

# **Vocational Education and Training Reform in the Republic of Serbia**

Manual 3

## **METHODOLOGIES FOR THE DEVELOPMENT OF COMPETENCE-BASED MODULAR CURRICULA IN VET**

Vocational Education and Training Reform Programme – Phase II

May, 2008.

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## Introduction

One of the goals of the VET Reform Programme - phase 2, financed by the European Agency for Reconstruction, was to support the Ministry of Education of the Republic of Serbia in optimisation of the VET system in developing new curricula according to the need on the labour market.

This development implied:

- Clear definition of occupational/educational standards;
- Transparency of competences and qualifications;
- Transferability - opportunity for horizontal and vertical mobility;
- Competency- based assessment;

For this purpose, the following main activities were undertaken:

- Definition of 4 priority sectors by the MoE on the basis of labour market analysis,
- Development of educational standards for appropriate profiles from each sector
- Development of a concept and vision for an assessment system by specifying assessment methods
- Defining assessment criteria based on educational standards
- Piloting of first year implementation of the new curricula in the selected pilot VET schools;

The 4 priority sectors were Tourism and Catering, Wood-processing, Mechatronics, ICT-Telecommunication.

During April-September 2006, a total of 8 educational standards were developed by the VET-centre with the involvement of social partners from the 4 sectors. Identification of knowledge, skills, and attitude needed for the students to be able to perform within certain profile was the core and basis of the work, and a DACUM analysis method was adapted and used for this purpose. For future work on standards development the Project has developed a Handbook in Occupational Analysis, describing the DACUM method. The DACUM documents have created a basis for the development of curricula in the VET Programme, Phase II.

During October 2006 – May 2007 outcome based (competency-based) curricula were developed by special trained teachers from the pilot schools - in the following profiles: Tourism technician, Cook, Waiter, Confectioner, Primary wood-processing, Upholster, Mechatronics and Telecommunication technician.

This handbook describes the philosophy behind the outcome based curricula and the different steps that have to be undertaken for the development.

Regarding implementation of the new curricula and the assessment instructions, please refer to these two separate handbooks.

## Glossary

Competence:	Achievement of the knowledge, skills and attitudes required by an employee in order to perform a given occupational task.
Competency:	A description of the ability one possesses when able to perform a given occupational task effectively and efficiently.
Competency-based education:	An instructional program that derives its content from validated tasks and bases assessment on student performance. Learning materials used in these programmes identify, verify and publish in advance of instruction the competencies (tasks) the student is to learn and perform, the criteria by which the student will be evaluated, and the conditions under which evaluation will occur. Instruction emphasises the ability to do as well as knowing the how, and why. Student performance and knowledge are evaluated individually against stated criteria, rather than against group norms.
Curriculum:	A description or composite of statements about “what is to be learned” by the student in a particular instructional programme; a product that states the “intended learning outcomes”.
Educational/Training programme:	The complete curriculum and instruction (what and how) that is designed to prepare a person for employment in a job or other particular performance situation.
Learning outcomes	A statement in measurable terms of what the student must do to master a task or outcome.
Occupational area:	This is a broad grouping of related jobs. Example: food service
Occupation/job:	A specific position requiring the performance of specific tasks – essentially the same tasks are performed by all employees having the same title. (example: baker)

Occupational/job analysis:	A process used to identify the tasks that are important to employees in any given occupation.
Outcome-based vocational education:	Essentially synonymous with competency-based vocational education. Expected outcomes of student participation in a vocational-technical programme are identified, and measures of competency are utilised in the instructional system
Skill:	The ability to perform occupational tasks with a high degree of proficiency within a given occupation. Skill is conceived of as a composite of three completely interdependent components: cognitive, affective, and psychomotor.
Task:	A work activity that has a definite beginning and ending, is observable or measurable, consists of two or more definite steps, and leads to a product, service, or decision.
Task analysis:	The process of analysing each task to determine the steps, related knowledge, attitudes, performance standards, tools and materials needed, and safety concerns required of employees performing it.
Verification	The process of having experts review and conform the importance of the task (competency) statements identified through occupational analysis. Other questions, such as the degree of task learning difficulty are also frequently asked. This process is also sometimes referred to as validation.



## The Strategy for Development of Vocational Education and Training in Serbia

Extracts from the Strategy for 'Development of Vocational Education and Training in the Republic of Serbia, endorsed by the Government, December 2006:

Current developments in market economies show that education and the development of capacities in human resources have the highest priority in the national strategies and the strategies of political, economic and technological progress. In Serbia, the processes of reconstruction and transformation of education, especially vocational, are preconditions for the sustainable social and economic development. Investments in education for the provision of appropriate and pragmatically applicable human resources are a must for Serbia. Therefore, educational policy is not just the policy of creating human resources but a part of overall social development policy.

In accordance with the needs and requirements of labour market, the needs of society, the aims and tasks of the whole vocational education and training system, the strategic documents in the field of education (in accordance with sustainable development), but also with the individual wishes and abilities of students and trainees – the further reform process of vocational education and training in the Republic of Serbia should include:

- Further improvement of outcome-based modular curricula. Introduction of new curricula; different organisational models and the re-definition of forms, ways and contents of professional practice in companies based on the partnership agreements between the schools and socio-economic partners;
- Development of an appropriate balance between general and vocational education, theory and practice;<sup>1</sup>
- Definition of educational profiles and occupations in order to adjust them to economic reality and the principles of sustainable development;
- Rationalisation of the secondary school network, in accordance with the needs of economy, labour market, local communities, requirements of social and economic development and employment policy and in accordance with the wishes and abilities of students;
- Enlargement of capacity of three-year vocational schools as a direct response to the needs of economy;
- Institutionalisation of continuing and active social dialog in the spheres of vocational education development and employment;
- Modernization and development of professional practice and practical teaching in secondary schools and educational institutions, as well as in companies;

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<sup>1</sup> Possible models of a ratio between general and vocational education are proposed in the pilot curricula of secondary VET

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- Quality assurance of vocational education, based on the constant monitoring and evaluation of learning results and teachers' performance, schools and educational institutions;
  - Development of transparent, functional and fair systems for assessment and evaluation of students' achievements;
  - Securing better horizontal and vertical mobility of students within vocational education as well as the mobility towards further education;

## **The Concept of the Curriculum**

In the strategy for 'Development of the Vocational Education and Training' the curriculum in vocational education and training is defined as the structural basis for the organisation and implementation of education and training, as well as for achieving the intended learning outcomes. The curriculum defines:

- objectives, outcomes and contents of education and training,
- processes and activities necessary for their achievement and implementation (organisational forms, strategies, models and methods of teaching and learning),
- ways of assessment and criteria for the assessment of achievement.

The diversification of curricula, content and teaching methods in the Republic of Serbia enables the introduction of various forms of curricula, according to the needs of labour market, local self-government and schools.

In this way it is possible to introduce new teaching methods, especially forms of active teaching and various combinations of theoretical teaching and professional practice.

In this process it is important to provide:

- Satisfactory balance among general and vocational education, vocational theoretical education and professional practice and practical teaching;
- Vertical and horizontal mobility within a curriculum and within the one or more fields of work;
- Introduction of modular<sup>2</sup> learning principle;
- Links with higher of education and mobility towards high education.

All the processes and activities in education and training in this kind of strategic projection are aimed at achieving objectives and outcomes of education and have to be adjusted, well balanced and diverse in order to meet social needs, needs of local self-government and individuals. In accordance with these principles, the main task of vocational education and training programmes is to provide

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<sup>2</sup> Module is a set of functionally connected knowledge, skills and attitudes (competences) necessary for performing a certain task.



knowledge, skills and attitudes (competences) for students and adults. Vocational education and training curriculum should enable:

- personal development of those who participate in educational process,
- quality improvement of the levels of competence of an individual for performing job;
- meeting the needs of work process concerning professional attitudes (competencies gained);
- promoting employment and lifelong learning.

Reform documents related to the development of vocational education and training in the Republic of Serbia (the period 2001-2006) envisage that vocational education and training curricula should be realised through subjects, modules, practical teaching and professional practice, with different duration throughout the school year. Modules are specific, separate segments or learning packages that lead to achievement of defined learning outcomes.

Modules may be independent or parts of broader curricular, i.e. organisational units. They are designed on the basis of complementary principles, diverse educational demands and defined thematic tasks. The structure of modules also enables gaining knowledge, skills and attitudes (competences) interdisciplinary, i.e. it enables cross-subject linking.

Modularisation offers multiple benefits for the improvement and development of vocational education and training, especially for the modernization of curricula. These benefits are:

- Greater flexibility in planning and organizing educational process;
- Greater efficiency and cost-effectiveness of educational process;
- Better response to the labour market needs;
- Improved vertical and horizontal mobility,
- More efficient response to individual needs and capacities of students and adult students,
- Possibilities for students and adult students to choose their own learning path, their own way of obtaining work competencies and qualifications;
- Easier re-entry to vocational education for the purpose of finishing school or obtaining additional qualifications.

