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REPORT ON ACQUIRED TEACHING AND LEARNING METHODS

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University of Nis

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List of abbreviations

AUTh	Aristotle University of Thessaloniki
BOKU	University of Natural Resources and Life Sciences, Vienna
CBHE	Capacity Building in Higher Education
EACEA	Education, Audiovisual and Culture Executive Agency
EHEA	European Higher Education Area
EQF	European Qualification Framework
HE	Higher Education
HEI	Higher Education Institution
NEO	National Erasmus Office
NMBU	Norwegian University of Life Sciences, Norway
PWMC VV	Public Water Management Company ''Vode Vojvodine''
SWARM	Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders
UACEG	University of Architecture, Civil Engineering and Geodesy, Bulgaria
UNI	University of Nis, Serbia
UL	University of Lisbon, Portugal
UoM	University of Montenegro
UNIRIFCE	University of Rijeka, Croatia
UNMO	Dzemal Bijedic University of Mostar
UNS	University of Novi Sad
UNSA	University of Sarajevo
UPKM	University of Pristina in Kosovska Mitrovica
TCASU	Technical College of Applied Sciences Urosevac with temporary seat in Leposavic
WB	Western Balkan
WRM	Water Resources Management

1. Introduction

This document is a part of activity WP2.5 Theme-based training of teaching staff for acquiring new teaching and learning methods created under the project SWARM "Strengthening of master curricula in water resources management for the Western Balkans HEIs and stakeholders" (Project number 597888-EPP-1-2018-1-RS-EPPKA2-CBHE-JP).

The present report initially presents the principles of learning, where the proposed principles are presented. The next chapter is devoted to the learning outcomes of a master programme. Chapter 4 proposes some widely accepted teaching techniques. Finally, the report is concluded with the strategy that was followed for developing new courses and updating existing ones under the aim of innovative approaches that are presented in the first chapters of this report.

2. Principles of learning

The principles of learning together with a short but comprehensive description of those principles are provided in the following bullets:

- Consolidation: The frequent repetition of knowledge is the most effective way to allow the newly acquired knowledge to be adopted. Taking notes or asking questions in class are similarly effective techniques to consolidate knowledge as the repetitive learning process itself.
- Distributed practice: Several shorter study sessions are preferred over fewer and longer study sessions. For beginners' simpler and shorter paths to knowledge acquisition are required than for experts.
- Determinedness: Learning requires a certain level of determinedness to achieve the aim of remembering the knowledge. It is more helpful to keep a constant level of learning challenge rather than only doing it once in a while.
- Meaningful organization: When learning, the human brain requires change and a variation of stimuli. This works best when putting order and structure into the learning matter. Hence, the already existing knowledge frequently requires re-arrangement in order to optimize the mental capacity available. This can be compared to achieving an organized structure on a writing desk. Re-organisation and structuration essentially require time and the capability to group items into meaningful subunits.
- Interest: In order to learn something, interest in the subject must be present. Only relevant, interesting and essentially important information will be retained. Therefore, tutors need to put structure into the matter, avoid confusing details and provide connections to the bigger picture related to the knowledge gained.
- Selectivity: Our brain's capacity for learning is limited. Thus it is not helpful to try to keep insignificant knowledge. Learning therefore should aim at quality rather than quantity. Similar to a bathtub which is overflowing once too much water is filled in, additional knowledge has the tendency to overflow unless a certain level of selectivity is applied to the knowledge, focusing only on the essential aspects.
- Realistic aims: Learning large amounts of knowledge within short time is nearly impossible. Knowledge needs to be divided into manageable pieces in order to always have an end in sight. Realistic learning goals need to be set and appropriate rest phases in between are required.
- Packaging and presentation: For learning success it is important how the learning content is presented. The human brain has a tendency for becoming bored easily, hence diversity and change as well as attractive content and animation are needed to keep a constant level of activation. A teacher thus needs to use various different methods of knowledge presentation, e.g. different ways of presenting learning materials and different teaching methods, to disseminate the knowledge to the students.

