

Database of common descriptors for  
defining required skills, knowledge  
and competences of the targeted  
construction professionals

D5.1

Public document –

Database of common descriptors for  
defining required skills, knowledge and  
competences of the targeted  
construction professionals

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ViaEuropa Competence Centre sro

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# 1 Introduction

Deliverable 5.1 documents the implemented activities going together with Task 5.1 - Further development (harmonisation) of qualification descriptors and units of learning outcomes of new trainings for mutual recognition. Task 5.1 continued the work accomplished in work package 2 (Identification and evaluation of existing certification schemes and implementation methods for blue collar workers and building inspectors), 3 (Development of missing certification schemes for blue collar workers) and 4 (Development of missing certification schemes for building inspectors).

D5.1 has had been a public document describing the actual development status of the European database of certified professionals as of the date of publication, which has been later available online. This document has provided a description of the developed input in task 5.1 to enable the registration of qualifications of professionals.

## 2 Development of the harmonized descriptors for targeted professionals

As anticipated by Annex 1 (part A) of the Grant Agreement, the partners set up an expert group for the further development of the harmonized descriptors per each targeted profession:

Table 1: Responsibility for trades in each partner country

TARGETED ULOS	FLAT ROOFS	VENTILATION	BUILDING INSPECTION
Austria	Ronald Setznagel	Georg Trnka	David Frick
Hungary	Karoly Matolcsy	Karoly Matolcsy	Karoly Matolcsy
The Netherlands	Jan Cromwijk	Jan Cromwijk	Frans Koene
Slovakia	Frantisek Doktor	Peter Doktor	Frantisek Doktor

In work package 3 and 4 the ULOs for the targeted professions were further developed in cooperation with all partners with the target to develop European ULOs to be implemented in the database. In this process the first level harmonization of learning outcomes was embedded. In work package 5 (task 5.1) the partners were asked to translate the ULOs into their national languages and to validate the descriptions of learning outcomes according to their national qualification standards and practices (described in their national qualifications frameworks). The validation process had to comply with the following methodology:

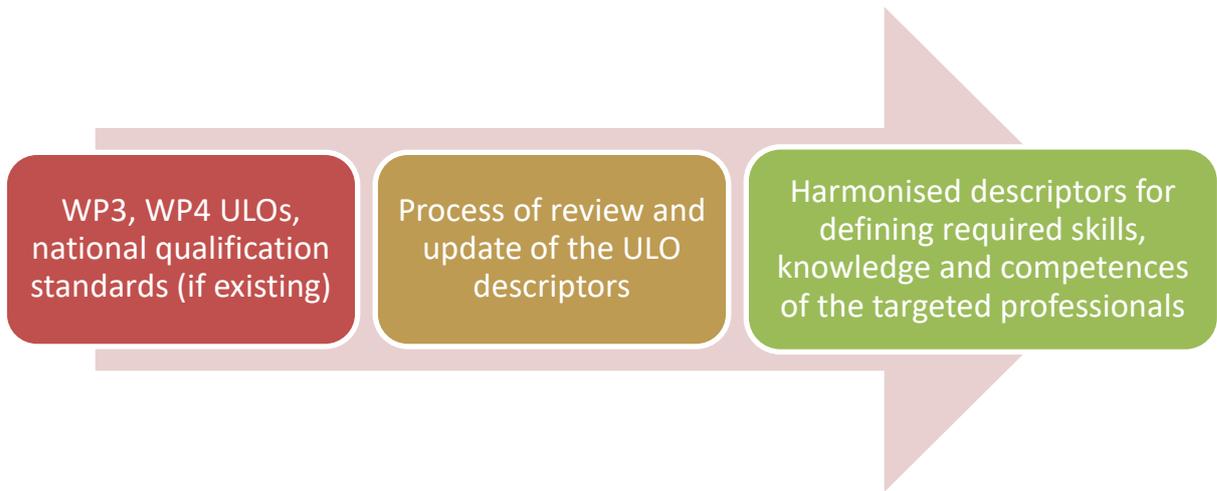


Figure 1: Process of the work

The process of review and update of the ULO descriptors followed the steps:



Figure 2: Process of review and update of ULOs

### 3 Finalising the ULO descriptors

Fortunately, only a few conflicts were identified during the validation process. After having a final list, the descriptors were translated into the national languages of the participating countries and uploaded into the ULO database.

The full list of harmonized descriptors for defining required skills, knowledge and competences is mentioned below.

Table 2: Harmonized descriptors for defining required skills, knowledge and competences

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
1	Add a proper maintenance schedule to the manual	Able to compose a manual	Acceptable noise levels
2	Add adjustment state to the manual	Able to differentiate between the suitability of different condensate drains	Acoustic/noise protection requirements and applicable solutions
3	Adjust supply fan properly	Able to handle dangerous substances	Advantages and disadvantages of different locations for the control unit
4	Adjust the exhaust fan properly	Able to install all specified ancillary components such as sound attenuators in accordance with the manufacturer's specifications	Advantages and disadvantages of exhaust or recirculation hoods in combination with ventilation
5	Answer questions on the influence of ventilation systems on the energy efficiency of the building	Able to insulate air ducts vapour-tight when needed	Advantages and opportunities of BIM
6	Apply energy-efficient roofing measures when possible and suitable	Able to mount the ventilation unit vibration free according to the manufacturer's instructions	Air quality parameters (CO <sub>2</sub> , VOC, PM <sub>2.5</sub> , odour) and their relationships
7	Apply fire safety measures and check valves in the wall(s)/floor	Add adjustment states to the manual	Air- and vapour tight sealing of penetrations in thermal envelope
8	Apply requirements concerning health or prevention of damage due to moisture	Adjust exhaust valves	Airflow requirements concerning health
9	Apply selected sealing techniques correctly	Adjust fan capacities	Airtight connection of MVHR unit
10	Apply the correct fire safe sealing	Adjust the supply valves	Airtight duct classes

