Visualization of the Logical Structure of Biologically and Ecologically Oriented Curriculum and its Application in Teaching to Increase the Level of Understanding of Causality (Coherence of Cause and Effectin) in the Curriculum.

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Abstract:

The experience of teaching biologically and ecologically oriented curriculum indicates that the knowledge of science facts and processes described does not necessarily mean understanding the causality of the mechanism behind these facts and processes. The mentioned problem of causality of the logical structure of the curriculum (and thus the more effective teaching of the biologically and ecologically oriented curriculum) is proposed by the graphic visualization of the system of the logical structure of the curriculum in the process of teaching (using the possibilities of computer technologies). The research also includes a pedagogical experiment to verify of the effectiveness teaching with the applied to the visualization of the logical structure of the curriculum. The results of our research have confirmed the correctness of our suggested solution to the problem.A good scheme will replace the long article and the rhetorical.

Keywords: Natural Science, Flash animations, Effectiveness of teaching.

I. Introduction

Orientation to the basic structure of the subject means that it is necessary to teach less, but to a greater depth and with a greater impact on the wider context. The pupil's and studen's brains should not be stocked with more diverse, isolated knowledge, but should include what may be called the "Union Philosophy". This is a quantitative page of orientation to the structure of the curriculum. The qualitative aspect is to prioritize the formation of competences before knowledge acquisition [5].

Visualization of the logical structure of the curriculum is a set of characters that represents the main ideas of the subject's subject. It is a distinctive scheme or a logical model of curriculum.

Graphic visualization of the logical structure of the curriculum may be described as follows: "The graphic form of visualization of the logical structure of curriculum will

understand graphic representation (visual distraction) a plurality of logical curriculum of the supporting points and the links between them (the system of the logical structure of curriculum)".

In both the theoretical and experimental levels, Bruner meets the logical structure of the curriculum and its impact on learning. Bruner argued that when pupils understand the structure of their subject matter, they will easily understand the whole topic [5]. Bruner's structuralism, based on the requirement to structure knowledge, to understand the fundamental structure of the subject, to create basic concepts, ideas, key words, meets with the ideas of P. W. Burus and G. Brooks, representatives of the development of thought processes in the concept of theoretical and practical synthesis [5].

The reference to the application of Bruner's ideas in the specific teaching of technical subjects' is in Melezinek [5]. Melezinek proposed a system of teaching which, in the German translation, was called a system of teaching emphasizing the structure of learning and logical connection in the curriculum (in the sense of Bruner's understanding of the curriculum structure) [5].

II. Structural Components of Visualization of the Logical Structure of Curriculum

When visualizing the system of the logical structure of natural science (biologically and ecologically) curriculum, we use mainly the following structural components: applets, word maps, orientation graphs, , development diagrams, Venn diagrams, structure grams, tables and graphs, other components and their complexes [3]. Other omponents include eg. sequence diagrams, interactive computer graphics components (hypertext, drag and drop, etc.). usable eg. for the creation of anchors, crosswords, etc. but also graphs, tables, etc.

II.1 Applet

The structural component has an exceptional position among the other listed components for visualization of the logical structure of the curriculum. Indeed, in this component, all other components for visualizing the system of the logical structure of the curriculum as a subcomponents can be included (at the same time a complex of structural components).

To put it simply, the Applet is one purpose (especially educational) program, which was developed on the platform of the so-called modern elements intelligent computer graphics. These elements make it possible to visualize of the logical structure of the curriculum only in the degree of clarity that cannot be achievedotherwise (that ca not be attain with traditional technologies and techniques of visualization). In terms of concreteness:

- the application of computer animation and simulation (the ability of processes and phenomena running in science systems to slow down, accelerate or shred in time, but also to virtualize objects that ca not be seen with the naked eye - they are too small, or large, inaccessible to humans, or real non-existent, etc.
- application components called. Interactive Computer Graphics (hypertext, drag and drop, etc.).

