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PEDAGOGICAL CONDITIONS OF DESIGN AND APPLICATION OF COMPUTER PROGRAMS AS MEANS OF ENVIRONMENTAL EDUCATION OF SENIOR PUPILS (on natural subjects material)

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GENERAL DESCRIPTION OF THE WORK

Urgency. Environmental issues and informatization of the society cause an urgent need for the appropriate sociological, psychological, pedagogical researches. A number of philosophical researches both in this country and in abroad show that ecologization together with informatization can jointly ensure the unity of the society and the nature in the stream of technical progress, sustainable development on the planet.

These world's trends are also priorities in the development of education. It was reflected at the Belarusan Teachers' Congress (1995), in Belarus Conception of Environmental Education (1998), in Belarus Conception of Informatization of Education, in Belarus Program of Development of Environmental Education (1998) and in Belarus Program of Informatization of Education (1997).

Universal points of classical pedagogy are of great importance for realization of the priorities mentioned. On the one hand, it was on the basis of these points, that environmental psychopedagogy as new methodological direction was developed. On the other hand, it was creative development of these points, that methodological background for computerization of academic and educational process was created.

Taking into account these points, instructional potential of computer programs at the lessons of natural subjects was studied. Biology, chemistry and geography are the very natural subjects environmental education traditionally bases on. There was a number of papers didactic requirements for the design of computer programs and their assessment were formulated in.

In schools, computer programs are growing from the *object of study* to *means of teaching* and further – to *means of education (upbringing)*. This is due to fantastic possibilities of computer programs. This follows also from the principle of integrated education, development, and ubringing.

Educational function of computer programs was once mentioned. Some ways of application of examiner computer programs aiming at education (upbringing) were once depicted. Computer programs are naturally entering the common context of audiovisual means. Nevertheless, design of specific educational programs and their vast implementation is hampered because no general theory of computer-supported education was created. It seems, this kind theory cannot be created at once. It is necessary previously to draft, to apply, and to examine it in any particular field of education.

Considering the situation, we guess environmental education is the most suitable field. Its world-scale importance and urgency for this country can explain this choice. Environmental issues in Belarus are very urgent regarding its small territory.

Presently, there are a lot of papers dealing with research of environmental education of different ages by various means including audiovisual means. Teenage has its own peculiarities (low level of perception of objects of live nature as subjects, environmental pragmatic-kind prejudgments, predominance of practical component in relations to the nature). Teenage is regarded to be critical as relations to the nature change dramatically. On the one hand, just teenager senior pupils begin studying basic computer science. On the other hand, computer-supported environmental education of senior pupils has never been an object for a special research. That is why we chose pedagogical conditions of design and application of computer programs as means for environmental education of senior pupils our research topic.

Research connection with the great scientific programs, projects. This research reflects main principles of Belarus Conception of Environmental Education (1998), of Belarus Conception of Informatization of Education, directions of applications of new information technologies planned in Belarus Program of Development of Environmental Education (1998) and in Belarus Program of Informatization of Education (1997).

Research goal. Determination of pedagogical conditions of design and application of computer programs as means for the environmental education of senior pupils when their studying natural subjects (biology, chemistry, geography).

Research object. Academic and educational process in 9-11 forms of secondary educational institutions as a field of pedagogical activity where computer-supported environmental education can be realized.

Research subject. Pedagogical conditions of design and application of computer programs as means for the environmental education of senior pupils when their studying biology, chemistry, geography.

Research hypothesis.

Environmental education will be improved dramatically if:

- Computer programs are used in educational process when teaching natural subjects and the following conditions are kept:
- The contents and the structure of computer programs are designed in accordance with principles of classical pedagogy, of environmental psychopedagogy, of problem situation theory;
- Computer programs are interactive towards pupils, this interaction is like an ideal pedagogical communication because of appropriate personification and stimulating pupils' reflection;
- Computer programs are applied by a knowledgeable teacher with high environmental and informational culture, at every stage of educational cycle within non-stop educational process.

Research objectives.

1. To analyze the present state of theory and practice of design and application of computer programs in the context of other audiovisual

means taking into account the possibility of their application aiming at environmental education at the lessons of natural subjects.

2. To state the role of computer programs as means of education in the educational process and as optimal study model of natural reality.
3. To find pedagogical conditions of design and application of computer programs as effective means for environmental education.
4. To design computer programs meeting the found conditions, to test them in real educational process, and to evaluate their effectiveness experimentally.

Research methods.