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
11	Avoiding of injuries of the insulation and waterproofing	Adjust ventilation system settings if needed	Airtightness test of ducts and its requirements
12	Carry out correct adjustment of all ventilation system settings	Apply evaluation methods and aspects on existing roof layers	Blower door test and its requirements
13	Carry out correct and complete execution of a user briefing	Apply different types of air duct insulation correct	Building decree regarding electricity and safety
14	Carry out hygiene check correct and clean if necessary	Apply rule of thumbs regarding dimensioning of ducts	Central ventilation system
15	Carry out tests of the waterproofing performance of the completed roof	Assess air exhaust with regard to placement, air short circuit, freedom from snow, etc.	Clean storage of ducts, registers and other components
16	Check and explain the type(s) of regulation system(s)	Assess before using the safety of the necessary working platform	Combination of cooker hood with heat recovery or system C
17	Check and mark the position and dimensions of the recess	Assess correctness of ventilation system settings (frost protection, time program, filter monitoring, etc.)	Common regular maintenance need of the installed MVHR systems
18	Check annual operation on good and safe functioning of the ventilation system	Assess if cleaning of fans is needed	Common solutions for optimising the position of the supply and extract registers
19	Check dimensioning of the ducts based on function of the room	Assess if cleaning of ventilation grilles is needed	Components of a maintenance contract
20	Check if ventilation system is of the right type	Assess outside air intakes with regard to placement, air short circuit, freedom from snow, etc.	Construction of wastewater system(s)
21	Check location of air exhaust	Assess pollution and cleaning duct(s)	Content of a good user-oriented manual
22	Check location of the external air intake	Assess the flat roof structure in terms of suitability for installation of solar panels	De-central ventilation system
23	Check necessary safety device depending on the fireplace	Assess the proper design of descending and minimum insulation	Decibel (dBA)
24	Check requirements regarding airtightness of ducts	Assess whether a ventilation system is running correctly	Decoupled closure and sealing of wall and ceiling apertures against structure-borne noise
25	Check suitability of the condensate drain (if necessary)	Assess whether cleaning or replacement of filters is needed	Default values for power consumption of a ventilation unit
26	Check zones if ducts are possible	Assess whether documentation is correct and complete	Differences between types of air ducts
27	Clean fans when needed	Assess whether documentation of mounted air ducts is correct	Different safety systems concerning lightning protection

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
28	Clean valves when needed	Assess zones for the possibility of air ducts	Different waterproofing systems (roof waterproofing with bitumen and plastic sheets, sealing prepare as well as liquid seals)
29	Clean/replace filters when needed	Avoid possibilities of damage or failure	Discharge flow
30	Compose a user-oriented manual	Avoid potential annoyance or irritation to occupants due to inappropriate positioning of registers	Documentation of a ventilation system (installation plan, device documentation with setting values, commissioning and balancing protocol, photos...)
31	Connect the ventilation unit, silencer and air ducts correct	Can fasten different air ducts in a tapered manner	Draft in relation with air velocity
32	Connect ventilation unit to the discharge water system	Capture and display the necessary material and tools for ordering and invoicing sizes	Draft in relation with pre-heating
33	Consider nature of the surface and recognize requirements	Carry out a hygiene check properly	Drilling techniques for holes in walls, floors and ceilings
34	Construct the duct system airtight	Check appropriate space around the unit for maintenance and proper operation	Drilling techniques for holes in walls, floors and ceilings
35	Create and use protocol and expertise in the regular maintenance and small repairs	Check if insulation of air ducts is needed	Duct cleaning methods
36	Create correct and complete documentation	Check if passages comply with fire protection regulation	Effect of different registers on airflow measurement
37	Create optimum circumstances for transport and storage of materials and tools	Choose appropriate protection measures	Effect of insulated ductwork
38	Create user manual for the completed roof	Classify air quality parameters	Effect of pressure drop
39	Define opportunities to create simpler and safer roof arrangement	Clean air ducts	Effective air circulation
40	Define the daily work, the temporary fixing and waterproofing	Clean fans	Effects of different fireplaces in the living space on ventilation system
41	Define the need for coordination with regard to cable routing, breakthroughs and overflow areas	Clean ventilation grilles	Elements and importance of the roof log

