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ACTIVITY-BASED PEDAGOGICAL METHODS IN PRACTICAL EDUCATION OF THE WATER QUALITY PROTECTION SUBJECT

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Abstract:

The goal of Environmental Engineering BSc Education is to teach professionals with appropriate ecological thinking and attitude. Key to achieve this is to introduce new and effective pedagogical methods that help forming system approach and complex thinking.

The most important objective of Water Framework Directive (WFD) is to protect and improve ecological state of water territories, water ecosystems and water connected terrestrial ecosystems. Only a complex-minded, systematically thinking engineer can follow the guideline of WFD.

An activity-oriented education is necessary to develop the right attitude of students. Such methods are the following: examination, observation, experiment, analysis, field exploration, case study, educational contract and impact assessment. All these activity are incorporated in the field project, which is an indispensable part of the environmental engineering education.

This paper shows practice oriented pedagogical methods in teaching Water Quality Protection. The methods reflect the objectives of WFD, according to 3rd National Environment Protection Programme, Decade of Sustainable Education.

Keywords: *environmental engineering educations, ecological attitude, environmental education, Water Framework Directive, pedagogical methods*

INTRODUCTION

Environmental Engineering BSc education in the Hungarian technical studies started in 2006. Its goal was to establish the society of engineers with modern scientific, ecological, technical, economical and management knowledge. According to directives and requirements of the education, environmental engineers are able to recognise environmental problems and jeopardises emerging at different areas and to determine measures to take. They have suitable knowledge how to decrease, prevent and cease existing environmental harms and damages. Engineers know local, regional, national and global environmental problems, furthermore they can use modern measuring and IT equipment as well as eco-friendly technologies and management systems [1]. The purpose of this course therefore is not less than educating technical experts with ecological attitude and complex-minded thinking. Nowadays there's big need for engineers, who can take consideration of economic and ecologic aspects with equal weight. This attitude is essential for sustainable development. Engineers can create, invent lot of things with their technical knowledge, but they can't recreate extinct living systems. The primary task of education is to provide engineers with ecological thinking and system-based approach enabling them to solve complex and global problems and to recognize cause and effect.

Activity-oriented education is the primary tool to develop the right attitude of students. Field exercises are the best out-of-school methods for students to get acquainted with the complex processes

of nature. It is an ideal area where future engineers can get experience to respect and be fond of nature as well as to develop environmental-care behaviour. Field exercise and its pedagogical methods are indispensable part of environmental engineering education, effectively complements traditional school education and ensures to train experts with appropriate ecological attitude.

1. ATTITUDE FORMING IN LINE WITH WATER FRAMEWORK DIRECTIVE (WFD)

The unified water politics of EU, namely the Water Framework Directive (WFD), came into effect on 22nd December 2000. It deals with objectives and tasks evolved by the integration of special areas from ecology, economy and engineering. The most important objective amongst these is to achieve good ecological and chemical state of natural waters by 2015 and to sustain this status in the future. The motif of Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 about establishing a framework for Community actions in the water policy is: „Water is not a usual commercial product, but rather a heritage, that must be protected, defended and treated as such", by this ensuring sustainable water usage. The Directive gives recommendations for ecological water quality improvement of surface waters, recognising the importance of good ecological status, highlighting that „Waters in the Community are under increasing pressure from the continuous growth in demand for sufficient quantities of good quality water for all purposes" [2].

In June 2001, Hungary as a to-be member of EU declared to introduce Water Framework Directive /Government Decision No. 2091/2001 (30/04)/ and committed itself to reforming water resource management. Main change is that ecological attitude has been clearly articulated, which was not typical in the former water assessment and resource management policy. The WFD's most important objective is to protect and improve ecological state of water territories, water ecosystems and water-connected terrestrial ecosystems.

The watershed management concept is another important change that employs systematic approach of water environment. The whole watershed area is treated as a complex system, where a lot of natural and human-created formations, as well as the humans themselves (namely the human society) exist together. Operation and internal attributes of the system depend on hardly controllable and influence able natural effects (such as sunshine, wind, atmospheric fall-outs) and human interference (like waste waters, refuses). These impacts induce changes in state of water supplies and water ecosystems. The system-based approach of water resource management assumes the existence of necessary knowledge. Having this knowledge, appropriate measures can be taken to help preserving water ecosystems and to support water utilisation. Thus water environment doesn't only mean water courses and still waters, but the whole watershed area [3]. This system-based approach is reflected in the Watershed Management Plan (WMP) issued by Central Directorate of Water Conservancy and Environmental Protection in December 2009, which is the base document for implementation of Water Framework Directive in Hungary.

