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STUDENTS ABILITY TO DETECT HUMAN NEGATIVE IMPACTS ON LOCAL ENVIRONMENTS AND LOOK FOR SOLUTIONS THROUGH SIMULATIONS

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Abstract *– The analysis of academic literature confirmed the advantages of case studies in cognitive development of students, but in it we did not find evidence for the ability of students to identify environmental problems in their surroundings and to use case studies for their solution. In the study we directed students to look for human negative impacts on their local environment and use these observations for formulating problems and for development of original solutions. Students from two secondary experimental schools – one professional and the other language school, were involved in the experimental design and performance. Students made lists of human impacts on their close environment and selected five of them that are most common and threatening. Two groups, one from each school, discussed the five cases, looked for solutions, prepared and presented posters with their results. Other two groups, again one from each school, also discussed the five cases, prepared scenarios of role plays, and presented them to the school audience. Ecological knowledge was assessed before and after the study. Students' skills for poster and role play presentations were assessed using prepared beforehand check lists with students' participation. The results showed the critical observation of students and their ability to distinguish between right and wrong in human environmental behaviour. They proved the positive effect of interactive teaching using case studies and discussions, role playing and poster preparation and presentation. They pointed out the difficulties which students met in the process of skill development, and the scaffolding they needed from the teacher.*

Keywords: *E*environmental education, human impact on the environment, comparative case studies, poster presentation, teaching methods

I. INTRODUCTION

Teaching methods that use students´ experiences can help for active involvement in the learning process. Effective techniques that encourage such participation are simulation and gaming because they favour integration of an environmental dimension into school and out-of-school educational processes. Environmental games and simulation prepared by the teacher, are widely used for providing realistic cases that help students develop critical thinking, effective communication and self-discipline. It is much more difficult but certainly more effective to use real environmental cases from the local surroundings, detected, discussed and developed by the students themselves with the guidance of the teacher. The preparation and use of original materials is much more stimulating both for students and teachers. To emphasize the advantage of simulation and gaming, this paper provides information on teaching objectives, various types of students involvement and the importance of assessment, and lists some difficulties teachers should be prepared for in using this technique.

II. OBJECTIVES OF THE PAPER

The research was directed to find the answers to the following questions:

1. Are students able to detect negative impacts of human activity to their surrounding environment?
2. Which students, from professional or from language school, are more critical and better equipped with ecological knowledge for observation and analysis of their environment?
3. What kind of difficulties do students meet in the preparation of posters and role plays on ecological context?

III. ANALYSIS OF RESEARCH:

Environmental education is well situated in the Bulgarian Educational System with the development of the new State Educational requirements[19]. Environmental problems are introduced in all school subjects, having priority in the sphere (CEA in Bulgarian) of Cultural Educational Area "Natural sciences and ecology", using the infusion and interdisciplinary approaches. Biology is most suitable for teaching the environmental principles as it gives the fundamentals of ecology.

The biological content in 9th and 10th grades is compulsory and gives the basic ecological and environmental concepts. In the 11th and 12th grades only some students choose a biology course. Therefore our efforts in the development of interactive didactic technology were based on content analysis of the biology programmes and textbooks of these two grades.

Working in a team, sharing ideas and efforts, learning from others and contributing to others' learning, are skills that have to be acquired as one is not born with them. Both the school age and the classroom provide the proper time and

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place for developing interactive motivations and competencies [3, 5, 7, 9, 10, 11, 14, 17].

The analysis of academic literature confirmed the advantages of case studies in cognitive development of students, but in it we did not find comparative evidence for didactic technologies and difficulties in applying poster presentations and role playing. In the study we directed students to look for human negative impacts on the environment and use these observations for problems formulation and for development of original investigations.

