Assessment of Generic Skills through an Organizational Learning Process Model

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Abstract: The performance in generic skills is increasingly important for organizations to succeed in the current competitive environment. However, assessing the level of performance in generic skills of the members of an organization is a challenging task, subject to both subjectivity and scalability issues. Organizations usually lay their organizational learning processes on a Knowledge Management System (KMS). This work presents a process model to support managers of KMSs in the assessment of their individuals' generic skills. The process model was deployed through an extended version of a learning management system. It was connected with different information system tools specifically developed to enrich its features. A case study with Computer Science final-year students working in a software system was conducted following an authentic learning approach, showing promising results.

1 INTRODUCTION

Lifelong Learning is generally defined as the educational activities that individuals have been involved during their lives (Ozdamli and Ozdal, 2015), involving learning experiences that take place at home, in the workplace, in universities and colleges, and in other educational, social, and cultural agencies, institutions, and settings, both formal and informal (Aspin and Chapman, 2007). Lifelong Learning in the workplace is a key factor for the success of companies, since today's competitive environment requires professionals in any field to continuously improve their skills in order to face new challenges in their area of knowledge (Gagnon et al., 2015; Hennekam and Bennett, 2017).

In this context, the demand of employees on companies has shifted its focus from knowledge to skills (Crebert et al., 2004). Competencies can be divided into subject-specific and generic (Andrews and Higson, 2008). While subject specific competencies are related to knowledge in the subject areas, generic competencies are the abilities, capacities and knowledge that any person should develop regardless of his/her subject area. Generic skills competence is relevant for organizations, and future graduates are preparing at universities to meet labour market needs (Fitó-Bertran et al., 2015; Edwards-Schachter et al., 2015). As a result, the strategic management has to focus on the internal capabilities of organizations in order to strategically align its human resources with employee capabilities (Svetlik et al., 2007; Huang et al., 2016). In organizations, generic skills such as leadership or teamwork are usually key to consider the most suitable candidate for a position (Nita et al., 2016). However, objectively determining the level of performance in generic skills of every member of an organization is a challenging task. This work becomes even more demanding for large-sized organizations, where the number of workers interacting can be really high.

The competence of an organization can be enhanced adding organizational learning to the relationship between knowledge transfer and dynamic competence (Huang and Guo, 2010). Organizational learning is the process by which an organization increases the knowledge created by individuals in an organized way and transforms this knowledge into part of the knowledge organization system. The process takes place at an individual level, at a group level and at a system organization level (Reese and Hunter, 2016), having a positive influence both organizational

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performance and organizational innovation (García-Morales et al., 2012).

To support organizational learning, medium or large size organizations usually rely on a *Knowledge Management System* (KMS). KMSs provide organizations with different advantages in terms of communication, learning, sharing information, information retrieval and learning functions integration (Liebowitz and Frank, 2016). Unfortunately, KMSs do not usually provide managers with objective indicators about the generic skills performance of their individuals (i.e. staff).

A Learning Management System (LMS) is a web-based virtual educational environment with different modules to support learning processes. LMSs are commonly used in educational centres at all levels and can also be considered as KMS tools (Abu Shawar and Al-Sadi, 2010). In a LMS, supervisor can analyze learning situations by collecting interaction records produced by these environments (Chebil et al., 2012; Fidalgo-Blanco et al., 2015b).

Thus, can learning records in a KMS be used as evidences to automate the assessment process of individuals' performance in generic skills? This paper proposes a process model ultimately aimed at assessing the acquisition of certain skills by using a KMS built on top of a LMS and a set of dedicated tools published under open-source license. This process and these tools facilitate both the manual assessment of generic skills linked to evidences and the automatic extraction of objective indicators for those skills. To test the process model, a case study assessing several generic skills of individuals is conducted, showing promising results.

The rest of the paper is organized as follows: Section 2 reviews the background. Section 3 introduces the proposed process. Section 4 presents the set of tools implemented. Section 5 describes a case study about the assessment of several generic skills through an authentic learning experience. Finally, in the last section, we provide a discussion along with conclusions and future research lines.

