IMPLEMENTATION OF APPLIED RESEARCH INTO THE STUDY PROCESS WHEN TRAINING THE PROFESSIONALS OF ENVIRONMENT PROTECTION
LIETIŠĶO PĒTĪJUMU IEVIEŠANA VIDES AIZSARDZĪBAS SPECIĀLISTU SAGATAVOŠANAS PROCESĀ

Palmira Ciplijauskienė, Nijolė Rukštelienė
Utena College, Faculty of Business and Technologies, Ecology Department
Maironio Str. 7, Utena 28142, Lithuania; tel.: +(370)68506918
E-mail: palmira.ciplijauskiene@gmail.com; aplinka@utenos-kolegija.lt

Abstract. *The studies on the college level are directed towards practical training, thus the applied research executed in colleges may be involved into the study process as one of the research teaching methods. This research not only ensures the link between theory and practice, but also trains general abilities of the students and personal characteristics highly valued by the employers. The article analyses the experience of Ecology Department to implement the applied researches "Evaluation of Water Quality in Shaft Wells" and "Determination of Nitrogen Dioxide Concentration in the Environment Air by Applying the Method of Passive Sampling" into the subjects of Environment Protection and Environment Monitoring. It discusses the way the studies are held, in what ways the students take part in research, how they evaluate it, what problems they face.*

Keywords: *nitrogen dioxide, nitrates, wells, applied environment research, Utena College.*

Introduction

The link between theory and practice is very significant in the study processes of colleges. In order to get ready properly for professional activity, a student has regularly deal with real situations and applies the gained knowledge in practice during the study process. Applied research, being one of the most important areas of college activity might be introduced into the study process and thus create natural conditions for the implementation of theoretical knowledge into practice. Applied research educates students' general abilities and personal characteristics, such as creativity, critical thinking which are under high demand by employers. According to L. Jovaiša [3, p. 259], creativity is educated by research, as well as heuristic, problem methods.

Ecology Department sees applied environment research as the most suitable research methods and implements them into the studies of Environment Protection and Ecology. The article analyses the application of two applied researches, i.e. the evaluation of water quality in wells by identifying the concentration of nitrates and microbiological pollution, and the identification of the concentration of nitrogen dioxide in the environment air by applying the method of passive sampling. The researches point out the following stages: planning the research activity, material collection, material analysis, research description and implementation of research results into practice [3, p. 259-260]. The execution of those researchers employs the methodologies that are not complicated and understandable by students and the implementation of which is rather cheap. On the other hand, the methodologies are acknowledged and applied by scientists and practitioners. The applied research is financed by the college or project funds are employed.

The aim is to analyse the pedagogical experience of Ecology Department in the implementation of applied research into the study process.

Materials and methods

The executed research is of naturalistic character, it employed such methods as observation, discussion, document collection and analysis. The pedagogical experience of the authors is revealed with reference to the research method of one-case-study [4, p. 110-115]. The article analyses the implementation of two examples of applied scientific research into the study process. The experience was gained in the second and third years of studies of Environment Protection and Ecology study programme between December 2007 and April 2008. The research was carried out by two groups of students counting up to 22-25 students. The article analyses the experience of the authors and a lecturer Inga Jakštonienė on how the applied research related to the study programme is introduced into a subject module. The material in the article is presented in the form of a descriptive report.

Results

The implementation of the applied research "Evaluation of Water Quality in Shaft Wells" in the subject *Environment Protection* of Environment Protection and Ecology study programme at Utena College. The volume of the subject Environment Protection is 5 local credits (7,5 ECTS), where 70 hours are for theoretical teaching, 56 hours for practicals and 74 are self-study hours. The subject Environment Protection is taught to the students in their second year of studies in autumn and spring semesters. The purpose of this subject is to be able to assess the after-effect of human activity on the environment. The main topics analysed in the studies of Environment Protection subject are as follows: a man and the environment; organization of environment protection; legal grounds for environment protection; public forms of environment protection; informing the society and ecologic education; ethics of ecology; structure and protection of the biosphere; the atmosphere, its structure, composition; the sources of anthropogenic pollution; influence of local and global atmosphere pollution on the environment and a man; water in the biosphere and its resources; methodology of identification of nocuous materials in effluent; soil, its characteristics, degradation, pollution, and other topics. The aims of Environment Protection subject are to be able to analyze the documents regulating the environmental activity, be able to assess the sources of anthropogenic activity, to understand the influence of local and global atmosphere pollution on the environment and a man, be able to assess EU requirements in the area of environmental protection. [1, p. 90].