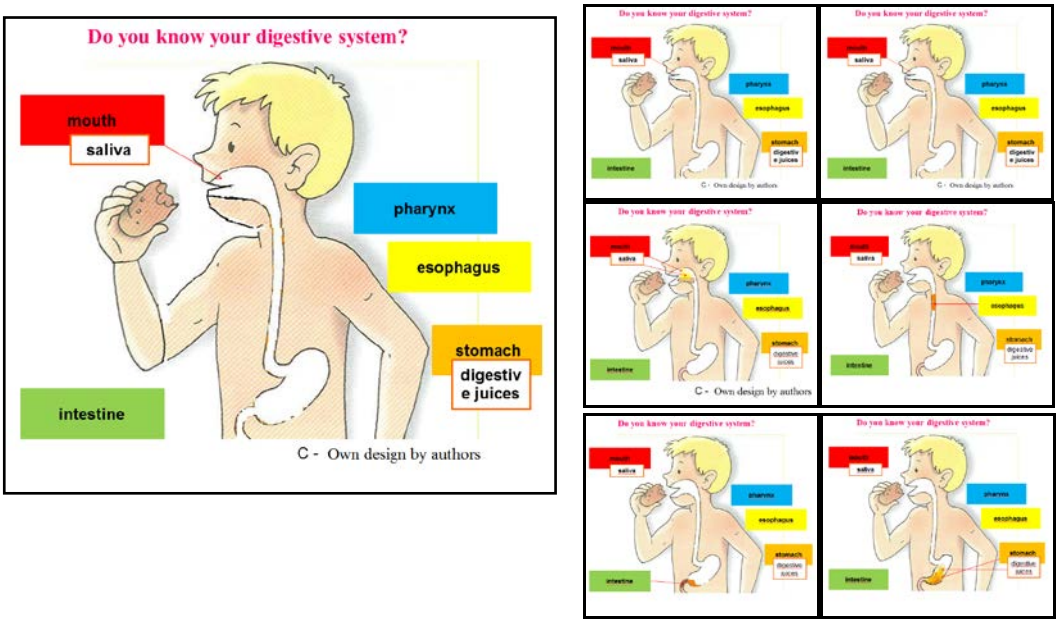


Fig. 1 The applet (key sequence) - Do you know your digestive system? (source - author's own design) [3].

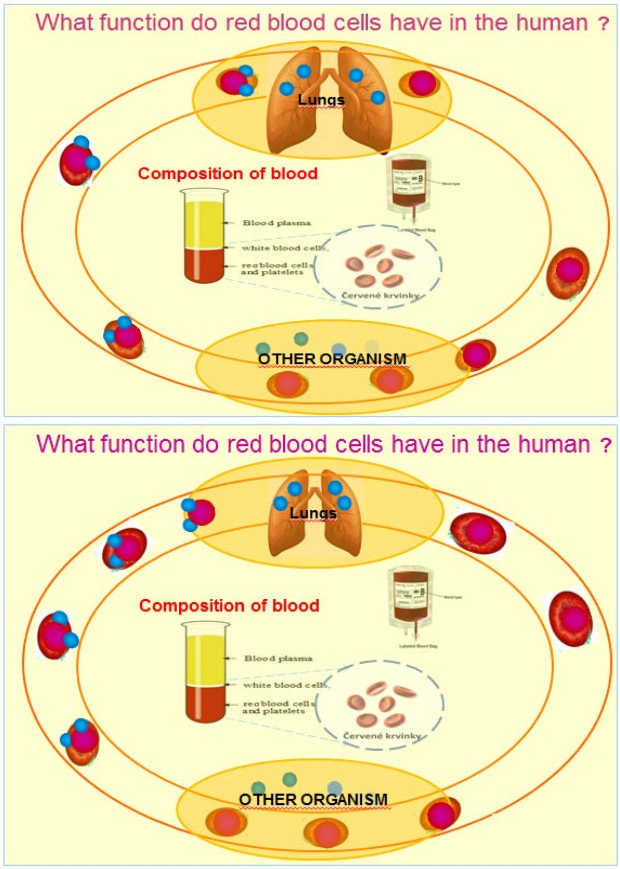


Fig. 2 The applet (key sequence)- What function do red blood cells have in the human body? (source - author's own design)

