USING INTERACTIVE CASE STUDIES TO SUPPORT STUDENTS' UNDERSTANDINGS OF LOCAL ENVIRONMENTAL PROBLEMS

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Abstract. The article presents designed and refined an interactive-enhanced curriculum module for 9th grade secondary school students in Bulgaria, based on environmental case studies. In the module activities students from two schools studied the local environments, performed observations and experiments, collected and analyzed data, prepared and presented posters and role plays, made connections between scientific processes and socio-scientific issues and drew conclusions about the global effects of locally created environmental problems. The students' critical observations of the quality of their surroundings helped them to make a list of local environmental problems, to apply interactive strategies in studying them and to propose rational scientifically based solutions. In the study the attention was directed to the advantages and disadvantages of poster presentations and role playing and to the specific

learning difficulties that students had to overcome. Students' achievements from the two experimental schools were assessed independently in order to give us insights into the details of learning using different interactive strategies and into the acquired performance skills, dependant on students' interests and personal abilities. The three versions of the module (traditional, dominated by teacher presentation; poster preparation and presentation in which students imitate scientific team research; and role playing in which students not only study the local environmental problems but assume social roles to cope with them) demonstrate three levels of students learning independence. Specific assessment tests and check lists were developed for analyzing, evaluating and comparing students' achievements in each version of the module and in each school. Ecological knowledge assessment tests were based on Bloom's taxonomy of educational objectives. Poster and role playing preparations and presentations were assessed by specific criteria, shown in the check lists.

Keywords: interactive-enhanced case study instruction, poster and role playing presentations, secondary school students' learning difficulties

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Introduction and background

In the face of global environmental and economic crises people have to organize themselves as an inseparable unity having common goals and struggling against common barriers. Human activities can no longer be "compartmentalized within nations and within sectors."[1)] Working in a team, sharing ideas and efforts, learning from others and contributing to others' learning, are skills that have to be acquired in the process of active learning, that was advocated by many educators (Davis, 1993; Davison & Pratt, 2003; Gurova, 2006; Hammer, 1997; Fry et al., 1999; Pollack & Fusoni, 2005; Paladini & Carvalho, 2008, Smith & McGregor, 1992, Kennewell et al., 2008, Sadler, 2011).

Both the school age and the classroom provide the proper time and place for developing interactive motivations and competencies.

The problem of our investigation is in the contradiction between the verbal good behaviour of students, shown in their ability to speak convincingly about environmental issues and their very often irresponsible real behaviour. Theoretically they know what should be done about improving the quality of their environment, but they do not apply their knowledge into practice and do not regard themselves responsible for doing it. Besides they more easily unite in destructive activities (throwing rubbish, wasting paper, braking benches in the parks, killing birds, destroying their nests, etc.) than in nature conservation work. Their aggression towards one another and to other people in their surroundings also increases. The reasons for this situation we see in the teaching and learning process mainly represented by lecturing of teachers and memorization of facts and ideas by students as well as in the lack of controversial intellectual communication in the classroom on real environmental issues (Taylor et al., 2009). Therefore we decided to investigate different possibilities of interactive case study strategies in order to solve the already mentioned environmental education problems. We expected that interactive personal involvement of students with locally oriented controversial environmental problems may enhance their environmental literacy as well as environmental responsibility for their own surroundings and may decrease their aggressive behaviour both to nature and to people. Although theoretical ideas behind our experimental teaching were not new, putting them into practice gave us excitement and real opportunities for new teaching insights. We designed and refined an interactive-enhanced curriculum module called "Act Locally – Think Globally", based on local environmental case studies. We tried to find the answers to several questions. 1) How do combined interactive techniques in the structure of different teaching methods based on real case studies

contribute to the development of students' environmental literacy and environmentally responsible attitudes?

2. What are the advantages and disadvantages of poster and role playing preparation and presentation?

3. What are the difficulties students face in poster and role playing preparation and presentation?

4. What kind of help do students need in the different versions of the teaching module?

Environmental education is well situated in the Bulgarian Educational System with the development of the new State Educational requirements.[2,3)] Biology is most suitable for teaching fundamentals of ecology and the environmental principles. Environmental problems are introduced in all school subjects, having priority in the Cultural Educational Area "Natural sciences and ecology", (KOO in Bulgarian), using the infusion and interdisciplinary approaches (Angelov et al, 2001; Ovcharov et al, 2001; Nikolov et al, 2001), whose shortcomings we tried to diminish when constructing the teaching module (Table 1).