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
42	Define the roofing interface (fixing, walking path, etc.) of the solar elements connecting with the substructures if necessary	Clean ventilation system if necessary	Environmental friendliness of materials
43	Describe pre-treatment of the substrate and measure the necessary geometry compliance	Close penetrations decoupled from structure-borne noise	Exhaust
44	Design the sensors and components of the failure detection system	Combine the energy-efficient roofing measures and its sustainable components	Fire safety regulation
45	Determine acceptable noise levels and measures to establish low noise rates	Connect the ventilation unit, silencer and air ducts in accordance with the manufacturer's specifications	Fire safe sealing
46	Determine an adequate solution of the functional layers for green roofs and access roofs	Correct typical errors in ventilation systems	First aid measures
47	Determine if cleaning is necessary and what cleaning method has to be used	Create optimal solution(s) of the joints at doors and curtain walls	Fixing plugs
48	Determine individual layers of the building envelope and indicate their function	Define and explain the impact of stress on flat roofs	Function and installation of solar thermal, PV and hybrid systems
49	Determine optimal roofing system for the given roof structure	Derivation of safety strategy depending on type of fireplace (room air-dependent or room air-independent)	Functions of roof areas and accessories
50	Determine supply airflow rate	Describe air quality	Global knowledge of needed airflows and corresponding dimensions of ducts
51	Determine the adequate solution for the joints and details of green and access roofs	Describe allowable wear for reuse	How complaints occur with regard to sound
52	Determine the necessary height of the out skirting and minimize cold bridging	Describe how to prevent moist or odour complaints	How external pressure losses can be measured
53	Determine the necessary preparation actions for the safe establishment of the lower joint	Describe the relation between airtightness and energy consumption and noise	How sound measurement works
54	Determine which parts are reusable and which parts/systems need to be replaced	Describe the types of regulation for ventilation systems	How to adjust exhaust fan
55	Dispose of hazardous substances correctly	Determine the influence of the joints on energy efficiency	How to adjust exhaust valves

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
56	Document mounted air ducts correct	Determine the necessary change of place and types of the elements	How to adjust fan capacities
57	Drill the right fixing holes properly	Determine to be applied roofing materials on type and characteristics	How to adjust supply valves
58	Ensure airtight seal at the location of MVHR unit and penetration of the thermal envelope	Determine what cleaning method has to be used	How to assess pollution of ducts
59	Ensure compliance regarding noise levels of ventilation system for different room occupancy types	Documentation of the work performed	How to check the proper functioning of a ventilation system
60	Ensure correct storage of components from the ventilation system prior to mounting the system	Draw shapes, surfaces and details	How to clean fans
61	Ensure effective air circulation through the room	Drill holes	How to clean filters
62	Ensure optimal flow rate in the room by correct positioning of supply and extract registers	Estimate acceptable noise levels in relation with user satisfaction	How to clean ventilation grilles
63	Ensure safety at work execution	Evaluate surfaces, structures and necessary geometry	How to connect air ducts airtight
64	Ensure that the client knows why and how they should replace the MVHR filter at regular interval	Evaluate whether a briefing was carried out correct	How to connect sensors
65	Ensure usability and easy access to the detection and control system	Explain advantage and opportunities of using BIM	How to correct typical faults in ventilation systems
66	Evaluate the influence of the joints on energy efficiency	Explain advantages and need of the failure detection system	How to dimension ducts so that additional pressure drops at registers or inlet/outlet are not needed for a proper air distribution
67	Explain the importance of commissioning of ventilation systems	Explain application of the principles of fire safe passages	How to document changes to mounted air ducts
68	Fasten air ducts with proper structure-borne noise coupling	Explain assessment of your own behaviour and necessary corrective measures	How to document work carried out
69	Fasten threaded rods / mounting brackets properly	Explain commissioning of ventilation systems	How to fix different air ducts in a tapered manner
70	Fix ducts in floors against flooding	Explain correct disposal of hazardous substances	How to fix ducts against flooding

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
71	Give an overview of the different stress impacts on the roof	Explain effect of demand control	How to handle dangerous substances
72	Give an overview the function of the layers and materials	Explain effects of different locations on the control unit	How to install data connections
73	Handle the cross-cutting issues of other trades	Explain energy savings through heat recovery	How to install different air piping systems clean and with tight sealing
74	Identification the general and local risks, maintain a safe working platform and PPE	Explain handling of hazardous substances	How to install silencers and connection with the ventilation unit
75	Implement measures to detect health and safety risks at work	Explain how the specific ventilation system works	How to install silencers or the connection according to the manufacturer's instructions
76	Insist secure safe access and working platform for maintenance and repair	Explain individual responsibility linked to the installation and use of safety equipment on flat roofs	How to install smart detection and control systems
77	Insist to secure safe access and working platform for maintenance and repair	Explain influence of ventilation systems on the energy efficiency of the building	How to integrate the cooker hood in a whole house ventilation system
78	Install all specified ancillary components such as sound attenuators correct	Explain measures to mitigate security risks on site	How to interpret blower door test results
79	Install new penetration on the roof securing high waterproofing performance and cold bridge avoidance	Explain necessary substrate requirements of the temporary waterproofing systems	How to mark recesses clear
80	Install overflow openings/grills correct	Explain the benefits and function of the building envelope	How to measure on roofs
81	Install power and data connections properly	Explain the importance and safe establishment of joints at low areas	How to measure airflows
82	Install protective and service layers	Explain the importance of proper transport and storage of materials and tools	How to mount a condensate drain
83	Install the air ducts clean and sealed tight	Explain the importance of the detailed and understandable user manual	How to mount check valves
84	Install the smart failure detection system	Explain the importance of the good geometrical data collection	How to mount control units
85	Install thermal insulation with proper fixing	Explain the importance of the regular maintenance and small repairs	How to mount fire dampers
86	Installation of green roofs & handling of cross cutting issues	Explain the necessary H&S condition for access to existing roofs	How to pre-set and install valves

