

From typical work tasks to units of learning outcomes

- The CREDCHEM-approach -

In the following we try to describe unambiguously all terms that are relevant for the designing of CREDCHEM-units of learning outcomes, to give declarations on their use and to separate them clearly from each other.

1. Competence and its meaning for CREDCHEM
2. Units of learning outcomes based on typical work tasks
 - a) Explanation
 - b) Way of presenting
3. Work task (versus learning task)
4. Analyzing work tasks
 - a) Outcome-orientation
 - b) action-knowledge
 - c) Skills
 - d) Knowledge – connections in natural sciences
 - e) knowledge – technological connections
5. The designing of units of learning outcomes – the matrix

1. Competence and its meaning for CREDCHEM

CREDCHEM is intended to enable young persons to carry out parts of their training in institutions (schools and companies) in the CREDCHEM-partner countries.

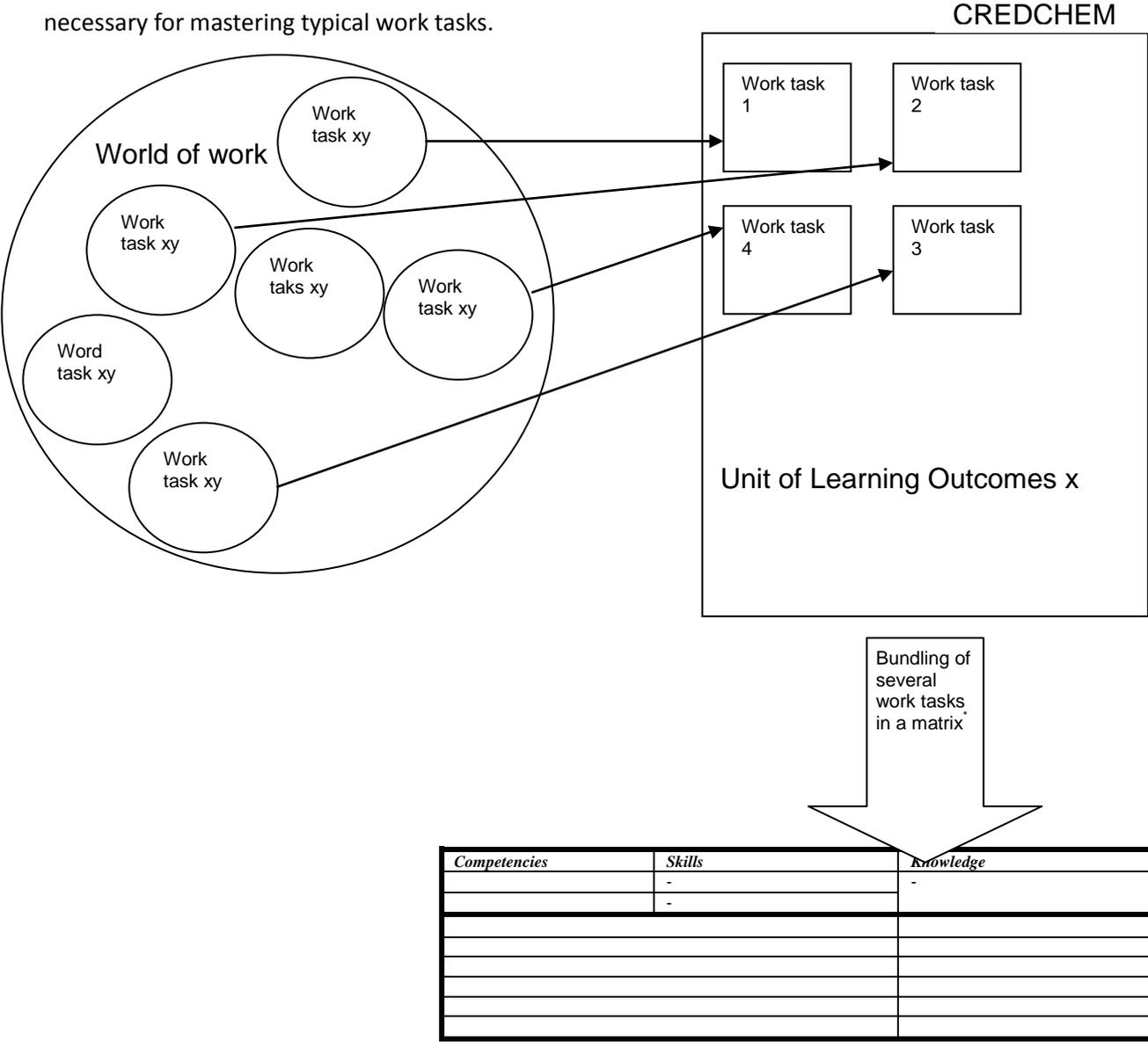
In order not to prolong unnecessarily the training by the staying abroad it must, in advance, be decided, which knowledge, skills and competence the young persons can acquire abroad. Thus this will safeguard that the young persons do not waste any training time and that the companies which