1. *Theoretical*: comparative analysis of philosophical, psychological, pedagogical, linguistic, methodical and instructional literature on the problem; logical and semantical analysis of particular pedagogical notions, studying and analysis of manifesting documents and school documentation.
2. *Observational and examining*: direct and indirect pedagogical observations of pupils' and teachers' activity in educational process; questioning and interviewing pupils and teachers.
3. *Experimental and praximetric*: constating and forming experiments, PC modeling and programming problem situations, studying and summarizing pedagogical experience.
4. *Mathematical methods of processing data:* calculating criteria of non-parametric statistics; graphic presentation of the results.

Methodological background.

- Manifesting documents by UNESCO and Belarus Education Ministry;
- Philosophical idea of sustainable development through ecologization and informatization of education (A.I.Kushnarenko, A.D.Ursul);
- Research of the role of arts and humanities in environmental education of senior pupils (I.S.Dezhnikova, A.S.Zakhliebny, I.D.Zveriev, V.M.Sienkievich, I.T.Suraviegina);
- Classical pedagogical principles of education combined with the problem situation theory (S.I.Viekslier, B.Z.Vulfov, T.V.Kudriavtsev, I.Y. Liernier, M.S.Matiushkin, M.I.Makhmutov, M.M.Potashnik, L.F.Spirin);
- Points of environmental psychopedagogy (S.D.Dieriabo, V.A.Yasvin);
- Psychological studies of effects of audiovisual means (V.P.Zinchenko, I.Y.Mielamiedov, D.I.Poltorak, L.P.Pressman, A.I.Fiodorov, G.I.Khoziainov).

New scientific results obtained:

- Role of computer programs as means for environmental education and as optimal study model of natural reality was stated.
- Pedagogical conditions of optimal design and of effective application of computer programs as means for environmental education of senior pupils at the lessons of natural subjects were found.
- Particular group of computer programs effective in environmental application according to the following typology was proposed: sensor

environmental trainer, situation modeling environmental trainer, genealogy-playing environmental trainer, computerized reader of environmental poetry.

- Computer programs meeting the found conditions were designed and successfully proved in environmental education of senior pupils at the lessons of biology, chemistry, geography.

Practical importance of the results. The designed computer programs – environmental trainers – can be applied to improve the environmental education of senior pupils within the system of other means. The proposed approach will be useful when designing new generation computer software including virtual reality and the Internet.

Main dissertation points to be defended:

1. Approach to design and application of computer programs as means for environmental education *on the integrated basis of classical pedagogy, of environmental psychopedagogy, and of problem situation theory.* According to this approach, teacher with high environmental and informational culture apply the reflection-stimulating and personified computer programs at every stage of educational cycle within non-stop educational process.
2. Statement of role of computer programs in the system of environmental education. Computer program is the optimal study model of natural reality regarding perfect balance between the immersion required and the subjective danger afforded. It is also audiovisual means of education since aspects of its elaboration and application meet 13 essential criteria of the education as a process.
3. Set of computer programs (environmental trainers) designed taking into account the pedagogical conditions found:

- *Sensor environmental trainer* to increase pupils' level of aspiration for non-pragmatic interaction with the world of the Nature, to increase their level of perception of objects of live nature as subjects through the perceptive channel;
- *Situation-modeling trainer* to develop pupils' skills of regular behavior in the Nature, to increase their level of perception of objects of live nature as subjects through the practical channel;
- *Genealogy-playing trainer* to increase pupils' level of immersion into the world of the Nature, to increase their perception of objects of live nature as subjects through the cognitive channel;
- *Computerized reader of environmental poetry* to increase pupils' level of aspiration for non-pragmatic interaction with the world of the Nature, to increase their perception of objects of live nature as subjects through the cognitive channel.

The challenger's personal share. The challenger himself, from the point of environmental psychopedagogy analyzed existing practice of application of both non-processored audiovisual means and computer programs in schools of Belarus. He theoretically proved the role of

computer programs as optimal study model of natural reality and as means of education. He elaborated the scenarios of the environmental trainers and programmed them as well. He programmed examiner computer program for evaluation of level of pupil's ecocentric consciousness. He managed the pedagogical experiment generally, and conducted particular biology and chemistry lessons applying the programs designed. He processed and interpreted the data obtained.