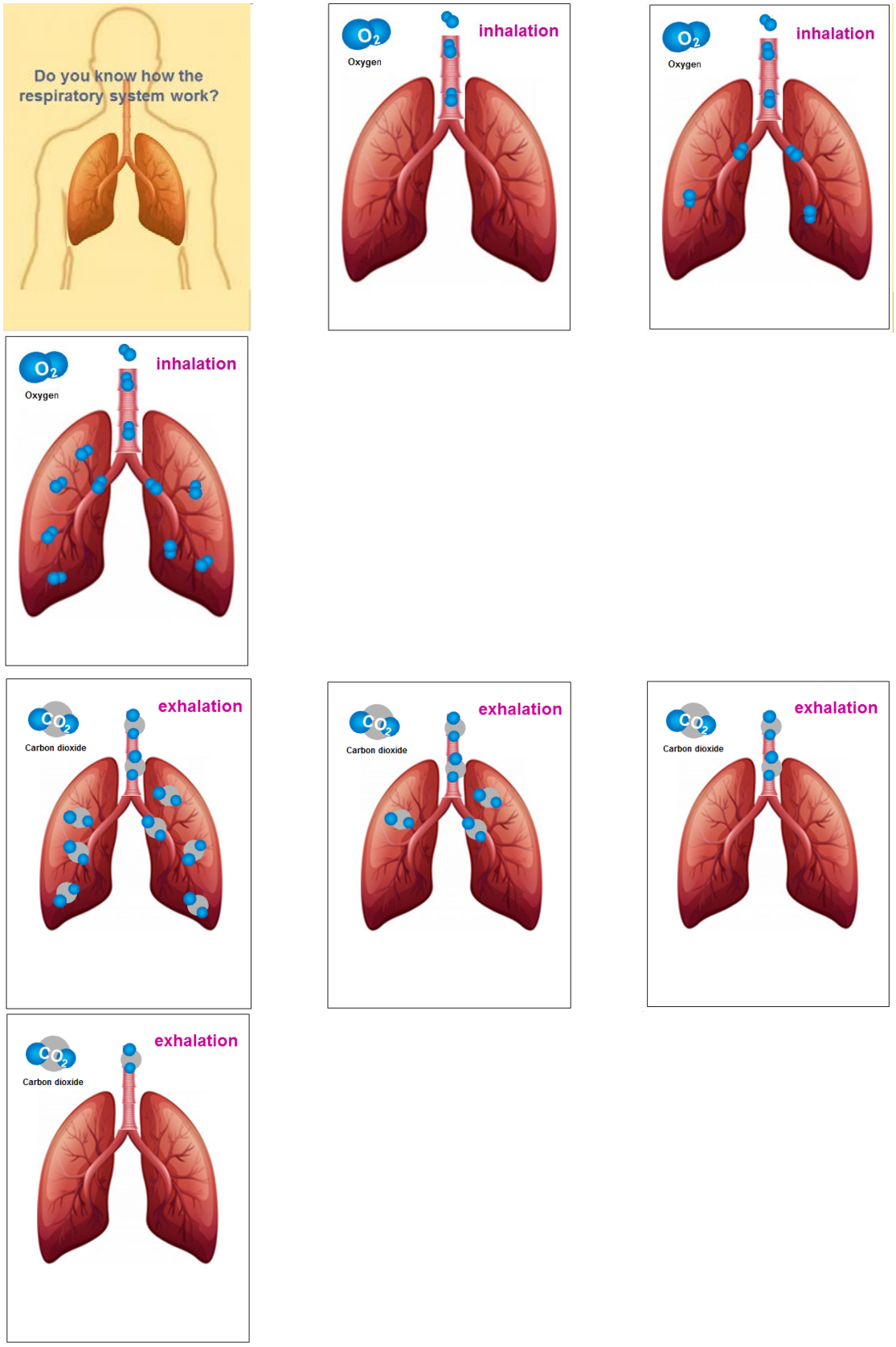


Fig. 3 The applet (key sequence) - Do you know how the respiratory systems work ? (source - author's own design).