Outcomes are clearly and unambiguously defined knowledge, skills and attitudes (competences) acquired upon completion of a specific programme, i.e. upon completion of educational and learning process. As such they are the basis for the planning, organisation and implementation of vocational education and the evaluation of achievement throughout the education and learning process. The outcomes are defined before the start of educational process and are known to teachers and students. In this way the following is enabled:

- Teachers and students have a clear idea about the objectives and tasks of learning;
- Social partners know which competences are acquired upon completion of certain educational programmes in vocational schools and other educational institutions.

According to this Strategy the VET Reform Programme 2006-2007 has developed the pilot curricula.

## A systematic approach to curriculum development

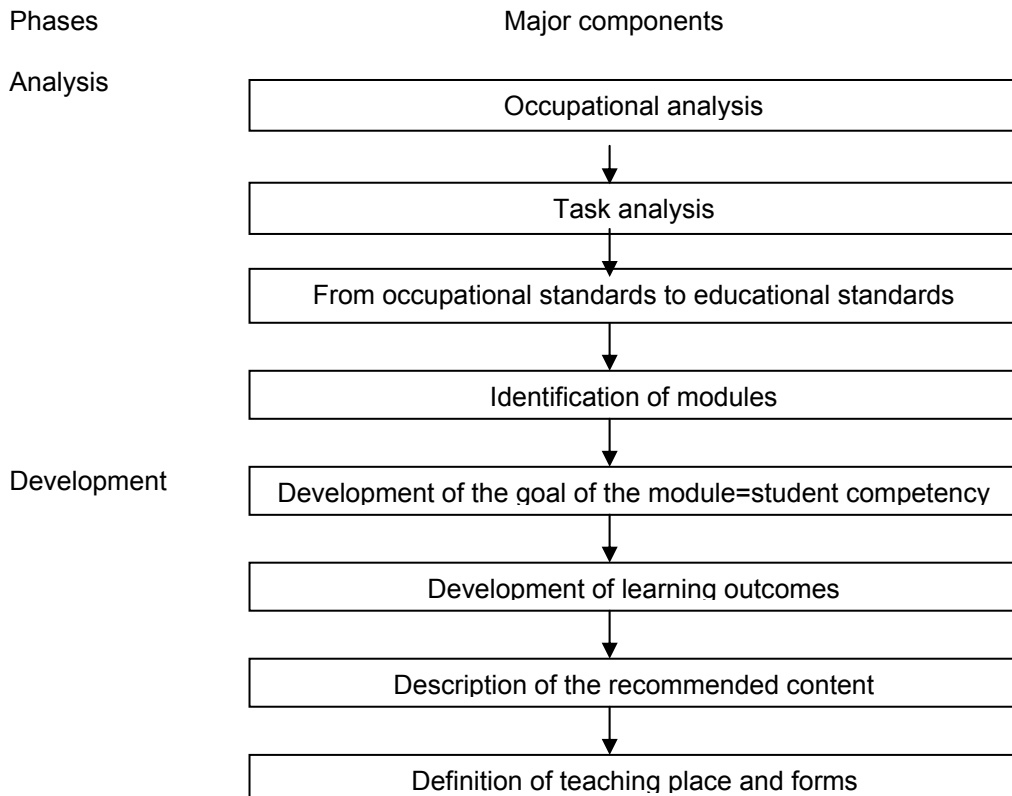
First a definition of curriculum, according to the Strategy as above:

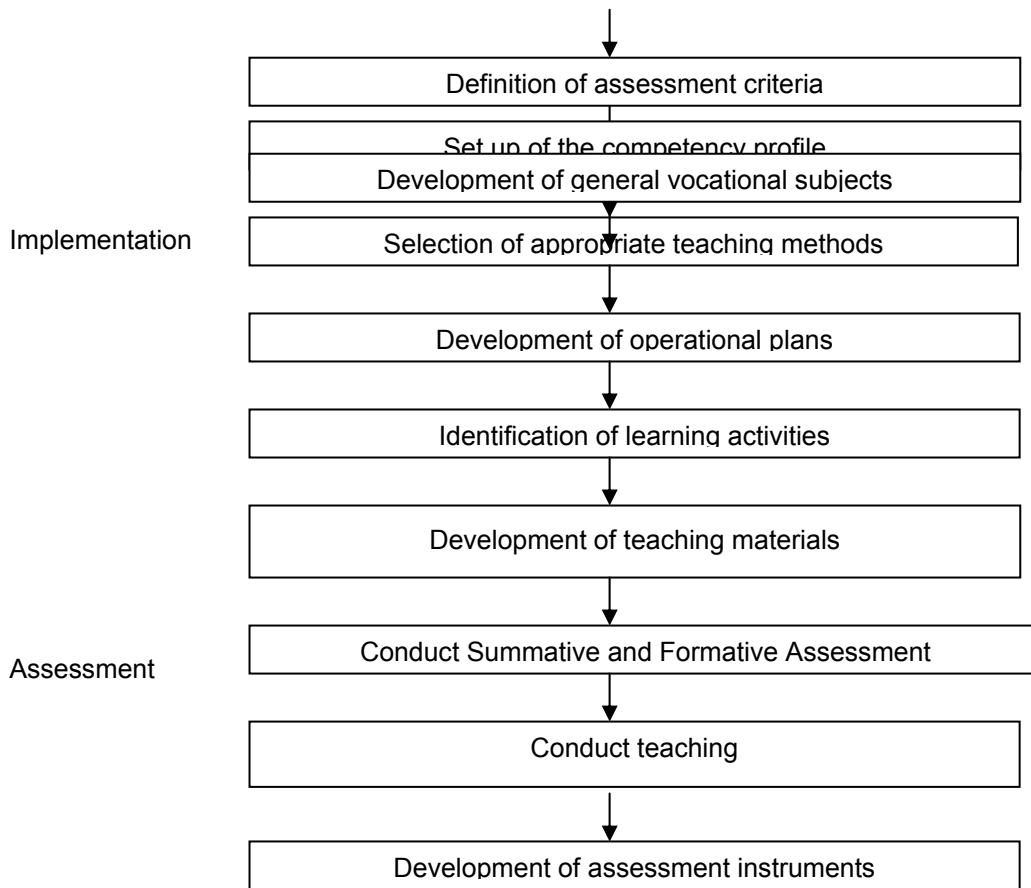
the curriculum in vocational education and training is defined as the structural basis for the organisation and implementation of education and training, as well as for achieving the intended learning outcomes. The curriculum defines:

- objectives, outcomes and contents of education and training,
- processes and activities necessary for their achievement and implementation (organisational forms, strategies, models and methods of teaching and learning),
- ways of assessment and criteria for the assessment of achievement.

To ensure that education and training derives from and delivers on actual student's needs, a systematic approach to education and training should be used. There are numerous system models, but their variations tend to be more cosmetic than real. The steps may carry different names, the system pie may be cut at different points and in different shapes, but the phases and components are identical in most essential ways: analysis, development, implementation, and assessment.

The following scheme gives an overview of the main phases that are also followed in this Handbook.





## Phase 1: Analysis of an Occupation

The first step (or component) is analysis. Education and training is not offered in a vacuum, education and training programmes are developed to meet needs, and needs should be arrived at, systematically, by identifying the difference (discrepancy) between current conditions or outcomes, and desired conditions or outcomes.

Some information is nice to know, but not essential. The trainer who is fascinated by the evolution of the typewriter, from manual to word processor, may be keen to sharing that information when training clerical staff. If that information does not directly meet staff training needs, however, lengthy provision of that information wastes resources and the students' time.

Thus, when new curricula are being designed, analysis involves taking each occupation for which education or training is to be offered and breaking that occupation down into key purposes/duties and major functions/tasks involved. This is called occupational or job analysis. Occupation or job is here defined as a single group of employees performing essentially the same type of work or having the same job title (e.g. a baker).

