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learning objectives”**

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1 Introduction

In the last few years, cloud computing has emerged as a promising paradigm for increasing the business value and productivity of the organizations. This paradigm allows reducing time to market, what provides organizations with the capabilities to find new business opportunities. What is more, cloud computing provides more efficient resource consumption, by optimizing the costs and adapting the resources to the requirements. Organizations need to adapt the classic view of their IT models, providing a more oriented financial perspective trying to adapt the costs to the benefits and the resources. Specially, European territorial public administrations will need to adapt their IT-based business processes.

The Nebula project aims at forming a Sector Skills Alliance that will deal with the mismatch on cloud computing skills in the territorial public administrations in order to improve employability of staff by enhancing their skills on this paradigm. This goal foresees the development of a VET program that will provide current and future public servants with the skills necessary to drive all the stages of the migration process and use of cloud services.

Work Package 4 (WP4) of the Nebula project aims at defining the learning objectives of the VET program together with the development of the curriculum and all the necessary learning and training content. In addition, innovative ways to deliver the training will be developed by providing game-based technologies and learning approaches focused on online platforms.

This report is the starting point of the WP4 and it takes the output from the previous Work Package 3, in which the required skills to be addressed by the program were defined. The objective of this report is the definition of the learning objectives that must be achieved by the VET program based on the skill mismatch.

The rest of the report is organized as follows. Section 2 presents the theoretical framework in for the definition of the learning objectives. Section 3 introduces the methodology that is followed for the development of this report. Section 4 defines the main characteristics that are associated to the learning objectives. Section 5 is aimed at obtaining the learning outcomes that are expected to be achieved by the students. Section 6 provides the structure of the learning objectives of the VET program according to the learning outcomes. Finally, Section 7 presents some concluding remarks.

2 Theoretical framework

When describing learning programs, some concepts must be firstly introduced, ranging from the most general to the most specific issues. As stated in Kennedy et al. (2007) the **aim** of a program or a module can be defined as a general statement of teaching intention, indicating what the teacher expects to cover in the program or in the specific module. Therefore, the aim is usually written from the teacher point of view to indicate the focus in which this program or module will be developed.

Related to this concept, **learning objectives** are used to represent specific statements of teaching intentions, indicating each of the specific areas that the teacher intends to cover in the program. Following this definition, the aim shows the main purpose of the teaching intentions while the learning objectives represent more specific information about what is expected to be achieved, becoming more precise and measurable. Hence, the aim is general and long-term while the learning objectives are more precise and short term.

The use of learning objectives is not enough to clearly determine the specific actions that are expected to be addressed in the program. Actually, there is not a clear agreement about the procedure to write learning objectives, because despite the fact that they are usually written from the teacher's perspective, other times they are written in terms of expected learning, i.e. from the outcomes perspective (Moon, 2002; Kennedy et al., 2007). Related to this issue, **learning outcomes** are used to provide a more precise definition of what is expected to be learned in the program. Learning outcomes are focused on the student's perspective, specifying what the student will be able to do after finishing the program. Thus, learning outcomes provide a tool to supplement the definition of learning objectives.

Conceptually, the difference between learning objectives and learning outcomes is not considerable due to objectives can be written as outcomes (European Union, 2011). Learning objectives are usually written as a guide for the teaching program while learning outcomes are expressed as a manifestation of learning.

The European Qualifications Framework (EQF) (European Communities, 2008) represents a common reference guide to define and describe qualifications from the most elementary studies to postgraduate

studies. The use of this framework allows the translation between different qualification systems and their levels across Europe. This is necessary to compare citizen's qualifications, increasing their transparency and portability in the different European countries. Therefore, the EQF contributes to promote lifelong learning by increasing the mobility, employability and integration of workers and learners.

This framework is based on learning outcomes that are divided in eight levels, each one representing different criteria of the learning achieved. According to European Communities (2008) and Goncalves et al. (2013), a learning outcome is defined as what a learner knows, understands and is able to do on completion of a learning process, which is defined in terms of knowledge, skills and competences. Each one of these three dimensions is defined as follows:

Knowledge represents the result of the assimilated information through learning. Conceptually, knowledge is the body of facts, principles, theories, and practices that are developed in a specific area of work of study, and can be theoretical or factual (European Communities, 2008; Goncalves et al., 2013).

Skills are referred to those abilities to apply knowledge and use resources acquired to complete tasks and solve problems. These skills can be cognitive (including logical, intuitive, and creative thinking) or practical (including manual abilities, the use of materials, tools, and instruments).

Competences are referred to the proven abilities to use knowledge, skills, and personal, social and/or methodological abilities, in work or study situations for the development of both professional and personal sides. These competences can be viewed as responsibility and autonomy.

During the development of the EQF, there was an agreement to use different categories (knowledge, skills and competences) as the basis of the framework. This is the most established way to define learning outcomes in several countries such as France or Germany (European Union, 2008; Najjar et al., 2011). Although learning outcomes can be described without explicit references to any of these three categories, the proposed differentiation is helpful to construct descriptors and clearly classify the level of qualifications.

Table 1 shows the list of descriptors provided by the EQF indicating the learning outcomes relevant to each of the eight levels of qualifications. In the EQF, the first cycle of the European Higher Education

Area (Bachelor) is classified at level 6, the second cycle (Master) at level 7, whilst the third cycle (Doctorate) is at level 8. It should be noted that Higher Education programs can be used to reach levels 6-8 but these levels can also be reached through informal and non-formal learning (Castillo et al. , 2011). As stated in European Communities (2008), all new qualifications developed in the European context should contain a clear reference to the appropriate EQF level.