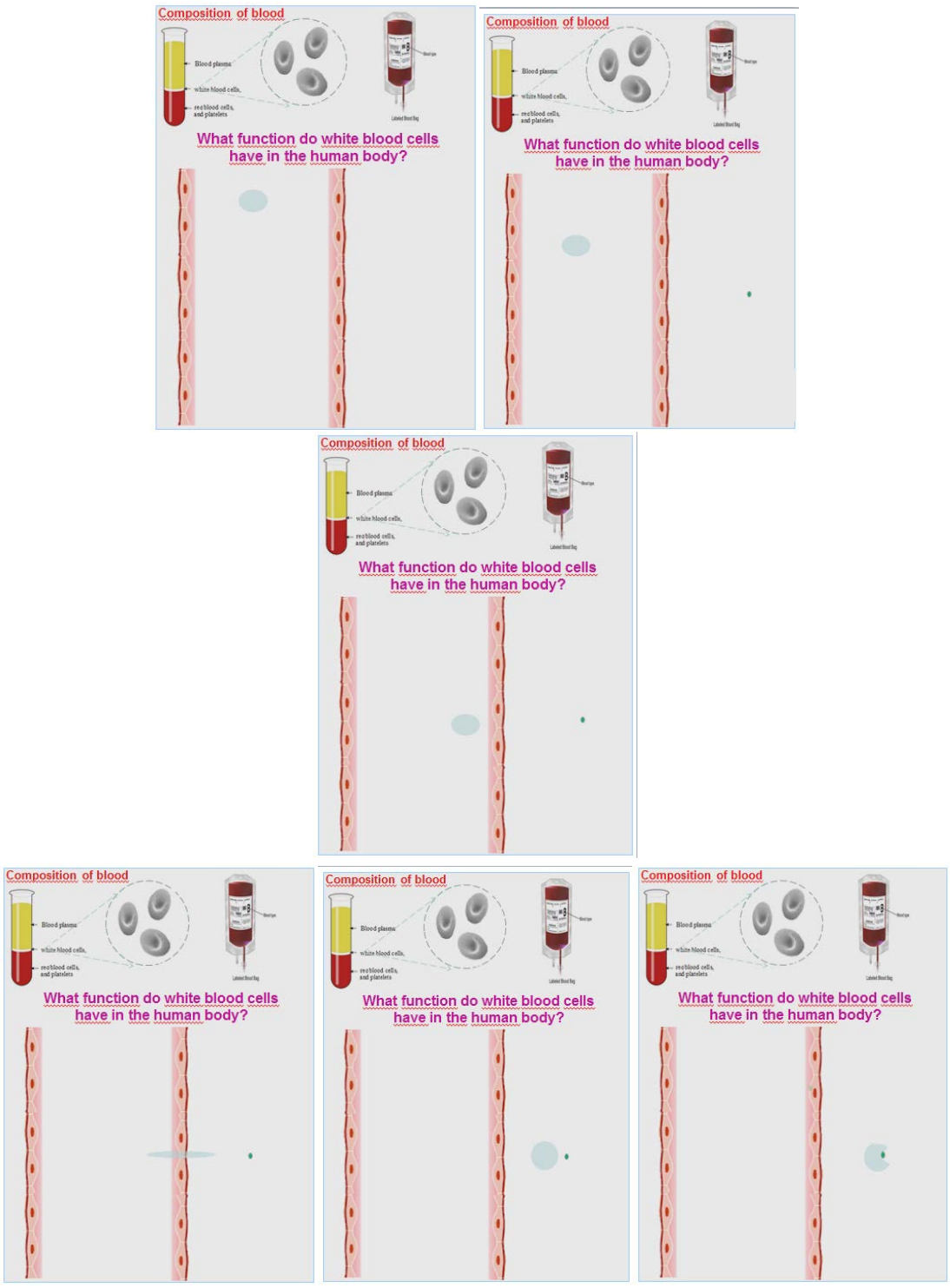


Fig. 4 The applet (key sequence) - What function do white blood cells have in the human body? (source - author's own design).