This is the reason for choosing biology as a school subject for studying the effect of interactive-enhanced curriculum module, based on local environmental case studies. The biological courses of both 9^{th} grade (population and species level of biodiversity) and 10^{th} grade (genetic level of biodiversity) are compulsory and develop the basic ecological and environmental concepts. In the 11^{th} and 12^{th} grades only some students choose biology courses.

Therefore our efforts in the development of interactive teaching strategy based on case studies were preceded by content analysis of the biology programmes and textbooks of the 9^{th} grade. We studied the concept structure and developed concept maps of each topic of the ecological chapters. Then we analysed the opportunities of the context, provided by the school recourses and the neighbouring environments for involvement of students into active

studies and solutions of real environmental problems. After that we developed three interactive teaching versions of local case studies.

Table 1. Environmental topics for the successive grades in the secondary school of Bulgaria

Grade	Environmental education aspect in the course of biology
7th	*Biodiversity*, Classification & protection of species, Five kingdoms (Monera, Protista, Plants, Fungi & Animals – invertebrates), extinct & threatened species from each taxon. *Organism & environment*: food interrelations, habitat, adaptation, human influence on the environment, hygiene.
8th	*Biodiversity*, Animal kingdom – vertebrates. Human body: structure, physiology, health & diseases. Hygiene of each body system & first aid in case of injuries. *Organism & environment:* ecosystem, biodiversity, food chains & food webs, cycle of matter. Humans as a part of nature.
9th	*Biosphere:* levels of biological organization, ecological factors, adaptations, populations, intra & inter specific interactions, ecological niche, behavior, communities, ecosystems, biomes, biogeochemical cycles of matter & flow of energy, ecological pyramids, succession, and equilibrium, impact of human activity on nature. Sustainable development.
10th	Multicellular organisms: levels of organization, individual development, *heredity & variation*, genotype, phenotype, *environment, mutations*, hereditary diseases. Biological evolution, struggle for existence, *natural selection*, *speciation*, microevolution, macroevolution, anthropogenesis.
11th	Cellular organization, genetic engineering, cloning, cellular cultures, *biotechnology*, mutagenic factors, homeostasis.
12th	Biological evolution: micro- & macroevolution, gene pool. *Biosphere: Organism & environment*, populations, communities, ecosystems, biomes, cycles of matter & flow of energy. Photoperiodism & homeostasis; productivity of ecosystems, biomes, noosphere (the sphere of human sense). *Rational use of natural resources*; national & international regulations; Pollution & biological monitoring, global environmental problems, sustainable development.

In the module activities students conducted case studies using real ecological experiments, observations and visualization of their findings with different techniques, analyzed data and draw conclusions about human impact on the environment and discussed their personal responsibilities and actions for

the enhancement of local environmental quality. They also draw conclusions of the effect of local environmental activities on the quality of the global environment.

Theoretical framework

According to Paladini & De Carvalho (2008) "*Active* means that students really take part and contribute to the process. *Interactive* is in the sense they create a collaborative and dynamic set of mechanisms to stimulate their own learning".

The fundamental bases of interactive learning are built up by the sociocultural theories of learning, giving priority to constructivism, scientific approach and cognitive reflection (Steffe & Gale, 1995; Anderson, 1984; Glasersfeld, 1996; Karpov, 2003). Vygotsky (1978) advocated that learning had to take place trough interaction in social groups and that thinking was a social product. He was the founder of the cognitive social constructivism as a pedagogical philosophy of teaching innovations. Development of learning skills depends on skills to construct activities and learning schemata. 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. (Hammer, 1997; Blanchette & Brouard, 1995; Barrows & Tamblyn, 1980) as well as scaffolding, shared activity, collaboration (Smith & McGregor, 1992), cooperation, reflective communication, etc. Despite the critics addressed to constructivists (Sweller, 1999, 2007; Mayer, 2004; Kirschner et al., 2006), constructivists' ideas continue to assist productive learning. Especially fruitful is Vygotsky's 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 and collaboration, that help

in the process of transmission of knowledge from individual to individual within the interacting group and reconstructing it in the long-term memory.