Skill development and attitude forming chapter of WMP (8.7.7) conceptualizes the following important objectives for Environmental Engineering education: "The goal is train such educated technical experts with modern scientific knowledge and attitude, who are able to join and actively take part either in daily jobs or in high-level applied and fundamental research, in different areas of water conservancy, environment protection and agriculture." [4].

Water Framework Directive intends to help developing and forming participants' knowledge, skills and their attitudes in order to achieve the objectives. To reach this goal it's necessary to enhance higher educations related to water resource management (i.e. hydrologist, hydraulic engineer, biologist, environmental engineer, agricultural and forest engineer) and develop environmental studies connected with sustainable water utilisation [4].

According to the 3rd National Environmental Protection Programme (2009-2014), environmental awareness pedagogy is an expected requirement at each education level. The Programme aims developments in pedagogy that realize the exploration of interrelation between problems and give authentic presentation of solution methods (holistic attitude, making distinctions of global, regional and local interests, conflict management, etc). "Besides keeping pedagogical methods which focus on lexical knowledge deliverance, it is necessary to urge competency-based education that surveys and understands the interrelations of everyday life. Delivery of knowledge about sustainable development and maintainability has to be an integral part of environmental awareness pedagogy tasks. Sustainability supposes lifelong learning in pedagogy practice too. This helps of growing up active and informed citizens who are creative and have problem-solving mind, who can orientate in the nature, environment, society, laws and business issues, and accept responsibility for their own and common actions." [5].

The chapter 5.1.1.3 of 3rd NEPP about Higher education determines a task to produce teaching materials suitable for given specialization. Besides strengthening environmental awareness thinking and attitude, these scientific-based teaching materials have to present environmental effects in a "cause and effect" type system never the less they also have to fit into course structure of every university. The document claims that outdoor training spots have to be used for emphasizing the on-hand orientation of training and strengthening its teaching sensation elements.

Environmental pedagogy is a primary instrument in attitude forming. Its objectives, as Mária Németh-Kováts wrote in her book entitled Forest pedagogy (1998) are: "This includes the fond of nature, open-minded attitude toward problems and supposes responsibility for future generations, and emotional influence too." [6]. Tasks are to form behaviour, scale of values, attitude and the expansion of knowledge about environment and human society. All these focus on manageability by the help of "fond of nature, built and social environment, and setting-up human-respecting conventionality based on emotion, intellect, aesthetic and ethic." [7]. Reaching these objectives can not be fulfilled only with indoor school activities, but it has to include instructional and educational tasks executed outdoors in the nature.

UN General Assembly Resolution (20/12/2002) proclaimed period between 2005 and 2014 a Decade of Education for Sustainable Development. It has concluded that the level of practical acquaintance, conflict management methods, and global knowledge is very low in present education systems. Scholar systems based on analytical knowledge and curriculum, segregated onto different teaching-lines are not suitable to establish system-based approach, which should be fundamental criteria of sustainability.

The above mentioned documents, by their declared objectives and tasks confirm the fact that ecological and technical thinking of environmental engineers have to be present with equal weight to maintain sustainable development. However, the fields of these two disciplines differ from each other, so ecologists' task is to diagnose problem, while engineers have to find an effective solution for problems, where ecological limitation is just one to consider among other factors [8]. After recognising these ecological limitations, they are manageable.

In the future, within the Environmental Engineering education we have to make efforts to introduce pedagogical methods to ensure attitude forming besides professional training, despite of relatively short training period (seven semesters).

In accordance with aforementioned requirements this paper aims at making proposals for a practical example that is suitable in higher education. This practical example tries to combine and fulfil the academic-level training requirements of higher education with field exercises that help attitude forming and integrate activity oriented tasks.