Preliminary implementation of the research was performed in 2007 when the department started applied research on the identification of water quality in shaft wells. The lecturer of the subject Environment Protection Inga Jakštonienė suggested involving the students into the research. Discussions with the students revealed that those students who had used the water from shaft wells had never been interested what the quality of the water was in their wells in regard to nitrates and microbiology. During theoretical teaching of the subject the research methodologies and the possibilities for their execution were analysed. To determine the concentration of nitrates, a spectrophotometric method was employed by using phenoldisulphonic acid [5, p. 103]. Phenoldisulphonic acid reacts to nitrates by turning into picric acid, which combines with ammonia making yellow colour ammonia picrate. The College did not have a spectrophotometer necessary to determine nitrates thus the tests were carried out by the laboratory of Joint Stock Company "Utenos vandenys". Microbiological laboratory equipped with all the main materials and means necessary to perform microbiological research has already been established at the college so the microbiological analysis of water samples was foreseen to be carried out at the Department. After the analysis on research methodologies and the possibilities for their execution were carried out, one of the practicals of Environment Protection subject was dedicated to collect water samples. The streets where the number of shaft wells is high and where their water is used for food were

selected. Communication with the owners of the shaft wells revealed that majority of them did not even know what are the dangers of using water of bad quality, what can be the reasons for well water pollution, what are the requirements for well establishment. The students communicated with the residents very willingly. The majority of the residents were satisfied to have their water examined for free; they inquired how and when they would learn the results of the research. At the first stage, 14 samples from 14 shaft wells were collected and they underwent microbiological analysis done by Ecology Department laboratory, and the rest part of the samples was passed to the laboratory of Joint Stock Company "Utenos vandenys". The analysis of microbiological pollution of shaft wells was narrowed up to the identification of the main microbial pollution indicator - Escherichia coli (*E. coli*), following the Lithuanian standard LST EN 9308-1 „Water Quality. Detection and Calculation of Escherichia Coli and Coliform Bacteria. Part 1. Membrane Filter Method".[6]. To identify Escherichia coli and to determine coliform bacteria, a standard analysis was used that consists of membrane filtering of the sample under examination, membrane incubation on selective medium, calculation of typical bacteria that breaks lactose and biochemical description of Escherichia coli. Microbiological research is the process that requires much accurateness and patience as the execution of such research often faces the problem of the result reliability due to possible influence of side microorganisms. Due to these reasons only a small number of students could take part in the research at a time, in addition, the method was already analysed during the practicals of the module "Microbiology and sanitary" in the first year of studies. Microbiological research was carried out by two students who had been explained about the importance of the result accuracy and reliability because the results will be presented to the residents and the research will be followed by an article for the town community.

Unfortunately, due to small premises, not all the students could observe the determination of nitrate concentration performed in Joint Stock Company "Utenos vandenys". The students who took part in the research observed the way the standard and working solutions were prepared, how a calibration curve was created, how the samples were processed, how to work with spectrophotometer and how to record the received data.

All those activities – microbiological research and determination of nitrates took place after the lectures since a small part of students was involved in it. After the results of both researches were obtained, on more practical of Environment Protection subject was devoted for result processing and generalisation. Following the received data, a calibration curve was drawn on graph paper, nitrate concentration was calculated with reference to optical density measurements of water samples obtained by using photocolorimeter and compared to marginal concentration. Nitrate concentration exceeded the indicated marginal concentration of the indicator [2] in over 40% of the analysed samples, for this reason a leaflet was designed telling about the requirements for well establishment, the basic quality indicators of drinking water, possible pollution sources, as well as the negative effect of nitrates and microorganisms on human health described. The leaflet was decided to be handed to the residents during the presentation of the research results. A stand of photos was created to illustrate the processes of sample collection and analysis. The students were questioned on how they evaluated their participation in the research which they saw very positively. The report was announced on the Internet website of the College.