In order to develop qualifications that are easily understandable and readable in the different European countries, these qualifications should be described following the specification stated in the EQF. The EQF covers the whole range of qualifications acquired in general, vocational, academic and training education, recognizing the diversity of the educational and training systems across Europe.

Table 1: Learning outcomes according to the levels of the EQF

	Knowledge	Skills	Competence
Level 1	basic general knowledge	basic skills required to carry out simple tasks	work or study under direct supervision in a structured context
Level 2	basic factual knowledge of a field of work or study	basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	work or study under supervision with some autonomy
Level 3	knowledge of facts, principles, processes and general concepts, in a field of work or study	a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	take responsibility for completion of tasks in work or study adapt own behaviour to circumstances in solving problems
Level 4	factual and theoretical knowledge in broad contexts within a field of work or study	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
Level 5	comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others

Level 6	advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	manage complex technical or professional activities or projects, taking responsibility for decision making in unpredictable work or study contexts take responsibility for managing professional development of individuals and groups
Level 7	highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research critical awareness of knowledge issues in a field and at the interface between different fields	specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
Level 8	knowledge at the most advanced frontier of a field of work or study and at the interface between fields	the most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

3 Methodology

The description of the learning objectives that are needed to be addressed by the VET program will be carried out in the context of the previous tasks of the Nebula project. The identification of the mismatch between skill supply and demand in territorial public administrations provided the set of skills that are needed to be addressed by the VET program. These skills were identified in T3.4, setting the requirements that the learning objectives of the VET program must accomplish. The current deliverable is focused on translating these skills into the set of learning objectives that will be addressed by the VET program. In order to do this, following we outline the most remarkable tasks that will be carried out:

- Identification of the main characteristics to properly formulate learning objectives.
- Obtaining the learning outcomes from the skills to be covered in the program.
- Description of the learning objectives.

4 Main characteristics of the learning objectives

The first step required to describe the learning objectives is the specification of the set of rules that should be associated to formulate learning objectives. As stated in European Communities (2008), in order to assure the quality in Higher Education and Vocational Education and Training in the context of the EQF, the learning objectives of the program should be clear and measurable.

According to Biggs et al. (2003), making clear the levels of understanding that are expected from the students and the performances that determine this understanding is a key issue for defining the learning objectives of the curriculum. In addition, as stated in previous sections, the development of qualifications that are compliant with the EQF requires the reference to the learning outcomes of the program. Learning outcomes provide a more precise definition of what is expected to be learned in the program. Thus, learning objectives can be written from the outcomes (European Union, 2011). Therefore, the definition of the learning outcomes that are needed to be achieved will allow determining the learning objectives that should be addressed in order to achieve these outcomes.

Related to this issue, there is a wide agreement about some set of rules that must be followed in order to write learning outcomes (Kennedy et al., 2007; Grün et al., 2009; Bisagni et al., 2010; European Union, 2011). Following, we summarize the most remarkable considerations that should be followed to describe learning outcomes:

- Learning outcomes must be formulated by using active verbs, which are clearly understandable.
- Learning outcomes must include a contextualization of the active verb, specifying related objects.
- References to the level of performance that is expected to be achieved must be specified. As an example, descriptions should refer the level of autonomy or responsibly that is expected.
- Finally, vague and open formulations must be avoided.

The above indications can be properly followed by using some methodologies as a support to write the specific learning outcomes. Bloom taxonomy (Bloom & Krathwohl, 1956) provides a traditional framework for writing learning outcomes. This taxonomy defines a hierarchy of levels that are expected to be achieved by the students. Depending on the specific domain of learning that is wanted to be assessed, different verbs can be used as keywords. As an example, verbs such as identify, describe, or

define can be used to define learning outcomes that demonstrate evidences in the knowledge dimension, while verbs such as apply, assess, or operate can be used to define learning outcomes that demonstrate evidences in the application dimension. The SOLO taxonomy (Biggs & Collins, 1982) gives a hierarchy that represents the different levels of learning that can be associated to a process. In this hierarchy, different verbs are associated to represent these different levels of complexity. As an example, verbs such as identify or describe are associated to basic levels of complexity while verbs such as analyze, classify, or assess are associated to higher levels of complexity.

The formulation of the learning outcomes will have associated a mapping to the different characteristic of the learning outcome and will determine the required level of complexity. The above taxonomies have been widely used as the basis to formulate the learning outcomes and therefore, they can be used as guidelines to determine the proper formulation of the learning outcomes, which also includes the level of performance that is expected to be achieved by the students. As an example, verbs such as identify, recognize, describe, or define can be associated to the knowledge dimension; verbs such as explain, analyze, or explain can be associated to the skills dimension; and verbs such as use, create, or organize can be associated to the competence dimension.

As stated in European Union (2011), the use of learning outcomes for describing qualifications is essential because they describe clearly the meaning of these qualifications. These descriptions define levels in terms of expected learning outcomes when these outcomes are achieved by a person in certain conditions (European Union, 2010). The description of detailed learning outcomes provides a clear view of the learning achievements, which could be used to represent the future content. The definition of each learning objective needs to be connected with a list of tasks that must be carried out in order to assess the learning objective (Barros et al., 2012; Biggs et al., 2003). Due to learning outcomes are viewed as achievements that must be observable and assessed, these concrete statements can serve as the indicators that assess that the learning objectives are properly acquired. Therefore, the definition of these assessments can be specified in terms of learning outcomes. Nevertheless, it is not recommendable when describing learning outcomes, to give more details than needed (European Union, 2011; Grün et al., 2009). If learning outcomes contain a lot of detail in order to serve directly as assessment, this may be counter-productive, causing the learning outcomes to be too complex, impacting negatively in their clarity.