2. CONVENTIONAL PEDAGOGICAL METHODS AND THEIR ACHIEVEMENTS USED IN WATER QUALITY PROTECTION EDUCATION

In Environmental Engineering BSc education the objective of water quality protection subject is to provide students with comprehensive knowledge about water quality protection and water resource management. It presents natural and social water circulation and water resources suitable for public water utilization. It studies effects influencing the state of natural waters in the industrializing world, pollution materials and their impacts on water quality as well as suitable controlling methods. It reviews general questions of water and water resource management, namely the principles of water resource management, water-supply management elements, current water demands and estimated demands in the future. Curriculum deals with the following important issues: different types of water utilization, water recycling and surveying possibilities of water reuse. Fundamental hydrological principles and descriptions of spreading process of pollutants in surface waters and ground waters are also presented in this subject.

The one-semester course consisting of 14 lectures (one hour a week) and 28 practical workshop lessons (two hours a week) gives the framework to comprehend the subject, review conceptions, definitions, processes, acquire experience and practical knowledge. Considering the volume of content to be covered and the limitation in number of students at workshops (20-25 persons), it can be stated that even at workshops the pedagogical methods of lecturing, explanation and presentation are the main means of education rather than hands-on activities.

2.1 Lecture

The purpose of lectures during workshops is to deliver new information, explain scientific relationships, rules, theses, concepts and to present phenomena, events, processes, objects expressively and meaningful. These types of lectures generally contain elements of narration, explanation and demonstration. In this situation teachers are active, students are passive [9]. Computer-aided presentations are the most widely used form of demonstrations. The large content and the limited amount of time at courses require giving lectures throughout workshops. Neither conventional education schedule (2x45 min.), nor the size of workshop room or number of students (20-25 students per workshop) support hands-on activity and give enough space for practical teaching. Lectures as pedagogical methods serve to improve attention and concentration and not to develop other competencies.

2.2 Presentation

Presentation methods can be effectively used for developing students' imaginal-visional thinking, exploring possibilities of practical utilization, arousing interest and for applying theoretical knowledge [9]. This method gives good opportunity for practical approach of the theoretical curriculum and helps comprehension process by examples and experiments. Unfortunately, it does not give a chance for students' self-directed activity. Majority of students still remain passive audience of the education process. Direct observation, presentation of objects and phenomena among real conditions can not be fulfilled during workshops of conventional education; and too many students in a group makes it even more difficult. Therefore in most cases teachers' perceived reality is represented by using indirect teaching tools. That's why presentation method is less suitable to develop students' autonomy, creativity and research activity.

2.3 Field trip

Objectives of out-of-school activities, like field trips, are to deliver realistic knowledge, and getting experiences [10]. Students can get more information about the subject on a field trip comparing to a lecture, so it makes them more motivated and interested. Field trips are important pedagogical instruments for shaping system-based approach and forming attitude. It gives opportunity for cooperation, team-work and develops adaptive capability of students.

Dues to the shortness of workshop lessons and the "credit–system" based scheduling of students groups, organizing such trip causes difficulties and very much depend on the individual teacher whether he/she wants to undertake problems of organization and invest extra work. In the usually available 2x45 minutes workshop timeframe it is difficult to organize an out-of-school field trip programme.

If to the abovementioned limits -workshop schedule, room capacity, number of students-make outdoor activity impossible, subject will be worked out in the form of lectures and computer-aided presentations (indirect demonstration).Therefore students loose opportunity to gain own experience, as well as the chance to get information directly from an expert specialized in that area. Face-to-face communications with industry representatives and specialists would be extremely important for students during the engineering education.

2.4 Learning by doing

The goal of learning by doing method is to let students make manipulative activity alone, in pairs or in small groups. This method is already based on direct action of students and helps them to apply their earlier gained theoretical knowledge in practice. It also supports them in getting on-hand skills and develops their experience too [9].

The best way of understanding the process of water quality assessment is the "learning by doing" method. Students, who actively take part in water qualification process, learn the rules of collecting samples, then analyse and evaluate them with measuring instruments in the laboratory. This way they

can get experience they can successfully use in their future works. Students learn how to use measuring instruments and the conditions of authentic measurement.

Due to the limited amount of time and the high measuring costs, these exercises are carried out in larger groups, giving just a few chances for individual work. However, team-work is an important and determinant factor in developing collaboration, helping each other and communication with team members.