- Comprehensibility: Subject matters which are devoid of meaning or use, are much harder, if not outright impossible to learn. Comprehensible and clear content, with examples drawn from life and practical applications, is easy to understand and leads to a better understanding of the learning subject.
- Creativity: Learning ultimately is not just about gathering knowledge. Building on the work and the person centred approach of Knowles (1984) and Rogers (1945) rather it should be seen as a personal development process. In that view, learning is a creative process that allows influences and inspiration by environment to take place. The teacher needs to understand and acknowledge this, and consequentially recognize students as different and unique personalities who might take different paths to achieving the knowledgeable aims of class. It focuses on the student rather than purely the transmission of knowledge and acknowledges the requirements of the student who may have differing abilities and interests within a subject. It requires the student to explore and make mistakes reflecting and learning from them. The goal of the approach is to shift some (if not all) responsibility for learning towards the student rather than complete dependence on the teacher. Hence the recognition of the learning outcomes is important for the teaching institution but also that skills as well as knowledge is built within the student cohort. Hands-on training, if possible, and homework, gives the students the required freedom to gain experience and to experiment what they are learning.

3. Learning outcomes

After understanding the principles of learning and drawing conclusions for the teacher's task of knowledge dissemination, the next step towards setting up a course is the definition of learning outcomes. Learning outcomes assist the teacher in selecting course content, design appropriate exams or other assessment techniques and also devise teaching and/or learning strategies appropriate for the course. On the other hand, the learning outcomes assist the students in identifying what the requirements for success in the course are, and consequentially understand what and for which purpose they are learning.

According to Weber (2017) learning outcomes have four important functions:

- They serve as guideline for teaching.
- They help the teacher in justifying the content he selected for his course.
- They help the teacher select the right teaching methods.
- They serve as evaluation tool for the teacher and his students.

A concept for cognitive learning outcomes was provided by Bloom (1956) and revised by Anderson and Krathwohl in 2001. According to this concept, a pyramid of six categories of thinking skills can be defined from lower to higher order:

- Remember: Recognizing and recalling facts.
- Understand: Understanding what the facts mean.
- Apply: Applying the facts, rules, concepts and ideas.
- Analyse: Breaking down information into component parts.
- Evaluate: Judging the value of information or ideas.
- Create: Combining parts to make a new whole.

When defining learning outcomes, it needs to be specified at which level the students are required to reach, this may typically not be the highest level, but an intermediate level. Learning outcomes (Biggs, 2003) should then be tailored to the desired level and set at programme, module and teaching session levels for a particular course. Bloom's taxonomy provides not only a framework for defining the learning objectives, but also a list of action verbs that can be used for writing down the learning outcomes, Table 1.

Table 1 Action verbs based on Bloom's taxonomy (Weber, 2017)

lower order thinking skills → higher order thinking skills					
remember	**understand**	**apply**	**analyze**	**evaluate**	**create**
arrange	abstract	appraise	attribute	appraise	arrange
copy	categorize	calculate	change	argue	assemble
define	clarify	carry out	combine	assess	compose
describe	classify	classify	compare	check	construct
identify	compare	construct	deconstruct	coordinate	develop
label	conclude	contrast	diagram	critique	create
list	contrast	criticize	differentiate	defend	design
locate	defend	demonstrate	discriminate	detect	devise
name	describe	diagnose	distinguish	estimate	formulate
quote	discuss	estimate	examine	judge	generate
recall	exemplify	execute	figure	monitor	hypothesize
recite	explain	identify	find	predict	invent
recognize	extrapolate	illustrate	coherence	qualify	manage
repeat	generalize	implement	focus	rate	modify
retrieve	identify	interpret	integrate	recommend	organize
select	illustrate	use	modify	support	plan
state	infer		organize	test	prepare
	interpolate		outline		produce
	interpret		predict		propose
	map		select		setup
	match		sketch		verify
	organize		solve		
	paraphrase		structure		
	predict		survey		
	reorganize		test		
	report				
	represent				
	restate				
	review				
	rewrite				
	subsume				
	summarize				
	transform				
	translate				