Learning outcomes can also be written as broad indicators that are too general to be assessed. These broad learning outcomes require further interpretation by the teachers. In this case, the specification of assessment indicators provides the criteria that are needed to make assessable the learning outcomes. Assessment indicators are based on learning outcomes statements and contain more detailed information about the context in which the learner is expected to do something and the expected level of autonomy. Assessment indicators contribute in the following purposes: to evaluate the achievement of the learning objectives and to define what is to be learned by the student. As an example, these indicators are used in the definition of the VET curriculums in Spain.

According to European Union (2011), designing a program needs to be an iterative process. The first step requires formulating the learning objectives that should be addressed by the program according to the skills that are wanted to be acquired. To do this, the learning outcomes are formulated to provide specific information regarding to what the learner should be able to do. When viewing the program as a whole and the learning outcomes grouped in different learning objectives, the preliminary learning outcomes might change. Again, if assessment indicators are specified, the definition of the learning objectives might change.

In summary, according to the descriptors provided by the EQF, our work will focus on determining the learning outcomes (student's perspective) that should be assessable and measurable without providing too specific details. As stated in European Union (2010), a set of learning outcomes that refer to a specific level of knowledge, skills and competences can contribute to improve assessment and thus, the quality of the certification process. The statements that represent the learning outcomes must have some verb which represents the level of learning that is expected from the student (European Union, 2011). Then, considering these learning outcomes, the learning objectives (teacher's perspective) can be properly formulated as the way to achieve these outcomes.

5 Obtaining the learning objectives

In previous task T3.4 of the Nebula project, an in-depth study was carried out in order to assess the degree in which the academic and commercial courses cover the distinct thematic areas of skills. According to this study, technical and security topics of cloud computing were sufficiently covered by academic and commercial courses. In contrast, transversal skills (*communication, analytical, and negotiation*) supplemented by *business change management*, displayed the lowest degree of coverage. Table 2 shows the skill mismatch which determines balance values for each thematic area of skills.

Table 2: Skill mismatch

Thematic area of skills	Type of skill	Balance values
Service Delivery	Technical	78
Security Strategy Development	Security	70
Virtualisation	Technical	57
System and Data Integration	Technical	43
Information Security Management	Security	9
<i>Financial Literacy</i>	<i>Managerial</i>	-13
<i>User Support</i>	<i>Technical</i>	-35
<i>Knowledge of the Law</i>	<i>Managerial</i>	-35
<i>Project/Process Management</i>	<i>Managerial</i>	-39
<i>Risk Management</i>	<i>Managerial</i>	-39
<i>Negotiation</i>	<i>Transversal</i>	-52
<i>Analytical</i>	<i>Transversal</i>	-52
<i>Communication</i>	<i>Transversal</i>	-57
<i>Business Change Management</i>	<i>Managerial</i>	-61

This analysis determines that more emphasis on managerial and transversal skills is required in the development of the VET program. Specifically, the learning objectives of the VET program must focus on the acquisition of *business change management, communication, analytical, and negotiation* skills. In addition, besides the program coverage on these areas, the program should also cover to the degree that is feasible the rest of the areas that showed a low degree of coverage according to what was determined in T3.4: *risk management, project/process management, knowledge of the law, and user support*. Therefore, the learning objectives will be determined in order to focus on the above skills. Although there is a large support, the VET program will complement these skills with the technical background that might be required.

In order to determine the learning outcomes and the learning objectives of the program, an appropriate way of proceeding is to establish those actions that are required for the different stages of the migration process. For each stage, different learning outcomes can be properly formulated in order to cover the required skills, identifying these learning outcomes with the thematic areas that are considered and with the domain according to the EQF. Considering the duration of the program, the learning outcomes will be defined such that the coverage of the different areas is coherent with the skill mismatch definition. In this sense, the support of taxonomies to determine the verbs used to define the learning outcome will be helpful to define the level of complexity. Finally, the obtained learning outcomes will be composed in order to define the learning objectives of the program.

5.1 Roadmap of the cloud migration

According to Pahl et al. (2013), cloud migration is the process of deploying the assets of the organization (data, applications, workloads, etc.) to the cloud. This migration may include all the assets or just some of its parts. Therefore, this process requires a precise analysis, assessment and implementation in order to ensure the functionality and performances by accomplishing the organizational requirements, and maintaining the availability and integrity of the rest of the organizational IT systems.

The migration to a cloud formation represents a process that can be viewed as sequential stages, which allow moving current workloads to cloud-based environments. In the last few years, several authors presented different approaches for defining the migration process (Ward et al., 2010; Varia, 2010; Sun &

Li, 2013; Jamshidi et al., 2013). Different terminologies have been used to refer to these stages, but it is widely agreed that some crucial actions are needed to carry out a migration process. Following, we summarize the main stages behind this process:

- Identification of the needs and requirements of the organization.
- Assessment of the cloud migration.
- Selection of the target system.
- Implementation of the cloud migration.

Moving to cloud requires an initial process of identification of the needs of the current IT systems and the requirements and priorities of the organization. In this stage, is important to understand the cloud paradigm and the implications for an organization related to the adoption of a cloud formation. The identification of the organizational assets is needed to determine the requirements and priorities of the organization. Therefore, the different deployment models and technological levels need to be understood in terms of the opportunities and threats that are associated to each one.

The specification of the requirements is needed to assess the viability of a cloud migration. This specification together with the knowledge of the benefits and risks that are associated to each cloud formation is essential to determine which parts of the organization would have gain if they are migrated to the cloud.