Approbation. The main dissertation points, the course of pedagogical experiment were presented *at international conferences* "Education of XXI Century: Issues of Raising Education Workers' Qualification" (Minsk, 1993), "Issues of Ukrainian Scientific Terminology" (Ukraine, Lviv, 1994), "New Information Technologies in Educational Processes" (Minsk, 1994), "New Technologies in System of Non-Stop Education" (Minsk, 1995), "Ecopedagogy: the State, the Issues, the Perspectives" (Minsk, 1995), "The Environment, the Technology, the Resources" (Latvia, Rezekne, 1997), 26th International Congress of the Nordic Society for Educational Research (Finland, Lahti, 1998), *at Belarusan conferences* "Development of the National System of Training Pedagogical Workers" (Minsk, 1994), "Development of Scientific Background for Conducting Pedagogical Practice" (Homel, 1994), "Development of Education in Latvia: the Past, the Present, the Future" (Latvia, Daugavpils, 1996). The dissertation was also discussed and approved at sessions of Vitebsk State University Chairs of Pedagogy and of Chemistry.

The research results were implemented in schools of Belarus for application aiming at environmental education of senior pupils. The proposed approach was lectured in course "The Computer and the Education" for Vitebsk State University students, and for the trainees of Vitebsk Teachers' Qualification Raising Institute.

Publications. The main dissertation points and the results were presented in 10 papers published in scholarly journals, in 19 abstracts published in conferencial abstract books. Total of 74 pages were published. The dissertation itself is internetted at http://www.geocities.com/RainForest/Wetlands/1061/ .

Structure and volume of the dissertation. The dissertation consists of introduction, of general characteristic of work, of two chapters, of conclusions, of list of quoted sources, and of supplements. The volume of the dissertation is 212 pages including 9 pages filled with 9 illustrations, 23 pages with 22 tables, 75 pages with 9 supplements (with illustrations and tables). List of quoted sources comprises 19 pages and contains 275 items in Belarusan, English, Latvian, Russian, and Ukrainian.

PRINCIPAL CONTENTS OF THE DISSERTATION

In the introduction and the general characteristic of the work the research urgency is stated, its goal and objectives are determined, new scientific results obtained and the practical importance are listed, the hypothesis and the main points to be defended are formulated.

The first chapter *"Application of computer programs for the environmental education as pedagogical problem"* deals with analysis of place and role of computer programs in the system of audiovisual means at the lessons of natural subjects, with statement of the educational function of computer programs, with pedagogical requirements to computer programs as means of environmental education, and with analysis of role of teachers' informational and environmental culture in the information society.

Audiovisual means (we consider cinema films, television programs, video records, etc.) are of great importance to present images of live nature at the lessons of natural subjects. Their prototypes (Chinese shade theater, Camera obscura, Catopria magica, etc.) were used in ancient and medieval times to realize education. We see the development of audiovisual means goes in direction of pupil's deeper immersion into the reality modeled, of this pseudoreality, of more freedom both for the teacher and for the pupil.

Actually, the rich collection of instructional audiovisual means on natural subjects (biology, chemistry, and geography) has been created. Some of them can be applied for environmental education. However, the effectiveness of non-processored audiovisual means is insufficient. It can be explained by their key disadvantage – inability of providing adaptive feedback and interactive regime.

It is computer programs – pedagogic programmed aids on natural subjects (biology, chemistry, geography), computer games, multimedia and the Internet that provide those feedback and interactive regime. Powerful possibilities cause the central place of computer programs in the system of other audiovisual means. But presently educational effect of computer programs is not due to designers' and programmers' purposeful activity. This effect results only if special pedagogical interaction "teacher - pupil - computer" is provided additionally.

Computer programs have been studied as means of teaching various disciplines, of cognition of reality around, of self-cognition and reflection, of developing culture of study activity. Computer programs have not been studied as educational (upbringing) means. But in fact it is recognized both by Belarusan and foreign researchers that computer programs are means of education, which serve to realize main methods of education. We made this conclusion upon analysis of pedagogical situations with application of computer programs. Those situations meet 14 essential criteria of education as a process.

"Pedagogical conditions" is not used in the same meaning by various researchers in pedagogy literature. Within the discourse of our research, we

understand pedagogical conditions as scientifically proved requirements, meeting which provide realization of contemporary environmental education – cultivating pupil's ecocentric consciousness (e-consciousness) of three united components – psychological immersion into the world of the Nature, perception of objects of live nature as subjects, aspiration to non-pragmatic interaction with the Nature.

Pedagogical conditions of design and application of computer programs as means of environmental education were not found yet. When determining them, the already known ergonomic, hygienic, didactic conditions of application in educational process should be kept. The best theoretical basis to create a system of these conditions is principles of classical pedagogy and conceptions of environmental psychopedagogy. The latter is a trend in pedagogy oriented to the modern ideal of environmental education – to e-consciousness.

The psychological research of human perception of audiovisual means is of great importance here. In the aspect of form and space, perception of computer is something average between perception of cinema film and of TV program: as compared with cinema screen, computer's one has smaller dimensions, but as compared with TV screen it is located closer to pupil (user). In the aspect of function, there is difference and advantage as computer ensures the interactive regime.

