CURRICULUM DEVELOPMENT FOR CLOUD SERVICES: ANSWERING THE NEEDS OF THE JOB MARKET

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Abstract

The technical development and adoption of cloud services in organizations has been growing rapidly over the last years. Thus, there is a high demand for skilled professionals in the field. Institutions of higher education have to adopt their curricula to meet the needs of the job market. This paper first describes a model for curriculum development for cloud services. Secondly, the resulting curriculum and its mapping into the European Skills, Competences, Qualifications and Occupations classification is briefly outlined. The resulting curriculum is freely available for anyone to exploit. The most potential use cases would be higher education institutions seeking to update their study offerings or individual students seeking for information on how to become a cloud specialist.

Keywords: curriculum development, cloud services, ESCO, higher education.

1 INTRODUCTION

The technical development and adoption of cloud services in organizations has been growing rapidly over the last years. Cloud services are applied in virtually all business domains and for many different purposes: from replacing the hardware on premises by deploying the infrastructure-as-a-Service (IaaS) model to enabling the use of a software without any installation by deploying the Software-as-a-Service (SaaS) model. Adopting, implementing and developing cloud services creates challenges for businesses in terms of recruitment problems, due to shortage of cloud skills on the job market. This in turn poses a challenge to educational institutions as they have to adapt their curricula to meet the new expectations of the job market and the students.

Surveys from governmental ([1], [2]) and business agencies ([3], [4]) indicate that cloud skills shortages represent a top obstacle for businesses to adopt cloud technologies into businesses' operations and IT strategies. A lack of skilled professionals brings risks that can delay or cause failures in cloud deployment projects ([5]). This can negatively affect a company's business and from a larger European perspective, can even hinder growth in EU countries ([2]). For educational institutions, this provides a clear trigger for the development of curricula to address this urging demand.

The high demand for cloud expertice poses challenges for educational institutions that provide higher and further education in computer science, information technology and information systems. Firstly, they must choose which technologies to teach, and which can be learnt at the workplaces. They also have to choose which environments will be used in the practical laboratory exercises and which practical skills should be taught. For example, choices between free and low-cost open-source solutions (such as OpenShift and Cloud Foundry) and services provided by large commercial companies (such as Microsoft Azure, Amazon Web Services, Google Cloud) have to be made. Secondly, also teachers' competencies must be kept up-to-date, and they have to develop their skills and knowledge continuously. Thirdly, it is also necessary to know the competence needs of companies at a detailed level so that teaching can be designed to meet the requirements. This paper describes a curriculum development process that attempted to solve the above described challenges. The work was done as a part of the European Digital Innovation Hub for Cloud based Services (Dihub) project [6]. Producing a curriculum at the EQF (European Qualifications Framework) level 6 [7] for the four cloud services job roles identified during the process was one of the goals of this joint work.

The curriculum development work methodology is described in Section 3 and the result of the work: the Cloud Services Curriculum is described in Section 4. Section 5 concludes the work and provides new avenues for further development.

2 RELATED WORK

There is some previous work on the development of cloud curricula. Adams et al. [8] and Foster et al. [9] present how the development of cloud curricula has been successfully done as joint efforts of universities in the US, Canada, UK and companies providing cloud services.

Aunimo et al. [10], Soitinaho and Palviainen [11] as well as Noll and Wilkins [12] describe how curriculum development in the field of IT has been done in close collaboration with business partners.

In addition to interaction with companies, also job adds published by businesses have been used as a source for forming an insight on the skills and knowledge needed by the job market. Ketamo et al. [13] use artificial intelligence methods to mine job adds from the Finnish job market to form an overview of the current needs. Vinel et al. [14] do the same using job adds from the Russian labor market. The job market of IT professionals is global [15, 16] and thus the development of the curricula can be done in an international cooperation. This reduces the amount of duplicate work and makes the process more efficient.

The European Skills, Competences, Occupations and Qualifications (ESCO) framework [17] maintained by the European Commission includes the job role of a Cloud Engineer. The documentation lists the skills that are required in this job role [18]. Also, commercial cloud service providers offer education paths and they have defined cloud services related job roles. Examples of these are the study offerings of the AWS Academy [19] and Microsoft Learn [20].

3 METHODOLOGY

The development of the curriculum consisted of the identification of the job roles and the skills related to these roles. At the same time, teachers were trained on cloud technologies related skills and new study modules were piloted in cooperation with companies.

3.1 The identification of job roles and skills

The identification of industry needs for cloud skills through a systematic analysis was performed together with companies during the year 2021. The work was done by the Algebra University College in Croatia. The steps that were taken are the following:

1. Description of key facts on cloud technologies based on the literature.

2. Identification of experts in cloud technologies, organization of interviews to chart the need-structure.

3. Based on the interview results, identification of specific jobs on the labor market that are pertinent for various aspects of cloud technologies with aim to cover all aspects of the cloud ecosystem.

4. Description of jobs identified under #3 in the matrix "tasks/skills" including relevance score for the most important skills. These four first phases are illustrated in Figure 1.

5. Description of jobs identified under #3 in the matrix "groups of skills" and establishing the mapping to the ESCO skills. This phase is illustrated in Figure 2.

6. Defining micro-credentials learning programs for life-long learning and certification programs. The result of this analysis is depicted in Figure 3.

7. Devising sets of recommendations on integrating the learning programs defined in #6 in the EQF6 study programs.

DIHUB DACUM Steps

Figure 1. The phases 1 - 4 of the curriculum creation process.