After taking the decision of migrating some of the parts of the current IT system to the cloud, an analysis of the cloud providers and their offerings is required in order to match the requirements for carrying out a migration of the system considering the offerings provided. An in-depth analysis is important to be carried out in this stage since the definition and selection of the target system will act as the guide for migration.

Finally, when the target system has been selected, the implementation stage will comprise the planning and execution of the migration process. First, a planning of the target environment (at different levels) according to the requirements of the source system is required. This planning defines the configuration of the target system according to the requirements collected. Second, the migration process must be implemented by following the predefined plan and the feasibility of the migration strategy must be assessed. Finally, it is important to evaluate each function point of the target system in order to validate

that the system is properly working. Following, we present a definition of the learning outcomes including the category (knowledge, skill, or competence) and the thematic area/s that are addressed.

5.2 Identification

The first task that should be addressed when talking about cloud computing and migration is related to the understanding of these concepts. This includes the identification of the different service models (SaaS, PaaS, and IaaS) and deployment models (public, private, community, and hybrid) (Vignos et al., 2013, Pahl & Xiong, 2013). From the business model perspective, it is also necessary the understanding of the cloud ecosystem and the components that are required to enable cloud services (IBM, 2012). Related to these issues, the following learning outcomes are defined:

Learning outcome	Describe the different service and deployment levels that are associated to cloud computing.
Category	Knowledge
Thematic area	Business change management

Learning outcome	Identify the key characteristics of cloud migration.
Category	Knowledge
Thematic area	Business change management

Learning outcome	Identify the main characteristics of the cloud ecosystem.
Category	Knowledge
Thematic area	Business change management

A key concern that is needed for cloud migration is referred to the understanding of the opportunities and the potential benefits that are associated to the cloud paradigm (Khajeh-Hosseini et al., 2011; Horwath et al., 2012; Pahl et al., 2013; Vignos et al., 2013; Montero & Llorente, 2013). It is also important to understand the different business models associated to the cloud ecosystem, which enable organizations to exploit business to drive innovation, identifying new business opportunities, and increasing business value and productivity (Aljabre, 2012; IBM, 2012). Related to these concepts, the following learning outcomes can be formulated:

Learning outcome	Summarize the opportunities and general benefits that are associated to the cloud formations.
Category	Knowledge
Thematic area	Business change management

Learning outcome	Understand the business models associated to the cloud ecosystem.
Category	Knowledge
Thematic area	Business change management

Another key concern in the initial stages of the migration process is related to the understanding of the main risks and threats that are associated to the cloud paradigm and the migration process (Khajeh-Hosseini et al., 2011; Vignos et al., 2013). Risks can be divided into categories depending on the different deployment models and the technological levels. In addition, the understanding of the models and technological approaches to mitigate these risks is also relevant. Associated to these concepts, the following learning outcomes are defined:

Learning outcome	Identify the risks and threats that are associated to the cloud formations.
Category	Knowledge

Thematic area	Risk management
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Learning outcome	Describe well-known approaches for risk mitigation.
Category	Knowledge
Thematic area	Risk management

The understanding of the legal implications that are associated to the cloud migration is another key issue for migration (Beserra et al., 2012; Vignos et al., 2013). The student needs to be aware about protection issues, rights, and legal obligations that are related to the organization and the migration process. Specially, international contexts should be considered because of the physical location of the data and applications may have associated legal restrictions. Legal issues need to be analysed in different dimensions such as functional, jurisdictional, or contractual. Associated to this concept, the following learning outcome is formulated:

Learning outcome	Summarize the legal implications that are associated to the functional, jurisdictional, and contractual dimensions of the cloud computing.
Category	Knowledge
Thematic area	Knowledge of the law

Considering the above knowledge, the initial steps of the migration process require the identification and evaluation of the legacy environment, especially from the value chain of the organization and also from the IT model view (such as data, applications, functions, and processes). This evaluation requires considering those aspects which can be influenced by the adoption of a cloud formation, such as security or legal issues (Beserra et al., 2012; Banerjee, 2012). The identification of the organizational assets from the perspective of issues such as risks, privacy, legal, etc. will provide the student with the tools to determine the considerations to focus the migration process. To carry out this evaluation,

general frameworks or models can be helpful (Pahl et al., 2013). According to these concepts, the following learning outcomes are defined:

Learning outcome	Understand the main considerations that are involved in the migration of the legacy environment.
Category	Knowledge
Thematic area	Analytical, business change management

Learning outcome	Determine the value chain of the organization.
Category	Skill
Thematic area	Business change management

Learning outcome	Use well-known techniques to analyse the context of the legacy environment.
Category	Skill
Thematic area	Analytical, business change management

5.3 Assessment

The evaluation of the organization together with the knowledge associated to the opportunities and threats of the cloud paradigm would provide the student with the required information for assessing how the current organization could be changed by the adoption of a cloud model (Pahl et al., 2013, Banerjee, 2012). On the one hand, the opportunities offered by the cloud paradigm reflect how the organization could take the advantages of the adoption of a cloud formation. From an economic perspective, the impact on the business model development needs to be determined.