Interactive methods are a subject for investigations and speculations of many authors, working on different aspects: describing specific characteristics of each interactive method (Smith & McGregor, 1992), constructing a model of interactivity (Paladini & Carvalho, 2008), working out interactive lesson plans and offering guiding principles for their implementation (Pollack & Fusoni, 2005), acquiring theoretical concepts and using case-studies (Blanchette & Brouard, 1995; Grant, 1997; Kreber, 2001), explaining the essence and use of group work and study teams (Davis, 1993), applying different interactive techniques into teaching models (Davison & Pratt, 2003),[4,5)] rethinking their significance for classroom organization and for raising students' interest and initiative (Gurova & Bozhilova, 2006), classifying them into situational, discussion and empirical as well as applying them into different subjects' teaching (Savcheva & Moinova, 2008; Kirova et al., 2011).

In searching and analysing the academic literature we found that educators' views on the problem were often overlapping, misleading or confusing, using different terms for similar actions (strategies and technologies, methods and techniques) (Angelo & Cross, 1993). Therefore we came to the conclusion to view interactive teaching as a complex system of strategies (scientific approach to teaching, discovery learning or inquiry approach, cognitive reflexion, etc.), technologies (case studies, excursions, ecological experiments and observations, field studies, brainstorming, discussions, etc.) and techniques (poster or role play presentation, concept mapping, documented problem solutions, pro and con grids, problem recognition tasks, assignment assessments, port folio preparation, etc.) subordinately interacting between themselves and modulating the cognitive activity of students (Kostova & Vladimirova, 2010). In other words, we regard their structure as subordination of educational approaches, teaching forms and methods, and teaching tools, as is

the didactic terminology in Bulgaria (Andreev, 1987). Interaction in learning means mutual, collaborative cognitive activity that is bidirectional or multidirectional (Kostova & Vladimirova, 2011). It is not possible to organize a successful learning of students without being acquainted with the "human cognitive architecture" and without continuously putting it in agreement with the real world (Sweller, 2007).

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 the interactive techniques involved in their structure and with little attention to environmental education in context as well as with few arguments from constructivist theories. We saw in that a significant research gap and decided to undertake a comparative study of the effects of some interactive techniques in using the case study method in environmental education in the course of biology teaching of secondary schools in Bulgaria.

The study

Preparation for the study

1). We analysed the state standards and the subjects' contents of the three versions of school text-books for the 9^{th} grade in order to work out the concrete goals of each topic and than to choose an adequate interactive teaching technique in environmental case studies.

We directed our attention to compare the use of poster presentation versus role playing in case studies of local environmental problems. The idea was to involve students in the development of case studies, concerned with

real environmental problems in order to replace traditional teaching on the same topic with active and interactive teaching and in order to find out the learning difficulties they meet. For that purpose we developed three versions for the practical application of the case study method providing successive increase of students' independence in studying real environmental problems of school surroundings (Table 2).

Table 2. Interactive teaching versions of local case studies enhanced curriculum module called "Act Locally – Think Globally"

1st Case studies with poster presentations & discussion	2nd Case studies with role playing and discussion	3rd Case studies presented & discussed by teachers
Scientific approach to teaching (learning by discovery), reflexive teaching; case studies, concept mapping, collaborative group work, data registration and analysis; documented problem solutions, pro and con grid, problem recognition tasks, discussions; analysis and assignment assessments of presentations; interviewing		Punctuated teacher's presentation of ecology lessons using illustrations with local environmental problems and concept maps; think brake;
Assessment tests for ecological knowledge acquisition before and after the experiment		
Ecological experiments, poster preparation & presentation	Ecological observations Scenario and role playing preparation & presentation	Students become self-monitoring listeners: work on the problem & write

2). Selection of schools and teachers: the sample of the study was chosen from two different schools in two industrial towns of Bulgaria – Dupnitsa and Plovdiv. It involved 184 nine grade students (16 years of age) for the experimental groups and 51 students for the control groups (Table 3). The number of students in the control group was deliberately chosen smaller as it was obvious from the theoretical studies that the teacher presentation was less effective than active students' participation. The control group was used as a comparison showing the effect of lowest students' independent learning activities. The differences and similarities between teacher qualification, school

and town resources and properties of surrounding environments were also taken into account.