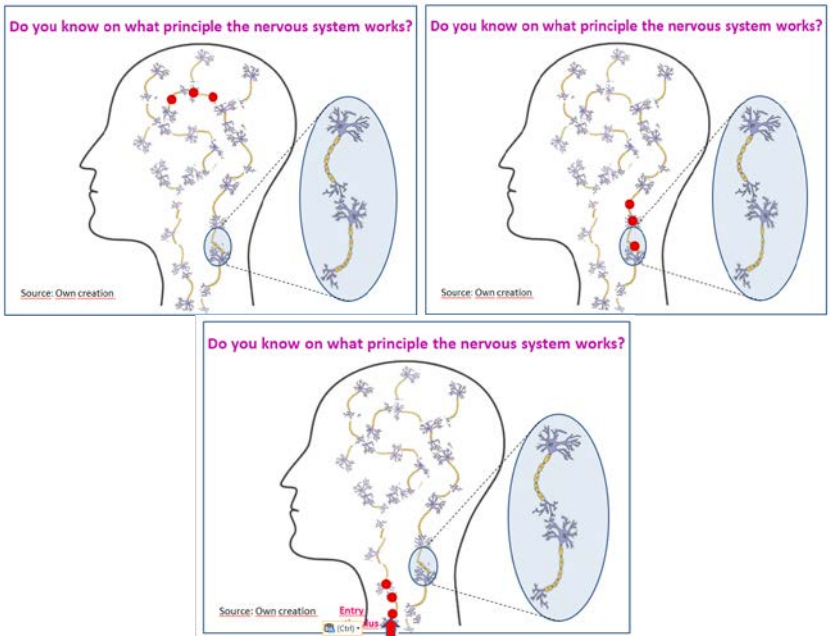
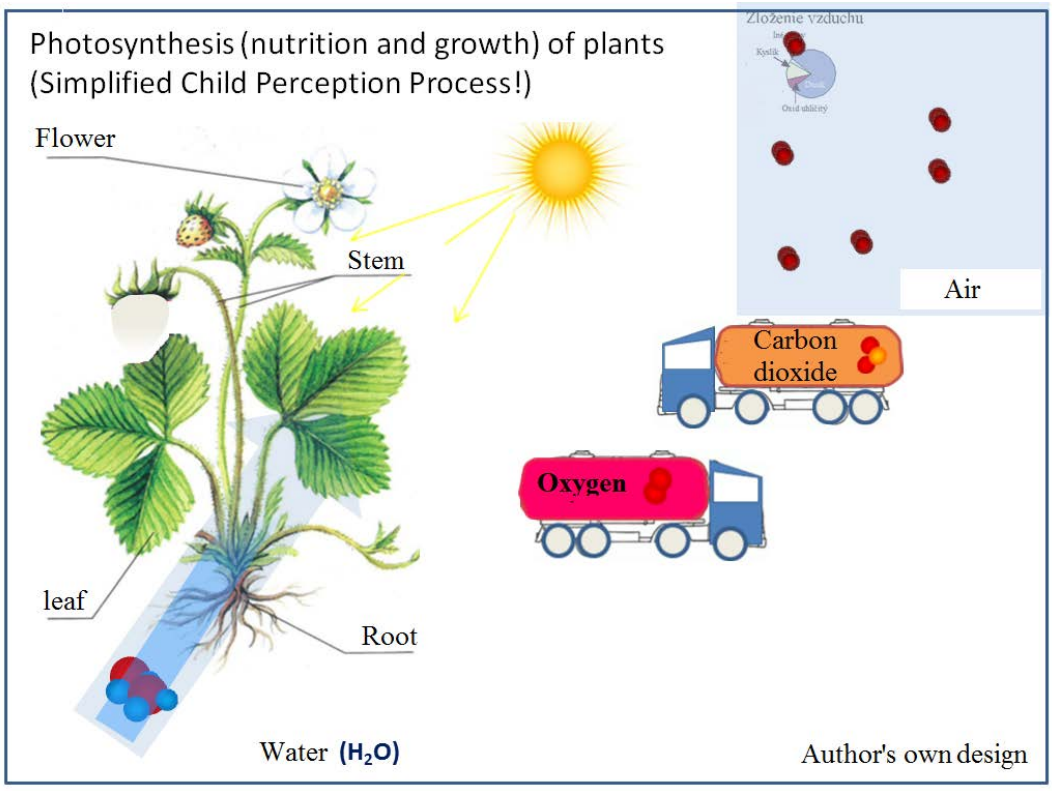
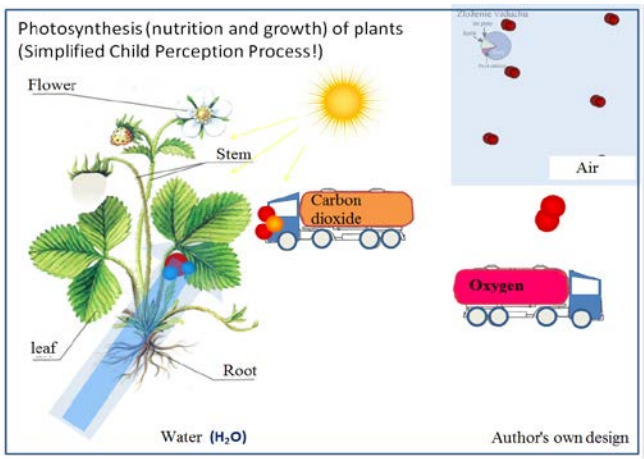