4. Teaching methods

After setting the learning outcomes of a course, the appropriate teaching methods can be selected. While the typical setup of a course normally involves only PowerPoint presentations, there exists a large number of techniques that consider the principles of learning as stated in chapter 2 and which can be used for specific purposes. It is strongly recommended to augment courses with innovative teaching methods and thereby avoid a tiresome experience for the students and reduced opportunities to learn.

4.1 Problem-Based Learning

Problem-based learning (PBL) approach exposes students to a problem they need to investigate in order to design and discuss solutions (Boud & Grahame 1997). This problem should be real world and ill-structured. It has unclear goals, has incomplete information, includes a high level of complexity, may not have a clear solution and requires an interdisciplinary approach (Savery 2006; Jonassen & Hung 2008; Moore 2011). Therefore, they have to involve collaboration and decision-making process (Savery 2006). PBL can be classified into different types such as diagnosis-solution problems, decision-making problems, policy problems, design problems (Jonassen & Hung 2008). On an environmental issue the students may adopt a diagnosis-solution and decision making problem approach. For instance, the students may be asked to consider the problem of Amazonian deforestation. They will have to analyse its causes and its consequences and to define the responses to mitigate intensive deforestation. However, they will not be asked to implement and evaluate these responses.

Adopting a problem-based learning approach is not as simple as adding a new activity into a traditional curriculum. Indeed it is “Not just a method but a way of learning” (Charles E. Engel in Boud & Grahame 1997). PBL approach implicates that the learning process is predominantly active. Inquiry-based and self-regulated learning (SRL) are key processes (English & Kitsabtas 2013) but not only. Another important process is the collaborative learning resulting from the group activities (Almajed & Skinner 2016). These three processes should occur successfully in order to facilitate the knowledge acquisition, clarification and retention, the development of critical thinking and analysing. Working within a group has also additional advantages. It provides opportunity for conflicting knowledge to be revealed and discussed and for the new knowledge to be co-created. Or, developing such skills is essential in environmental studies and in our educational system where students from different university background and cultures have to interact on a specific problem.

It must be highlighted here that the way a group will understand and solve the problem will vary according to the initial group composition and the group dynamic. This aspect is not without consequences for the teaching team as sufficient flexibility must exist in order to respond to the group learning needs. Indeed PBL is often a challenge for a teacher as his role

change from a specific knowledge provider to a facilitator of learning. Poikela & Poikela (2012) indicate, for instance, that the tutor should support the group in setting and structuring the problem, selecting and supporting and formulating the tasks, acquiring and integrating knowledge and clarifying the issues expressed by the group. The degree of the teacher's intervention in the group and in the individual learning can have a significant impact of their learning and their engagement.

Savin-baden (2016) discusses the opposition between scaffolding and liminality. In a problem-based learning approach the individual and the group are confronted to an ill-problem and, as such, have to experience to be stuck in the solving process and to overcome the difficult on their own. This experience is part of the learning process. But there is always a risk of disengagement and a failure of the learning. One critical issue with student-centred learning is that students have to learn to learn (Barrows and Tamblyn, 1980) and they are not used to it. Teacher can avoid this situation by scaffolding technique when necessary. Yet intervening in interdisciplinary study may be counterproductive as the teacher will naturally impose his disciplinary and thinking approach. Similarly Savin-baden (2016) discusses the issues of pedagogical knowledge and stance. The degree of intervention may vary depending of the module aims and learning outcomes, the problem to solve, the groups and the individual. Certain flexibility is thus required to adapt to specific situations occurring during the semester but the degree of intervention can also be planned in the curriculum. For instance, English & Kitsabtas (2013) propose an increase in self-regulation learning as the student progress in the activities. It permits for the teacher to initially frame the problem and the tasks and to guide the students in their enquiry with sufficient flexibility for creating solutions at the end of the process.