Table 3. Samples, teachers, experimental schools and materials for teaching and assessment

<table>
<tr><td colspan="5">The sample of investigation for the different styles of learning</td></tr>
<tr><td>Schools</td><td>Teachers</td><td colspan="2">Classes & Numbers</td><td>Styles of learning</td></tr>
<tr><td>Professional gymnasium “Acad. S. Korolev”, Dupnitsa, Bulgaria</td><td>Elka Vladimirova</td><td colspan="2">9b & 9c; E1a – 40
9d & 9e; E2b – 40
9a; C – 25</td><td>Poster presentation
Role playing
Lecturing</td></tr>
<tr><td>Language gymnasium “Plovdiv”, Plovdiv, Bulgaria</td><td>Ruslanda Kaleva</td><td colspan="2">9b & 9c; E3a – 54
9d & 9e; E4b – 50
9a; C – 26</td><td>Poster presentation
Role playing
Lecturing</td></tr>
<tr><td colspan="5">Similarities of experimental schools</td></tr>
<tr><td>Teachers</td><td colspan="2">School surroundings</td><td>Students</td><td>Syllabuses & textbooks</td></tr>
<tr><td>Teachers had acquired the highest teaching degree – 1st grade (5th grade being the lowest)</td><td colspan="2">Similar environmental problems: river pollution, street dog population increase, park ecosystem destruction, heavy traffic and increased unplanned building construction</td><td>Same grades, learning biology in Bulgarian; students do not attend special biology classes;</td><td>The same syllabus, textbooks with reduced ecological contents because students have different professional interests not connected with ecology; attend ecology clubs voluntary.</td></tr>
<tr><td colspan="5">Differences of experimental schools</td></tr>
<tr><td>Elka Vladimirova has specialization in EE; Ruslanda Kaleva – in critical thinking.</td><td>River Djerman (Dupnitsa) and river Maritsa (Plovdiv) have differences in some properties & local protection strategies.</td><td colspan="2">Students from Plovdiv are interested in language acquisition (mainly English) and are a year older than students from Dupnitsa, who are interested in profession acquisition e.g. industrial electronics, etc.</td><td>Students from Dupnitsa do not pass entrance exams and are enrolled without restriction; Students from Plovdiv pass entrance exams in Bulgarian language & mathematics.</td></tr>
<tr><td colspan="5">Materials for:</td></tr>
<tr><td colspan="2">Teachers</td><td>E1</td><td>E2</td><td>E3</td></tr>
<tr><td colspan="2" rowspan="2">State educational standards in Biology and in Information technologies for 9th grade students; a model for poster presentation and assessment; a model for role play presentation and assessment, tests for knowledge assessment; check lists for working sheets assessment; a table of recommended topics from the biology textbook for each case study;</td><td colspan="2">Challenge for motivation; working sheets for observation and data collecting; working sheets for interviews; a list of recommended web sites; hints for seeking help from other teachers (physics, chemistry, geography, information technology, social sciences)</td><td rowspan="2">Power Point Presentations of ecology lessons, demonstration of illustrations of environmental issues.</td></tr>
<tr><td>A model of a poster</td><td>A model of a role play</td></tr>
</table>

Then we organised and performed the preparation of teachers for the empirical pedagogical experiment having individual meetings with them and explaining the strategy of the investigation and the different strategies of teaching in the three versions of the module. In the process of the experiment we supervised the preparation of lessons, then visited the actual performance and after that discussed the achievements and shortcomings of each lesson with the teachers and also we assessed students achievements by tests prepared for the purpose of the study. We also interviewed students for their opinions and suggestions (Appendices).

The study took place in September–December of 2010. In the traditional teaching (control groups), ecological concepts were illustrated by means of examples from the environmental context. In the experimental groups the situation was the opposite: students had to discover and formulate environmental problems and after that to seek solutions to them based on adequate scientific explanations mainly from textbooks. In this way they were expected to develop literacy not only within science but also about science (Sadler, 2011). Such kind of literacy could enable them to make informed scientifically based decisions. We expected them to understand that industrial, commercial and domestic activities continuously created global environmental problems which could not be solved by technology alone. We wanted to imply in them the notion that ecological crisis was the result of maladaptive human behavior. Therefore we found it was necessary to identify the factors that influence pro-environmental behavior in order to organize successful EE.