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
87	Insulate ducts in systems with heat recovery	Explain the necessary H&S condition for maintenance and repair work	How to replace filters
88	Insulate the air ducts correct	Explain the necessary health & safety condition for access to existing roofs	How to sketch shapes, surfaces and details
89	Integrate and use of necessary safety equipment on roofs	Explain the necessary requirements of building the new roof penetration	How to use threaded rod and mounting brackets
90	Integrate cooker hoods properly	Explain the need and advantages of maintenance contract and roof diary	How various insulations are applied to air ducts
91	Laying, fixing and sealing the temporary waterproofing	Explain the need and function of the protective layers	HR performance and nZEB requirements for ventilation systems
92	Locate correct position of the ventilation-unit	Explain the opportunities of creating simpler and safer roof arrangement	Impact of noise levels on user satisfaction
93	Make connections, components and building joints properly	Explain the reasons why recirculation hoods are preferred	Impact of positioning registers on Indoor Air Quality and comfort
94	Make holes in wall or floor or correct the sizes if necessary	Explain the risk of increased humidity in a roof structure	Individual layers of the building envelope
95	Measure and interpret power consumption	Explain the rules and recommendations of making safe joints at high areas	Influence of exhaust valve(s) on airflows in rooms and influence of air speed on comfort
96	Mount all specified fire dampers correct	Explain the special conditions for material handling on existing roofs	Influence of valve on airflows in rooms and influence of air speed on comfort
97	Mount check valve(s) correct	Explain the technology challenges and its solutions working while building is in use	Influence of ventilation systems on the energy efficiency of the building
98	Mount control unit(s) and put them to work properly	Explain the use and importance of the smart failure detection system	Insight into what the user can / must do himself and what the maintenance company/installer must do
99	Mount proper safety systems	Explain the way of testing and validating the waterproofing performance of the roof	Insulation and heat recovery
100	Mount the right brackets properly	Explain the working of layers in the roofing system	Interaction of different ventilation systems in collective buildings
101	Mount the right support profiles properly	Explain what has to be done to keep the system in a good condition	Knowledge of energy efficiency need of nZEB buildings and its sustainable components: insulations, skylights, cavities, HR ventilation

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
102	Mount the sensors and put them to work properly	Explain what is needed for an effective air circulation in different room types and layouts	Knowledge of how to install various overflow systems
103	Mount the ventilation unit correct and vibration free	Explain what is needed for good maintenance	Knowledge of joints at low areas: valley, gully, gutter, outlet
104	Mount various mounting parts	Explain what the user needs to know for proper use	Knowledge of points at high areas: parapet walls, abutment walls, penetrations, movement joints
105	Open and repair existing roof to diagnose the state of art	Explain when check valves and/or fire safety measures are needed	Knowledge of reusability of components
106	Perform a proper airflow measurement	Explain when draft occurs	Knowledge of the commissioning of ventilation systems
107	Perform a proper blower door test	Explain when to use which type of regulation for a ventilation system	Knowledge of the various control types regarding comfort and energy consumption
108	Perform airtightness tests of the duct systems	Explain which noise levels are acceptable in each room type	Knowledge of ventilation system settings (frost protection, time program, filter monitoring...)
109	Perform smart measurements and data collection on the roof	Explain why and how clients should replace the MVHR filter at regular interval	Knowledge of where air ducts are not possible
110	Prepare a safe interface to the solar systems and secure safe and easy access for maintenance	Fix ducts against flooding	Knowledge of which adjustments are necessary for routing of the air ducts
111	Prescribe technology and systems to evaporate harmful humidity from the roof structure	In case of heat recovery insulate from the unit to the outside	Knowledge on designing a nZEB building in details
112	Prevent draft complaints	Identify cases of damage/failures	Knowledge on effect of humidity in roof structure
113	Protect other workers against hazardous substances	Initiative and acceptance of the necessary inputs of the other trades	Knowledge on green roof and access roof (terrace) joints and details
114	Provide assistance with selection of recirculation or exhaust air kitchen hoods	Install proper condensate drains in accordance with the manufacturer's instructions	Knowledge on green roof and access roof (terrace) layers
115	Realize advantages and disadvantages of various roofing layer structures	Install smart detection and control systems	Knowledge on joints of doors and curtain walls
116	Recognize and correct typical errors in a ventilation system	Insulate air duct(s) which penetrate the envelope air and vapour tight	Lifespan of components
117	Record the quantity of the work	Integrate cooker hoods in the whole house ventilation system	Manufacturer's instructions for appropriate spacing around ventilation unit
118	Seal breakthrough openings correct	Interpret blower door test results	Measures to prevent occupational diseases