4.2 Computer-based learning

Laurillard (2002) is explicit about the importance of feedback "For the learning process to be fully supported students should receive meaningful intrinsic feedback on their actions" and e-learning is a powerful mechanism for achieving this. It has also enabled skills to be introduced to the students, something that is impractical to do in a lecture or non-computer environment. The introduction of electronic e-learning practicals has allowed greater flexibility in the types of data, technology and resources presented to the students. These sessions have permitted the use of maps, imagery, numerical and textual data that otherwise the student would have little or no access to. E-learning sessions have the potential to broaden the range of geographical experiences of the students, better embedding issues into a global context, as well as permitting local field-based learning.

E-learning sessions can take greater account of individual learning (Laurillard, 2002). Students work their way through the practicals at their own pace and have access to numerous resources in order to help their increase their knowledge. It can be argued that the process of learning in these practicals is much more visible. The students are able to work through a series of tasks and the consolidation and extension of their knowledge is

much more transparent. Perkin (1999) argues that this is a recognised advantage of computer-based learning as opposed to more traditional teaching activities. Elearning can be designed to have elements that tailor the experience even more to the individual student. These aspects could be as straightforward as including preferences for coloured backgrounds and text, through related style-sheets, to more involved aspects that would take account of preferential learning styles and subsequently tailor resources to reflect this.

4.3 Group learning

As Biggs (2003) highlights that peer-group activities allow the students to discuss issues uninhibitedly with each other and follow through the processes of learning. It is important also to consider the size of group as Biggs (2003) suggests that this determines if each of the students can feel commitment and responsibility for the work.

4.4 Field-based learning (fieldwork)

Field-based learning can add some positive benefits to many water resources management related teaching and learning experiences. Fuller et al. (2000) argue that there are two difference approaches to the teaching and practice of field-based geography 'descriptive-explanatory' and 'analytical-predictive'. The first involves a more traditional approach whereby knowledge is merely transferred to students from the teacher. Students may still be asked to collect data and information; however they will be informed about the implication of these data for the field environment. The latter involves asking the students to carry out a "directed, semi-independent investigation [through which] to encourage students to see for themselves and deduce for themselves" ideas about the environment in which they are working. Fuller et al. (2000) argue that the value of each approach depends upon the level and experience of the students.

Allowing the students more freedom and encouraging them to engage in an activity that was more 'student-led' hopes that students would be encouraged to take greater responsibility for their own learning. Fuller et al. (2000) recognise this as a 'key educational objective' that is satisfied through fieldwork, particularly that which is project-based. It is hoped that by setting the students a problem/goal to achieve and by arranging them into groups, they will take on this challenge and engage with the task at hand. Through field-based project activities it is hoped that students would develop a number of personal, educational (e.g. data collection, critical analysis, reflection) and transferable skills. The activity-based nature of the project fostered deeper and more independent thinking (Ramsden, 1991).

Fieldwork is also recognized as challenging the relationship between the 'teacher' and the 'learner' and being a good way in which the normal barriers between the teacher and

student can be broken down enabling the students to more readily take part in exercises and learn more effectively (Dando and Weidel, 1971; as cited in Fuller et al., 2000). During fieldwork splitting students into groups can have additional advantages. If handled well, students often comment that they enjoy the element of competition involved and this can foster friendships within groups and also motivate them to work hard, be organised and do well. As Livingstone (1999, p72) argues this type of project and particularly public inquiry role-playing "helps students engage with the planning process and begin to grasp that decisions are made by individuals and groups of individuals with whom they can emphasise". By providing the students with a project brief and allowing them to follow through the processes of designing and justifying a project enables students to experience many aspects of the 'experimental learning cycle' (Kolb, 1984; as cited in Race, 2007, p7).