1st step: motivation

Students from the experimental groups 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 under the guidance of the teachers, students constructed Table 4.

Table 4. Real environmental cases, detected and analysed by students

Cases	Problems	Controversies
1. Construction of new buildings	Destruction of habitats and land pollution	People need homes & commercial buildings; Biological species need their homes as well;
2. Lots of dogs on the streets.	Uncontrolled reproduction and population growth	Dog population increases & dogs spread diseases; It is not moral to kill them or to throw them out of homes;
3. The local river is very polluted	Fishes & other animals are dying; wet habitats are affected	Industry and homes produce waste and pollute; Water animal and plant species should be saved; Sustainability depends on biodiversity
4. Trees in the parks are being cut	Destruction of ecological niches and ecosystems	Poor people need fuel in winter to warm homes; Trees are dominant species in the ecosystem and homes of many animals;
5. Heavy traffic & road accidents	Human health & lives threatened; animals killed	People need vehicles to go to work, but many people and animals are killed; Air, water & soil are polluted;

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 (Fry et al., 1999) as well as to extrapolate local problems to global issues.

2nd step: construction of working teams

Students were divided into 10 working teams in each school for each case study (Fig. 1).

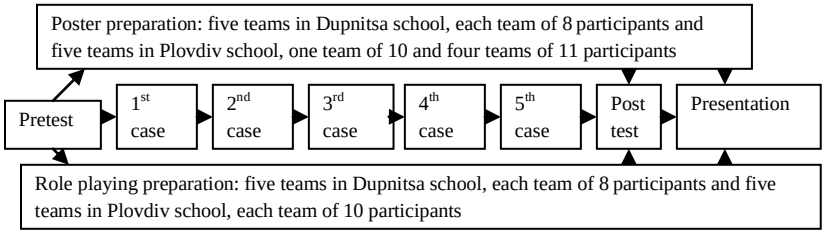

Fig. 1. Design of team work for poster and role play preparation

Five teams of each school had to investigate the environmental problems (one case for a team) and prepare posters and five teams had to investigate the same cases and prepare role plays (also one case for a team). Discussions in the classes directed students to look for sound scientific knowledge in order to solve the problems. Teachers gave them recommendations of topics to read from textbooks (Table 5). For that purpose each participant had to understand his/her task and responsibility for a successful team work. Analysis of environmental problems made them aware of their poor scientific background knowledge & experience. Teachers acted as facilitators guiding them through the successive steps in looking for solutions to the case studies. Under teachers' coaching each team developed an action plan and time-table for solving the studied case on the basis of sound ecological knowledge and for presenting their findings.

Table 5. Interrelationship between real environmental cases and deep ecological understanding

Case No	Required ecological knowledge	Recommended ecological topics from the textbooks of: Nikolov et al.,2001; Angelov et al., 2001.; Ovcharov et al., 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; size and population dynamics, survival curves & types of population growth
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.

Five discussion sessions were organized to study and clarify the chapter of ecology in the textbook "Biosphere: macro system – structure and processes". Students studied the lessons, constructed concept maps and gave oral presentations on each topic in the classroom. The teacher corrected errors and omissions.

3rd step: process of studying and solving the problem

The experimental groups performed the following common activities: gathered information through observation, experiments (studied chemical, physical and biological pollution of rivers using adequate tests), 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 (Table 5). 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. They were also asked to extrapolate the consequences on the global environment.

4th step: preparation for presentation

Both experimental groups had to perform specific activities.

E1 groups prepared posters to present at a class meeting. A poster for each studied case was prepared by the corresponding team according to the following required sections: topic, names of participants, photos, grade, school, date, summary, introduction, methods and materials, results, conclusions, references and acknowledgements. Each member of the team had a task in preparation and presentation of the poster. Each team had a leader, responsible for the organization of the work and for the presentation, at which he was giving the floor to the successive speakers. For each studied case two school periods were allocated – one for presentation and one for discussion. Students constructed concept maps of the ecological concepts pertaining to the studied cases. They organized school conference for the presentation of their posters at the end of the studied chapter. In this way they shared their achievements socially with the community and spread knowledge and enthusiasm among the school population. Poster preparation and presentation in its way was also a role playing as students played the roles of scientists they pretended to be at the school conference.