2 BACKGROUND

In the current competitive context, knowledge management process within organizations aims to enhance both their individuals and group skills. Some generic skills, such as teamwork or planning and time management, are fundamental for individuals' job performance and, consequently, the successes of the organization (Ahmad et al., 2012; Burt et al., 2010).

Thus, this knowledge management process is usually embedded in virtual learning frameworks. A study focused on building students' engagement in virtual courses demonstrated that the main reason for the high withdrawal rate was the participants' poor time management skill (Nawrot and Doucet, 2014). In this context, the Adaptive Semantic Web is a framework that enables skill-based customization of Web resources, including learning scenarios (Paquette et al., 2015). In that work, learners were automatically clustered into subgroups by their skills. These clusters were more suitable to foster collaboration and to adapt scenarios according to the cluster members' needs. Unfortunately, the author claims that the model was not simple to implement, and students' skills identification should be at least partly automated considering that a human tutor approach is not feasible for large groups.

Organizational learning is defined as the ability of an organization to gain insight and understanding from experience through experimentation, observation, analysis and a willingness to examine both successes and failures (Schön and Argyris, 1996). Companies that build structures and strategies in order to increase and maximize the organizational learning are distinguished as *learning organizations*. In (Abel and Leblanc, 2009), organizational learning is subdivided into three sub processes: Individual Learning Process, Social Process and Knowledge Management Process. Then, they are incorporated into E-MEMORAe2.0 tool, designed for knowledge sharing in an organizational learning context. A fully exploitation of the traces in E-MEMORAe2.0 tool was used to organize and improve collaboration (Wang et al., 2015). Besides, the authors proposed a recommender system based on the assessment of traces considering the time decay of knowledge.

Organizations are using KMSs to facilitate knowledge sharing. The way of interacting and sharing knowledge depends on individuals' skills and characteristics. A experiment demonstrated that individuals' perseverance in the tasks given and responsibilities taken positively influence their commitment with knowledge sharing (Wang et al., 2014). LMSs also support the management of learning processes within organizations, enabling peer-to-peer knowledge capture and sharing in a knowledge-based organization (Kline et al., 2017). A LMS can manage all aspects of organizational learning alleviating the knowledge creation.

Assessment instruments are applied by organizations to measure their individuals' skills. Bohlouli et al defined a standard competence model with five main skill categories and related sub-categories including over 70 skill questionnaires in different managerial

and employee levels (Bohlouli et al., 2013). Some of these instruments and models are well known and widely used by organizations. Unfortunately, the monitoring and assessment process of each learner through these instruments requires assessors to perform a significant effort (Fidalgo-Blanco et al., 2015a), so applications based on learning analytics are needed to alleviate the assessment process.

According to Siemens' definition, learning analytics is the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning (Siemens, 2010). Students' performance in generic skills have been assessed through the collection of students' activity records with LMSs by means of software based on learning analytics (Balderas et al., 2018).

3 ORGANIZATIONAL LEARNING PROCESS

With the objective of providing answers to the requirements of training and knowledge assessment in an organizational environment, we propose the process model shown in Figure 1. This process model includes several roles and both manual and computer-assisted activities. All of these are aimed at the acquisition and assessment of the participants' skills in training activities of a given organization. The process model comprises the following sequence of activities:

1. *Identification of Training Needs and Required Skills:* First, the manager in charge of organizational learning within the organization identifies the learning needs. Second, he/she designs a specific learning plan. This plan lists the catalog of skills expected for all learners. The manager maintains the catalog of the skills and learning outcomes for the organization by using a specific tool.
2. *Design of Learning Activities:* Subsequently, the manager designs the learning activities needed for the training plan by using the features of a KMS. This way, he/she is able to monitor the learning activities that learners are engaging.
3. *Deployment of Assessment Instruments:* By using e-assessment systems, detailed feedback-enriched assessment of learners can be supported.
4. *Mapping Activities to Assessment Instruments and Skills/Learning Outcomes:* A conceptual model containing the elements of interest involved in this mapping is depicted in Figure 2. This model includes assessment instruments structured in dimensions and sub-dimensions. Once the assessment instruments have been deployed, the manager should indicate the skills and learning outcomes that are developed by the learners through learning activities. Then, it is necessary to make a mapping among the involved activities, the sub-dimensions of the assessment instruments, and the skills and outcomes.
5. *Engagement in Formative Activities:* After setting up the learning environment and the needed configurations for the assessment, the training activities in which the learners are involved are carried out.
6. *Performing Manual Assessment Activities:* The manager has to proceed with the assessment by analyzing the learning results generated by learners. To perform this step, the manager uses the assessment instruments previously created according to the required skills.
7. *Performing Computer-assisted Assessment Activities:* The analysis of the learning results generated by the learners may be partially assisted by using specific tools developed for those purposes.