On the other hand, the risk assessment would provide the guidelines to detect those requirements and constraints that may affect the migration process. To assess these risks, indicators can be defined as well as approaches to mitigate these risks. As stated in Doherty et al. (2012), the assessment enables organization to determine their strengths and weaknesses for migration. In this sense, the potential benefits provided by the cloud paradigm need to be cross-analyzed with the risks associated to this paradigm. The objective of the assessment is to determine the elements of the existing IT infrastructure and the dependencies between the components, capturing business concerns (Pahl et al., 2013; Banerjee, 2012; Nussbaumer & Liu, 2013). This allows establishing key expectations from cloud adoption, assessing appropriate business areas according to their impact and including strategies for risk assessment. The early detection of any potential organizational constraint that may affect the migration would prevent the organization to further continue with the migration process. Related to these issues, the following learning outcomes are defined:

Learning outcome	Determine the economic impact of the cloud business models in the organization.
Category	Skill
Thematic area	Financial literacy, business change management

Learning outcome	Apply techniques for identifying risks associated to the adoption of the cloud paradigm.
Category	Skill
Thematic area	Risk management, analytical, business change management

Learning outcome	Apply well-known frameworks to assess the impact of moving data and processes to the cloud.
Category	Skill
Thematic area	Analytical, business change management

Learning outcome	Acquire an analytical and critical view to determine the right decision about migration.
Category	Competence
Thematic area	Analytic al, business change management

Related to the assessment, the student must also acquire transversal skills. In more detail, not only the opportunities associated to the cloud paradigm must be identified, but also it is required to disseminate these opportunities to the organizational staff, especially to the stakeholders, in order to involve all of them in the migration process. As stated in Pahl et al. (2013), the attitude of stakeholders towards migration may be positive or negative. Some specialists can react positively while other can be reluctant to change due to lose of control and their status due to management actions may not be required anymore. To achieve this, it is necessary to enable the student to acquire the competences to organize the information and elaborate arguments in favour and against the cloud migration for each business solution. Thus, if some staff members are reluctant to change, the student should be able to present solid arguments which are not easily refuted. According to these, the following learning outcomes are defined:

Learning outcome	Demonstrate the ability to organize available information according to their relevance.
Category	Competence
Thematic area	Communication

Learning outcome	Synthesize the information to communicate messages effectively.
Category	Competence

Thematic area	Communication
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Learning outcome	Expose the benefits that would cause the adoption of a cloud formation.
Category	Skill
Thematic area	Communication, business change management

Learning outcome	Expose changes in business processes.
Category	Skill
Thematic area	Communication, business change management

Learning outcome	Provide arguments related to the potential risks that may appear and how these can be mitigated.
Category	Skill
Thematic area	Communication

Learning outcome	Develop a critical attitude to assess how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives.
Category	Competence
Thematic area	Business change management

5.4 Selection

The analysis of the cloud providers and their offerings is another important task that should be carried out. Relevant parameters that should be included in this analysis comprise the service models offered by the cloud provider, the types of services provided, the rates and price models associated to each service, the Service Level Agreements (SLAs) offered by the provider, the location of the data servers, the security mechanisms, or the user support offered. This analysis allows obtaining relevant information regarding the cloud provider offerings in order to determine whether or not the organizational and application requirements are satisfied by the offerings. In case that some requirements are not satisfied by the offerings, actions such as modify these requirements or reject the provider should be carried out. It is also required to provide the student with the methodologies to define a business model based on cloud, obtaining the valuation of cloud services.

The analysis of the cloud providers according to their offerings would allow the student to compare different providers (Andrikopoulos et al., 2013; Guo et al., 2014). According to Pahl et al. (2013), since several cloud providers can be analysed, different business may be chosen to be allocated to the most cost-effective solution. Therefore, this task requires a carefully evaluation in order to ensure the compatibility between the cloud solution and the requirements. This can be summarized in the following learning outcomes:

Learning outcome	Evaluate the different cloud providers and their offerings.
Category	Skill
Thematic area	Analytical

Learning outcome	Define a value chain associated to a cloud service
Category	Skill
Thematic area	Financial literacy

Learning outcome	Obtain the value of a cloud service
Category	Skill
Thematic area	Financial literacy

Learning outcome	Define a business model based on cloud.
Category	Skill
Thematic area	Business change management, analytical

Learning outcome	Establish the requirements for the legacy environment.
Category	Skill
Thematic area	Analytical

Learning outcome	Determine the target model according to the requirements of the legacy environment.
Category	Skill
Thematic area	Analytical

In order to match the requirements with the cloud provider offerings, it is necessary to understand the implications of the constraints and the solutions to these constraints. All this information will be determined in the contract, therefore, may be required to communicate with the cloud provider in order to discuss some adjustments in the contract. It is also important to provide the student with the guidelines required for contract management and SLA according to the business, management, and security requirements established. Apart from this, it is also important to provide the student with

negotiation capabilities in order to discuss with the provider certain terms and conditions. The following learning outcomes are related to these concepts:

Learning outcome	Integrate contractual agreements in a business model.
Category	Skill
Thematic area	Business change management, knowledge of the law

Learning outcome	Describe SLA according to the business, management and security requirements.
Category	Skill
Thematic area	Negotiation, knowledge of the law

Learning outcome	Negotiate SLA with providers according to established requirements.
Category	Skill
Thematic area	Negotiation

Learning outcome	Develop facilitator behaviours for negotiation.
Category	Competence
Thematic area	Negotiation

Learning outcome	Overcome difficulties during the message transmission.
Category	Competence
Thematic area	Negotiation, communication

Learning outcome	Demonstrate the ability to organize available information according to their relevance.
Category	Competence
Thematic area	Communication

Learning outcome	Synthesize the information to communicate messages effectively.
Category	Competence
Thematic area	Communication