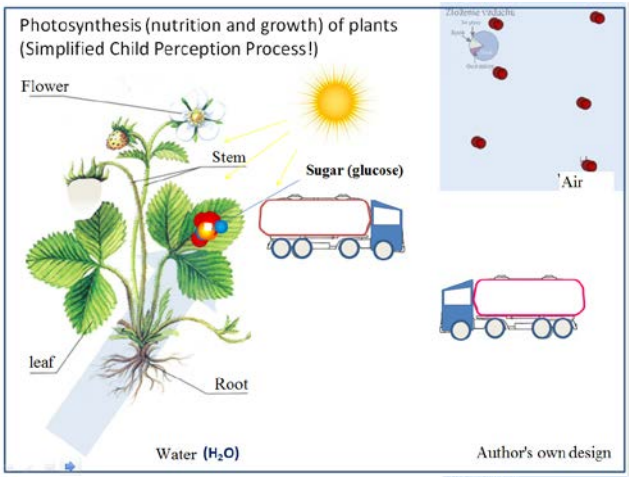
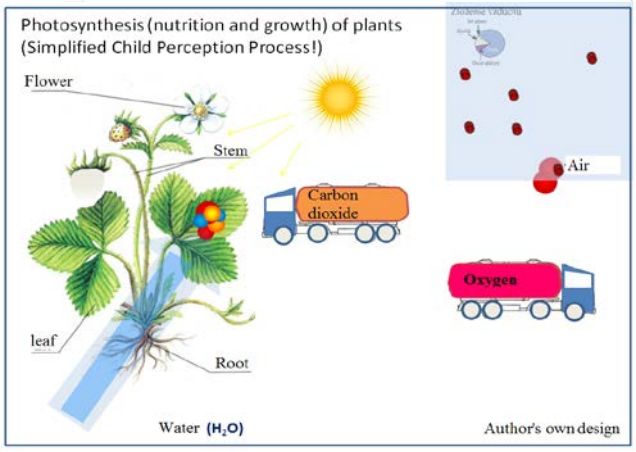