4 IMPLEMENTATION

To support the organizational learning process proposed, a set of tools were used, some of them specifically developed under open-source license:

- Moodle Learning Management System to design learning activities (activity 2).
- EvalCOMIX to develop assessment instruments (activity 3). Available in (EvalComix, 2011).
- Gescompeval to map activities to assessment instruments and skills/learning outcomes (activity 4). Available in (Gescompeval, 2014).
- EvalCourse to perform a computer-assisted assessment based on learning analytics (activity 7). Available in (EvalCourse, 2015).

The following subsections present these tools.

4.1 Learning Management System

To design learning activities, we have opted for using Moodle as a LMS, a very popular and widespread open source web-based system (Rice, 2006). We created some specific tools to enrich Moodle with managing assessment instruments, managing skills and analyzing learning activities by extracting desired indicators.

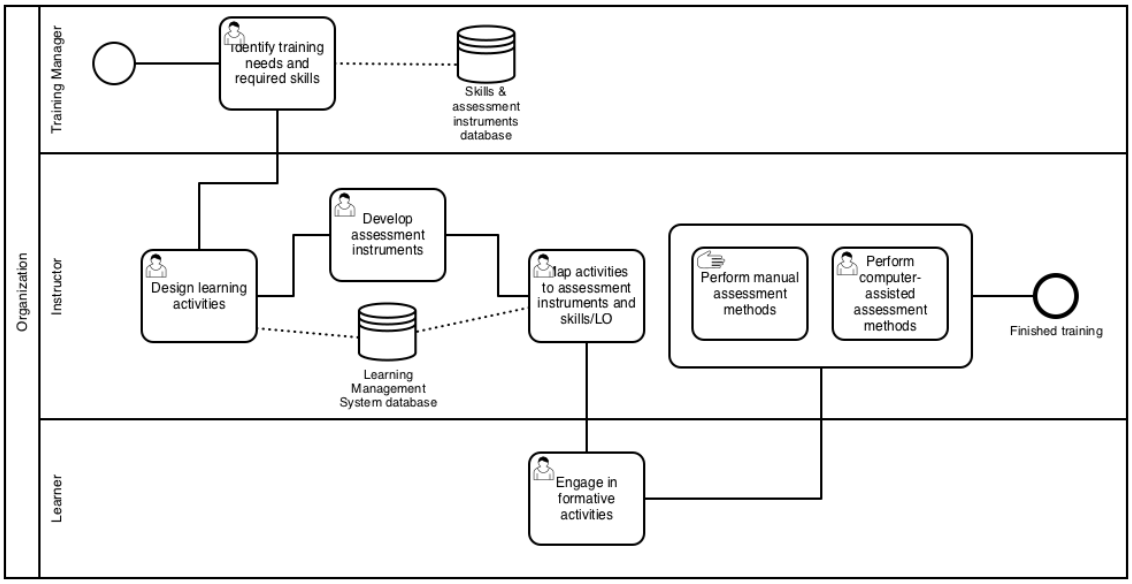

Figure 1: Organizational process model for the assessment of acquired skills.