5.5 Implementation

Once the requirements of the legacy environment have been established according to the provider offerings, a migration plan needs to be developed (Hajjat et al., 2010). Designing a migration plan requires identifying all the tasks comprised in the migration process, their needs and dependencies, establishing the sequence in which these tasks will be carried out. The required capabilities for dealing with these tasks need to be provided in terms of technology, skills, and tools, determining the responsibilities of the parties involved in the process. Then, the milestones, time frame, metrics and role distribution for the project team need to be specified (Pahl et al., 2013). Associated to these concepts, the following learning outcomes are defined:

Learning outcome	Create a migration plan which achieves the expectations of the organization.
Category	Competence
Thematic area	Business change management, project management

Learning outcome	Identify the tasks that are involved in the migration process, their needs and dependencies.
Category	Knowledge
Thematic area	Project management

Learning outcome	Determine the roles and responsibilities of the different parties involved in the project.
Category	Skill
Thematic area	Project management

Learning outcome	Use methodologies to establish the milestones, activities and success criteria.
Category	Skill
Thematic area	Project management

Next, the design of the target environment should be accomplished according to the established requirements (Banerjee, 2012). This includes the design of the target environment at different levels such as hardware, virtual machine, operating system, middleware, and application. Depending on the patterns of utilization analyzed, some key architectural or hardware sizing decisions may be considered. The most appropriated strategy decisions regarding the planning of the migration must be considered. It is highly recommended to start with a pilot migration in order to assess the viability of the whole process beforehand. The following learning outcome is defined for this concept:

Learning outcome	Determine the target environment for the migrated assets.
Category	Skill

Thematic area	Analytical, project management
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The definition of management policies for assessing the correct execution of the tasks and the proper performance of the target system are also needed. According to Pahl et al. (2013), the time frame and the metrics of each milestone can be viewed as the success criteria to assess that the project is being developed as expected. Another key issue is the definition of management policies to specify the set of remedial actions that are required to minimize the risks that may appear during the implementation of the migration (Banerjee, 2012). Thus, risk management need to be considered here as part of the migration of the source system (Pahl et al., 2013). In addition, after a pre-established period of monitoring and after assessing that the target system is performing as expected, the old source-servers and images are usually de-commissioned or re-purposed (Banerjee, 2012). During the migration execution, coordination with the other IT and managerial staff must be required in order to get informed about the process. The following learning outcomes are associated with the above concepts:

Learning outcome	Provide a management plan which includes assessment and risk analysis.
Category	Skill
Thematic area	Project management, risk management, business change management

Learning outcome	Establish management policies to supervise the migration plan and the execution of the target system.
Category	Skill
Thematic area	Project management, business change management

Learning outcome	Coordinate with managerial and technical staff in order to properly accomplish the migration plan.
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Category	Competence
Thematic area	Communication, project management

Methodologies are required to ensure that the SLA is fulfilled (Goudarzi et al., 2012). Therefore, abilities need to be provided in order to monitor the SLA requirements and metrics, taking corrective measures with the provider. The following learning outcomes are related to this concept:

Learning outcome	Monitor the accomplishment of SLA requirements and metrics.
Category	Skill
Thematic area	Project management, negotiation, business change management

6 Definition of the learning objectives

The definition of the learning outcomes not only provide us with the specific information about what is expected to be able to do the student and how the learning process can be assessed but also allows us to determine the corresponding EQF levels that are associated to the program. According to this, the most suitable EQF levels range from level 4 to 5 (Table 3).

Table 3: EQF levels.

	Knowledge	Skills	Competence
Level 4	factual and theoretical knowledge in broad contexts within a field of work or study	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
Level 5	comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others

The learning outcomes that have been determined provide us with the specific information about what the student should be able to do after finishing the VET program. As stated in Section 4, the definition of the learning objectives must be connected with the learning outcomes, determining criteria in order to assess the learning objective. Considering the learning outcomes, our next step is focused on grouping them on specific learning objectives representing statements of the different teaching intentions which could be more precise and measurable. Following, we present the different learning objectives following the order in which learning outcomes were formulated:

Learning objective	Provide a view of the migration concept and the different service and deployment levels that are associated to cloud computing.
Learning outcomes	Identify the key characteristics of cloud migration. Describe the different service and deployment levels that are associated to cloud

	computing.
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Learning objective	Explore the cloud ecosystem and the business models that are associated.
Learning outcomes	Identify the main characteristics of the cloud ecosystem. Understand the business models associated to the cloud ecosystem.

Learning objective	Address the opportunities and general benefits that are associated to the cloud models.
Learning outcomes	Summarize the opportunities and general benefits that are associated to the cloud models.

Learning objective	Address the risks and threats that are associated to the different cloud models and the responses to mitigate or avoid these risks.
Learning outcomes	Identify the risks and threats that are associated to the different cloud formations. Describe well-known approaches for risk mitigation.

Learning objective	Address the legal implications associated to the cloud migration.
Learning outcomes	Summarize the legal implications that are associated to the functional, jurisdictional, and contractual dimensions of the cloud computing.

Learning objective	Provide the student with techniques to analyse the legacy environment.
Learning outcomes	Understand the main considerations that are involved in the migration of the legacy environment. Use well-known techniques to analyse the context of the legacy environment.

Learning objective	Provide the student with the techniques to identify the value chain of the organization, analysing the economic impact of the cloud adoption.
Learning outcomes	Determine the value chain of the organization. Determine the economic impact of the cloud business models in the organization.