In searching the academic literature we found that the views were oriented on treating interactive teaching as a complex system of strategies, technologies and techniques subordinately interacting between themselves and modulating the cognitive activity of students. Interaction in learning means mutual, collaborative cognitive activity [11], that is bidirectional or multidirectional [14]. The fundamental basis of interactive learning is built up by the socio-cultural theories of learning, giving priority to constructivism, scientific approach and cognitive reflection [7, 8, 15]. According to L. C. Vygotsky [20] learning takes place trough interaction in social groups and thinking is a social product. The ideas of constructivists build up the foundations of many models of learning, such as: learning by discovery, problem learning, scientific or inquiry approach to learning, simulation-based learning, case-study, incidental learning, etc. [2] as well as scaffolding, shared activity, collaboration [17], cooperation, reflective communication [5], etc. Despite the critics addressed to constructivists, constructivists' ideas continue to assist productive learning. Especially fruitful is Vygotsky' idea of the zone of proximal development (ZPD), explaining the essence of directed discovery. Those and many other authors point out the significance of well-organized learning in the classroom, based on structured knowledge, guided discovery, active partnership, collaboration, that helps in the process of transmission of knowledge from individual to individual within the interacting group and reconstructing it in the long-term memory.

Analyzed literature confirms the positive contributions of interactive teaching to learning and personal development of students as it provides opportunities for sharing ideas, getting support, working hard and making work successful, taking responsibility for personal engagement in learning, showing tolerance to other participants' ideas, learning communication skills, etc. However in searching the literature we came across of studies on separate methods without a comparison between them and with little attention to environmental education in context as well as with few arguments from constructivist theories. Besides we didn't find educational strategies developing students' competencies to detect negative human impacts on the environment. Living in deteriorating surroundings without a vision on high quality and healthy environment students become used to low environmental standards. We saw in that a significant research gap and decided to undertake a study directed to making students understand the characteristics of ecologically sound surroundings through interactive learning of ecology.

IV. METHODOLOGY

The sample of the study involves 184 nine grade students (16 years of age) for the experimental groups and 51 students for the control groups (Table 1).

In the traditional teaching, ecological concepts were illustrated by mans of examples from the environmental context (control groups). In the experimental groups the situation was the opposite: in seeking solutions to formulated by themselves environmental problems students had to find out adequate scientific explanations mainly from textbooks. In this way they were expected to develop literacy not only within science but also about science [16].

TABLE 1THE SAMPLE OF INVESTIGATION FOR THE DIFFERENT STYLES OF LEARNING

Schools	Teachers	Classes & Numbers	Styles of learning
Professional gymnasium "Acad. S. Korolev", Dupnitsa	Elka Vladimirova	9b & 9c; E1 – 40 9d & 9e; E2 – 40 9a; C – 25	Poster presentation Role playing Lecturing
Language gymnasium "Plovdiv", Plovdiv	Ruslanda Kaleva	9b & 9c; E1 – 54 9d & 9e; E2 – 50 9a; C – 26	Poster presentation Role playing Lecturing

Such kind of literacy could enable them to make informed scientifically based decisions. Ecological crisis is the result of maladaptive human behavior. Therefore it is necessary to identify the factors that influence pro-environmental behavior in order to organize successful EE (Fig.1).

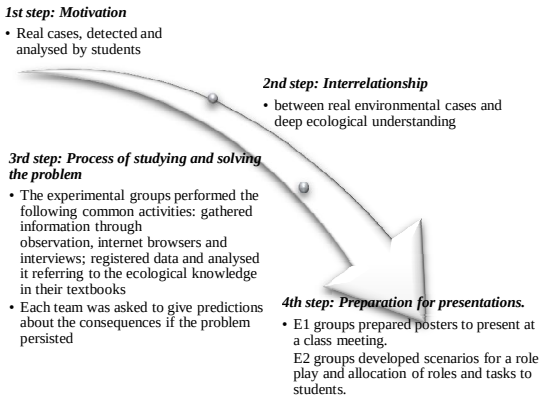

Fig.1 Four steps for dealing with real environmental cases

*1st step:*Motivation. Students were asked to observe carefully the surroundings from school to home and make a list of human abuses to the environment. Discussion followed using the questions: "Why the listed situations are considered harmful to the environment? How do they affect humans? How can they be solved?" As a result of the discussion students constructed the following table (Table 2).