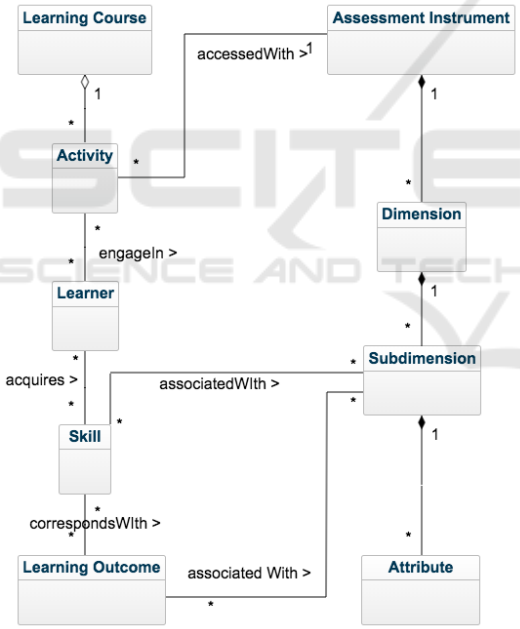

Figure 2: Conceptual model containing the main elements of interest in the KMS.

4.2 EvalCOMIX

We used EvalCOMIX to carry out the e-assessment activities in our architecture. It is a web service specifically designed to develop and manage different assessment instruments such as scales or rubrics. Each assessment instrument has its own structure based on dimensions, sub-dimensions and attributes.

EvalCOMIX provides an API that can be integrated with other e-learning systems to use designed assessment instruments (Sáiz et al., 2010). Therefore, a specific block called EvalCOMIX_MD was implemented to integrate EvalCOMIX with Moodle. As other Moodle blocks, it is implemented in PHP and JavaScript. EvalCOMIX_MD provides three learning assessment methods to be included in Moodle activities: teacher assessment, self assessment and peer assessment.

4.3 Gescompeval

We developed Gescompeval to manage skills and learning outcomes in the proposed architecture. It is a REST web service which provides a read-only API to retrieve these skills and learning outcomes. Gescompeval includes a web interface to handle basic CRUD (Create, Read, Update, and Delete) operations and to connect skills to learning outcomes (and vice versa). Both API and web interface follow a model-view-controller (MVC) architecture implemented Symfony2, a PHP framework.

The integration of Gescompeval into Moodle was carried out through the development of a Moodle 2.X block extension called Gescompeval_MD. This block uses Gescompeval REST API to retrieve skills and learning outcomes data in Moodle courses. Then, this information can be connected to activities and assessed applying EvalCOMIX assessment instruments through EvalCOMIX_MD. The overall integration architecture between EvalCOMIX, Gescompeval and Moodle is displayed in Figure 3.

The integration of EvalCOMIX and Gescompeval

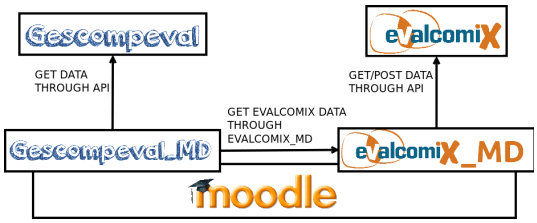

Figure 3: Skill management and e-assessment architecture.

with Moodle supports the assessment of specific skills and learning outcomes for each learner and the compilation of their grades. First, instructors have to select the required skills or learning outcomes by using Gescompeval_MD interface and then, they link them to the corresponding sub-dimension of their EvalCOMIX tools. We display an example of this connection in Figure 4. Second, skills/learning outcomes get the grades from the sub-dimensions they are connected with and combine those grades to get the overall grade of their dimension. Finally, the grades for each skill/learning outcome are displayed in a report to provide formative feedback. These reports are dynamic graphics developed using Google Charts.

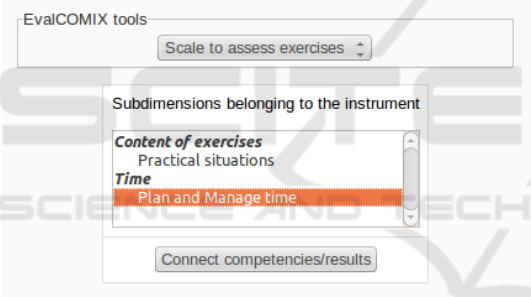

Figure 4: Selection of sub-dimension snapshot.