Psychological channels of forming subjective relations to the objects of live nature are valid both for the objects themselves and for their PC displayed images. Inclination to the objects of live nature is formed through the perceptive channel, interest – through the cognitive channel, aspiration – through the practical channel. Whether these relations turn positive is up to the personification of computer programs and to the positive emotions arising when interaction with the program.

Environmental education includes personal labilization (understanding inadequacy of personal behavior in the Nature and willing to become better), mastering the adequate technologies of interaction with the Nature, and subjectification of objects of live nature (percepting them as subjects with equal rights). Computer programs should be applied at every stage of environmental education. At the beginning and the closing stages they are necessary in examination of level of e-consciousness, the process of examination itself has educational significance. At the central stage computer programs function as environmental trainers.

Pedagogical trainers are usually designed on the basis of problem situation theory in education. The trainers help to solve constrains that often appear when practical realization of problem environmental puzzle. In these puzzles pupil usually are suggested to make a decision, to undertake a fictive action. When doing it, the pupil's emotions are quite real that has an effective forming impact. Through interaction with computer programs, the pupil become stronger in proper actions in pseudoactivity modeled. However, the trainer is not an isolated and sufficient educational means,

one should apply other educational means to full solving the pedagogical aim. That is why researchers used to tell "computer support" only not presumptuous "computerized upbringing".

The contents of computer programs designated for effective environmental education at the lessons of natural subjects should meet the requirements of being based on methodological, methodical and didactic principles of classical pedagogy and of environmental psychopedagogy. Further application of computer programs should meet requirements of complex and non-stop application. To meet these requirements together with definite ergonomic and hygienic ones, teachers' high environmental and informational culture is necessary.

The components of this culture are: *knowledge* of information society theory, of real progress in the field of new information technology, of psychological aspects of design and application of computer programs that can be potentially implemented for environmental education of pupils; *skills* of using the advantages of new information technologies for nature conservation, of immediate assessment of fresh computer programs, of their installation, approbation and implementation; *beliefs* in opportunity and necessity of making use of advantages of information society aiming at minimization of destructive impact on the nature; *experience* of looking for the environmental information in databases and the Internet.

Teachers' environmental and informational culture is analyzed in the context of sustainable development. The contemporary environmental issues are in fact the moral and ethical ones.

The second chapter "*Ways of increasing effectiveness of computer-supported environmental education at the lessons of natural subjects*" deals with practical designing computer programs as optimal study models of natural reality and as means of environmental education, with composition and structure of environmental trainers, with organizing the pedagogical experiment to cultivate pupils' e-consciousness applying environmental trainers.

It is necessary to take into account the pedagogical peculiarities of teenage when designing computer programs. Teens as compared with others ages have low level of subjectification of natural objects, stable pragmatic-kind environmental prejudgments, predominance of practical component in relations to the Nature.

Based on the results of the analysis of computer programs in the context of other study models of natural reality, we drew a concluision that they are opmimal models because in their case the balance between needed and affordable subjective danger is the best.

The contents of school courses contains enough fundamentals to plan environmental trainers. There are evolution of species, evolutional philogenetic tree, genealogy trees, heredity *in biology*. There are critisism of vitalism theory, problem of origin of oil and coal *in chemistry*. There is geochronological scale *in geography*. By the way of combining common

evolutional tree of live beings with a particular pupil's genealogy tree it turns possible to create a trainer. The work with it would contribute to understanding the unity of origin of both human and other live natural objects, to cultivate psychological immersion into the world of the Nature, to perception of objects of live nature as subjects through the cognitive channel.

There are wave processes, fundamentals of optics and acoustics *in physics.* Knowledge of laws of spreading light and sound, their quantitative evaluation makes it possible to create a trainer. The work with it would contribute to development of sharp hearing and color vision necessary for profound acquainting with objects of live nature, to understanding the unity of physical basics for positive and negative audial and visual natural releasers, to beat the live natural objects-related stereotypes, to perception of objects of live nature as subjects through the perceptive channel.

There are novels, essays, poems, etc. with actual environmental contents *in Belarusan literature*. Together with literate means of creating images and sugette analysis it makes possible to create interactive computerized versions of arts. Pupils' working with them would contribute to cultivating aspiration for non-pragmatic interaction with the world of the Nature. It is also turning possible to create a trainer, work with which would contribute to learning environmentally-acceptable norms of behavior in the Nature and (in specific form) - to perception of objects of live nature as subjects through the practical channel.