Learning objective	Provide the student with methodologies to assess the impact of moving data and processes
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	to the cloud, reducing the risks associated to the migration process, and considering the legal implications.
Learning outcomes	<p>Apply techniques for identifying risks associated to the adoption of the cloud paradigm.</p> <p>Apply well-known frameworks to assess the impact of moving data and processes to the cloud.</p> <p>Acquire an analytical and critical view to determine the right decision about migration.</p>

Learning objective	Train the student with techniques to effectively communicate the benefits that would cause the adoption of the cloud paradigm.
Learning outcomes	<p>Demonstrate the ability to organize available information according to their relevance.</p> <p>Synthesize the information to communicate messages effectively.</p> <p>Expose the benefits that would cause the adoption of a cloud formation.</p>

Learning objective	Train the student with techniques to effectively communicate the changes in the business process.
Learning outcomes	<p>Demonstrate the ability to organize available information according to their relevance.</p> <p>Synthesize the information to communicate messages effectively.</p> <p>Expose changes in business processes.</p>

Learning objective	Train the student with techniques to discuss with the organizational staff the impact that would cause the adoption of the cloud paradigm, providing arguments to discuss the potential risks and how these can be mitigated.
Learning outcomes	<p>Provide arguments related to the potential risks that may appear and how these can be mitigated.</p> <p>Demonstrate the ability to organize available information according to their relevance.</p> <p>Synthesize the information to communicate messages effectively.</p> <p>Develop a critical attitude to assess how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives.</p>

Learning objective	Provide the student with frameworks to evaluate the cloud providers and service models in
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	order to determine the most suitable cloud formation according to the requirements of the candidate assets.
Learning outcomes	Evaluate the different cloud providers and their offerings. Establish the requirements for the legacy environment. Determine the target model according to the requirements of the legacy environment.

Learning objective	Provide the student with methodologies to analyse the economic model of a cloud system, defining a business model based on cloud.
Learning outcomes	Define a business model based on cloud. Define a value chain associated to a cloud service. Obtain the value of a cloud service.

Learning objective	Provide the student with the capabilities to integrate contractual agreements in a business model.
Learning outcomes	Integrate contractual agreements in a business model.

Learning objective	Provide the student with methodologies to develop, monitor, and report SLA which are compliant with the requirements of the organization and business processes.
Learning outcomes	Describe SLA according to the business, management and security requirements. Monitor the accomplishment of SLA requirements and metrics.

Learning objective	Train the student with techniques to negotiate contracts and SLA with providers according to the established requirements of the legacy environment.
Learning outcomes	Negotiate SLA with providers according to established requirements. Develop facilitator behaviors for negotiation. Overcome difficulties during the message transmission. Demonstrate the ability to organize available information according to their relevance. Synthesize the information to communicate messages effectively.

Learning objective	Provide the student with the guidelines and tools for creating a migration plan.
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Learning outcomes	<p>Create a migration plan which achieves the expectations of the organization.</p> <p>Identify the tasks that are involved in the migration process, their needs and dependencies.</p> <p>Determine the roles and responsibilities of the different parties involved in the project.</p> <p>Use methodologies to establish the milestones, activities and success criteria.</p> <p>Determine the target environment for the migrated assets.</p> <p>Provide a management plan which includes assessment and risk analysis.</p> <p>Coordinate with managerial and technical staff in order to properly accomplish the migration plan.</p>
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Learning objective	Provide the student with the techniques to supervise and monitor the migration plan and execution.
Learning outcomes	Establish management policies to supervise the migration plan and the execution of the target system.

After obtaining the list of learning objectives of the VET program, these will be grouped for representing consistent and independent modules, which can be achieved and assessed in a determined period of time. A module comprises a co-related and coherent set of learning outcomes which can be assessed and validated as an independent component. Therefore, the learning objectives can be logically and comprehensively grouped in order to address specific aims. Considering the constitution of the learning objectives, we divide them into four different modules, each one focused on a different aim:

1: To define the fundamental concepts that are associated to cloud computing and migration to the cloud, identifying the most relevant opportunities and general benefits.

2: To provide the student with the capabilities to understand the cloud business models and the economic impact of these models.

3: To provide the student with the capabilities to analyse the risks and legal implications associated to the migration process, assessing the influence of these in the data, processes, and applications.

4: To provide the student with the methodologies and tools to fully migrate the candidate applications and data to the target cloud system.

Following, we present the specific definitions of each module according to the learning objectives and the learning outcomes that are addressed:

Learning objectives
<p>The first aim of this module is to define the fundamental concepts that are associated to cloud computing and migration to the cloud, identifying the most relevant opportunities and general benefits. This aim can be divided in the following learning objectives:</p> <ol style="list-style-type: none"> a. Provide a view of the migration concept and the different service and deployment levels that associated to cloud computing. b. Address the opportunities and general benefits that are associated to the cloud models. c. Train the student with techniques to effectively communicate the benefits that would cause the adoption of the cloud paradigm.
Learning outcomes
<p>The learning outcomes associated to this module are the following:</p> <p>KNOWLEDGE</p> <ol style="list-style-type: none"> 1. Identify the key characteristics of cloud migration. 2. Describe the different service and deployment levels that are associated to cloud computing. 3. Summarize the opportunities and general benefits that are associated to the cloud models. <p>SKILLS</p> <ol style="list-style-type: none"> 1. Expose the benefits that would cause the adoption of a cloud formation. <p>COMPETENCES</p> <ol style="list-style-type: none"> 1. Demonstrate the ability to organize available information according to their relevance. 2. Synthesize the information to communicate messages effectively.
Main thematic area of skills
<p>Business change management, Communication, Analytical</p>

Learning objectives

The aim of this module is to provide the student with the capabilities to understand the cloud business models and the economic impact of these models. This aim can be divided in the following learning objectives:

- a. Explore the cloud ecosystem and the business models that are associated.
- b. Provide the student with the techniques to identify the value chain of the organization, analysing the economic impact of the cloud adoption.
- c. Provide the student with methodologies to analyse the economic model of a cloud system.
- d. Provide the student with the capabilities to integrate contractual agreements in a business model.
- e. Train the student with techniques to effectively communicate the changes in the business process.