The work made them look upon their environment in a new way and actively involve themselves in the study. The aim was not only to perform some activities but also to

concentrate and acquire deep insight into ecology and environmental problems [6]. Students were directed to look for the reasons that made people deteriorate their environment in order to be able to find out reliable solutions.

2nd step: Making choices, establishing working teams and allocating tasks. Students were divided into working teams according to their interests and learning tasks were allocated for each team.

TABLE 2REAL CASES, DETECTED AND ANALYSED BY STUDENTS

Cases	Problems	Controversies	Cases
1. Construction of new buildings	Destruction of habitats	People need homes & commercial buildings; Biological species need their homes as well;	1. Construction of new buildings
2. Lots of dogs thrown out in the streets.	Uncontrolled Reproduction	Dog population increases & dogs spread diseases; It is not moral to kill them or to throw them out of homes;	2. Lots of dogs thrown out in the streets.
3. Heavy pollution of the local river.	Fishes & other animals are dying	Industry and homes produce waste and pollute; Water animal species should be saved;	3. Heavy pollution of the local river.
4. Cutting of trees in the parks.	Destruction of the park ecosystem	Poor people need fuel in winter to warm homes; Trees are dominant species in the ecosystem and homes of many animals;	4. Cutting of trees in the parks.
5. Heavy traffic & road accidents	Human health & lives threatened	People need vehicles, but many people are killed; Air, water & soil are polluted;	5. Heavy traffic & road accidents

Discussions in each team were directed to looking for sound solutions of the problems. For that purpose each participant had to understand his/her task and responsibility for a successful team work. Students arrived at the conclusion that their knowledge & experience were not enough for solving the problems and asked their teacher for help (zone of proximal development). Under the guidance of the teacher each team developed an action plan and time-table for solving the studied cases on the basis of sound ecological knowledge and for presenting their findings (table 3).

3rd step: Process of studying and solving the problem. The experimental groups performed the following common activities: gathered information through observation, internet browsers and interviews; registered data (photos, quantitative results of the number of species that lost their homes due to construction, number of dogs and number of bitten people, threatened species by pollution, number of cut trees in the parks, killed or injured people in road accidents) and analysed it referring to the ecological knowledge in their textbooks. Each team was asked to give predictions about the consequences if the problem persisted, to prepare recommendations for the solution of the environmental problem and to give ideas about their own participation in the solution.

TABLE 3 INTERRELATIONSHIP BETWEEN REAL ENVIRONMENTAL CASES AND DEEP ECOLOGICAL UNDERSTANDING

Case No	Required ecological knowledge	Recommended ecological topics from the textbooks of: T. Nikolov et all; P. Angelov et all; V. Ovcharov et all (2001)
1	Habitats and ecological factors	Environment and ecological factors. Habitats and adaptations. Ecological niche. Human impact on the environment.
2	Populations and population dynamics	Characteristics and structure of populations; sizeand population dynamics, survivalcurves&typesofpopulationgrowth
3	Water ecosystems	Communities & ecosystems. Aquatic ecosystems. River ecosystems: types, biodiversity and impact of pollution.
4	Land ecosystems: natural and artificial	Types & structure of ecosystems. Cycle of matter and flow of energy. Biodiversity and ecological balance. Urban ecosystems and environmental problems. Sustainability.
5	Behaviour and safety	Behavioural adaptations. Biosphere, anthropogenic impact and human health.

4th step: Preparation for presentations. Both experimental groups had to perform specific activities: E1 groups prepared posters to present at a class meeting. E2 groups developed scenarios for a role play and allocation of roles and tasks to students.