Gescompeval_MD provides two types of feedback reports. On one hand, a global report of all learners who participate in the course is provided. This report calculates the average grade of all learners' grades. On the other hand, individual reports with the grades of each learner are also provided. Both reports include an option to select if existing connections between skills and learning outcomes must be taken into account to calculate the grades. Additional information is displayed through a pop-up window when users place the mouse pointer over a skill/learning outcome graphic. This information includes: code, name, value and those activities where the skill/learning outcome were developed.

4.4 EvalCourse

Finally, we used EvalCourse, a standalone application based on learning analytics that we developed to provide instructors with reports about students' interactions with the LMS. EvalCourse was developed following the model-driven architecture (MDA) methodology, to deal with concepts of an educational domain model. In particular, it executes queries coded in SASQL, a domain specific language to easily design online learning assessment on students' generic skills based on their interactions with LMSs (Balderas et al., 2015), providing several reports with the information required.

EvalCourse supports two different configurations. Firstly, it can be directly connected to the LMS database. This is the desired operation mode, because reports are based on live updated information. Unfortunately, sometimes is not possible to obtain permission to establish a connection with the database of an institutional LMSs. In these cases, it can work with a backup of a LMS course, i.e. a snapshot of the records of a course in a given moment.

5 CASE STUDY

This case study follows an authentic learning approach (Lombardi, 2007) in order to promote students to explore, discuss and construct products in real-world projects. In our case, this experience simulates a I.T. company where employees in a project had to develop a software system. The employees were six students of Computer Science degree in their fifth (final) year. They had to fulfill several milestones, each one with a software deliverable for a certain deadline.

During their development tasks, they had to perform several generic skills. In this case study, the instructor posed tasks in which students should perform the following skills: (a) *ability to work autonomously*, and (b) *ability to plan and manage time*.

Then, students' performance in those generic skills were assessed following both the manual and the computer-assisted methods within the organizational learning process proposed.

5.1 Manual Assessment

The instructor defined two assessment instruments thorough EvalCOMIX, containing a dimension for each generic skill. Each deliverable was assessed with four attributes: correctness, efficiency, speed of execution and applied knowledge. They were assessed in a scale of: *none* (one or no deliverable has the attribute), *some* (at least two deliverables have it) and *all* (every deliverable has it). Additionally, submission time was assessed with one single attribute with four values: *delayed* (submitted after deadline), *average*

planning (submitted one or two hours before deadline), *good planned* (submitted one day before deadline) and *excellent planning* (more than two days before deadline).

Then, while students delivered their pieces of software, the instructor assessed not only the technical work well or badly done (specific skills), but also their planning and their ability to work autonomously by using Gescompeval.

5.2 Computer-assisted Assessment

Secondly, EvalCourse was applied in order to complement the former manual assessment. The first aspect to analyze consists on checking if the students had delivered their assignments on time, delayed or even if they had some pending assignment at the end of the semester. The instructor can retrieve for that information with the following SASQL code:

```
Evidence pieces_of_sw_delivered:
    get students
    show milestones
    in assignment.
```

By using SASQL, the instructor can dynamically redesign the query to or obtain information, contrast an hypothesis and even check additional information that can be used to assess a skill. For instance, the instructor detected that those students who delivered all their pieces of software on time, had a greater number of accesses to the LMS that the others. This information was retrieved with the following SASQL code:

```
Evidence accesses_platform:
    get students
    show access
    in campus.
```

Thus, the computer-assisted assessment gave the instructor the opportunity to detect information about students' behaviour. This information was interesting to assess one of the aimed skills and even some additional ones. The following subsection discuss the results obtained.

5.3 Discussion

Regarding the *ability to plan and manage time*, the two assessments provide different approaches. On the first hand, Gescompeval gives a better grade to those students who submit their piece of software one day before the deadline (*good planned*) or two or more day before it (*excellent planning*). On the other hand, EvalCourse gives the instructor a summary with the number of pieces of software delivered, which of them were delivered on time, and which of them were not delivered. Figure 5 displays this comparison.