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
119	Seal gap between fire damper and wall/floor properly	Interpret laws and occupational safety and health working on height	Measuring instrument for power consumption
120	Select and store tools and materials properly	Interpret power consumption	Methods and technology for taking samples from existing roof layers
121	Set exhaust valves properly	Judge whether the sound is within the permissible range	Moist problems regarding ventilation
122	Set supply valves properly	Judge which procedure or drilling technique is most advantageous	Most common accessories related to the extended performance of the ventilation
123	Setup and mount required exhaust valves correct	Locate beams and support structure of the building	Mounting brackets
124	Setup and mount supply valves correct	Locate fire resistant passages through a wall/floor	Necessary certification
125	Take measures to mitigate security risks on site	Make a good fire safe sealing	Necessary content of a user manual
126	Use adequate and safe protection measures (both collective and personal)	Make airtight connections for different air duct types	Necessary maintenance of ventilation systems
127	Use adequate and safe working platform(s)	Make clear requirements of the detail building of green roofs and access roofs	Need for continuous ventilation to prevent moist complaints
128	Use BIM system for design and operate the roof	Make clear the requirements and advantages of the green roofs and access roofs	Opportunities to evaporate humidity through renovation technology
129	Use dangerous substances safe and environmentally friendly	Make connections between air ducts and MVHR unit airtight	Possibilities for fire resistant passages
130	Use maintenance contract and roof log properly	Make data connections according to the manufacturer's specifications	Prevent contamination and adjustment of valves after completion of all other work on the construction site
131	Use safe transport devices for vertical and horizontal transport of materials and tools	Make holes in walls/floors/ceilings	Principles of fire-resistant passages
132	Verify location of the control unit	Make power connections according to the manufacturer's specifications	Principles of selection and storage of tools and materials
133	Verify selected silencers	Mark walls and ceiling openings clearly	Proper dimensioning of the inlets and outlets
134	Write report on cost calculation and validation	Measure power consumption	Proper fixing and placement of the unit
135		Mount check valves	Proper training of connectors and components and building joints
136		Mount fire dampers	Proper training of connectors and components and building joints
137		Mount overflows/grills correct	Proper use of duct caps

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
138		Mount sensors	Proper use of silencers
139		Optimise the position of supply and extract registers to ensure optimal flow rates in the spaces	Protection measures for handling dangerous substances
140		Perform a blower door test	Purpose and function of the layers and materials of the building envelope
141		Perform airflow measurement	Regular maintenance and small repairs
142		Perform for airtightness tests on the ventilation system	Related H & S rules as working on height, working on scaffolding, etc.
143		Perform pressure loss measurements	Related H & S rules regarding material transport, electrical hand tools, etc.
144		Perform roof measurements	Relevant standards for airtightness of ducts
145		Perform sound measurement	Required adjustment states for the manual
146		Pre-set and mount exhaust valves according to data sheet	Requirements and preparation for the installation of the roofing systems
147		Pre-set and mount supply valves (diffusers) according to data sheet	Requirements for air exhaust (placement, type, size...)
148		Provide sufficient make up air	Requirements for exhaust air routing
149		Raise awareness of the client towards the importance of regular maintenance	Requirements for installation of solar thermal and PV systems on flat roofs
150		Read technical drawings	Requirements for outdoor air intake (placement, type, size...)
151		Recognize need for coordination with regard to cable routing, breakthroughs and overflow areas	Risk definition and protective measurements avoiding accidents
152		Recognize type of ventilation system	Risks of accidents in everyday work
153		Recognize typical errors in ventilation systems	Risks presented by contaminants and / or moisture / humidity
154		Replace or clean filters	Roofing layer materials by type, use and properties
155		Require the proper selection and storage of materials and tools	Roofing work while building is in use
156		Seal air ducts tight	Room combination ventilation system
157		Seal gap between damper and wall/floor	Room layouts and effects on air circulation
158		Securely fix the routing and positions of ducts and register	Room types

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
159		Select an adequate safety system	Room uses and effects of those uses on air circulation
160		Select appropriate connection details	Rules for MVHR filter replacement
161		Select correct mounting parts	Safe access circumstances for flat roofs
162		Select the right sealing technology	Safe access circumstances for flat roofs
163		Set exhaust fan	Safe and protective transport and storage of materials and tools on the ground and on the roof
164		Store ducts, registers and other components clean a proper	Safe implementation of the post installation penetration
165		Test the substrate metrological	Safe material transport to and on the existing roof
166		Use ducts caps	Safety equipment on flat roofs and their installation, use and documentation
167		Use personal protective equipment correct	Safety measures when working with hazardous substances
168		Use the benefits and function of the applicable materials for waterproofing	Sealing techniques for fire dampers
169		Use the necessary collective and personal protection measures	Selective waste management
170		Use the right mounting brackets	Sensors and their characteristics
171		Use the right support profiles	Smart failure detection systems
172		Use the right type of fixing plugs	Sound recommendations for different room occupancy types
173		Use threaded rods and mounting brackets	Standards and regulations on occupational safety and health
174		Verify functioning of the sensors	Stress on the building envelope and the seal: water, water vapor, snow, ice, wind load, sun, UV, thermal stresses, mechanical stress
175		Verify the damping rate of silencers	Suitability of different condensate drains
176		Verify with the designer if prescribed location is not suitable	Support profiles
177			Temporary waterproofing before mayor renovation works
178			Test opportunity of the performance of the completed roof
179			Testing methods for airtightness of ducts