Meeting the pedagogical conditions found, in accordance with contracts signed between VSU Pedagogy Chair and secondary schools No.6 of Navapolatsk, No.3 of Glybokaye, No.2 of Lepel, No.2 of Haradok, between VSU Pedagogy Chair and Domzharytski environmental lyceum, between VSU Pedagogy Chair and Gymnasium No.2 of Vitebsk (on establishing joint pedagogical lab) – sensor environmental trainer (senset), situation modeling environmental trainer (situet), genealogy-playing environmental trainer (genet) and computerized reader of environmental poetry were programmed. Primarily, a test of the trainers was conducted in the normative group (25 pupils) organized by way of stratification. The educational effect was ensured through saturating each of three components typical for every trainer (the orienting, the executive and the control-correcting).

Each component of e-consciousness is combined of appropriate personal features: 1) environmental caution, environmental moderation, environmental spirituality, and environmental activity; 2) environmental/aesthetic wideness, environmental modesty, and environmental approachability; 3) environmental aestheticity, environmental interest, environmental sincerity, and environmental disinterestedness. According to this structure, a special examiner computer program was designed to evaluate senior pupils' e-consciousness (high, higher than medium, medium, lower than medium, low levels).

Within the framework of the forming pedagogical experiment, a control and two experimental groups were organized in each of the following secondary schools: NoNo.1,2 of Lepel, No.3 of Glybokaye, No.6 of Navapolatsk, No.43 of Homel, environmental gymnasium No.3 of Baranavichi and gymnasium No.1 of Hantsavichi as the main massive.

In the control group (131 pupil) environmental education was conducted at biology, chemistry, geography lessons with application of non-processored audiovisual means according to the schedule of secondary schools. Evaluation of e-consciousness was conducted at the beginning, during and when closing the experiment. But the pupils saw neither own evaluation results nor others' ones (the results were not displayed). The teachers didn't teach the environmental ethic to the pupils.

In the 1st experimental group (117 pupils) environmental education was conducted at the lessons of the same subjects with application of instructional computer programs from Belarusan Library of Educational Software. Their contents didn't meet the found conditions of the design. Though evaluation of e-consciousness was conducted systematically, the pupils didn't saw the results. The teachers didn't teach the environmental ethic to the pupils.

In the 1st group we checked whether the introductive part of the hypothesis was true. Namely, whether environmental education would be improved when application of computer programs at the lessons of natural subjects.

In the 2nd experimental group (133 pupils) environmental education was conducted at the same lessons with application of the trainers. Each teacher had a high level of informational and environmental culture, was knowledgeable about the hardware and able to provide assistance to the pupils when necessary. Previously, the teachers themselves learnt the fundamentals of environmental psychopedagogy and of environmental ethic. The lessons were conducted in computerized labs. The senior pupils were systematically included into the forming activity of the following kinds:

1) individual computerized self-control – at the beginning, during and when closing the experiment – with systematical explaining environmental ethic by the teachers. Each pupil saw both his/her own results and the results of his/her mates. This fact served as stymulus for self-perfecting.

2) individual work with the trainers within integrated academic process, participation in all conservational events organized by natural subject teachers in school.

In the 2nd experimental group we check whether the principal part of the hypothesis was true. Namely, whether application of computer programs as means for environmental education requires meeting the found methodological, methodical, didactic conditions of design, complex and non-stop application. Trained teachers with high environmental and informational culture studied the effectiveness of complex and non-stop application of interactive and personified trainers.

Besides, after a year three new experimental groups were organized in the same schools as an additional massive. By this, we randomized the basis (gymnasium and ordinary forms changed their places in these experimental groups) and further proved positive effect of the trainers in environmental education. However, the main aim was to verify each apart pedagogical condition of design and application of computer programs.

In the third (149 pupils), *the fourth* (106 pupils) and *the fifth* (146 pupils) *experimental groups* conditions of complex and non-stop application were not kept consciously.

Evaluation of e-consciousness was conducted individually by the examiner program and by pedagogical consilium every year, beginning in September, 1994. The duration of the experiment was 5 years in the main massive, 4 years in the additional.

Initially, most senior pupils had low e-consciousness. In the row "psychological immersion into the world of the Nature – aspiration to non-pragmatic interaction with the world of the Nature – perception of live objects of nature as subjects" the share of pupils with low levels increased, with high levels – decreased, respectively.

By the end of the forming experiment (May, 1998) we had 2.5 times increasing share of pupils with high levels of perception of objects of live nature as subjects in the 1^{st} experimental group while 8 times increasing in the 2^{nd} experimental group; 1.8 times decreasing share of pupils with low levels of perception of objects of live nature as subjects in the 1^{st} experimental group while 3.5 times decreasing in the 2^{nd} experimental group. At the same time, we observed practically no changes in share of pupils with high levels in the control group and insignificant decreasing (down to 2 percent) in share of pupils with low levels.