Observing the students being so interested in specific activity and changing positively (communicating with the residents more freely, strengthening confidence in their knowledge, etc.) it has been decided to continue the research on the college basis. In 2008 the college obtained photocolorimeter and reagents, and the concentration of nitrates was determined in the department laboratory. The description of practical assignment "Determination of Nitrate Amount in Water" was developed that helped the students to get ready. One of the subject module practicals was devoted to create a calibration curve. The students of a subgroup are

divided into smaller groups of 3-4 with a separate specific task each of them. During the practical the students prepared solutions, worked with photocolorimeter, created a calibration curve. During another practical the students worked in small groups, took samples, communicated with people. Microbiological tests were carried out immediately. Microbiological tests were carried out by two or three students and the results of the research were used for the development of the course papers or the final diploma thesis. Determination of nitrate amount in sampled water is executed during the next practical and the work is defended during the next practical. In 2008, 65 wells of Utena town residents were tested for water quality, an information leaflet was designed and distributed among the residents of the town, the report developed and uploaded in the College Internet website and local newspaper. In addition to the organised research of water quality in town wells, two students tested the quality of well water in their residential area and employed the researches and results in their final thesis.

The implementation of the applied research "Determination of Nitrogen Dioxide Concentration in the Environment Air by Applying the Method of Passive Sampling" in the subject *Environment Monitoring*. Environment monitoring is the second subject closely related to the research of environment quality. The subject of Environment monitoring is taught to the students in their third year of studies, in autumn semester. The purpose of this subject is to provide with the fundamentals of the knowledge on environment condition, its anthropogenic changes, influence on the living nature and a man, the methods of its observation, research and assessment. The volume of the subject in local credits is 4 credits (6 ECTS), where 52 hours are for theoretical teaching, 40 hours are for practicals and 68 are self-study hours. The most important topics analysed in the framework of the subject are as follows: the structure of monitoring programmes; data analysis and interpretation; air, water and soil quality and control over its condition; monitoring of the natural ecosystems of atmosphere, water, soil, flora and fauna [1, p. 121]. Direct follow-up of this subject is the practice placement of Environment Monitoring carried out in enterprises, state parks and other locations where state or economic monitoring is being carried out. The subject carries the specific character – monitoring is a long-term observation and the subject itself is studied only for one semester. Since the studies of Environment Protection and Ecology are delivered in modules at Utena College, the studies of the subject shorten to 8 weeks. Due to this, it is not possible to perform environment monitoring under real conditions, but it is possible to execute various practical activities that are applied in real activity by environment protection professionals. Much valuable information may be collected during some or many years of observation by following a designed observation plan, performing observations applied in practice. Since the students are changing, the role of a teacher in environment monitoring performance and storage and processing of the data becomes very significant. One of the researches available is the determination of nitrogen dioxide concentration in the environment air by applying the method of passive sampling. This is a not expensive, not complicated and rather informative method applied for many years at Vytautas Magnus University and other institutions [7]. The essence of the method is that a filter saturated with triethanolamine that reacts to nitrogen dioxide is hanged on a test point, the filter is removed in 4 days and the average concentration of nitrogen dioxide is determined by using a photocolorimeter. The research has been implemented after it had been financed by Utena District Municipality Fund of Ecology Projects with 1500 Litas. The project was coordinated and the research implemented together with students by the authors of the article under the supervision of Assoc. Prof. Dr. Gediminas Kilikevičius. That way the scientific character, consistency of the research and the reliability of the data collection, storage and analysis were ensured.