E2 groups developed scenarios for a role play and presented it in front of other students as audience (Table 6). In their studies and presentations they assumed many roles, not only of scientists but of many occupations, which broadened their social understandings and skills.

Table 6. Types of roles allocated to team members

Member of the team and roles to fulfil	Tasks for each role and each case study				
	Case 1	Case 2	Case 3	Case 4	Case 5
Leader:	organises, opens the role play, leads the discussions, tries to reach consensus, formulates conclusions				
Ecologists: specialists in	Urban ecology	Animal ecology	Aquatic ecology	Land ecosystems	Ethology & ecology
	comment on the scientific validity of decisions and predict consequences of anti-ecological behavior				
Doctors: specialists in	Human hygiene	Parasitic diseases	Gastric diseases	Social hygiene	Surgery
NGO's representatives; Mayors	Representatives of nature conservation societies, animal protection, biodiversity protection, sustainable development, etc. The Mayor was acquainted with the problems and offered programs for solutions.				
Business representatives	Builders	Dog dealers	Factory managers	Wood sellers	Car sellers
Sufferers from	Noise & accidents	Echinococcosis	River pollution and park destruction		Injuries & lost relatives
Science commentator	Understands the scientific content. Demonstrates critical thinking. Knows the results of the investigations.				
Portfolio organizer	Collects and arranges information and illustrations into folders and demonstrates them during the play				

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 7).

Assessment of posters was carried out according to predetermined criteria and scores (Appendix 1). Seven criteria (components, scientific content, arrangement, labels, design, conclusions & aesthetics) on a five-point scale were used for the assessment of each poster (Table 8).

Table 7. Achievements of students in acquiring ecological knowledge

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

Table 8. Achievements of students in preparing & presenting posters and role plays

Varieables	Posters Roles	Scores					Statistical characteristics			
		1	2	3	4	5	Average	Mo	Me	SD
	Professional gymnasium "Acad. S. Korolev", Dupnitsa, Bulgaria									
E1a -40	Posters	2	3	4	10	21	4.13	5	5	1.18
E2b-40	Roles	2	4	5	22	7	3.70	4	4	0.91
	Language gymnasium "Plovdiv", Bulgaria									
E3a-54	Posters	1	3	6	9	35	4,37	5	5	1,01
E4b-50	Roles	4	6	7	20	17	4.04	4	4	1.34

Assessment of roles was carried out according to the specific requirements of each role (Appendix 2) on a five-point scale (Table 8).

Criteria and credits for the assessment of tests', posters' and roles' achievements were prepared and discussed before the experiment with the students involved and with the help of specialists (teachers of other subjects and actors from the theatre). This step was very important as it clarified the expected results as goals in education and motivated students to work for

them. 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 to each item of the tests beforehand was also important. Students had to understand that knowledge assessment should correspond to Bulgarian national standards. That was a basis for comparing the achievements of students from the two different schools.

Knowledge achievements based on Bloom's taxonomy of educational objectives (understanding – mark 1, application– mark 2, analysis– mark 3, synthesis– mark 4 and evaluation– mark 5) (Tables 7 and 8) showed a significant step forward in better performance of students but it is far from being satisfactory. On the whole the trends were on the correct direction and with correct speed in both experimental groups.

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

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.

Based on the theoretical 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 explanations. Every step had to be guided. Left alone they were confused. The guided discussions by the teacher directed them to find the correct path to the solution. The discussion started with posing of a problem, making propositions about its solution. The greatest difficulty students met when planning the observations. The proposed observations were drawn on the blackboard and then expected results were discussed. Very often the first propositions were wrong and after drawing to visualize the observation or the experiment, it became obvious that scientific results were not possible. That was a kind of collective, joint creativity. Braver and more creative students made propositions, others were involved in speculating and criticizing, and in this process thoughts were directed to look for modifications based on mistakes and finally to arrive at right answers. Fewer students were involved actively with questions, ideas, criticism or proposition of a solution. More of them listened intensely, tried to follow and understand the thinking of others, which activated their own thinking. The degree of creative thinking of the whole team was much higher than in the traditional lesson.

The actual making of the poster proved to be very difficult. Students needed instruction about the materials, the design, structure, components, their relative size, place and 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 to find out that students felt uneasy to express thanks to their teachers or to other consultants, very often parents. They used to take that help for granted as if teachers and consultants were obliged to do it and it didn't caused them efforts.