send the young persons abroad can know that the staying abroad serves the purpose of training. In order to do this knowledge, skills and competences must be analyzed in a structured way and thus be made transparent. Hereby we refer to the “occupational capacity to act”. Being “competent to act in an occupation” means to solve work tasks independently and responsibly. Thus the best way to describe the competence is by analyzing the underlying work tasks with regard to the knowledge and skills which are needed for their realization. This done, in the next step exemplary tasks will be defined with which can be assessed whether an increase of competence has occurred.

2. Units of learning outcomes based on work tasks

a) Explanation

In a unit of learning outcomes the knowledge, skills and competences are described which are necessary for mastering typical work tasks.



In the field of action “work in the laboratory” the CREDCHEM-team has defined the following units of learning outcomes:

LE 1: Preparation and follow-up of analysis and synthesis

LE 2: Defining of material constants and material characteristics

LE 3: Spectroscopic analysing of materials

LE 4: Volumetrically / gravimetrically analysing of materials

LE 5: Chromatographically separating and analysis of mixed materials

LE 6: Production of inorganic and organic materials

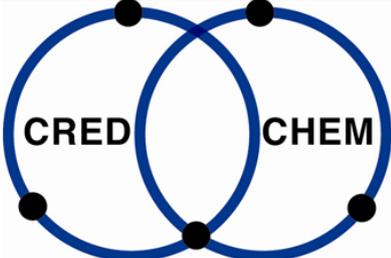
LE 7: Procedures of synthesis

LE 8: Supervising production processes

LE 9: microbiological testing of materials

b)Way of presenting

We use the SME master+ template for illustrating the units of LO in one field of action (laboratory)

Title of the field of action	Work in laboratory		
EQF Level			
Total ECVET points	100 Not discussed yet		
Units of Learning outcomes	U1	Preparation and follow-up of analysis and synthesis	
	U2	Defining of material constants and material characteristics	
	U3	Spectroscopic analysing of materials	
	U4	Volumetrically / gravimetrically analysing of materials	
	U5	Chromatographically separating and analysis of mixed materials	
	U6	Production of inorganic and organic materials	
	U7	Procedures of synthesis	
	U8	Supervising production processes	
	U9	microbiological testing of materials	
Cross sectional Learning Outcomes	To acquire the learning outcomes properly the following qualifications are essential: <ul style="list-style-type: none"> ▪ s/he is able to act with social and ecological responsibility, ▪ s/he is able to adopt a quality management, ▪ s/he is able to use information and communication technology. not discussed yet		

The units of learning outcomes 1 to 9 describe the demands which the skilled workers meet in the in the real world of work. Young persons have to master these demands in whatever system they are trained. For this reason we take the professional work tasks from the world of work and use them as the basis for the designing of units of learning outcomes (Step 1).

A CREDCHEM- unit of learning outcomes is so to say a complex of typical occupational work tasks on a topic in a field of action. Some occupational work tasks have been analyzed and will be analyzed by us in the project (i.e. we define knowledge, skills and competences hidden in them). The work tasks represent the units of learning outcomes and establish the basis for formulating the occupational capacity to act.

Allocation of work tasks to units of learning outcomes (not complete)

LE 1_Trennen und Mischen von Stoffen	LE 2_Bestimmen von Stoffkonstanten	LE 3_Stoffe spektroskopisch analysieren
<u>Analysed work tasks:</u> <ul style="list-style-type: none"> - Extraktion von CuSO₄ (DECVET) - Filtrat. von CaCO₃ (DECVET) - Herstell. NaOH-Lsg. (DECVET) - Umkristall. von Sulfanilsäure (DECVET) - Wasserdampfdestill. Von Toluol (DECVET) 	<u>Analysed work tasks:</u> <ul style="list-style-type: none"> - Säuregehalt mit pot. Titr. (DECVET) - Schmelzp.-Bestimm. (DECVET) - Zuckergehalt mit Aräometer (DECVET) - Alkoholische Gärung und Destillation (DECVET) - Qualitätskontrolle Sonnenblumenkerne (BG) - Schmelz- und Siedepunkt, Dichte (IT) 	<u>Analysed work tasks:</u> <ul style="list-style-type: none"> - spektralfotometr. Bestimmung von Co- und Cr-Ionen (HU/PL) KS 2, KS 3
LE 4 Stoffe volumetrisch/ gravimetrisch analysieren	LE 5 Stoffgemische chromatografisch trennen und analysieren	LE 6 anorg. und org. Stoffe herstellen
<u>Analysed work tasks</u> <ul style="list-style-type: none"> - Komplex. Bestimmung von Ca-Ionen (HU/PL) KS 1 - Permang. Bestimmung von Ca-Ionen (HU/PL) KS 1 - Redoxtitration von Cu(II)-Ionen (IT) - Permang. Bestimmung von Fe(II)-Ionen (DECVET) - SB-Titration von Essigsäure (BG) 	<u>Analysed work tasks</u>	<u>Analysed work tasks</u> <ul style="list-style-type: none"> - Herstellung von Acetylsalicylsäure (DECVET)
LE 7_Syntheseverfahren	LE 8_Produktionsprozesse überwachen	LE 9 Stoffe mikrobiologisch untersuchen
<u>Analysed work tasks</u> <ul style="list-style-type: none"> - mehrstufige Synthese (DECVET) 	<u>Analysed work tasks</u>	<u>Analysed work tasks</u> <ul style="list-style-type: none"> - Immobilisieren von Enzymen (BG) - preparation of cultivating medium (SK)