It can be explained by the fact that trainers, meeting the found pedagogical conditions, complex and non-stop applied in the 2^{nd} experimental group are more effective means of environmental education than existing instructional computer programs on natural subjects applied in the 1^{st} experimental group.

By the same one can explain generally low results in the control group. Although, application of non-processored audiovisual means provided certain medium level of psychological immersion into the world of the Nature.

It has been found, that the environmental trainers were the most effective in cultivating perception of objects of live nature as subjects and in cultivating environmental spirituality, environmental modesty, environmental sincerity, and environmental disinterestedness.

Statistical fidelity of the results was evaluated with Pirson criterion $\chi 2$. Its value exceeded the critical 9,488 both for the massives as a whole and for each apart form. It showed essential difference in distribution of senior pupils in the control and the experimental groups according to five levels of

e-consciousness by the end of the experiment. It showed also the hypothesis had been true.

Calculating Kendall coefficient of rank correlation showed the correlation between personal features of e-consciousness was closer in the 2nd experimental group than in the control group. It showed more harmonized structure of e-consciousness when the trainers meeting the found conditions are applied.

The designed trainers were implemented in schools that constitute the experimental basis of the research and in other schools of Vitebsk region. The implementation was conducted in accordance with official letter of Vitebsk Regional Department of Education No.123 18 February 1998.

CONCLUSIONS

1. Computer programs are kind of audiovisual means. Their significance in environmental education system is dramatically increasing now, in epoch of the information society and of global environmental crisis. Computer programs are also means of education since pedagogical situations with computer application meet 14 essential criteria of education as a process.

Existing computer programs have certain potential for cultivating psychological immersion into the world of the Nature as a component of senior pupils' ecocentric consciousness. But two other components remain under-developed. However, even the mentioned effect is insignificant and up to the additionally provided interaction "teacher - pupil - computer". This effect can be reinforced providing actualization of environmental knowledge and the necessity of using this knowledge in the world of the Nature.

Within the system of study models of natural reality, computer programs play a role of optimal models because of perfect balance between the required immersion and the affordable subjective danger as well as because of providing adaptive feedback and interactive regime. Set of computer programs for effective environmental education consists of four trainers. Interaction with them realize principles and methods of classical pedagogy, of environmental psychopedagogy, of problem situation theory. This interaction cultivates senior pupils' ecocentric consciousness through all the channels (the perceptive, the cognitive, and the practical) at all the stages (personal labilization, mastering the adequate technologies, and subjectification of objects of live nature) [1, 5, 6, 7, 8, 9, 10, 11, 12, 14, 18, 20, 24, 26].

2. The main pedagogical conditions of design of computer programs as means of environmental education of senior pupils are:

- *contents of computer programs meeting principles of education and upbringing in classical pedagogy*: of immersion into activity and into PC modeled pseudoactivity; of stimulation of this activity; of humanism; of

enjoying success; of support onto positive features; of considering aging and individual peculiarities; of scientific approach; of integrated education, development, and upbringing;

- *contents of computer programs meeting principles of environmental psychopedagogy – principles of organizing stimuli*: suggesting to the pupils all kind of stimuli – optical (picture) and acoustic (sound) – through all the channels of cultivating ecocentric consciousness; suggesting stimuli that actualize appropriate psychological mechanisms; suggesting stimuli meeting pupil's individual, aging, national peculiarities;
- *contents of computer programs meeting principles of environmental psychopedagogy – principles of organizing environmental activity:* including pupil into the most heterogeneous natural objects-related activity (pseudoactivity); including pupil into the activity that actualizes appropriate psychological mechanisms; including pupil into the activity meeting his/her individual psychological peculiarities;
- *personification of the programs, organizing the interaction according to the model of ideal pedagogical communication, computer programs meeting methodical principles of environmental psychopedagogy*: cultivating speculations on the basis of both scientific information and art; stimulating mechanisms that let objects of live nature show themselves as subjects; mastering technologies that let pupil "participate" in the life of the Nature itself [15, 19, 21, 22, 23].

3. The main pedagogical conditions of application of computer programs as means of environmental education of senior pupils are:

- *complexity* – it is necessary to apply the entire set of environmental trainers influencing through all the channels of forming subective relations to the objects of the nature;
- *non-stopping* – it is necessary to apply computer programs at each of three stages of educational cycle – the examiners at the first and at the last, the trainers – at the central. It is necessary to apply trainers at each of three stages of cultivating pupils' ecocentric consciousness – of personal labilization, of mastering technologies of interaction, of subjectification.