Most surprising was the situation 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 place for themselves in the play. Students did not like 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.

It was very difficult and time consuming to arrange meetings with professionals for students to acquaint them with the social engagements and responsibilities of the roles they had to play. The work took a whole year for the students and the teachers to prepare a role play and present it to a public. Smaller episodes of the play were acted in the classroom as a rehearsal and as a demonstration of the studied situation and also as helping students to improve their social abilities and overcome their shyness. The attention was always directed to the ecological aspects of each role – ideas, thoughts, deci-

sions had to be ecologically evaluated. That helped students understand how often decisions were made with shire ignorance and mere boasting. They began to ask questions and think about their responsibilities for their own lives: "Should they live the decisions into the hands of ecologically ignorant people or wasn't time for them to take their decisions into their own hands?" And: "Are they qualified enough to take the full responsibility, not having acquired the necessary ecological knowledge?" Such kinds of thoughts and discussions we consider as the best outcomes of teaching. It was very difficult for them to convert the observed situation into words and to prepare the scenario. In this step of the development of the play they sought help from their literature teacher.

During the actual presentation the same jury as in the assessment of posters was engaged to assess the achievements of each student using Appendix 2.

Results are summarized in Table 9. The scores in poster presentations are a bit higher than in role playing but the difference is not very high (Table 9: 4, 7, 11 & 12). Experimental groups (scores from tests, posters and role playing) score better than control groups (Table 9: 1, 8, 9 & 14). Scores on post-tests are significantly higher than scores on pre-tests (Table 9: 2, 3, 5, 6, 10, 13, 15 & 16). Students from Language gymnasium score higher than students from the professional gymnasium.

Table 9. Statistical analysis (based on tables 6 & 7, using SPSS procedure)

Cronbach's alpha	1) E1a, E2b, E3a, E4b & C1, C2	,6706
Table 6	2) E1a, E3a posttest & E1a, E3a pretest	,8430
Table 6	3) E2b, E4b, posttest & E2b, E4b pretest	,9693
Table 6	4) E1a, E3a posttest & E1b, E4b posttest	,6877
Paired sample T-test	5) E1a, E3a pretest & E1a, E3a posttest	8,190
Table 6	6) E2b, E4b pretest & E2b, E4b posttest	17,826
Table 6	7) E1a, E3a, & E2b, E4b posttests	1,586
Table 6 & 7	8) Experimental (E) & Control groups (C)	- 11, 587

Friedman test	9) E & C Chi-square 10) E1a, E3a pretest & E1a, E3a posttest 11) E1a, E3a, & E2b, E4b posttests	8,000 2,000 1,000
Wilcoxon Signed Rank Test Table 6 & 7	12) E1a, E3a posttest & E1b, E4b posttest 13) E1a, E3a pretest & E1a, E3a posttest 14) E & C, sum of ranks 36,00	1,461 1,342 2,521
One-sample T-test	15) E1a, E3a pretest & E1a, E3a posttest 16) E2b, E4b pretest & E2b, E4b posttest	40,760/ 6,270 27,523/12,600

The experimental teaching using interactive methods stimulated the development of higher order thinking skills (to see and formulate a problem, to work out a hypothesis, to perform observations and collect data, to evaluate data according to a specific purpose and objective criteria, to propose solutions and deduce consequences; to respond actively and responsibly to environmental issues).

Conclusions

The reported findings from the overall study of constructing environmental education on the basis of interactive teaching using case studies in two variations – poster presentation versus role playing, allow 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 environmental education 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.

The brief information about biology school contents shows that there are some favorable possibilities for interactive teaching and some obstacles. The possibilities we saw in the topics of the school syllabus, which included important ecological and environmental concepts to be discussed in the school lessons. The difficulties we addressed to the high academic character of the

contents of the textbooks and the lack of time for practical exercises, ensuring contact with real situations.

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 both 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.

Case studies were more difficult to organize, more time and effort consuming than traditional teaching and if we measured effect against time and effort we had to give up interactive and innovative teaching. But because we measured effect against outcomes, we were convinced and encouraged to give priority to interactive teaching methods.