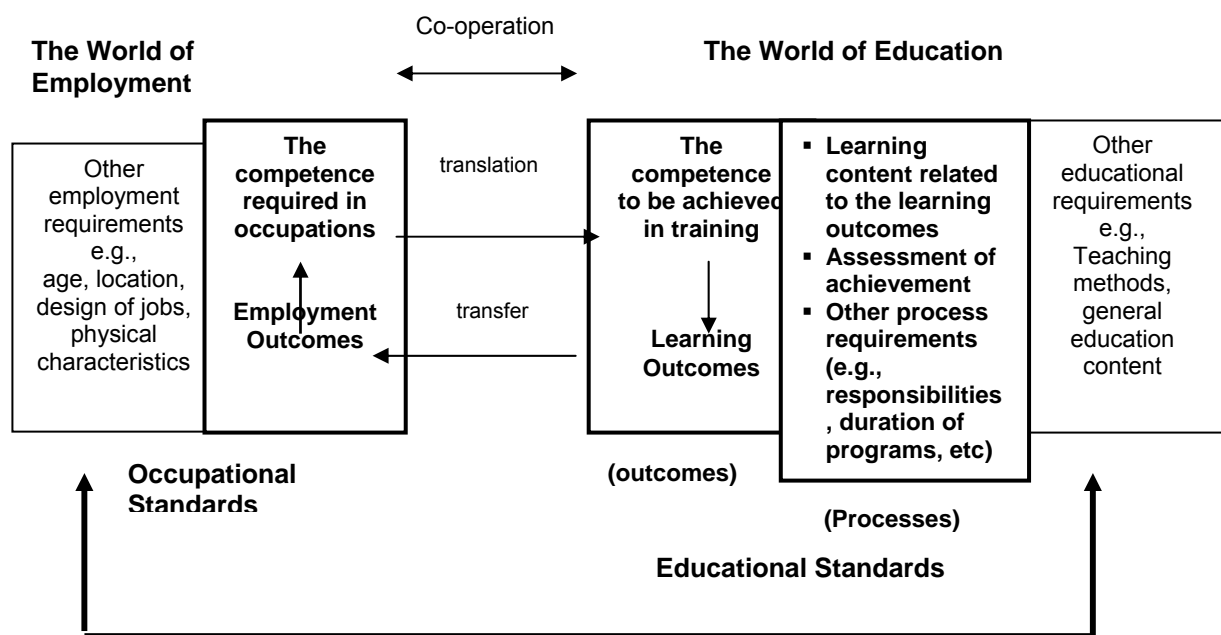
Through this analysis process and /or through verification of the analysis, information is gathered about each task (e.g. is it actually performed by employees, how often, how difficult is it to learn); this information provides a basis for selecting the tasks to be included in the curriculum. Occupational standards always refer to performance, i.e. to outcomes, -that means they specify what performance must be demonstrated, and not what must be learned.

Each selected task/function is then broken down into its teaching elements: the steps performed in carrying out the task, the knowledge required, safety considerations, equipment and tools needed, and so on. This is called tasks analysis. By identifying the current level of skill and knowledge of the students and comparing that to occupational and task analysis data, an appropriate educational programme – for both initial and continuing training- can be developed.

For further information about the analysis method, please, see Handbook on Occupational Analysis.

### Translating Occupational Standards into Educational Standards

The needs of employment (occupational standards) must be translated into a language that can be understood in education and training. The goal is to translate the language of action and inputs in employment to the language of inputs in education, which enable educational professionals to plan and deliver learning programmes. One immediate step that can be taken is to develop learning standards and outcomes that describe what people will be able to do at the end of a learning programme. Then learning outcomes can be linked to employment outcomes defined in occupational standards. The next figure represents the entire process:



System components that are not related

(Source: Adapted from an unpublished paper by Bob Mansfield and Hermann Schmidt, 1999)

In the figure above the educational standard has two components: outcomes and processes. The primary linkage is between the educational standard outcome and occupational standard employment outcome. If this direct linkage is made, employment requirements will directly determine the learning outcomes. The Phase 2 chapter in this Handbook contains examples of how the linkage between occupational standards and educational standards is made. It should be noted, however, there may not be total comparability since some elements of occupational standards may not be included in the educational standards and vice versa. For example:

- Employment is primarily interested in the acceptable level of competence for a person to perform effectively in an occupation, which the person may achieve in education and which must be transferred into employment. But educational standards may include other elements because of legislation, educational practice, and the educational structure (many vocational education students would like to continue their studies at University, which requires a certain level to be obtained for the general subjects,) or elective subjects are included because they give general, additional, useful and interesting information, - all of these are not part of the occupational standards.
- Education may not be interested in some parts of occupational standards because education cannot influence them. For example, an employer may define jobs in a particular way that requires staff in a certain geographical location and with very specific knowledge ( e. g. winegrowers with specialised knowledge about one type of grapes): education standards can have no influence over these decisions.

## Phase 2: Development of Curricula

The second phase of the systematic approach is development. It is during this phase that the curriculum is outlined. Some elements that make up the curriculum derive from the information and data gathered during the analysis phase.

As the Serbian VET reform programme II used the DACUM analysis method, it will in the following be referred to by using the terms duty and tasks which are coming from that method.

1. A first point is to identify the modules that can derive from the occupational analysis. If the analysis is well developed the duties will create the basis for the identification of modules.

The definition of a module according to the above mentioned Strategy is: Modules are specific, separate segments or learning packages that lead to achievement of defined learning outcomes. As an example of a module from Telecommunication: 'TC installations and equipment'

If the occupational analysis is not so well done, the duties/tasks may be selected to a logical composition that can make up modules.

To compose the right order of modules requires that the curriculum developer considers carefully which pre-knowledge is required from the student to be able to follow the teaching of the next module.

In connection to structuring the curriculum regarding identification of modules, other factors also have to be considered - the number of tasks to be addressed as competencies in education. The factors include:

**Task Selection** - For a variety of reasons, tasks may be deselected. For example, tasks rated low in importance and low in learning difficulty may be excluded. A 4-year school programme may exclude competencies that then have to be addressed in a 3-year school programme.

**Task Clustering** - Once task analysis reveals the knowledge, skills, and attitudes required of each task, tasks with similar learning requirements can be clustered together for teaching efficiency reasons. Clustering also avoids presenting the same knowledge needed in two or more learning modules.

2. A second point is to state the goal of each module – the goal to be understood as the end-of training performance, expected by the student = student competency. The goal describes the intention of the learning.

The Goal of the 'TC installation and Equipment module': Enabling the student to deal with installation cables and conductors for assembling/mounting installation equipment. (Please, refer to Annex 1)

Goals	Outcomes
Description of learning intention	Description of learning results
What the teacher will do	What the student will do
Are formulated in sentences starting with "enabling"...	Are formulated in the form of active verbs (drills, installs, etc.)

3. A third point is the development of learning outcomes. This is the core point of the outcome-based (competency-based) curriculum. The outcomes in a module description should tell the reader precisely what a student must be able to do to pass the module. They should describe significant knowledge, skills, and attitude - not too general and not too detailed. (This might be indicated by the number of outcomes relative to the size of the module. There is no correct number of outcomes for a module, but as a guide, developers might expect to set between 3 and 5 outcomes for a 50 hour module).

The outcomes must always relate clearly to the title of the module. It should always be possible to put the words 'The student is able to ...' at the beginning of the outcome. The outcomes should provide a clear guide to the student and the assessor/teacher and be capable of being understood by other users (e.g. employers).

The outcome statements should derive directly from the results of the task analysis and should be stated in terms of observable employee behaviours. In this way, it is possible to ensure that

the results of teaching are measurable. E.g. one of the learning outcomes from the 'TC installation and Equipment module' is 'the student is able to assemble installation equipment and electrical protection of equipment and devices'.

How much work is involved in developing learning outcomes will depend to a great extent on the quality and details of the work that have gone before. If there is access to high-quality and complete occupational and task analysis results, all or most of the information needed to develop excellent learning outcomes should be there, because the action to be performed should be clearly defined in the task analysis.

If, on the other hand, only a list of verified tasks to work from is at hand, a great deal more work will be required.

All learning outcomes must have an action component describing what the student will be able to do (demonstration of task performance, knowledge, attitudes, and/or skills). This component may also be called a performance component (competence component) to stress that observable, measurable behaviour must be described. In fact, any learning outcome, to be measurable, must contain a statement describing an observable action.

Note that the statement starts with a verb. Two verbs are not useful: 'understand' and 'know'.

Going back to the module 'TC installation and Equipment module' looking at some examples of learning outcomes:

- List types and components of installation cables and conductors
- Explain the types and role of protection and grounding for telephone installation, equipment and devices'
- Assemble installation equipment and electrical protection of equipment and devices'.