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
180			Testing methods for airtightness of ducts
181			The need for airtightness of ducts
182			Thermal insulation of different types and their differences
183			Types and properties of substrate
184			Types of regulation for ventilation systems (CO2, VOC, humidity, presence, time, capacity switch)
185			Typical faults in ventilation systems
186			Typical issues when power consumption is too high
187			Use of alternative fixing systems (click, prefabricated)
188			User briefing must contain (functionality, location and location of the haptic components, operation and control, filter change...)
189			Vapour-tight insulation
190			Various protective materials and their processing
191			Various seal shapes and materials
192			Various smart failure detection systems
193			Ventilation in combination with heat pump (heating and domestic hot water)
194			Ventilation system with or without heat recovery
195			Vibration-free assembly of units
196			Warning and notice requirements, acceptance of inputs of other trade: electricity, mechanical, fixing need
197			Warranty circumstances
198			Wear indications
199			What airtight ducts are
200			What belongs to a complete hygiene check (diffusers, air ducts, ventilation unit, external air intake, exhaust air ducting)
201			What is needed for good maintenance of ventilation systems

ULO NR.	COMPETENCE	SKILLS	KNOWLEDGE
202			What types of silencers are available
203			When a condensate drain is necessary
204			When a condensate drain is necessary
205			When cleaning of ducts is needed
206			When cleaning of fans is needed
207			When cleaning of ventilation grilles is needed
208			When cleaning or replacement of filters is needed
209			When draft occurs
210			Where and how to seal air ducts and its joints
211			Where silencers are required
212			Which airflow measurement device to use

## 4 ANNEX I: More information about developing descriptors of learning outcomes

This annex is added to support the further development of ULO with a publicly available overview of the BLOOM verbs.

### 4.1.1 Definitions stated by the EU<sup>1</sup>

The following definitions are cited from the Council recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning.

**'learning outcomes'** means statements regarding what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and responsibility and autonomy;

**'knowledge'** means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the EQF, knowledge is described as theoretical and/or factual;

**'skills'** means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments);

**'responsibility and autonomy'** mean the ability of the learner to apply knowledge and skills autonomously and with responsibility;

'competence' means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.

#### 4.1.2 Steps towards writing effective learning objectives:

1. Make sure there is one measurable verb in each objective.
2. Each objective needs one verb. Either a student can master the objective, or they fail to master it. If an objective has two verbs (*say, define and apply*), what happens if a student can define, but not apply? Are they demonstrating mastery?
3. Ensure that the verbs in the programme level objective are at least at the highest Bloom's Taxonomy as the highest lesson level objectives that support it. (Because we can't verify, they can **evaluate** if our lessons only taught them (and assessed) to **define**.)
4. Strive to keep all your learning objectives measurable, clear and concise.

#### 4.1.3 The BLOOM verbs<sup>2</sup>

Table 3: List of Bloom verbs

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Cite	Add	Acquire	Analyze	Appraise	Abstract
Define	Approximate	Adapt	Audit	Assess	Animate
Describe	Articulate	Allocate	Blueprint	Compare	Arrange
Draw	Associate	Alphabetize	Breadboard	Conclude	Assemble
Enumerate	Characterize	Apply	Break down	Contrast	Budget
Identify	Clarify	Ascertain	Characterize	Counsel	Categorize
Index	Classify	Assign	Classify	Criticize	Code
Indicate	Compare	Attain	Compare	Critique	Combine
Label	Compute	Avoid	Confirm	Defend	Compile
List	Contrast	Back up	Contrast	Determine	Compose
Match	Convert	Calculate	Correlate	Discriminate	Construct
Meet	Defend	Capture	Detect	Estimate	Cope
Name	Describe	Change	Diagnose	Evaluate	Correspond
Outline	Detail	Classify	Diagram	Explain	Create
Point	Differentiate	Complete	Differentiate	Grade	Cultivate
Quote	Discuss	Compute	Discriminate	Hire	Debug
Read	Distinguish	Construct	Dissect	Interpret	Depict
Recall	Elaborate	Customize	Distinguish	Judge	Design
Recite	Estimate	Demonstrate	Document	Justify	Develop
Recognize	Example	Depreciate	Ensure	Measure	Devise

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
<b>Record</b>	Explain	Derive	Examine	Predict	Dictate
<b>Repeat</b>	Express	Determine	Explain	Prescribe	Enhance
<b>Reproduce</b>	Extend	Diminish	Explore	Rank	Explain
<b>Review</b>	Extrapolate	Discover	Figure out	Rate	Facilitate
<b>Select</b>	Factor	Draw	File	Recommend	Format
<b>State</b>	Generalize	Employ	Group	Release	Formulate
<b>Study</b>	Give	Examine	Identify	Select	Generalize
<b>Tabulate</b>	Infer	Exercise	Illustrate	Summarize	Generate
<b>Trace</b>	Interact	Explore	Infer	Support	Handle
<b>Write</b>	Interpolate	Expose	Interrupt	Test	Import
	Interpret	Express	Inventory	Validate	Improve
	Observe	Factor	Investigate	Verify	Incorporate
	Paraphrase	Figure	Layout		Integrate
	Picture graphically	Graph	Manage		Interface
	Predict	Handle	Maximize		Join
	Review	Illustrate	Minimize		Lecture
	Rewrite	Interconvert	Optimize		Model
	Subtract	Investigate	Order		Modify
	Summarize	Manipulate	Outline		Network
	Translate	Modify	Point out		Organize
	Visualize	Operate	Prioritize		Outline
		Personalize	Proofread		Overhaul
		Plot	Query		Plan
		Practice	Relate		Portray
		Predict	Select		Prepare
		Prepare	Separate		Prescribe
		Price	Subdivide		Produce
		Process	Train		Program
		Produce	Transform		Rearrange
		Project			Reconstruct
		Provide			Relate
		Relate			Reorganize
		Round off			Revise
		Sequence			Rewrite
		Show			Specify
		Simulate			Summarize
		Sketch			
		Solve			
		Subscribe			
		Tabulate			
		Transcribe			
		Translate			
		Use			

Verbs to avoid (refer to more internal, not directly measurable, processes): know, grasp, appreciate, think, believe, value, and realize.