The competence which is necessary for solving all work demands in a unit of learning outcomes will

be structured and bundled on the basis of the work tasks which we have analyzed.

3. Work tasks versus learning tasks

Work tasks correspond to the demands of work which are typical in the vocational praxis. Normally there is a context given in which the importance of the task in the total process of the company is explained. It is typical for a work task that there is a stipulation of time in which the order has to be carried out. The skilled worker must solve the task independently and responsibly and develop and carry out ways of solving problems, i.e. in order to solve the given order vocational capacity (competence) to act is needed.

Example:

Produce before tomorrow 25 g of pure Acetylsalicylic acid. This is needed for a number of tests with painkillers.

Learning tasks are often work orders which are prepared with didactical support.

Example:

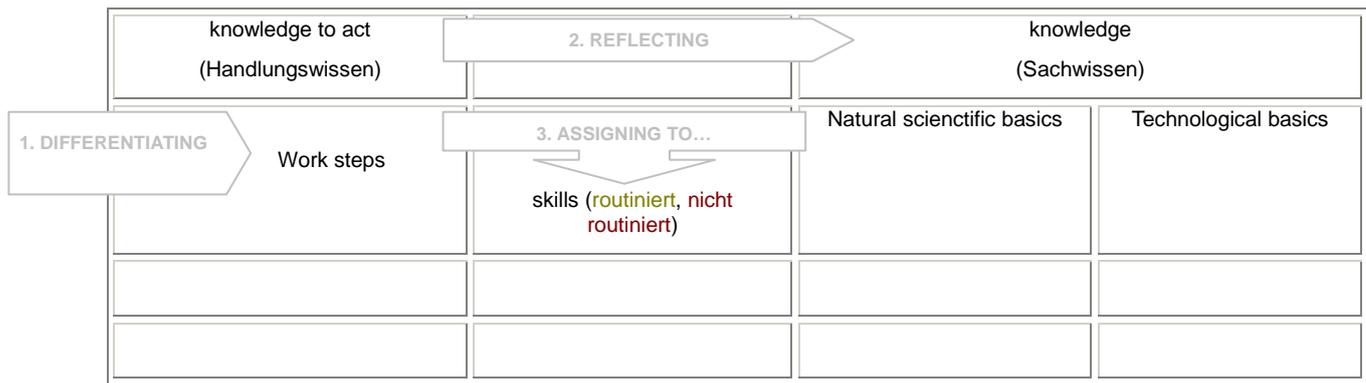
Produce 25 g of pure Acetylsalicylic acid by acetylation. Use standard pipe equipment. Calculate at first the quantities which you must use. answer the following questions in your evaluation : Why must it be heated to a temperature of 95 degrees celsius? Why must it be cooled by ice-water in the next step? Can the product be also washed with warm water? Give reasons for your statement.

4. Analyzing work tasks

The purpose of the analysis of work tasks is to make the vocational action competence transparent which is needed for the mastering of the work task. The work task is exemplary for the definite learning outcomes unit.

a) Outcome-orientation

In order to understand the increase in competence only the result of learning processes are relevant – presuming that different ways (venues of learning, methods ...) will lead to the same results. Thus we are not interested in input categories but only whether a person is able to carry out work tasks. The didactic directions will also be left out. Only the steps which a skilled worker must make in order to carry out the task belong in the first column in the following table:



b) Knowledge to act

The term “knowledge to act” describes the knowledge of thinking and handling which is necessary in order to carry out a work task. These are listed in column 1 in their chronological order.

Example: Planning analysis, filling beaker, write protocol, calculation of volume

c) skills (routine / not routine)

Which skills are needed in order to realize action-knowledge? Skills which are not based on routine are characterized by a change between planning-reflection phases and action-phases.