Besides analyzing water samples in a laboratory, other learning by doing methods, i.e. researches, observations and case-studies are needed to develop skill and competency. When all of these elements are available at the same time, it can lead to the most powerful evolvement of system-based approach, moreover understanding and discovering cause and effect connection of water ecosystem and water pollution. This method assumes out-of-school activity and field exercise too, nevertheless the organisation problem is still there, like in case of field trips. Learning by doing can be implemented as out-of-workshop lesson activity, because the 2 x 45 minutes lesson timeframe is not enough for getting to the spot, making measurements and observations.

As a summary, we can conclude, that lectures, are more emphasised in the practical teaching of Water quality protection subject, than other individual or group activity based methods due to aforementioned limits. This statement is valid for the other subjects of this type of education too, due to the recent restrictions, that universities had to decrease number of teaching hours of these subjects or completely ceased them in many cases. However, it is crucial to have workshops and supporting alternative pedagogical methods in environmental engineering education to develop engineers' appropriate competency and skills.

3. ACTIVITY-ORIENTED PEDAGOGICAL METHODS IN THE PRACTICAL TEACHING OF WATER QUALITY PROTECTION SUBJECT

There are more alternatives to develop practical teaching of Water quality protection subject. One of these is field exploration that can be accomplished by blocked schedule, breaking with traditional teaching hour schedule. It gives the opportunity for continuous out-of-school activity and project work. It is extremely important in higher education that students are given project tasks, in which self-directed work is essential as well as group collaboration. Graduates most likely will have to start-up with taking part in group works; therefore it is essential to develop and elaborate students' collaboration skills.

Block schedule concentrates the available teaching hours, so that it makes possible for students to get experiences during field exploration. Besides professional training, attitude forming can take place too. The most effective instruments of attitude forming are exploration and observation, that directly made in the nature. These allow students to get complex, activity-oriented, sensation like, system-based approach of environment. It also develops students' scale of values, behavioural culture and collaboration skills during field exploration [11].

In our case, tri-weekly block schedule with 5x45 minutes teaching hours makes it possible to deliver theoretical knowledge necessary for workshop exercise. After this quasi lecture, students access the

nearest examination spot around the school, where they make biological and chemical examinations, water flow measurements and direct observations in the nature. The time between two workshops is sufficient for research and investigation tasks at home. This teaching form expects from students higher autonomy and creativity. Besides taking part actively, it is important that students have to learn and acquire the subject on their own. Self-directed learning implemented by this way needs such teaching methods that generate the ability of self-development in the area of complex-minded thinking, emotional, willing and action. Mária Kováts-Németh (2010) proposed a new structure for these methods in her book entitled "From forest pedagogy to environment pedagogy". She made alignments between methods, tasks and activities. Develop of autonomy, creativity and research-ability can be reached effectively by applying the methods of exploration, observation, examination, analysis, field exploration, case-study, learning contract, home work, impact assessment [10].

Applying classroom and outdoor workshops as presented in Table I., makes possible to implement abovementioned pedagogical methods. Besides making education interesting and eventful, these methods help to develop skills, abilities and attitude forming too.

Table 1: Block scheduled workshops of Water quality protection subject

Week	Workshop 1st, 4th, 7th, 10th, 13th week 5*45' + last week of the semester 3*45' Σ 28 hrs	Method	Activity - task
1.	The workshop goal: process of water qualification, rules and laws. Presentation about Aranyhegyi stream and its watershed area, field inspection, data collection about watercourse. On-the-spot demonstration about anthropogenic and natural effects that influence water quality.	discussion lecture observation demonstration homework	empirical data collection making notes record keeping self-directed investigation
4.	Demonstration of analytical methods and measurement principles applied during water qualification process. Discussing of field exercise, assigning of groups' tasks. Sampling spots identifying according to task goal, field exploration.	lecture demonstration research	identification of goals and problems
7.	Overview of water flow measurement. In groups measuring of water flow based on simple flow velocity and chemical attenuation principles on sampling spots.	discussion field research	measuring
10.	Collecting samples at sampling spots. Analyzing chemical parameters on the spot and in the laboratory. Bio-monitoring – BISEL grading at the spot	field research	measuring experiment research
13.	Checking measured data, evaluation Hydrological modelling (WQMCAL)	analyzing demonstration	data processing comparing organizing
14.	Hand in protocol Writing test papers	test	

3.1 Observation

Besides data collection at home and ground-scouting at Aranyhegyi stream, students take notes and photos. Having analysed these data, they can set up a sample collection plan for exploring main pollution sources. They collect empirical data about watershed area, watercourse, natural and anthropogenic impacts. This is a prerequisite of understanding cause and effect connections. During observations made in the near surroundings the fond of nature being formed. This kind of admires or fondness toward the nature might be a keystone of environmental conscious behaviour that can motivate the process of learning.