#### 4.1.4 Background information on Bloom's Taxonomy<sup>3</sup>

Bloom's Taxonomy is a classification of the different objectives and skills that educators set for their students (learning objectives). The taxonomy was proposed in 1956 by Benjamin Bloom, an educational psychologist at the University of Chicago. The terminology has been recently updated to include the following six levels of learning. These 6 levels can be used to structure the learning objectives, lessons, and assessments of your course.

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
2. **Understanding:** Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
3. **Applying:** Carrying out or using a procedure for executing or implementing.
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing.
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

Like other taxonomies, Bloom's is hierarchical, meaning that learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels. You will see Bloom's Taxonomy often displayed as a pyramid graphic to help demonstrate this hierarchy. We have updated this pyramid into a "cake-style" hierarchy to emphasize that each level is built on a foundation of the previous levels.

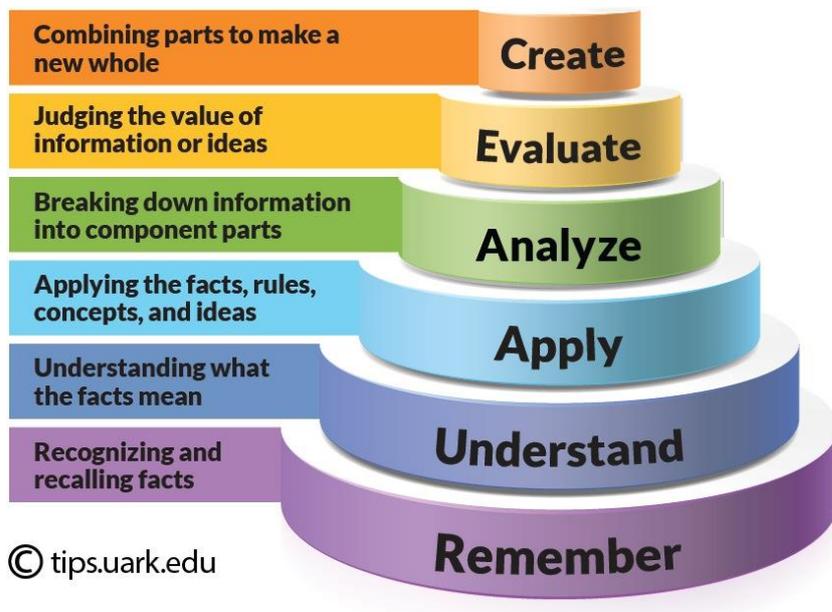


Figure 3: Bloom's hierarchy pyramid<sup>1</sup>

#### 4.1.5 How this can aid in course design

Bloom's taxonomy is a powerful tool to help develop learning objectives because it explains the process of learning:

- Before you can **understand** a concept, you must **remember** it.
- To **apply** a concept, you must first **understand** it.
- In order to **evaluate** a process, you must have **analyzed** it.
- To **create** an accurate conclusion, you must have completed a thorough **evaluation**.

However, we don't always start with lower order skills and step all the way through the entire taxonomy for each concept you present in your course. That approach would become tedious—for both you and your students! Instead, start by considering the level of learners in your course:

1. Are lots of your students' freshmen? Is this an "Introduction to..." course? If so, many learning objectives may target the lower order Bloom's skills, because your

<sup>1</sup> You may use this graphic for educational or non-profit use if you include a credit for Jessica Shabatura and citation back to this website.

students are building foundational knowledge. However, even in this situation we would strive to move a few of your objectives into the **applying** and **analyzing** level but getting too far up in the taxonomy could create frustration and unachievable goals.

2. Are most of your students' juniors and seniors? Graduate students? Do your students have a solid foundation in much of the terminology and processes you will be working on your course? If so, then you should not have many **remembering** and **understanding** level objectives. You may need a few, for any radically new concepts specific to your course. However, these advanced students should be able to master higher-order learning objectives. Too many lower level objectives might cause boredom or apathy.

#### 4.1.6 How Bloom's works with learning objectives

Fortunately, there are "verb tables" to help identify which action verbs align with each level in Bloom's Taxonomy.

You may notice that some of these verbs on the table are associated with multiple Bloom's Taxonomy levels. These "multilevel-verbs" are actions that could apply to different activities. For example, you could have an objective that states "At the end of this lesson, students will be able to **explain** the difference between H<sub>2</sub>O and OH<sup>-</sup>." This would be an **understanding** level objective. However, if you wanted the students to be able to "...**explain** the shift in the chemical structure of water throughout its various phases" Then this would be an **analyzing** level verb.

Adding to this confusion, you can locate Bloom's verb charts that will list verbs at levels different from what we list below. Just keep in mind that it is the skill, action or activity you will teach using that verb that determines the Bloom's Taxonomy level.