5. Implemented strategy for courses innovation

The strategy that was proposed to be followed in order to integrate innovation issues in the existing and new courses, is interconnected with the principal aim of the current programme, i.e. the strengthening of master curricula by promoting innovative but also well-established approaches. The proposed strategy is based on two principal issues:

- Utilization of knowledge produced during previous work packages and relevant actions, and
- Continuous consultation with the project partners for the selection of approaches and the decision making processes.

5.1 Utilization of knowledge produced during previous WPs

Regarding the utilization of the knowledge and work that was conducted during the first phases of the programme, the work that was implemented during previous actions of Work Package 2 (WP2) is utilized in the present activity WP2.3. The most characteristic example is the Catalogue of competences that was defined in activity WP2.1 (depicted in the following table), where, afterwards, the WB partners used these competencies to make the appropriate links among subjects and competencies.

Table 2 Catalogue of Competences

General Competencies	Subject-Specific Competencies
• communicating, verbally and in writing, clearly and effectively, • critical thinking, • scenario modeling, • creativity, • initiative, • prediction of solutions and consequences, • collaboration, • working in multidisciplinary team, • working in an international context, • working autonomously, • generating new research ideas, • intensive use of ICT in acquiring knowledge and solving problems, • solving complex multidisciplinary problems in theory and practice applying acquired knowledge, • social and civic responsibility, • development of professional ethics and	• understanding the wider context of the engineering discipline, its practical applications, societal impact and limitations, • acceptance of the general principles and practices of engineering professional codes of conduct, • following general laboratory, workshop and/or fieldwork safety guidance and precautions, • understanding of climate changes and hydrological hazards, • mastering of methods, procedures and processes of risk identification, • devising strategies and developing methodology and methods of emergency as part of WRM, • optimizing and managing available resources in WRM systems, • statistical data processing in order to

responsibility, • effective leadership, • strategic thinking, • identification and analysis of problems in WRM, • experience-based critical decision making, • staying up-to-date with technological development, • holistic and proactive approach to WRM situations, • clearly and unambiguously transfer knowledge to the professional and wider public, • applying knowledge in practice, • retrieving, analyzing and synthesizing data and information, with the use of necessary technologies, • designing and managing projects, • respecting natural environment, • demonstrating social, professional and ethical commitment and sensitivity to gender issues, • being critical and self-critical, • using acquired theoretical and practical knowledge to solve unseen engineering problems, • presenting written technical reports to others and to make oral presentations that are reasoned, logical and time-limited, to a variety of audiences, • responding to written material critically, effectively and efficiently, • presenting ideas, key facts, problem solutions and results effectively, both orally and in writing, in a variety of settings including group/team work.	define and make adequate conclusions, • applying ICT in WRM, • development of human resources in WRM, • applying specialized civil engineering fields in WRM, • understanding and using appropriate methods for research design regarding data collection and analysis, particularly focused on contemporary qualitative and quantitative methods, cognizant of the needs of special populations, • using appropriate engineering software packages as an aid to research, analysis, problem solving and presentation, • using computer systems to access learning resources, receive communications regarding the degree programme, undertake assessments and submit assignments, • preparing technical drawings by hand (following appropriate training), • producing sketches to communicate ideas and concepts, • using chemicals and other consumables competently and safely (following appropriate training), • using appropriate equipment competently and safely (following appropriate training), • forming logical, reasonable conclusions and make sound recommendations based on available data and/or observations, • obtaining necessary data from scientific and technical documents, reports, and other reference materials, • undertaking work with a high level of initiative and commitment to the task in hand, • preparing, processing, and interpreting data and/or observations using appropriate techniques, • writing documents dealing with natural resource issues and technical information, drawn from a variety of sources,

	• defining objectives for simple projects in a variety of disciplines and to develop and implement basic work plans, • drafting proposals, funding requests, and requests for proposals, • identifying needs and set priorities, including facilitation of group efforts to define and prioritize broad water resource program needs, • defining information needs, including needs for research, inventory, baseline studies, and follow-up monitoring, • developing innovative solutions to complex or intractable issues, • implementing water supply and water efficiency plans and programs.