Example: Problem solving skills (analysis of the problem, development of a solving path, realization of the solving path, reflection whether the problem is solved).

Skills based on routine are characterized by the fact that the thinking phases (in contrast to the not routine-based skills) are not necessary any more.

Example: Car-driving after years of driving praxis (whether gear-shift must be made or not is almost unconsciously decided).

d) Knowledge of natural science contexts

Each work step is based on knowledge on natural scientific contexts. Access to the context is obtained when each work step is reflected. It may be laws, formulas, information on materials and much more.

How is the natural scientific context understood?

Example: The reaction mixture must be heated to the temperature of 100 degrees Celsius. Ask for the natural scientific context: Why must it be heated to 100 degrees, why not more or less? The answer can be found in the natural scientific fundamentals.

e) Knowledge of technological contexts:

Here the work steps concerning the equipment and gadgets must be reflected. Why is exactly this and not other equipment used?

Example: For the synthesis closed equipment with reflux condenser is used. Why? Why can the

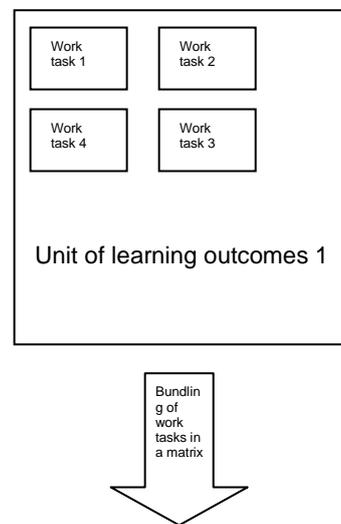
equipment not be open and what is the function of the reflux condenser? The answer is found in the technological context.

Based on that the unit of learning outcomes will be presented in a matrix.

5.The designing of units of learning outcomes - the Matrix

On the basis of the analyzed work tasks all learning outcomes of a unit will be generalized in a matrix. Thus the matrix describes the vocational competences which are to be acquired in this unit. The learning outcomes are described as follows: levels of competences, knowledge and skills. Example:

Unit of learning outcomes 1: mixing and separating materials (graphic)



Unit of Learning Outcomes 1: Mixing and separating of materials		
Competence	Skills	Knowledge
Competence level 1: Carrying out of action according to work instruction - Trennt und mischt Stoffe nach den gängigen Verfahren und passt diese je nach Bedingungen an (wählt je nach Eigenschaften der Stoffe Verfahren aus)	- Nimmt Aufträge entgegen und plant eigene Arbeitsschritte - Baut Apparatur auf, geht dabei exakt, sorgfältig, routiniert mit Labortechnik um - Berechnet Mengen	- kennt Strukturmerkmale, die für Verhalten/ Eigenschaften eines Stoffes verantwortlich sind - Stoffkenntnisse (Eigenschaften, Struktur, R- und S-Sätze) - kennt Trenn-/ Mischprinzipien und entsprechende Verfahren (kennt Handlungsschritte)
Competence level 2: Problem-oriented carrying out - geht mit für verfahrenstypischen Problemen um	- Problemlösefähigkeit - Anwenden von Fachwissen - Reflexionsfähigkeit	- kennt Löslichkeiten der Stoffe (bei unterschiedlichen Temperaturen) - kennt Neutralisationsreaktion
Competence level 3: Optimising of methods / procedures - ...	- ...	- ...
Work tasks		Competence level
Extraktion von CuSO ₄		
Filtration von Calciumcarbonat bei Unterdruck		
Herstellung einer Natriumhydroxid-Maßlösung		
Umkristallisieren von Sulfanilsäure		
Wasserdampfdestillation von Toluol		

In addition to this there is country-specific and country-independent information.

Country specific information:

- Reference to the national qualifications (pathways of learning, training programmes)
- Credits
- Learning venues, in which the unit can be carried out

Country independent information:

- the proposed duration of a mobility measure in order to pass the unit
- Reference to EQF-level
- kind of assessment

Lerneregebniseinheit 1: Mischen und Trennen von Stoffen		
<i>Reference to the national qualifications</i>	DE	Lernfelder 1+2; Qualifikationseinheiten 6.4+7.1+8.2 des Ausbildungsberufes ChemielaborantIn
	BG	
	IT	
	SK	
	CZ	
<i>Credits:</i>	DE	
	BG	
	IT	
	SK	
	CZ	
<i>Level (EQF):</i>		
<i>Kind of assessment:</i>	Stufe 1+2 der Kompetenzerfassung	
<i>Learning venue:</i>	DE	Company / training provider
	BG	
	IT	
	SK	
	CZ	
<i>Proposed duration of mobility measure:</i>		