V. RESULTS AND INTERPRETATIONS

Assessment of tests was carried out using a scale. The maximum number of points corresponds to 100% of acquired knowledge. From 0 to 20% mark poor (1) was assessed, from 21 to 41% - average (2), from 42 to 62% - good (3), from 63 to 83% - very good (4) and from 84 to 100% - excellent (5) (Table 4).

Assessment of posters was carried out according to predetermined criteria and scores. Seven criteria (components, scientific content, arrangement, labels, design, conclusions &

aesthetics) on a five-point scale were used for the assessment of each poster. Assessment of roles was carried out according to the specific requirements of each role on a five-point scale.

Criteria and credits for the assessment of tests', posters' and roles' achievements were discussed before the experiment with the students' participation. This step was very important as it clarified the expected results as goals in education and motivated students to work for them. Discussion was done with the help of specialists (teachers of other subjects and actors from the theatre). Before the sessions for clarifying the criteria everything seemed very easy for the students as they had very vague ideas about the professions they were intended to imitate. Besides, it awakened their responsibility – it is much easier to learn something by heart but it's very difficult to put it into practice. The argumentation for the credits given to tests results before hand was also important as credits were closely related to educational standards.

TABLE 4 ACHIEVEMENTS OF STUDENTS IN ACQUIRING ECOLOGICAL KNOWLEDGE

Varieables	Tests	Scores				
		1	2	3	4	5
Professional gymnasium "Acad. S. Korolev", Dupnitsa, Bulgaria						
E1a – 40	Pre	14	16	8	2	-
	Post	-	4	8	17	11
E2b – 40	Pre	10	13	11	6	-
	Post	-	7	9	11	13
C1 – 25	Pre	8	10	5	2	-
	Post	4	9	6	4	2
	Statistical characteristics					
	Tests	Average	Mo	Me	SD	
E1a – 40	Pre	1.95	2	2	0.87	
	Post	3.88	4	4	0.93	
E2b – 40	Pre	2.32	2	2	1.02	
	Post	3.75	5	4	1.10	
C1 – 25	Pre	2.04	2	2	0.93	
	Post	2.64	2	2	1.18	
Language gymnasium "Plovdiv", Bulgaria						
	Tests	Scores				
		1	2	3	4	5
E3a – 54	Pre	8	16	18	9	3
	Post	-	-	10	23	21
E4b- 50	Pre	5	19	14	9	3
	Post	-		7	20	23
C2 – 26	Pre	5	12	7	2	-
	Post	1	3	11	6	5
	Statistical characteristics					
	Tests	Average	Mo	Me	SD	
E3a – 54	Pre	2.69	3	3	1.09	
	Post	4.20	4	4	0.73	
E4b- 50	Pre	2.72	2	3	1.07	
	Post	4.32	5	4	0,71	
C2 – 26	Pre	2.23	2	2	0.94	
	Post	3.42	3	3	1.06	

Knowledge achievements based on Bloom's taxonomy of educational objectives (table 4, fig. 2) showed a significant step forward in better performance of students but it is far from satisfactory. Based on J. Piaget [15]we can explain the results with the difference of students' development. They did not march all in one row at the same speed, but everybody paced with his/her personal speed. On the whole the trends were on the correct direction and with correct speed. Both interactive methods provide well enough for successful learning.

Some ecological concepts were difficult to grasp, e.g., ecological niche, population growth curves, consortive links (animal on one single tree) between plants and animals in an ecosystem, etc., and the direct observations helped them understand and apply concepts correctly.