Further examples and references of material that was produced in WP1 and WP2 and are used during the implementation process of WP2.3 are mentioned in the following section.

5.2 Consultation with PB for final decisions

As for the consultation process, in WP2.2 entitled as "Development of courses content and syllabi", the WB project partners with the assistant of the EU partners proposed a set of courses per university and provided the courses content and syllabi. To do so, the procedure that was adopted and implemented is consisted in the following 4 interconnected steps:

- **Step 1.** The EU project partners created a report entitled as "EU Universities' Courses and Syllabi". In the report the relevant courses on the thematic of water resources management that are within the curricula of the EU Universities were identified and described. The report was used by the WB Universities as guidance to develop their proposed courses.

- **Step 2.** The project partners concluded on the new courses as well as the existing courses that wanted to be updated. The outputs of this process, i.e. the proposed number of courses per institution, which is clearly described in the WP2.1 and WP2.2. is summarized in the following table, Table 3.

Table 3 Number of new and updated courses per curricula

WB HEI	Undergraduate		Master	
	New courses	Upgrade/improve of existing courses	New courses	Upgrade/improve of existing courses
University of Pristina in Kosovska Mitrovica/ Faculty of Technical Sciences		2	4	
Technical College of Applied Sciences Urosevac-Leposavic			3	
University of Montenegro/ Faculty of Civil Engineering				4
University of Novi Sad/ Faculty of Technical Sciences			5	1
Dzemal Bijedic University of Mostar/ Faculty of Civil Engineering			1	2
University of Nis/ Faculty of Civil Engineering and Architecture	3		1	2
University of Sarajevo/ Faculty of Civil Engineering				4
TOTAL	3	2	14	13

- **Step 3.** A common format for the description of the courses was agreed among the WB project partners. The general form that was proposed and approved is presented in the following table, Table 4.

Table 4 Form for courses description

Study programme:
Level:
The name of the course:
Lecturer (Name, middle name, last name):
Course status:
Number of ECTS:
Prerequisites:
Course objective

<table>
<tr><td colspan="5">Learning outcomes</td></tr>
<tr><td colspan="5">Content</td></tr>
<tr><td colspan="5">Literature</td></tr>
<tr><td colspan="4">Number of classes of active teaching</td><td>Other</td></tr>
<tr><td>Lectures:</td><td>Exercises:</td><td>Other form of lectures:</td><td>Study and research work:</td><td></td></tr>
<tr><td colspan="5">Teaching methods</td></tr>
<tr><td colspan="5">Grade (maximum number of credits 100)</td></tr>
<tr><td>Pre-exam requirements</td><td>Credits</td><td colspan="2">Final exam</td><td>Credits</td></tr>
<tr><td>activity during lectures</td><td></td><td colspan="2">written exam</td><td></td></tr>
<tr><td>practical teaching</td><td></td><td colspan="2">oral exam</td><td></td></tr>
<tr><td>colloquia</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>seminar paper</td><td></td><td colspan="2"></td><td></td></tr>
</table>

- **Step 4.** The WB partners proposed the syllabus of the proposed courses. A consolidated document that included all the syllabus was created and was sent to the EU partners for their comments and reviews.

- **Step 5.** EU partners proceeded in the review of the proposed courses, their content, objective and teaching outcomes. A consolidated review was sent to the WB project partners.

- **Step 6.** The WB partners carefully deliberated the revised courses. Many comments were accepted, but there were also a lot of comments that couldn't be accepted, such as the change of the name of a course, since this is a process that needs approval at Ministerial level. The final report, i.e. the WP2.2 was produced.

It should be noted that all the aforementioned issues relative to learning outcomes, and teaching methods were introduced in the proposed syllabus per HEI.

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