Teachers' high informational and environmental culture is an especial pedagogical condition of design and application of computer programs as means for environmental education [15, 19, 21, 22, 23].

4. The set of computer programs for effective environmental education consists of:

- *sensor trainer (senset)*, destinated for developing analyzers aiming at liberation from negative anti-environmental stereotypes, for creating physiological basis to aesthetic acquainting objects of live nature through computer generation of definitely structured natural and artificial sensor stimuli and organizing pupils' activity to study, to distinguish fine the stimuli suggested;

- *situation modeling trainer (situet),* destinated for developing skills of proper behavior in the Nature through creating (with computer modeling, literature language, psychologically exact presentation) an art image of real problem situation and organizing pupils' activity to find a socially acceptable and self-safe solution;
- *genealogy-playing trainer (genet),* destinated for cultivating speculations about unity of human society and the world of the Nature, about the world of the Nature as spiritual value through programming pupil's genealogy tree, computerized combining it with evolutional tree of the live world and organizing pupil's activity to study the hybride tree with relations of its branches;
- *computerized reader of environmental poetry,* destinated for developing skills of aesthetic acquainting the world of the Nature through PC displaying environment-related poems and organizing pupils' activity to percept them properly and to comment independently [2, 3, 4, 17, 25, 27, 28, 29].

5. Application of the environmental trainers at the lessons of natural subjects (biology, chemistry, geography) in senior forms provides:

- more essential (as compared with non-processor audiovisual means and existing instructional computer programs) increase of components of senior pupils' ecocentric consciousness;
- more essential (as compared with non-processored audiovisual means and existing instructional computer programs) increase of particular personal features of senior pupils' ecocentric consciousness;
- more harmonized structure of senior pupils' ecocentric consciousness. In this case, there are closer correlations between environmental caution and environmental spirituality, curiosity and disinterestedness, activity and caution, sincerity and approachability, environmental/aesthetic wideness and environmental modesty [9].

LIST OF PUBLICATIONS

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SUMMARY

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PEDAGOGICAL CONDITIONS OF DESIGN AND APPLICATION OF COMPUTER PROGRAMS AS MEANS FOR THE ENVIRONMENTAL EDUCATION OF SENIOR PUPILS
(on natural subjects material)

Key words: computer program, environmental trainer, audiovisual means, ecocentric consciousness, environmental upbringing, environmental psychopedagogy.

Research object: academic and educational process in 9-11 forms of secondary educational institutions as a field of pedagogical activity where computer-supported environmental education can be realized.

Research subject: pedagogical conditions of designing and application of computer programs as means for the environmental education of senior pupils when their studying biology, chemistry, geography.

Research goal: determination of pedagogical conditions of designing and application of computer programs as means for the environmental education of senior pupils when studying natural subjects (biology, chemistry, geography).

Main research methods: logical and semantical analysis of particular pedagogical notions, direct and indirect pedagogical observation of teachers' and pupils' activity in educational process, questioning and interviewing, PC modeling and programming, studying and summarizing the pedagogical experience, mathematical methods of non-parametric statistics.

The research has proved the computer programs act as optimal models of natural reality and means of environmental education. Pedagogical conditions of computer program optimal design and further effective application based upon the environmental psychopedagogy have been formulated. Specific computer programs called sensor environmental trainer, situation modeling trainer, genealogy environmental trainer, and computerized reader of environmental poetry have been designed and successfully tested.

The environmental trainer programs should be applied to improve teen environmental education within system of other means. New generation computer software including virtual reality and the Internet should meet the determined pedagogical conditions when designing and implementation.

Р Э З Ю М Е

Слабін Уладзімір Канстанцінавіч

ПЕДАГАГІЧНЫЯ ЎМОВЫ РАСПРАЦОЎКІ І ВЫКАРЫСТАННЯ КАМП'ЮТЭРНЫХ ПРАГРАМ ЯК СРОДКА ЭКАЛАГІЧНАГА ВЫХАВАННЯ СТАРШАКЛАСНІКАЎ
(на матэрыяле прыродазнаўчых дысцыплін)

Ключавыя словы: камп'ютэрная праграма, экалагічны трэнажор, экранна-гукавыя сродкі, экацэнтрычная свядомасць, экалагічнае выхаванне, экалагічная псіхапедагогіка.

Аб'ект даследавання: вучэбна-выхаваўчы працэс у 9-11 класах сярэдніх агульнаадукацыйных вучэбных устаноў як тая галіна педагагічнай дзейнасці, у якой можа быць ажыццёўлена экалагічнае выхаванне з выкарыстаннем персанальных камп`ютэраў.