Learning outcomes

The learning outcomes associated to this module are the following:

KNOWLEDGE

1. Identify the main characteristics of the cloud ecosystem.
2. Understand the business models associated to the cloud ecosystem.

SKILLS

1. Determine the value chain of the organization.
2. Determine the economic impact of the cloud business models in the organization.
3. Define a business model based on cloud.
4. Define a value chain associated to a cloud service.
5. Obtain the value of a cloud service.
6. Integrate contractual agreements in a business model.
7. Expose changes in business processes.

COMPETENCES

1. Demonstrate the ability to organize available information according to their relevance.
2. Synthesize the information to communicate messages effectively.

Main thematic area of skills

Business change management, financial literacy, communication, analytical, knowledge of the law

Learning objectives

The aim of this module is to provide the student with the capabilities to analyse the risks and legal implications associated to the migration process, assessing the influence of these in the data, processes, and applications. This aim can be divided in the following learning objectives:

- a. Address the risks and threats that are associated to the different cloud models and the responses to mitigate or avoid these risks.
- b. Address the legal implications associated to the cloud migration.
- c. Provide the student with methodologies to assess the impact of moving data and processes to the cloud, reducing the risks associated to the migration process, and considering the legal implications.
- d. Train the student with techniques to discuss with the organizational staff the impact that would cause the adoption of the cloud paradigm, providing arguments to discuss the potential risks and how these can be mitigated.

Learning outcomes

The learning outcomes associated to this module are the following:

KNOWLEDGE

1. Identify the risks and threats that are associated to the different cloud formations.
2. Describe well-known approaches for risk mitigation.
3. Summarize the legal implications that are associated to the functional, jurisdictional, and contractual dimensions of the cloud computing.

SKILLS

1. Apply techniques for identifying risks associated to the adoption of the cloud paradigm.
2. Apply well-known frameworks to assess the impact of moving data and processes to the cloud.

3. Provide arguments related to the potential risks that may appear and how these can be mitigated.

COMPETENCES

1. Acquire an analytical and critical view to determine the right decision about migration.
2. Demonstrate the ability to organize available information according to their relevance.
3. Synthesize the information to communicate messages effectively.
4. Develop a critical attitude to assess how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives.

Main thematic area of skills

Business change management, communication, analytical, risk management, knowledge of the law

Learning objectives

The aim of this module is to provide the student with the methodologies and tools to fully migrate the candidate applications and data to the target cloud system. This aim can be divided in the following objectives:

- a. Provide the student with techniques to analyse the legacy environment.
- b. Provide the student with frameworks to evaluate the cloud providers and service models in order to determine the most suitable cloud formation according to the requirements of the candidate assets.
- c. Provide the student with methodologies to develop, monitor, and report SLA which are compliant with the requirements of the organization and business processes.
- d. Provide the student with the guidelines and tools for creating a migration plan.
- e. Provide the student with the techniques to supervise and monitor the migration plan and execution.
- f. Train the student with techniques to negotiate contracts and SLA with providers according to the established requirements of the legacy environment.

Learning outcomes

The learning outcomes associated to this module are the following:

KNOWLEDGE

1. Understand the main considerations that are involved in the migration of the legacy environment.
2. Identify the tasks that are involved in the migration process, their needs and dependencies.

SKILLS

1. Use well-known techniques to analyse the context of the legacy environment.
2. Evaluate the different cloud providers and their offerings.
3. Establish the requirements for the legacy environment.
4. Determine the target model according to the requirements of the legacy environment.
5. Describe SLA according to the business, management and security requirements.
6. Monitor the accomplishment of SLA requirements and metrics.
7. Determine the roles and responsibilities of the different parties involved in the project.
8. Use methodologies to establish the milestones, activities and success criteria.
9. Determine the target environment for the migrated assets.
10. Provide a management plan which includes assessment and risk analysis.
11. Establish management policies to supervise the migration plan and the execution of the target system.

COMPETENCES

1. Create a migration plan which achieve the expectations of the organization.
2. Negotiate SLA with providers according to established requirements.
3. Develop facilitator behaviors for negotiation.
4. Overcome difficulties during the message transmission.
5. Demonstrate the ability to organize available information according to their relevance.
6. Synthesize the information to communicate messages effectively.
7. Coordinate with managerial and technical staff in order to properly accomplish the migration plan.

Main thematic area of skills
Business change management, analytical, communication, negotiation, project management

7 Conclusions

In this report, the learning objectives of the VET program have been defined. The methodology that we followed to define these learning objectives provides a consistent definition in the context of the theoretical framework provided by the EQF and the literature. In addition, since the learning objectives have been defined by considering the skill mismatch, these learning objectives are consistent with the required managerial and transversal skills.

In more detail, the majority of the learning objectives are related to the most demanded thematic areas of skills. Specifically, 16 out of 18 learning objectives address *business change management, analytical, communication, or negotiation* skills. In addition, the skill area which presented the most severe skill shortage (*business change management*) is covered by 14 out of 18 learning objectives defined. What is more, other thematic areas are also addressed: *risk management, project management, financial literacy, and knowledge of the law*.

The following task T4.2 will be focused on the development of the curriculum structure for the VET program. This curriculum will provide the specific guidelines to define the VET program.

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