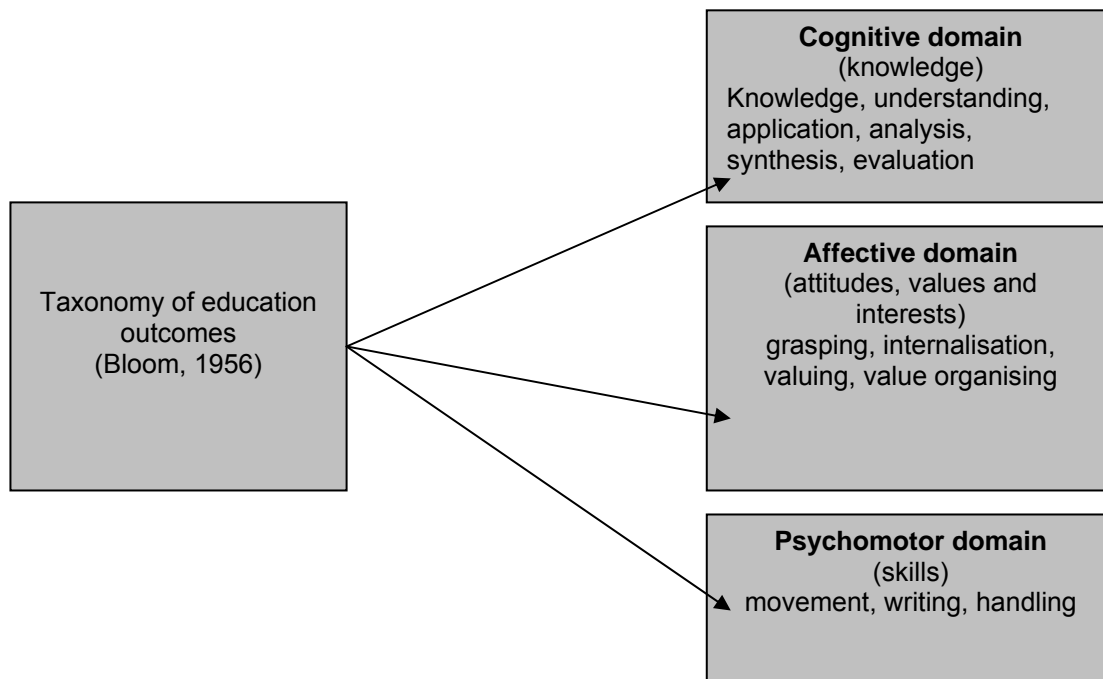
The action verbs used indicates the communication to the user, reader, teacher, and assessor about what performance is expected. 'List' and 'explain' indicate that some knowledge is required, and for the third one 'assemble' that some skills are required.

The selection of verb has to be carefully considered, if the verb 'list' and 'explain' are compared, it immediate indicates a difference in level. 'List' requires from the student to memorize what has been learned, only from the memory, but 'explain' indicates that the student also has an understanding of 'the types and role of protection and grounding for.....'

With the use of Bloom's<sup>3</sup> taxonomy as the starting point, outcomes are classified into cognitive, affective and psychomotor, and formulated at different levels - knowledge, skill and attitudes level.

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<sup>3</sup> Benjamin S. Bloom, ed. Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain (1956)



Benjamin Bloom divides the cognitive domain into six levels. Cognitive outcomes at the lowest level (i.e. knowledge) require students to recognise or recall correct facts, data, or information. Such learning outcomes usually call for students to list, identify, or in some way recognise or recall a particular piece of information.

Learning outcomes at the higher levels in the cognitive domain require students to do more than simply recognise or recall factual information correctly. They also require students to use that information in some way. Learning outcomes at the second level of cognitive domain (i.e. understanding), for example, may call for students to summarise, interpret, translate, or paraphrase facts, data, or information. Outcomes at still higher levels may require application, analysis, synthesis, or evaluation of factual information.

In the same way the affective and psychomotor domain are divided into levels.

Please, see annex 2: the cognitive domain. Annex 3: the psychomotor domain. Annex 4: the affective domain. Annex 5: Comparison of domains.

Each learning outcome has a similar grammatical structure. The first part is a description of the action or actions required to achieve the outcome. This is a verb. Then comes the object of the action, using a noun or nouns. Finally, and if necessary, the context of the action - this could be the purpose of the action, to whom the action is directed etc. Here are two examples of learning outcomes.



The action: Verb(s)	The object of the action: Nouns	The context of the action:
serve	food and drinks	to customers
receive and check	the quality of raw materials	for bakery and confectionery production

4. The fourth point is to describe the recommended content of the module.

The recommended content does not have to be described for each learning outcome, more outcomes can be combined.

5. The fifth point is to define the teaching place and forms.

Some skills are best taught in the classroom, some in the lab; and some through on-the-job training; the nature of the task to be learned will suggest the setting in which it should be taught and evaluated.

A classroom setting is especially efficient when a great deal of information must be conveyed to a number of students at the same time. Classroom teaching can be teacher-directed and /or student-centred, depending on the nature of the methodology used.

A laboratory or workshop setting is useful when students need hands-on-practice. A well-designed lab or shop will stimulate job conditions insofar as possible. Thus, working in the lab/workshop allows students to approximate on-the-job performance to a certain degree.

An on-the-job-training setting is appropriate when students need experience of practising a skill or skills in an actual work environment, working under real conditions and under the supervision of qualified personnel.

6. The sixth point is assessment criteria to be defined.

Assessment criteria (sometimes called “performance criteria”) set out standards against which students must be assessed. They must always be derived from the outcome and explain the essential qualities of performance. (The number of criteria will vary from module to module,

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but as a guide, there should be between 4 and 8 criteria for each outcome.) It should be possible to assess the whole outcome using one assessment, with a check that each criterion is being met: separate assessment instruments should not be required for each criterion. The criteria should enable the teacher/assessor to judge either an aspect of the way the student carries out an activity described in the outcome or a quality of something produced by the activity. The criteria should provide a clear guide to the student and the teacher/assessor; they must be clearly stated and not open to interpretation.

The purpose of the assessment criteria is simple. The assessment criteria tell clearly what is important to teach and to learn.

To be clear the assessment criteria should be written in a standard format. The assessment criteria always begins with the unwritten statement 'the student is able to ...' The written assessment criteria then begin with an action verb that is carefully selected to communicate what is expected by the student. Just like following the rules of formulating the learning outcomes.

The assessment describes an observable, measurable behaviour.

The simplest way to begin to develop assessment criteria is to start looking at the steps developed in the tasks analysis in the DACUM chart.

Below, an example as a part of the steps in a DACUM chart for the profile of a carpenter:

Learning outcome:                      adjust the wood-processing machine

- Steps:
1. Parameters necessary for work on the machine are assigned
  2. Processing speeds are defined
  3. Tools for automatically navigation of working subjects are prepared
  4. Drain spots for pneumatically transport are adjusted
  5. Existing work safety means are checked
  6. Individual work safety means are prepared

Using this example we here try to develop the assessment criteria related to the learning outcome.

1. examine one step at a time:  
each step has to be carefully examined
2. analyse the steps for technical knowledge. E.g. for the first step on the list:  
Ask the question, 'what must the student KNOW to be able to do this step?' In the first step the student must first know the specific parameters for the machine. So, good assessment criteria could be:

- list the parameters necessary for the work on the machine

Or for step no. 4. What knowledge is important here? The assessment criteria could be:

- explain why and how drain spots for pneumatically transport must be adjusted

3. Analyse steps for related skills. When analysing for skills, the key skills such as problem solving and decision making skills must not be forgotten. What if the work safety means only partially exist?

The student must be able to make a decision about what to do. Assessment criteria could be:

- analyse the situation of work safety

The final result of the assessment criteria related to the learning outcome: 'adjust the wood-processing machine'

1. list the parameters necessary for the work on the machine
2. define and set the processing speeds
3. select and prepare the tools for automatically navigation of working subjects
4. explain why and how drain spots for pneumatically transport must be adjusted
5. analyse the situation of work safety
6. prepare individual work safety

Developing assessment criteria helps two people. First it helps the teacher to decide what is important to teach and what teaching sequence is best. Second, it helps the student to focus on learning the 'must know' information. In other words, assessment criteria are a major part of a well planned learning outcome.

7. The seventh point is to develop the general vocational subjects, which are developed to support the technical learning (in the modules) with theoretical knowledge. The general vocational subjects are developed in the same way as the modules, following the same philosophy, only difference is that here there are topics, the rest is the same, having objectives (= goals) and learning outcomes. The occupational analysis results can not be used in the same way as for the development of the module, but requires experienced general vocational subject teachers that are able to link the general vocation subjects to the practical oriented modules to ensure that there is coherence.