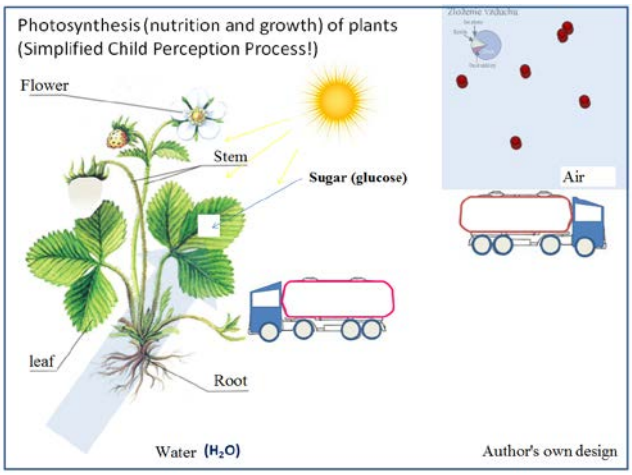
Fig. 5 The applet (key sequence)- Do you know on what principle the nervous system works?




Photosynthesis (nutrition and growth) of plants
(Simplified Child Perception Process!)
Flower
Stem
Carbon dioxide
Air
Oxygen
leaf
Root
Water (H₂O)
Author's own design


Photosynthesis (nutrition and growth) of plants
(Simplified Child Perception Process!)
Flower
Stem
Sugar (glucose)
Air
leaf
Root
Water (H₂O)
Author's own design


Photosynthesis (nutrition and growth) of plants
(Simplified Child Perception Process!)
Flower
Stem
Carbon dioxide
Air
Oxygen
leaf
Root
Water (H₂O)
Author's own design