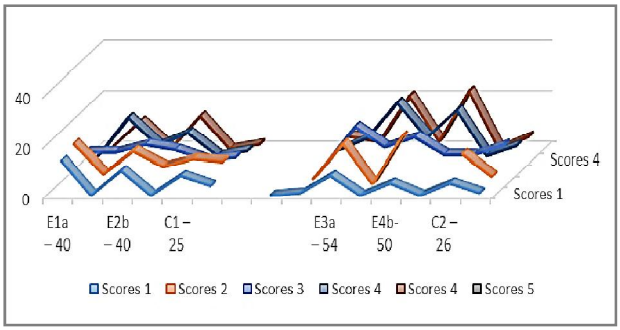

Fig. 2The comparison between students' test results

There were differences in the achievements of the two schools. In the professional school students were poorer in academic achievements. They were more inclined to work with their hands but the acquired knowledge helped them understand the dangers to ecological equilibrium & responsibilities to it of the professions they were engaged in. The students from the language school were able to use information from internet in a foreign language and the tasks they performed stimulated their interests and achievement not only in ecology but also in their language studies.

We expected better results from poster presentations and role playing and in the process of the experiment we came across many difficulties the students had to overcome:

Difficulties with poster preparation: students had to be taught how to observe, what event to photograph, how to take notes, how to measure, make tables, plot graphs, seek explanation. Every step had to be guided. Left alone they were confused. The guided discussion by the teacher directed them to find the correct path to the solution. Fewer students were involved actively with questions, ideas, criticism or offer of solutions. More of them listened intensely, tried to follow and understand the thinking of others. The degree of creative thinking of the whole team was much higher than in the traditional lesson.

The actual making of a poster proved to be very difficult. Students needed instruction about the materials, the design, structure, components, their relative size, place & designation, etc. They were not used to make summery of the topic in 2-3

sentences. The rubric "Method and materials" was also new to them; let alone the tables and graphs. Very often they forgot acknowledgements and felt uneasy to express them. We were surprised at the difficulties of students to formulate proper thanks to the teacher or to other consultants, very often parents.

Most surprising was the presentation when some students refused to present their posters even though they were very well prepared. We had a special conversation with them to find out that they dreaded public performance. While some craved for publicity, others suffered from it and we had to find the correct ways to regulate both. We had to organize mini presentations first within the class and after that within the school. The final evaluation of the projects was done by a jury of 5 experts (biology teacher, language & literature teacher, art teacher, the town ecologist and a student from an upper grade).

Role playing proved to be more difficult than poster preparation and presentation. Some students found it far beyond their abilities to step in "somebody else's shoes" and speak on his/her behalf, but others recognized that they were born to it and enjoyed it very much. The fact that they were allowed to choose the role that suits them best, helped them to find a proper part for themselves in the play. Students did not want to play negative roles. It was very difficult to persuade them. Then the preparation of the scenario and learning the details about the role needed thinking, seeking new knowledge, meeting new people and finally looking at the professions and the significance of knowledge in it in a new way. It took time, engaged them deeply and required more efforts. Some were not prepared to undergo such a process and were ready to give up, but the majorities saw a possibility for a new action and new experience and were very excited. They recognized their appeal for professional orientation.

VI. CONCLUSIONS

The reported findings from the overall study of constructing EE on the basis of interactive teaching using case studies in two variations – poster presentation vs role playing, allowed us to draw the following conclusions:

Interactive methods are important teaching acquisitions to make the classroom a stimulating place for students' personal development. They are especially valuable in EE because environmental problems are the result of joint human impact and can be overcome only with joint human efforts. Both need effective human interaction in all aspects of life including education, where the foundations for its development are laid.

Our methods of involving students in looking for, observing, documenting, analyzing and interpreting conflict environmental situations, and trying to propose scientifically based solutions, proved successful. Case studies with poster presentations and case studies with role playing presentations were productive, well accepted and involving. They enhanced students' academic achievements and at the same time helped them develop social interactive skills, such as constructive and tolerant interactions as well as collaborative learning and sharing of ideas and efforts. Role playing proved to be much more difficult, but more productive in social development. Guided discovery learning should be given priority than unguided.

We think that both methods should be used in good terms with traditional, so that teaching could achieve multiple benefits from the best achievements in innovative and traditional teaching.

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