Please, see annex 6

8. The eighth point is to set up the competency profile.

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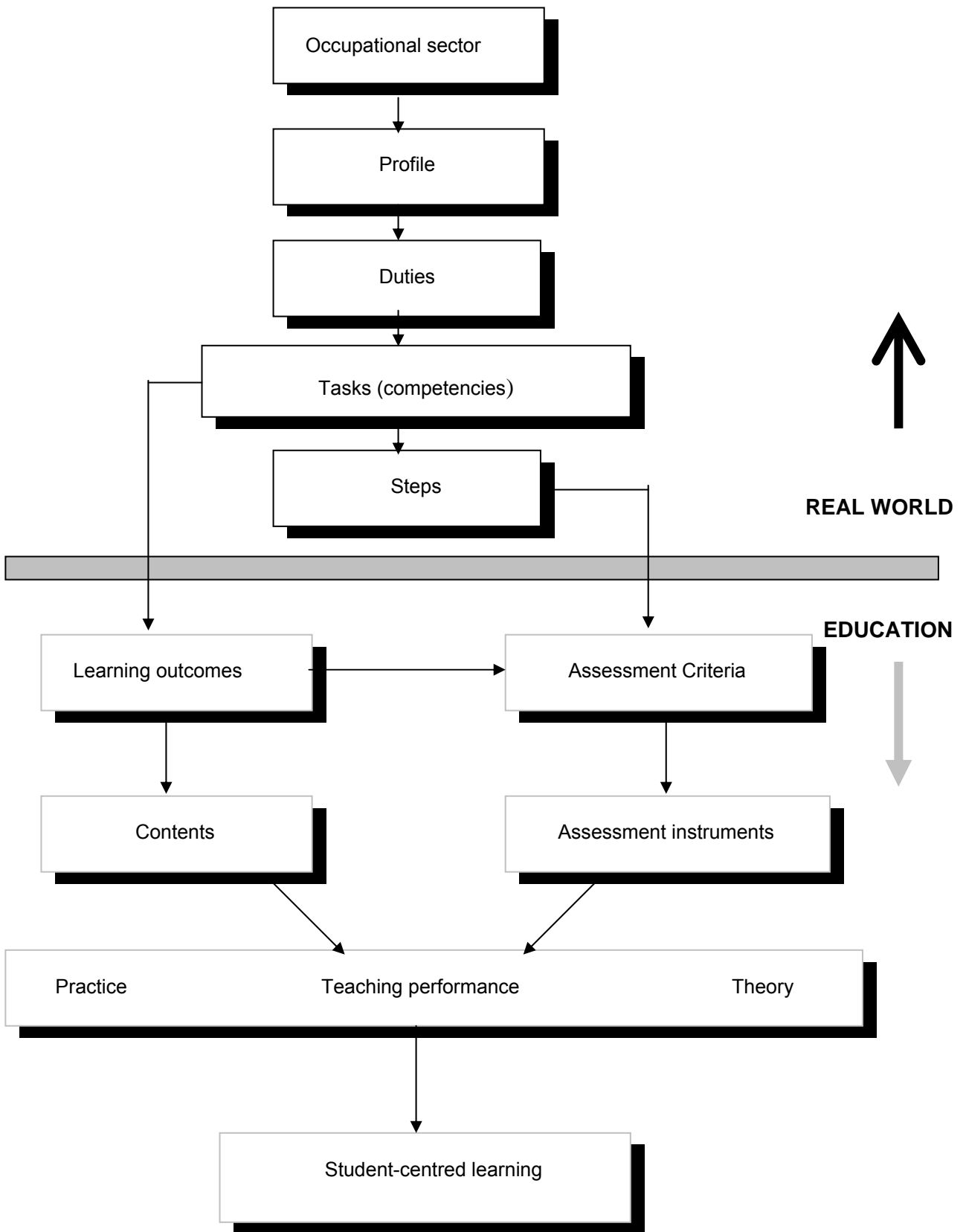
A "competency profile" is a set of competencies and associated behaviours that link directly to the work to be performed.

The set up of the competency profile means a collection of the competencies stated in the goals of the modules and grouping the main knowledge, skills and attitudes related to the goals.

The development of an outcome-based occupational profile provides a document with many potential uses. Produced in a chart form, like the table used in Serbian curricula, the profile graphically displays the main outline of the knowledge, skills and attitudes learned in the programme.

By referring to such a profile, students and interested others (e.g. company executives) can comprehend the total programme and its contents more readily. They can quickly see that the programme is designed to prepare students to perform those skills (actually what the employee is able to do on the job).

The profile can also be used in helping students develop their learning plans. In the perspective of life-long learning, the future need for adults will be to identify those skills they already possess and those they wish to develop. This will go for unemployed as well as for employees. From the table of the occupational profile it is possible to go further on to the modules and to select the exact module needed. Employees with an outdated education will benefit from the modules that in short term can provide them with the competences that they are lacking.



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### **3 or 4 year Vocational Education**

The criteria for the VET school programmes require general and vocational subjects, transformed in theory and practice to ensure employability and further education options at both the 3-year and 4 year levels.

For the 3-year programme level:

- Academic competency achievement requirements must be defined for the end of the 3 years and might be best provided through applied general subjects.
- Occupational competency achievement requirements and employment options must be defined for the end of the 3-year programme. Occupational competencies may be obtained with a high extend of vocational practice.

For the 4-years programme level:

- Academic competency achievement requirements must be defined for the end of the 4 years, taking in account the possibilities for students to continuing their educational path. Here it is worth mentioning that the level of academic competencies must be in accordance with the requirements for entering higher education at university level.
- Occupational competency achievement requirements and employment options must be defined for the end of the 4-year programme. In order to ensure the employability, also the 4-year programme needs vocational practice.

### **Phase 3: Implementation of Curricula**

The implementation phase deals with how the learning outcomes and supporting contents will be taught: what learning activities, training materials, and teaching methods will lead students to mastery of the required skills and knowledge.

Because this is a systems approach, each phase builds upon the work of the previous phase(s). The competency profile provides the bare bones of the learning programme, and modules and operational plans provide the specific details.

If the modules/subjects are developed correctly, they reflect the preferred training setting (classroom, workshop, etc.) and the desired level of performance (e.g. knowledge, simulation, actual performance). This information, in turn, suggests what activities would be appropriate, what materials are needed, and what methods should be employed.

If the learning outcomes state that the student needs to perform a manipulative skill, for example, then the methods, materials, and activities should facilitate and support skill development. The skill might be demonstrated in class (show a videotaped or filmed demonstration) and the teacher provides the students with a handout that lists the steps and safety requirements involved in performing the skill. And, once the students have seen the skill performed and read about the steps involved, they should be required to participate in an activity involving practice of the skill, perhaps in a guided laboratory experience.

Putting the plans to use assumes the presence of trained teachers/trainers, access to the needed facilities and equipment, and the availability of students who possess the prerequisite (entry-level) knowledge and skills to succeed in the planned programme. Each teacher/trainer, then, is responsible for preparing for and conducting teaching on the basis of the developed operational plans.

For further information about implementation of curricula, please refer to the 'Handbook on Implementation of New Curricula'.

### General and Vocational Subject Integration

This chapter is intending to develop a creative and innovative option for the 3 and 4 years programme of the VET schools that will provide expanded opportunities for students.

The use of applied general subjects is a way to motivate students, who are not interested in learning academic concepts because they can not see a reason to learn them. But if the general subjects (academic) content is made more relevant, with examples from the "real world", students will respond more positively.

As with most education initiatives, there are a variety of definitions and approaches used to implement academic and vocational integration – but basically, integration involves teaching that incorporates examples from one module/subject to another module/subject.

Integration can be as simple as teachers from academic (general) and occupational areas work together to plan joint activities for students. An example might be a project where students from both math and electronics classes work collaboratively to accomplish tasks involving complementary concepts from both disciplines. Another example might involve physics and automotive classes where the teachers have planned to teach the concepts of transmission of power simultaneously so each one reinforces the other and students are better able to see the connections.

The curricula for the study of general subjects and the curricula for specific technical skills must be coordinated in a step-by-step progression.

Much of the research on effective learning environments supports the concept of applied academics. In fact, studies have shown that pupils, students and adults learn best in an environment that requires active processing, stimulates creativity and innovation, and that includes authenticity or meaningful content. How these learning environments are constructed is directly related to the teaching methodologies used in the classroom. Techniques such as guided practice, role-playing, writing and interviewing are listed as the most effective. Among the least effective are lecturing, panel presentations, viewing films or tapes and exhibiting materials.

## **Phase 4: Assessment of Achieved Outcomes**

Measuring the achievement of learning outcomes involves the development of another foundation piece: assessment instruments. Using the clues provided by the action word in the learning outcomes

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(e.g. construct, repair, recall, classify), the appropriate instruments can be devised, taking into consideration if the instrument should measure knowledge or skills.

Learning and assessment must be linked at the beginning of learning so that students know how their success will be measured. Clearly identified learning outcomes provide vital information about what the student is expected to do at the end of the learning experience and how performance will be assessed (e.g. what assessment criteria must be met).

### **Assessment of knowledge**

Knowledge assessment is the process of determining whether students have achieved the cognitive learning outcomes. Assessment is, in large part, carried out through the use of tests, - systematic tools used to determine the amount of learning a student has achieved.

### **Assessment Techniques**

There are a number of different ways to assess knowledge. In some situations, in an informal way – formative assessment - e.g. just a short oral quiz to refresh the students' memory or a full-blown, formal written test, - summative assessment – for giving marks.

Regardless of how formal or informal the testing situation is, however, the assessment techniques that is used to measure student knowledge will be of two types: objective and subjective.

Some kinds of knowledge test are called objective. Teachers/assessors do not need to use either judgement or opinion to determine whether a student's answer is right or wrong. Students' answer can be compared to a simple scoring or answer key. The following types of techniques are considered to be objective:

- Multiple-choice
- Matching
- Completion
- True-false

Other kinds of assessment techniques are called subjective because they do not require the use of judgement and interpretation in scoring answers. Teachers/assessors must resolve a number of questions in scoring subjective techniques: Is a given answer right answer? Is it partially right? If a question is worth 20 points, how many points should be awarded a partially right answer? The following types of techniques are considered to be subjective:

- Essay
- Oral presentation



There is another basic difference in these techniques. Some techniques require students to supply the answer from memory. The subjective types are mainly supply items. Of the objective types, only one is a supply item: completion. Completion technique requires students to respond by filling in the blank or giving a short answer (word, numeral, symbol, or phrase), again from memory.

