aware methodologies the e-learning process and content. A policy enforcer agent will keep business policy alignment up to date. (iv) Context-aware delivery: based on a broader user context and from diverse context sources this service will improve user productivity by delivering information with a higher probability of relevance for the user. (v) Collaborative learning: will be supported by a social-network web tool that will allow content and knowledge co-creation and dissemination. (vi) Knowledge asset protection: information leaking we will minimized by security measures that will be developed to prevent company knowledge to be obtained without permission.

And particularly:

• Content Builder. Once matching is done and all parts of a specific formation becomes available, this component will build all course content, avoiding unwanted side-effect on content delivery due to eventual unavailability.

• Work Companion Component. will provide a time-line control to aid course takers to keep track

on their formation. Course takers will be able to come back to a specific point in time and re-make a specific problem automatically creating a new time-line branch that will give the opportunity to experiment new solutions and improve overall score.

• Multimodalities as new learning tool for present or distant resources that will help on practical content simulation.

5 CHALLENGES AND RELATED WORK

We envision the more in-depth consideration of the following challenges: (i) Content co-creation mechanisms require elaboration on how to combine academic knowledge (justified theoretically but is sometimes hard to realize in practice) and practical knowledge ('working' in real life but its application is sometimes not the best solution in long run). (ii) The control over content updates is a challenge since the content core which is globally distributed is then locally adjusted and it remains insufficiently clear how these updates are restricted from being inconsistent. (iii) Performance is considered to be also a challenge because of a required balance between tools and services – tools would enforce their 'embedded' functionality while (globally invoked) services would not always comply with it. Not claiming for exhaustiveness in our challenges analysis, we are to consider these three challenges in our further work on the realization of the proposed in this paper solution directions.

In (Shishkov & Van Sinderen, 2009), we have considered related work in three directions, namely: (i) Virtualization of learning (project LiLa (2009) addresses the challenge of making lab experiments more widely accessible, through automation and control via Internet, driven by advanced access control mechanisms); (ii) Adoption of Service-Oriented Architecture for enterprise systems in Education (IMS Global Learning Consortium (2009) has proposed an actual architecture for education-related enterprise systems); (iii) Tooling (tools such as Moodle (2010) are currently undergoing development that nevertheless strongly depends on the envisioned upcoming advances in the direction of service-orientation).

6 CONCLUSIONS

In this paper, we have presented solution directions that concern the collaborative, adaptable, and flexible upskilling of employees, exploiting Service-Oriented Computing and Context-aware Computing. In particular, we have proposed a service model incorporating innovative learning ideas and a vision on the ICT realization of this model, providing elaborations on requirements, architecture, and implementation. We consider this contribution useful since: (i) it is inspired by consideration of actual pedagogy (learning) problems; (ii) it envisions IT solutions that are based on established and proven paradigms; (iii) it concerns a solution that has been justified with regard to architecture and implementation (though not yet exemplified).

We would further this work as follows: (i) strengthening the pedagogy-related background through consideration of exploratory case studies; (ii) extension and detailing of the service model; (iii) further development of the architecture; (iv) considerations of the platform perspective; (v) validation through prototype implementation.

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