Table 4: Bloom's key verbs

Bloom's Level	Key Verbs (keywords)	Example Learning Objective
<b>Create</b>	design, formulate, build, invent, create, compose, generate, derive, modify, develop.	<i>By the end of this lesson, the student will be able to design an original homework problem dealing with the principle of conservation of energy.</i>
<b>Evaluate</b>	choose, support, relate, determine, defend, judge, grade, compare, contrast, argue, justify, support, convince, select, evaluate.	By the end of this lesson, the student will be able to determine whether using conservation of energy or conservation of momentum would be more appropriate for solving a dynamics problem.

<p><b>Analyze</b></p>	<p>classify, break down, categorize, analyze, diagram, illustrate, criticize, simplify, associate.</p>	<p><i>By the end of this lesson, the student will be able to differentiate between potential and kinetic energy.</i></p>
<p><b>Apply</b></p>	<p>calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, perform, present.</p>	<p><i>By the end of this lesson, the student will be able to calculate the kinetic energy of a projectile.</i></p>
<p><b>Understand</b></p>	<p>describe, explain, paraphrase, restate, give original examples of, summarize, contrast, interpret, discuss.</p>	<p><i>By the end of this lesson, the student will be able to describe Newton's three laws of motion to in her/his own words</i></p>
<p><b>Remember</b></p>	<p>list, recite, outline, define, name, match, quote, recall, identify, label, recognize.</p>	<p><i>By the end of this lesson, the student will be able to recite Newton's three</i></p>

		laws of motion.
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Learning objective examples adapted from, Nelson Baker at Georgia Tech:  
 nelson.baker@pe.gatech.edu

They can also be shown in a so-called task-oriented question construction wheel<sup>4</sup>.

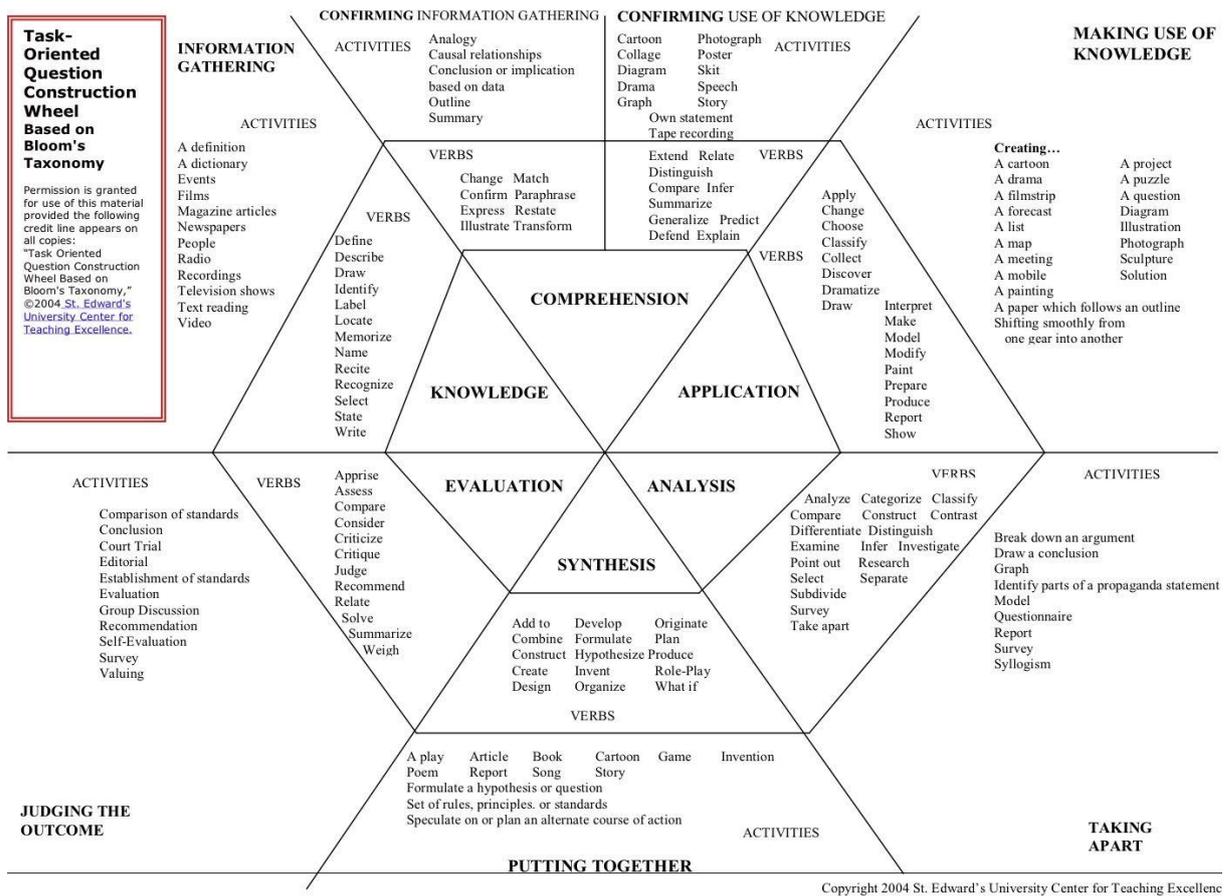


Figure 4: Task oriented question construction wheel



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