The other types of objective techniques (multiple-choice, matching, and true-false) are selection types. Students are given two or more possible answers from which to select the correct answer or answers. Selection techniques test students' ability to recognise correct information, whereas supply techniques test students' ability to recall correct information and, in some cases, to interpret, apply, analyse, synthesise, or evaluate it as well.

### **Assessment of skills**

Skills Assessment is the process of determining whether the students have achieved the skill outcomes. The assessment activity most appropriate for this determination is called performance testing, most often conducted as part of laboratory/workshop training, performance testing provides a practical means of assessing how well students actually perform in (1) carrying out a process or sequence of tasks and/or (2) creating a product.

The assessment instrument used for performance testing is often called performance measure. Cognition is also measured implicitly; in performing, which means that the student is applying the knowledge gained. Likewise, some of the assessment criteria specified may be related to the attitude domain. Performing a task frequently involves far more than simply performing the right steps in the right sequence. When assessment criteria measure whether the task was performed carefully, neatly, and safely, the attitude domain is involved.

Notice that the term, assessment criteria, plays a major role in this discussion. Each student is measured against specific established assessment criteria.

### **The Good Assessment: In Theory and in Practice**

What makes assessments good or bad? What qualities should the assessment instruments have?

Should the instruments be build on objective or subjective techniques? How to choose?

There is general agreement that good assessment instruments should have three key characteristics.

They must be valid, reliable, and usable.

The following intend to helping to ensure that assessment instruments measure what they are supposed to measure, and measure it consistently, while remaining practical and usable.

Base assessment instruments on the learning outcomes (and assessment criteria). The learning outcomes in a curriculum indicate what students should be able to do (as a result of teaching) in order to demonstrate mastery of knowledge, skills, and attitude.

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The learning outcomes specify the level of knowledge or skills required and the criteria against which the students' achievements should be measured. The assessment instruments are therefore developed in the way that the students can demonstrate the required knowledge or skills at a specified level (e.g. recall, analyse, install, assemble, etc.) This will be of great importance in ensuring that the assessment instrument has high validity – that it actually measures what it is supposed to.

Provide clear, full, and simple directions. Difficult, complicated, incomplete directions can reduce the validity and reliability of the assessment, because the measurement will not be consistent. Some students will answer in one way because they thought they were supposed to, whereas other students will answer it in a complete different way, again because they thought they were supposed to. Should this occur, scores will not truly indicate whether students knew the material or not.

The students may be helped by including a sample item, with the correct answers appropriate marked, along with test directions. An example provides students with another opportunity to be sure they understand the direction appropriately.

For further information about 'Assessment' please, refer to the Handbook "Assessment in Secondary Vocational Education and Training"

## **Evaluation**

Evaluation of the educational programme and its modules/subjects generally serves the following purposes:

- To improve the curriculum - Curriculum improvement is probably the most important purpose that evaluation can fulfil. If the results of knowledge tests indicate consistently the students are not learning adequately, those responsible for curriculum development will want to take steps to remedy the situation. This may involve working with rethinking how the curriculum is designed so that learning does occur when the education is offered again in the future. The assessment results thus can provide one source of vital information for overall curriculum evaluation. It could also involve working with the teacher to improve his/her teaching ability.
- To assist in making and justifying decisions - Many decisions must be made in the process of developing and maintaining a high-quality educational programme; for example: What programmes should be offered and what educational content should be included? What entry-level skills should students possess? What changes/improvements to existing curricula must be made to ensure their effectiveness? Decisions that are based on intuition alone often lead to undesirable outcomes. Rational decisions, based on evaluative information, are defensible and justifiable.

In summary then, a system approach to education and training involves specific steps. These steps build upon the other. In addition, completing all steps produces information that is useful in future planning. Thus, the system ensures that decisions are arrived at through data-gathering and sound

logic rather than guesswork, and the system strengthens itself by using the data gathered to improve subsequent education and training.



**Annex 1. Example of a module**

**OBJECTIVES, OUTCOMES, RECOMMENDED CONTENT AND GUIDELINES FOR IMPLEMENTATION AND ASSESSMENT OF MODULES**

Module:	TC installations and equipment	Module reference no:	1/2	Module duration:	116 classes
OBJECTIVES	OUTCOMES Upon the completion of the module student is able to:	RECOMMENDED CONTENT OF THE MODULE	RECOMMENDED GUIDELINES FOR IMPLEMENTATION AND ASSESSMENT OF THE MODULE		
<ul style="list-style-type: none"> <li>Enabling a student for processing, grouping, connecting/joining, soldering installation cables and conductors and for assembling/mounting installation equipment</li> </ul>	<ol style="list-style-type: none"> <li>List types and components of installation cables and conductors</li> <li>Prepare tools and materials for processing and connecting installation cables on reglets and connectors</li> <li>Process installation cables, group and connect on reglet and connectors, by shooting in and connecting</li> <li>Join and solder installation conductors and cables on reglets and entwine the wires</li> <li>Explain the types and role of installation equipment and devices</li> <li>Explain the types and role of protection and grounding for telephone installations, equipment and devices</li> <li>Assemble installation equipment and electrical protection of equipment and devices</li> <li>Make a telephone installation for ZTF connection</li> <li>Explain types and causes of problems and damages on telephone installations</li> <li>Check telephone installation and fix damages and problems</li> <li>Range the wiring closet</li> <li>End TC cables into wiring closet</li> <li>Make and ground equipment.</li> </ol>	<ul style="list-style-type: none"> <li>Installation conductors and cables with copper conductors, coaxial cables , types and components</li> <li>Materials for isolation of electrical conductors and cables</li> <li>Electrical and transmission characteristics of installation cables and conductors</li> <li>Equipment and devices for phone installations: - distributional, input &amp; output wiring closets, fuse boxes, safety fuses, grounds, KRONE regelets etc...</li> <li>Multipin and BNC connectors (connectors for coaxial cables)</li> <li>Specialized pliers for cables and connecting</li> <li>Tools for shooting conductors into reglets</li> <li>Solders, universal instrument, installation tools...</li> <li>MT combination, tester for connected cables, conductivity checker</li> <li>Standards and norms for telephone installations, TC equipment and protection of telephone equipment and devices</li> </ul>	<p>At the beginning of the module objectives, outcomes, the plan and way of assessment.</p> <p>The attitudes of a student envisaged by the module should be formed and assessed during all teaching forms.</p> <p>Teaching forms</p> <p>The module should be carried out through:</p> <ul style="list-style-type: none"> <li>theory</li> <li>practice</li> </ul> <p>A class division</p> <p>A class should be divided into two groups while carrying out:</p> <ul style="list-style-type: none"> <li>practice</li> <li>theory</li> </ul> <p>Teaching place</p> <ul style="list-style-type: none"> <li>Theory teaching should be carried out in a cabinet for theory teaching</li> <li>Practice should be carried out in a cabinet for practice</li> </ul> <p>*Specific aspects of the module implementation</p> <p>Assessment</p> <p>The assessment of outcome achievement should be done through:</p> <ul style="list-style-type: none"> <li>Monitoring outcome achievement</li> <li>Knowledge tests</li> <li>Practical skills tests</li> </ul>		