Прадмет даследавання: педагагічныя ўмовы распрацоўкі і выкарыстання камп`ютэрных праграм як сродка экалагічнага выхавання старшакласнікаў пры вывучэнні біялогіі, хіміі, геаграфіі.

Мэта даследавання: вызначэнне педагагічных умоў распрацоўкі і выкарыстання камп`ютэрных праграм як сродка экалагічнага выхавання старшакласнікаў (9-11 класы) пры вывучэнні прыродазнаўчых дысцыплін (біялогіі, хіміі, геаграфіі).

Асноўныя метады даследавання: логіка-семантычны аналіз асобных педагагічных паняццяў, прамыя і ўскосныя педагагічныя назіранні за дзейнасцю настаўнікаў і вучняў у вучэбна-выхаваўчым працэсе, анкетаванне і інтэрв`юіраванне, канстатуючы і фарміруючы эксперымент, мадэляванне і праграмаванне з дапамогай персанальнага камп`ютэра, вывучэнне і абагульненне педагагічнага досведу, матэматычныя метады непараметрычнай статыстыкі.

Навуковая навізна вынікаў даследавання заключаецца ў абгрунтаванні ролі камп`ютэрнай праграмы як аптымальнай вучэбнай мадэлі прыроднай рэчаіснасці і сродка экалагічнага выхавання, выяўленні педагагічных ўмоў аптымальнай распрацоўкі і эфектыўнага выкарыстання камп`ютэрных праграм як сродка экалагічнага выхавання старшакласнікаў на грунце палажэнняў экалагічнай псіхапедагогікі, стварэнні і апрабацыі комплексу камп'ютэрных праграм - сенсарнага экалагічнага трэнажора, сітуацыйнага экалагічнага трэнажора, генеалагічна-экалагічнага трэнажора, камп'ютэрнага зборніка экалагічнай паэзіі.

Распрацаваныя экалагічныя трэнажоры могуць выкарыстоўвацца для паляпшэння экалагічнага выхавання старшакласнікаў ў сістэме іншых сродкаў. Выяўленыя педагагічныя ўмовы неабходна ўлічваць пры распрацоўцы і ўкараненні камп`ютэрных камп'ютэрных праграм новага пакалення - "светаў" віртуальнай рэчаіснасці, Internet.

РЕЗЮМЕ

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ПЕДАГОГИЧЕСКИЕ УСЛОВИЯ РАЗРАБОТКИ И ИСПОЛЬЗОВАНИЯ КОМПЬЮТЕРНЫХ ПРОГРАММ КАК СРЕДСТВА ЭКОЛОГИЧЕСКОГО ВОСПИТАНИЯ СТАРШЕКЛАССНИКОВ
(на материале естественнонаучных дисциплин)

Ключевые слова: компьютерная программа, экологический тренажёр, экранно-звуковые средства, экоцентрическое сознание, экологическое воспитание, экологическая психопедагогика.

Объект исследования: учебно-воспитательный процесс в 9-11 классах средних общеобразовательных учебных заведений как та область педагогической деятельности, в которой может быть осуществлено экологическое воспитание с использованием компьютеров.

Предмет исследования: педагогические условия разработки и использования компьютерных программ как средства экологического воспитания старшеклассников при изучении биологии, химии, географии.

Цель исследования: определение педагогических условий разработки и использования компьютерных программ как средства экологического воспитания старшеклассников (9-11 классы) при изучении естественнонаучных дисциплин (биологии, химии, географии).

Основные методы исследования: семантический анализ отдельных педагогических понятий, прямые и косвенные педагогические наблюдения за деятельностью учителей и учеников, анкетирование и интервьюирование, констатирующий и формирующий эксперимент, моделирование и программирование с помощью персонального компьютера, обобщение педагогического опыта, математические методы непараметрической статистики.

Научная новизна результатов заключается в обосновании роли компьютерной программы как оптимальной учебной модели природной действительности и средства экологического воспитания, выявлении педагогических условий оптимальной разработки и эффективного использования компьютерных программ как средства экологического воспитания старшеклассников, создании и апробации комплекса компьютерных программ – сенсорного экологического тренажёра, ситуационного экологического тренажёра, генеалого-экологического тренажёра, компьютерного сборника экологичной поэзии.

Разработанные экологические тренажёры могут использоваться для повышения эффективности экологического воспитания старшеклассников в системе других средств. Выявленные условия необходимо учитывать при разработке и внедрении «миров» виртуальной реальности, Internet.