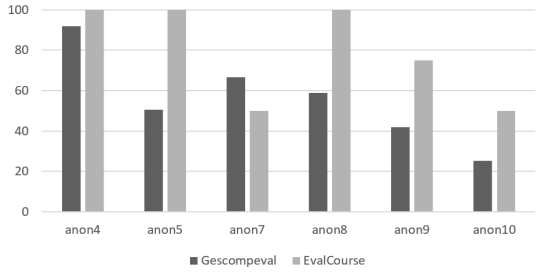

Figure 5: Comparison of both approaches for planning and time management performance.

However, if we take into account Gescompeval report for planning and time management and the accesses to the campus obtained via EvalCourse, students' numbers are more similar (Figure 6).

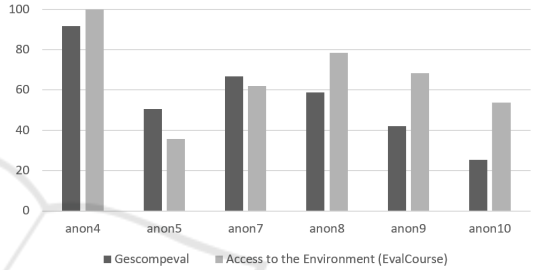

Figure 6: Comparison of students' planning and time management with their accesses to the LMS.

It is important to highlight that the instructor could assess other students' generic skills not initially considered using EvalCourse reports. Figure 7 shows the students' grades in four generic skills performed by the instructor with those reports: *ability to plan and manage time*, *capacity to learn and stay update with learning*, *ability to be critical and self-critical* and *ability to work autonomously*.

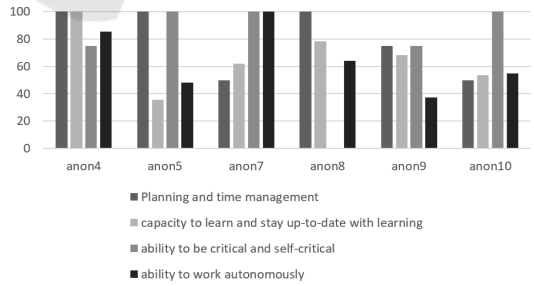

Figure 7: Assessment of students' skills via EvalCourse.

These assessments are interpretations that the instructor could assume with the obtained indicators, but the validity of the application of these indicators to a particular skill is outside the scope of this work. We can conclude that the instructor could refine students' assessments with the objective indicators automatically provided by EvalCourse. Actually, this is

what concerns our proposal. To draw further conclusions, this work requires deeper research, but it is a valid first approach.

6 CONCLUSION

Although performance in generic skills is increasingly important for organizations to succeed in the current competitive environment, its assessment in the workplace remains as a challenging task.

In recent years, several alternatives to solve this issue in educational contexts have been presented. Unfortunately, they rely on different activities that are usually supported by isolated information systems. In this paper, we have proposed a process model ultimately aimed at automate the assessment of skills in a KMS. We extended Moodle, a popular LMS, with a set of specifically developed tools, such as Gescompeval, EvalCOMIX and EvalCourse.

The process model was tested by deploying a learning experience to assess final-year undergraduate students' performance on several generic skills. The experience was based on authentic assessment principles. On the one hand, the instructor mapped the activities to skills and performed the assessment by using Gescompeval and EvalCOMIX. On the other hand, the instructor applied EvalCourse to design queries in a domain language to retrieve indicators about students' performance. These indicators were firstly applied to refine the previous assessment and secondly to easily detect new indicators applicable to other skills.

Results were promising, providing the manager of the KMS with an automated process to assess different skills using objective indicators. Additionally, students obtained detailed feedback, based on their interactions in the KMS. Anyway, this part of the process model needs further study to get a stronger conclusion on its validity, as the use of Gescompeval might present scalability issues if the organizational learning have a high number of users. Nevertheless, the computer-assisted assessment provided by EvalCourse retrieves different indicators simply by writing a query, regardless of the number of participants. Therefore, this is a positive evidence of its potential when the number of users increase.

As a future work, we are enhancing the software interface of the different tools developed so they can be connected to other LMS different than Moodle.

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