**Annex 2. Bloom's Cognitive Taxonomy**

Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
<p>Definition: Remembers previously learned material.</p> <ul style="list-style-type: none"> <li>• cite</li> <li>• define</li> <li>• describe</li> <li>• numerate</li> <li>• identify</li> <li>• indicate</li> <li>• label</li> <li>• list</li> <li>• locate</li> <li>• match</li> <li>• name</li> <li>• outline</li> <li>• point</li> <li>• recall</li> <li>• recognize</li> <li>• reproduce</li> <li>• select</li> <li>• state</li> <li>• tabulate</li> <li>• write</li> </ul>	<p>Definition: Grasps the meaning of material (lowest level of understanding)</p> <ul style="list-style-type: none"> <li>• approximate</li> <li>• articulate</li> <li>• associate</li> <li>• characterize</li> <li>• clarify</li> <li>• classify</li> <li>• contrast</li> <li>• convert</li> <li>• differentiate</li> <li>• delineate</li> <li>• describe</li> <li>• discuss</li> <li>• explain</li> <li>• give example</li> <li>• locate</li> <li>• paraphrase</li> <li>• predict</li> <li>• review</li> <li>• summarize</li> <li>• translate</li> </ul>	<p>Definition: Uses learning in a new and concrete situation (higher level understanding).</p> <ul style="list-style-type: none"> <li>• adapt</li> <li>• apply</li> <li>• calculate</li> <li>• classify</li> <li>• complete</li> <li>• compute</li> <li>• demonstrate</li> <li>• determine</li> <li>• discover</li> <li>• establish</li> <li>• estimate</li> <li>• explore</li> <li>• factor</li> <li>• illustrate</li> <li>• investigate</li> <li>• make</li> <li>• manipulate</li> <li>• maintain</li> <li>• orient</li> <li>• perform</li> <li>• predict</li> <li>• prepare</li> <li>• produce</li> <li>• relate</li> <li>• set</li> <li>• simulate</li> <li>• solve</li> <li>• use</li> </ul>	<p>Definition: Understands both the content and structure of material.</p> <ul style="list-style-type: none"> <li>• analyze</li> <li>• break down</li> <li>• categorize</li> <li>• compare</li> <li>• contrast</li> <li>• correlate</li> <li>• deduce</li> <li>• detect</li> <li>• differentiate</li> <li>• discriminate</li> <li>• examine</li> <li>• figure out</li> <li>• group</li> <li>• manage</li> <li>• maximize</li> <li>• minimize</li> <li>• optimize</li> <li>• order</li> <li>• outline</li> <li>• select</li> <li>• separate</li> <li>• train</li> <li>• transform</li> </ul>	<p>Definition: Formulates new structures from existing knowledge and skills.</p> <ul style="list-style-type: none"> <li>• arrange</li> <li>• assemble</li> <li>• budget</li> <li>• code</li> <li>• combine</li> <li>• compile</li> <li>• construct</li> <li>• create</li> <li>• cultivate</li> <li>• design</li> <li>• develop</li> <li>• enhance</li> <li>• explain</li> <li>• facilitate</li> <li>• formulate</li> <li>• generalize</li> <li>• generate</li> <li>• improve</li> <li>• integrate</li> <li>• organize</li> <li>• plan</li> <li>• prepare</li> <li>• produce</li> <li>• propose</li> <li>• relate</li> <li>• revise</li> <li>• sequence</li> <li>• specify</li> <li>• write</li> </ul>	<p>Definition: Judges the value of material for a given purpose.</p> <ul style="list-style-type: none"> <li>• alleviate</li> <li>• assess</li> <li>• communicate</li> <li>• conclude</li> <li>• consider</li> <li>• counsel</li> <li>• criticize</li> <li>• critique</li> <li>• decide</li> <li>• defend</li> <li>• detect</li> <li>• elicit</li> <li>• estimate</li> <li>• evaluate</li> <li>• grade</li> <li>• interpret</li> <li>• judge</li> <li>• justify</li> <li>• measure</li> <li>• predict</li> <li>• prescribe</li> <li>• rank</li> <li>• rate</li> <li>• recommend</li> <li>• reinforce</li> <li>• release</li> <li>• review</li> <li>• select</li> <li>• score</li> <li>• support</li> <li>• test</li> <li>• validate</li> <li>• verify</li> </ul>

### Annex 3. Psychomotor domain

Psychomotor domain

				Naturalisation	
			Articulation	Definition: Completes one or more skills with ease Example: Responds effectively to unexpected experiences. Performs a task with a machine that it was not originally intended to do (machine is not damaged and there is no danger in performing the new task).	
		Precision	Definition: Combines one or more skills in sequence with harmony and consistency Example: Manoeuvres a car into a tight parallel parking spot. Operates a computer quickly and accurately. Displays competences while playing the piano		
	<th>Manipulation</th>	Manipulation	Definition: Reproduces a skill with accuracy. The accuracy is achieved by practicing Example: Performs a mathematical equation as demonstrated. Follows instructions to build a model. Responds hand-signals of instructor while learning to operate a forklift. Use a personal computer. Repair a leaking faucet. Drive a car.	<ul style="list-style-type: none"> <li>boil</li> <li>brake</li> <li>correct</li> <li>cross</li> <li>elevate</li> <li>focus</li> <li>fry</li> <li>hit</li> <li>jump</li> <li>paint</li> <li>pass</li> <li>plane</li> <li>rearrange</li> <li>saw</li> <li>sew</li> <li>steer</li> <li>thread</li> <li>type</li> <li>weave</li> </ul>	<ul style="list-style-type: none"> <li>adapt</li> <li>alter</li> <li>change</li> <li>organise</li> <li>combine</li> <li>assemble</li> <li>compose</li> <li>construct</li> <li>create</li> <li>design</li> <li>shape</li> </ul>
<th>Imitation</th>	Imitation	Definition: Performs skills according to instruction rather than observation Example: Knows and acts upon sequence of steps in the manufacturing process. Recognises one's abilities and limitations. Shows desire to learn a new process (motivation). NOTE: This subdivision of Psychomotor is closely related with the "Responding" subdivision of the Affective domain	<ul style="list-style-type: none"> <li>assemble</li> <li>calibrate</li> <li>dismantle</li> <li>fasten</li> <li>fixe</li> <li>grind</li> <li>heat</li> <li>illustrate</li> <li>mend</li> <li>mix</li> <li>operate</li> <li>sketch</li> <li>trace</li> <li>react</li> <li>respond</li> <li>revise</li> <li>refine</li> <li>transfer</li> </ul>		
Definition: observes skills and tries to repeat Example: Estimates where a ball will land after it is thrown and then moving to the correct location to catch the ball. Adjusts heat of stove to correct temperature by smell and taste of food. Adjusts the height of the fork on a forklift by comparing where the forks are in relation to the pallet.					
<ul style="list-style-type: none"> <li>adjust</li> <li>choose</li> <li>copy</li> <li>detect</li> <li>differentiate</li> <li>distinguish</li> <li>identify</li> <li>follow</li> <li>imitate</li> <li>select</li> <li>repeat</li> <li>reproduce</li> </ul>	<ul style="list-style-type: none"> <li>complete</li> <li>execute</li> <li>display</li> <li>explain</li> <li>move</li> <li>manipulate</li> <li>measure</li> <li>proceed</li> <li>react</li> <li>show</li> <li>state</li> <li>use</li> </ul>				

## Annex 4. Affective domain

Affective domain

					Characterising
				<b>Organising</b>	
			<b>Valuing</b>		
	<b>Responding</b>				
<b>Receiving</b>					
<p>Definition: Awareness, passively attending to certain stimuli</p> <p>Example: Listen to others with respect. Listen and remember the name of newly introduced people</p> <ul style="list-style-type: none"> <li>ask</li> <li>choose</li> <li>describe</li> <li>follow</li> <li>give</li> <li>hold</li> <li>identify</li> <li>locate</li> <li>name</li> <li>notice</li> <li>point to</li> <li>select</li> <li>erect</li> <li>reply</li> <li>use</li> <li>tolerate</li> </ul>	<p>Definition: Complies to given expectations by reacting to stimuli</p> <p>Example: participates in class discussions. Gives a presentation. Questions new ideal, concepts, models, etc. in order to fully understand them. Know the safety rules and practice them.</p> <ul style="list-style-type: none"> <li>answer</li> <li>assist</li> <li>attempt</li> <li>conform</li> <li>co-operate</li> <li>discuss</li> <li>greet</li> <li>help</li> <li>label</li> <li>practice</li> <li>present</li> <li>read</li> <li>react</li> <li>recite</li> <li>report</li> <li>select</li> <li>share</li> <li>tell</li> <li>write</li> <li>visit</li> <li>volunteer</li> <li>question</li> </ul>	<p>Definition: Displaying behaviour consistent with a single belief or attitude in situations where not forced to obey</p> <p>Example: Demonstrates belief in the democratic process. Is sensitive towards individual and cultural differences (value diversity) Shows the ability to solve problems. Proposes a plan to social improvement and follows through with commitment. Informs management on matters that one feels strongly about</p> <ul style="list-style-type: none"> <li>accept</li> <li>complete</li> <li>demonstrate</li> <li>differentiate</li> <li>explain</li> <li>elect</li> <li>follow</li> <li>form</li> <li>initiate</li> <li>join</li> <li>justify</li> <li>propose</li> <li>read</li> <li>report</li> <li>select</li> <li>share</li> <li>support</li> <li>work</li> </ul>	<p>Definition: committed to a set of values as displayed by behaviour</p> <p>Example: Recognises the need for balance between freedom and responsible behaviour. Accepts responsibility for one's behaviour. Explains the role of systematic planning in solving problems. Accepts professional ethical standards. Creates a life plan in harmony with abilities, interests, and beliefs. Prioritise time effectively to meet the needs of the organisation, family, and self</p> <ul style="list-style-type: none"> <li>adhere</li> <li>alter</li> <li>appraise</li> <li>challenge</li> <li>combine</li> <li>compare</li> <li>defend</li> <li>explain</li> <li>formulate</li> <li>generalise</li> <li>integrate</li> <li>modify</li> <li>organise</li> <li>prepare</li> <li>relate</li> <li>synthesise</li> </ul>	<p>Definition: total behaviour consistent with internalised values</p> <p>Example: Shows self-reliance when working independently. Co-operates in group activities (displays team work). Uses an objective approach in problem solving. Displays a professional commitment to ethical practice on a daily basis. Revises judgements and changes behaviour in light of new evidence. Values people for what they are, not how they look.</p> <ul style="list-style-type: none"> <li>act</li> <li>discriminate</li> <li>display</li> <li>influence</li> <li>insist</li> <li>modify</li> <li>perform</li> <li>practice</li> <li>propose</li> <li>qualify</li> <li>revise</li> <li>serve</li> <li>solve</li> <li>verify</li> <li></li> </ul>	