Both poster presentation and role playing were well accepted by the students and all of them were involved. Role playing proved to be much more difficult, but more productive in social development. Using interactive teaching students acquired both new ecological knowledge and new methods of discovering it, i.e. science as a product and science as a process. That convinced us that guided discovery learning had priority before 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. The contribution of our experiment is in the design, refinement and practical application of an interactive-enhanced curriculum module, based on local case studies for the development of environmental literacy.

NOTES

1. http://conspect.nl/pdf/Our_Common_Future-Brundtland_Report_1987.pdf
2. *Държавен вестник,* бр. 48/13 юни 2000 г.
3. *Държавен вестник*, бр. 46/28 май 2004 г.
4. http://www.gcbe.us/6th_GCBE/data/Situational%20Teaching%20Model.doc
5. http://www.materials.ac.uk/guides/casestudies.asp

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APPENDIX 1: Assessment of posters

APPENDIX 2: Assessment of a role play

Criteria	***Scores***				
	5	4	3	2	1
Components of the poster	All components presented	One omission: photo or bibliography	2 omissions & 1 mistake	More than 2 omissions & mistakes	Serious omissions & mistakes
Scientific contents	Precise & correct sentences	One insignificant mistake	2-3 mistakes	More than 3 mistakes	Unsuitable illustrations with mistakes
Arrangement	Correct & hierarchical	Minor omissions	1-3 mistakes	More than 3 mistakes	Incorrect arrangement
Labels on illustrations	Correct & complete	With 1-2 mistakes	3-4 mistakes	More than 3 mistakes	Many mistakes in the labels
Design	Correct & precise by hand or by means of a computer	Clear & logical with minor inaccuracies	Difficult to orientate & understand	Lacking logical structure	Requirements for design are not met
Conclusions	Clearly formulated on the factual basis	1-2 expression inaccuracies	More than 2 expression inaccuracies	Conclusions not clear	Not supported by facts
Aesthetics	Beautiful colorful rubrics with proper size & shape	Minor deviations	2-3 improper sizes	More than 3 mistakes	Choice & arrangement not good

Roles	Activities and scores
Leader	Opening words. Gives the floor to the speakers. Accordingly dressed (official clothing). Good pronunciation, confident, well acquainted with the scenarios of the play. Closing speech: well prepared, short & meaningful. Artistic. **Credits:** 5 4 3 2 1
Ecologist	Describes the ecosystem (urban, aquatic & terrestrial): processes & interactions, consequences of human influence for nature & for human beings; needs of ecological decisions well supported with argumentation; suitable clothing, good diction, excellent knowledge of facts, concise presentation, artistic, confident **Credits:** 5 4 3 2 1
Investigator	Describes the study: problem, hypothesis, methods, observations, instruments, data & conclusions. Excellent knowledge of the work of scientists and of the structure of the investigation. Clothing & diction good, confidence, concise presentation, artistic, tolerant **Credits:** 5 4 3 2 1
Doctor	Knows the causative agents, symptoms, development & risks of the diseases; understands the difficulties in the treatment; knows & states his/her reasons for prophylactic measures on a ground basis; persuades people to take decisions based on scientific knowledge; **Credits:** 5 4 3 2 1
Mayor, lawyer, journalist, NGO's representative	Knows the laws, respects the discussed situations & people's sufferings, seeks objective decisions, obeys the facts, willing to compromise & prevent from new conflict situations, keeps calm & constructive atmosphere. **Credits:** 5 4 3 2 1
Business representative	Knows the problems & articulates arguments for the significance of his/her business profit for people and for the development of the infrastructure. Well convinced in the necessity of sustainable development for the stability of society. **Credits:** 5 4 3 2 1
Sufferer from the environment destruction	Very well acquainted with the problems of the imitated person – victims of accidents, losers of property, suffers of psychological disorders, social limitations, consequences for the affected families & for society. **Credits:** 5 4 3 2 1
Science commentator	Understands the scientific content. Demonstrates critical thinking. Knows the results of the investigations. Self-confident, clear pronunciation, good diction, attracts attention, deeply involved, intelligent, values the work & findings of the teams in accordance with contemporary understandings and future trends. **Credits:** 5 4 3 2 1
Portfolio organizer	Collect photos, tables with results, discussions, sessions, etc., all the documentation of the work of the team & arranges them into the portfolio (files, CD). Keeps everything in full order, well-structured in successive rubrics and contents, clearly labeled, so that the necessary document can be quickly found. **Credits:** 5 4 3 2 1