From Tasks to Skills

Figure 2. The phase 5 of the curriculum creation process.

After the process, possible new skills not in the ESCO vocabulary were identified. Also adjustments to the definitions of the terms of the vocabulary based on the analysis were considered.

3.2 Creation of the Curriculum

The design work for the new cloud service curriculum began with a survey of existing studies in all educational institutions participating in the Dihub project. The existing study modules covering the required skills were taken as a basis for the new curriculum. The contents of some study modules had to merged and in some study modules, only a part of the module was taken into the new curriculum. If none of the organizations had existing study modules with the required skills, it was reviewed together, and, if necessary, the content was sought elsewhere. A couple of courses were created and piloted during the Dihub project. There were also some courses which have not yet been piloted in any of the partner institutions. Recommendations were made for the necessary new content based on the requirements gathered from companies, the offerings of other universities and on literature. joint

mapping work. The work was done iteratively and shared content allowed for flexible and up-to-date work without duplication.

4 THE CURRICULUM FOR CLOUD SERVICES EXPERTS

The result of the work on defining the cloud roles and skills is depicted in Figure 3. The process was explained above in section 3.1. The skills range from technical ones (Virtualization) to soft skills (presentation) through business skills (e.g., Cloud TCO).
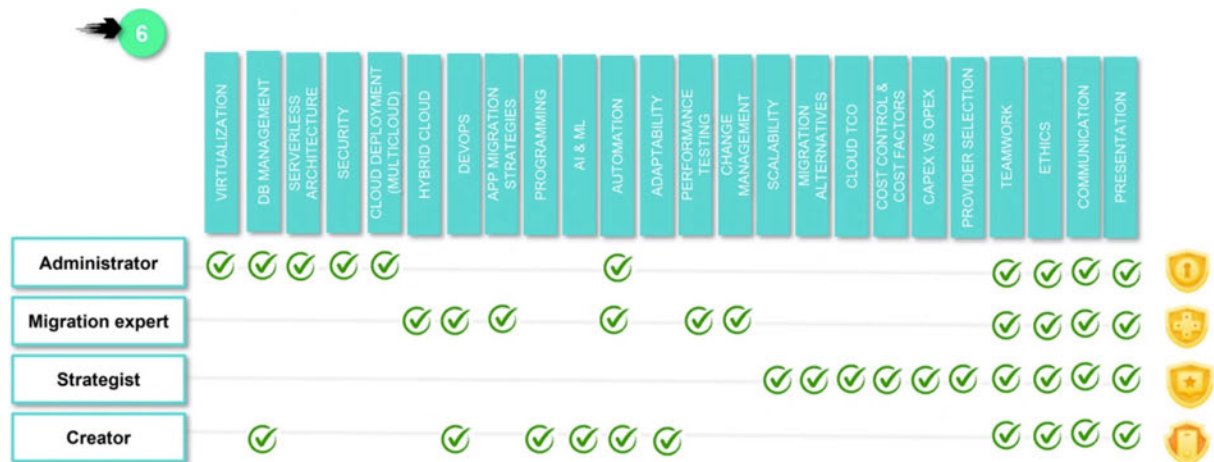

Figure 3: The identified cloud job roles and the skills required for each skill are depicted here.

The skills are mapped to the relevant ESCO skills. The exact mapping of each skill is given in the curriculum document which is available online at: tinyurl.com/dihubCur . Along with the Cloud services curriculum for the level EQF 6, it also contains one job role for the EQF level 4 and the description of skills related to it. This job role is the IT-support specialist for cloud services. However, the curriculum at the secondary school level (EQF 4) was defined as a separate process and it is not described in this paper.

The proposed curriculum was designed with the intention to flexibly address varying skill sets needed in the different job roles described in the previous section. For each job role, the curriculum includes several technical and business study modules and a common set of soft skills.

The different EQF6 job roles covered by the curriculum, alongside with the total amount of ECTS, are listed below and the details are depicted in Figure 3. Each job role includes technical, business, and soft skills study modules:

- – Cloud manager/administrator (56 ECTS)
- – Cloud migration expert (57 ECTS)
- – Cloud strategist and monetization expert (45 ECTS)
- – Cloud service/content creator (58 ECTS)

The soft skill study modules amount to a total of 16 ECTS and include the following study modules: Teamwork, Ethics, Communication, and Presentation.

Educational institutions interested in using this curriculum as a reference can flexibly pick study modules that best suit the institution's educational profile.

Assessment criteria in the curricula are based on generic templates applied for the following assessment areas: theoretical knowledge, practical knowledge, project work, written papers, and presentation skills assessment. For each assessment area, the curricula provide a criteria template offering grades on the following scale: Excellent, Very Good, Good, Pass, Fail. Educational institutions can flexibly map this generic assessment criterion to their grading systems with this approach.

5   CONCLUSIONS

This paper described the methodology used for creating a cloud services curriculum based on the needs of the job market. The standard vocabulary (ESCO) was used in the curriculum to describe the skills needed in the different job roles. The result of the curriculum development process is a complete curriculum covering four job roles related to cloud services. This curriculum may be used by educational institutions when they plan and implement their study offerings either for the degree students or for the students of further education. Also students may benefit from the curriculum when they gather their study modules from the offerings of several education providers. The curriculum itself is very useful, but maybe even more useful is the process for joint curriculum development and the experiences gathered from its implementation. These may serve as guidelines for future curriculum development endeavours in other areas of expertise and other levels of education

ACKNOWLEDGEMENTS

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