Annex 5. Comparison of domains

Blooms Taxonomy

I N C R E A S I N G  D I F F I C U L T Y	↑	Domain		
		Cognitive	Psychomotor	Affective
		Evaluation: makes decisions and judgements based on criteria or rationale	Naturalisation: completes one or more skills with ease and becomes automatic.	Characterising: total behaviour consistent with internalised values
		Synthesis: combines elements to form new entity from the original one		
		Analysis: separates whole into parts until relationships are clear	Articulation: combines one or more skills in sequence with harmony and consistency	Organising: committed to a set of values as displayed by behaviour.
		Application: uses information in a situation different from original learning context	Precision: reproduces a skill with accuracy proportion and exactness and usually performed independently of original source	Valuing: displaying behaviour consistent with a single belief or attitude in situations where not forced to obey.
		Understanding: interpret, translate or summarise given information	Manipulation: performs skills according to instruction rather than observation	Responding: complies to given expectations by reacting to stimuli
		Knowledge: recognition and recall of information	Imitation: observes skills and tries to repeat	Receiving: aware of passively attending to certain stimuli

Performance levels within the three domains

**Annex 6.** General vocational subject

Subject : TECHNIC OF DIGITAL TRANSMISSION

Fond of classes per year 99 classes

Class Third

Objective 1. Gaining necessary knowledge needed for working in TC network

Topics	Objective	Outcomes Upon completion of the module, the student is able to:	Recommended contents according to topic	Ways of implementation of programme
Digital signals	<ul style="list-style-type: none"> <li>Gain knowledge on digital signals</li> </ul>	<ul style="list-style-type: none"> <li>Explain concept of digital signal.</li> </ul>	<ul style="list-style-type: none"> <li>Concept of digital signal. Rectangle impulse. Pulse-ranging technique train. Spectre of rectangle impulse.</li> <li>Binary and M-arm signal</li> </ul>	<ul style="list-style-type: none"> <li>At the beginning of the module, introduce objective/s and outcomes, plan and assessment methods to students.</li> </ul> <p>Teaching processes</p>
Impact of transmission system on digital signals	<ul style="list-style-type: none"> <li>Gain knowledge on impact of system functions on digital signals</li> </ul>	<ul style="list-style-type: none"> <li>Analyse impact of transmission on digital signal</li> </ul>	<ul style="list-style-type: none"> <li>Impact of transmission system on digital signal.</li> <li>Impact of noise on digital signal transmitting.</li> <li>Speed of transmission</li> <li>Capacity of channels</li> </ul>	<ul style="list-style-type: none"> <li>The subject will be implemented through following teaching processes</li> <li>Theoretical teaching 66 classes</li> <li>Exercise 33 classes</li> </ul> <p>Class division per groups</p> <p>The class will be divided into 2 groups during implementation:</p>
Digitalisation of a system	<ul style="list-style-type: none"> <li>Gain knowledge on digitalisation of a system</li> </ul>	<ul style="list-style-type: none"> <li>Explain scaling of signal</li> <li>Explain quant process of signal</li> <li>Explain coding of signal</li> </ul>	<ul style="list-style-type: none"> <li>Discretization of signal by time (uniform and non-uniform timing). Theorem of timing. Reconstruction of timed signal.</li> <li>Discretization of signal by current values (number of quant, errors in quant process). Uniform and non-uniform quant process. Compression.</li> <li>Coding. Classification of PCM coders. Decoding.</li> <li>Impulse-code modulation</li> </ul>	<p>Place for teaching implementation</p> <ul style="list-style-type: none"> <li>Theoretical teaching will be implemented in classroom/cabinet</li> <li>exercises will be implemented in laboratory</li> </ul> <p>Recommendations for teaching implementation</p> <ul style="list-style-type: none"> <li>Digital signals To define a signal as a physical process, carrying some message, to give an example, to show signal in time and frequency domain. Analysis and synthesis of complex-periodical rectangle signal, to process on wave level</li> </ul>
Signal processing before entering the line	<ul style="list-style-type: none"> <li>Gain knowledge on signal processing before entering the line</li> </ul>	<ul style="list-style-type: none"> <li>Explain signal processing before entering the line</li> </ul>	<ul style="list-style-type: none"> <li>Line codes. Protection coding, Protection systems, role and types of codes.</li> </ul>	
Quality of digital transmission	<ul style="list-style-type: none"> <li>Gain knowledge on quality of digital transmission</li> </ul>	<ul style="list-style-type: none"> <li>Explain impact of inter-symbolic interference and jitter on quality of digital transmission</li> </ul>	<ul style="list-style-type: none"> <li>Display of inter-symbolic interference, bit error, jitter, eye diagram.</li> </ul>	<ul style="list-style-type: none"> <li>Impact of transmitting system function on digital signals. To get familiar with impact of non-perfect system functions. To outline negative impact of noise. To</li> </ul>

Digital modulations	<ul style="list-style-type: none"> <li>Gain knowledge on digital modulation</li> </ul>	<ul style="list-style-type: none"> <li>Explain the role of digital modulations</li> </ul>	<ul style="list-style-type: none"> <li>Concept of digital modulations, and their role in digital systems. Digital amplitude modulations ASK, Digital frequency modulations FSK, Digital phase modulations PSK.</li> </ul>	<p>define the speed of transmission and concept of channels</p> <ul style="list-style-type: none"> <li>Signal digitalisation To clarify the concept of discrete signal, discretization of signal by time, and current values. To show the process of coding and decoding on concrete coder and decoder.</li> <li>Signal processing before entering the line To explain adjustment of lines to digital signal, to explain methods of line coding, with emphasis on reasons for their usage, and the importance of scrambling. In case of optical transmission, to point out codes needed for this type of transmission.</li> <li>Quality of digital transmission To get familiar with impact of inter-symbolic interference and concept of jitter. To define bit error.</li> <li>Digital modulations To process modulations of digital signal and subtype</li> <li>Multi-channelled transmission with time rate sequence of channels Students should be able to understand possibility multi-channelled transmission through realisation of time multiplex. To explain principle of time multiplex on system PCM-30</li> <li>Regenerative transmission To explain the principle of impulse regeneration in order for students to notice advantage of digital transmission. како би ученици уочили предност дигиталног преноса. To point out importance of proper extraction of basic digital usage.</li> </ul> <p>Assessment Assessment of outcome accomplishment perform through:</p> <ul style="list-style-type: none"> <li>Monitoring of outcome accomplishment</li> <li>Knowledge tests</li> <li>Tests of practical skills</li> </ul>
Multi-channelled transmission with time rate sequence of channels	<ul style="list-style-type: none"> <li>Gain knowledge on multi-channelled transmission with time rate sequence of channels</li> </ul>	<ul style="list-style-type: none"> <li>Explain multi-channelled transmission through realisation of time multiplex and its appliance on PCM-30 system</li> </ul>	<ul style="list-style-type: none"> <li>Time multiplex</li> <li>Formatting of primary PCM frame. Frame and subframe PCM-30 Sincronisation and signalisation. Organisation of upper-level frames.</li> </ul>	
Regenerative transmission	<ul style="list-style-type: none"> <li>Gain knowledge on regenerative transmission</li> </ul>	<ul style="list-style-type: none"> <li>Explain the principle of impulse regeneration</li> </ul>	<ul style="list-style-type: none"> <li>Principle of impulse regeneration.</li> </ul>	

				Approximate number of classes by topics <ul style="list-style-type: none"> <li>▪ Digital signals</li> <li>▪ Impact of transmission systems function on digital signals</li> <li>▪ Signal digitalisation</li> <li>▪ Signal processing before entering the line</li> <li>▪ Quality of digital transmission</li> <li>▪ Digital modulations</li> <li>▪ Multi-channelled transmission through realisation of time multiplex</li> <li>▪ Regenerative process</li> </ul>
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#### RECOMMENDED LITERATURE FOR REALISATION OF SUBJECT

1. Чоја, В., , Основе технике дигиталног преноса за трећи разред електротехничке школе, Завод за уџбенике, Београд, 2003.
2. З., Урошевић, Савић, М., Телекомуникације-елементи теорије, анализе и обраде сигнала, Наука Београд, 1995
3. Менарт, Ј., . Јанковић, Ђ., Живановић, Г., Техника Дигиталног преноса за 4 разред електротехничке школе, ЗУНС Београд

#### CORELATION WITH OTHER SUBJECTS / MODULS

1. Transmission systems
2. Terminal equipment
3. Access networks