The preparatory stage of the research started in June 2008 with a lecture of Assoc. Prof. Dr. Gediminas Kilikevičius "Atmosphere Pollutants, their Sources, Impact and the Methods of

Determination". The lecture was delivered to the 2nd and 3rd year students, teachers and representatives of various institutions. It was followed by the training of the teachers, as a new research methodology was introduced. Assoc. Prof. Dr. Gediminas Kilikevičius introduced the method of photocolorimeter determination of nitrogen dioxide concentration by applying passive samplers. A rsearch plan has been designed, the network for samplers display, the samplers prepared, a calibration curve created. The training was a very relevant solution as it would have been difficult to master a new method without the supervision of an experienced professional. There would always be a chance that something might have been misunderstood or misperformed.

The second stage of the research was the collecting and storage of the data about the air quality of the town. The samplers were planned to be displayed tree times in July, September and October. Since July is a month free of students, the solvents were prepared, saplers hanged, removed, samplers deployed and concentration of nitrogen dioxide determined using photocolorimeter by the teachers. In September, during the studies of the subject of Environment Monitoring the students were involved into the research, however at different levels: two students developed course papers and their final thesis on the topic thus they took part in all the stages of the research; the rest of the students were involved in the rsearch during thier practicals. Two practicals, 4 hours each were devoted to that. To get ready for the students in advance, a description of the practical assignment was developed. The first practical was devoted for solvent preparation and creation of a calibration curve. At the beginning of the practical the teacher introduced the students to the research being carried out, its financing, indicated the students' role in it, as well as that the results of the research will show air quality all over the town, at crossroads, the results will be announced on the Internet and in the local media. For those reasons the students were asked to work very responsibly. Theoretical background of the students on how to prepare solvents, work with a photocolorimeter, draw a calibration curve on graph paper and computer was cheked. The students worked in groups of 3-4, prepared different solvents and identified one point of calibration curve each. One of calibration curves is drawn on graph paper and the other – with a computer using Excel programme. The second practical was devoted for the analysis of samplers. The samplers were displayed and removed in the planned sites by the students, who had chosen to develop their course papers and final thesis on this topic. It is rather complicated to involve the whole group into this activity as there are many sampler sites that are located in the network covering the whole town territory, transportation of samplers would last for the whole day and it is difficult for the whole group move around the town. Due to that, all the students took part only in the analysis of samplers. At the beginning of the practical, the students account for their activities performed earlier, compare calibration curves designed by using different techniques, analyse how to use and read them. It may be concluded that a calibration curve drawn by using Excel programme is more accurate and all the following calculations may me done on a computer, whereas using a calibration curve created in hand, one has to do all the calculations mechanically what makes the whole process more dificult and increases mistake occurance. During discussion, a teacher checks the students theoretical knowledge on the pollution with nitrogen dioxide, its sources and dissemination in the environment, the norms for air pollution in Lithuania. Students work in pairs and are given 3-5 samplers to analyse. Under the teacher's supervision the students deploy the samplers, perform measurements by using photocolorimeter. The results are processed by using Excel programme and are recorded into the annexes of a practical assignment description. This description was designed by the author of the article Nijolė Rukštelienė and the annexes were designed with assistance of a student Edvardas Zavackas [8]. Each of the groups processes at least one result without using a computer and compares the results. The conclusions are drawn by comparing the received results to the existing norms

on pollution, as well as to the situation in other towns and cities. The information for comparison is taken from the website of the Ministry of Environment of the Republic of Lithuania. The assignment is completed by defending it at the beginning of the third practical. The student's knowledge of air pollution with nitrogen dioxide, understanding the methodology and ability to apply it, the ability to analyse the results and draw conclusions are assessed.

Two students who had chosen to develop their course papers and the final thesis related to the research topic, under the supervision of the teachers, planned the time of the research, hanged and removed the samplers, prepared solvents, collected data, gathered theoretical background and executed the research. Actions in the laboratory and the town were carried out during the lectures, practicals and after the classes. The development of course papers and the final thesis allows looking at the research in various terms. In case of the research the concentration of nitrogen dioxide was tested in the corners of the chosen net (680 m x 680 m) – 30 points in total and the received results indicate background concentration of nitrogen dioxide in the air. Based on the data collected in this net, a course paper is being developed "Structuring of Background Environment Monitoring in Lithuania" and the final diploma thesis "The Analysis of Utena Town Air Pollution with Nitrogen Dioxide". The concentration of nitrogen dioxide may be determined not only in the intersections of the net, but also at the crossings of the busiest streets of the town and the streets of residential areas. The analysis of the pollution at these points is followed up with the development of a course paper "Town Air Monitoring "and the final diploma thesis "Analysis of Traffic Pollution in Utena Town". One of the students is developing a scientific article on air pollution with nitrogen dioxide in Utena town to be presented for the students' scientific conference. This creates possibility to improve scientific skills.