3.2 Homework

Students complete ground-scouting observation with self-directed home investigation and prepare the water quality assessment plan by the help of collected data. It is an important task to determine sampling spots, that require personal ground exploration, accurate and all-out surveying of area by the help of maps and other available documents. The watershed area of the stream can be easily localized with maps. Autonomous activities help formation of sense of responsibility and sense of duty [10].

3.3 Research

Students can assess problems based on ground-scouting observation facts and data deriving from their self-directed activity. Fields exploration gives opportunity for students to set up their own projects according to their centre of interest. They can fulfil necessary examinations in their projects that might lead to the root idea of their later thesis or scientific student conference papers.

3.4 Field exploration

Comparing toa classical field exercise, field exploration is an extended and synthesizing method, that contains multi-level activities. These are the followings: sampling, sample analysis on the spot and in the laboratory, keeping records of measured data. Four or five students in a group take samples at the previously decided sampling spot and analyse those samples on the spot and later in the laboratory. They learn how to use measuring instruments and gain skills at water analytical methods. By dividing the task into parts among them, they can help and assist each other in solving the job successfully.

3.5 Analysis

During analysis process, the main goal for students is to think about tasks that may come after this analysis. They also have to compare their analysis with similar research results. Students can make final deductions based on their analysis and comparisons made, and choose possible measures that help to achieve better water quality. Analysis can not be done without system-based approach and recognizing case and effect connections. Experiences and adventures learnt during this half-year field exploration and students' self-directed learning supplemented by workshops knowledge, collectively provide the evolution of ability of planning, problem solving and decision making. Following this pattern, students can easily evaluate similar cases and situations, because they have acquired the necessary skills for water quality assessment.
The above detailed water quality assessment exercise besides the professional training ensures the evolvement of complex and comprehensive approach and ecological thinking. It gives students learning experience, that –among others- develop their critical and creative thinking, collaboration and conflict management skills. Despite the limited curriculum framework (28 lessons per semester) it can successfully make competence based environmental engineering education. Teaching becomes more colourful and interesting, students get better motivated and it helps to raise interest of potential applicants.

SUMMARY

Field works, observations and examinations in the nature play a decisive role in the education of environmental engineers. There are no suitable mathematical rules for defining cause and effect correlations because the many-sided nature has complicated and labyrinth-like connections as well as its inevitable fortuitousness. One must see and feel to understand the processes of the nature. This goal is served by examinations made on the spot. During environmental adequate education, the recognition process being adjusted to the natural complexity of life.

Curriculum and supporting practical activities have to be setup such way, that students accept and apply "conception of integrated watershed" [2]. By acquiring this knowledge, they will be able to ensure sustainable utilization of water supplies. The field exploration, as a pedagogical method gives some help for that. This paper has presented block schedule as a kind of realisation of this pedagogical method. During seven semester of education there is a five day field workshop what makes an opportunity for field exploration and research. Another option is the project-like teaching, announced as independent subject or executed as workshop. During these classes students might do their own researches that suits for their interest too. Lot of scientific student conference papers and plenty of theses of those students taking part of field workshops confirm effectiveness of this method.

Improving quality and level of higher education is a social expectation, which considering abilities and demands of youth generation can not be satisfied with traditional methods. It might be important to launch and apply alternative methods widely that are based on group work and experience, and require self-directed work too. These methods might form and develop competencies that employers expect from entrants.

The presented Water quality protection workshop and its supporting pedagogical methods make it possible to achieve the objectives of WFD, WMP, 3rd National Environmental Protection Programme

and of Decade on Education for Sustainable Development, and fulfil expectations claimed in Training and output requirements of Environmental Engineering.

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