Discussion

Two cases of the implementation of applied research into the study process discussed by the article illustrate that this might be a good balance between theory and practice. One may choose these applied environment research for the study process which suit the study programme. Transfer of the applied research into the study process is positively valued by students since participation in real activity adds to the students' research experience, strengthen their self-confidence, educates an active citizen sensitive to the problems of the living environment. Students understand that during their studies they perform significant activities, widely applied in practice, the results of which are interesting to environment protection professionals and the society. In addition to the gained professional knowledge the students improve general abilities to communicate, cooperate, listen to and hear different opinions, defend one's point of view, and apply information technologies in practice. This kind of activity improves teacher-student relations, makes them cooperate, lets them reveal new things and adjust to various situations. Unfortunately, these activities are time-consuming, and formally allocated time is too short to perform them. The situation may benefit from strict time planning and application of various forms of work, when a certain part of the research is carried out during a practical and the rest students who are interested in the topic more seriously may deepen their knowledge and develop a course paper or a final thesis. In addition, these activities require certain expenses. The solution to it would be development of project applications for various funds. Implementation of applied research into the study process improves professional, scientific and methodological competencies of the teachers. The announcement of the research results by various information means raise the status of the college, makes it more attractive for the future students.

Conclusions

1. Implementation of the applied research into the study process ensures the implementation of theory-practice link. Applied research raises the status of the college, promotes the study programmes it is executed under. On the other hand, execution of applied research demands for more time and finances from the teachers' and students' side.

2. Execution of applied research is interesting and significant to the students since it makes the mastery of theory easier, allows applying the knowledge gained in the studies of other subjects. When executing applied research, the students improve their general abilities to communicate, cooperate, analyse, present and ground one's opinion; educate positive personal characteristics: creativity, diligence, responsibility, accurateness.

3. Implementation of applied research into the study process is significant to teachers since it improves professional, scientific and methodological competencies of the teachers, improves teacher-student relations.

Bibliography

1. Aplinkosauga ir ekologija: Neuniversitetinių studijų programa. Utena: Utenos kolegija, 2003. 198 p.
2. Geriamojo vandens saugos ir kokybės reikalavimai: HN 24:2003. Lietuvos higienos norma. Vilnius: Lietuvos Respublikos sveikatos apsaugos ministerija, 2003. 25 p.
3. Jovaiša L. Ugdymo mokslas ir praktika. Vilnius: Agora, 2001. 501 p.
4. Kardelis K. Mokslinių tyrimų metodologija ir metodai. Kaunas: Technologija, 1997.
5. Unifikuoti nuotekų ir paviršinių vandenų kokybės tyrimų metodai. 1dalis. Cheminiai analizės metodai. Vilnius: Aplinkos apsaugos ministerija, 1994. 223 p.
6. Vandens kokybė. Žarninių lazdelių (Escherichia coli) ir koliforminių bakterijų aptikimas ir skaičiavimas. 1 dalis. Membraninio filtravimo metodas (ISO 9308-1:2000): Lietuvos standartas. Vilnius: Lietuvos standartizacijos departamentas, 2001. 15 p.
7. NO_2 koncentracijos nustatymas pasyvaus kaupimo metodu. Prieiga per internetą 2009-01-26: http://gamta.vdu.lt/bakalaurai/bakalaurai.html
8. Projekto "Azoto dioksido koncentracijos nustatymas Utenos miesto ore pasyvaus kaupimo metodu apžvalga". Prieiga per internetą 2009-01-26 http://www.ukolegija.lt/index.php?154146999