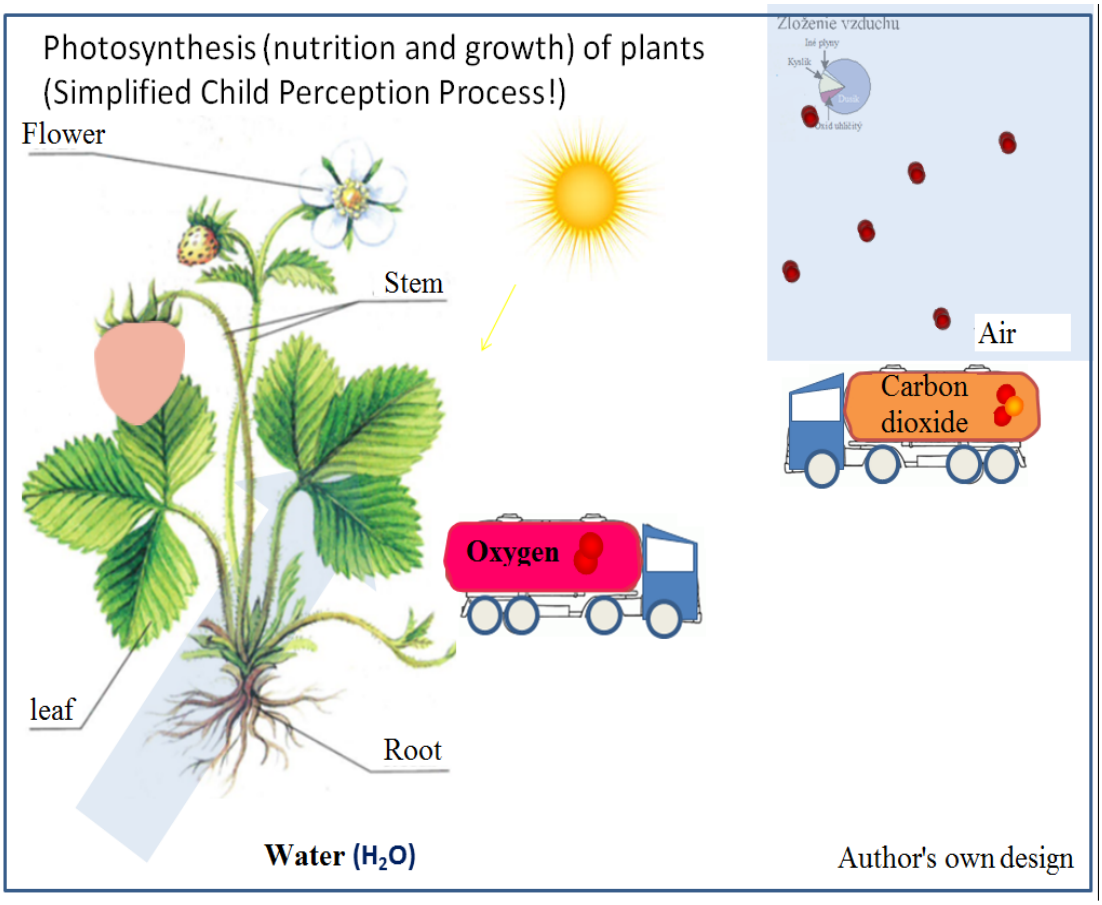


Fig. 6 The applet (key sequence) - Photosynthesis (nutrition and growth) of plants.

II.2 Word maps

Word maps are very suitable for the record of logical links in the hierarchy of the system of concepts of the system of the logical structure of curriculum.

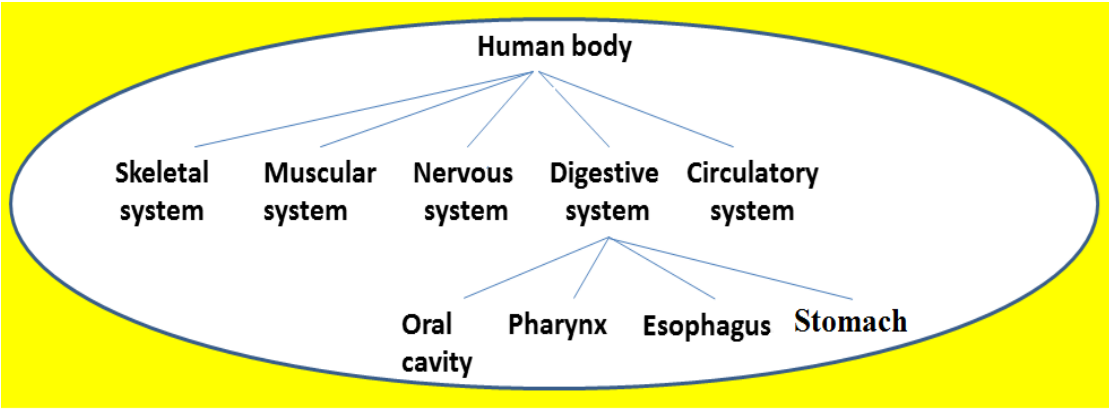


Fig.7. Word maps (print form), The human body systems (source - author's own design)

- Computer visualization of the system of the logical structure of curriculum (Fig. 8 –Fig. 9) and its advantages in comparison with the traditional graphic from of visualization (on the base of hypertext).to visualize the logical links between the elements of curriculum in the various sites;

- to establish a system of mutually plunged subsystems of the virtually visualized system of the logical structure of curriculum created in the form of integrated modeles.

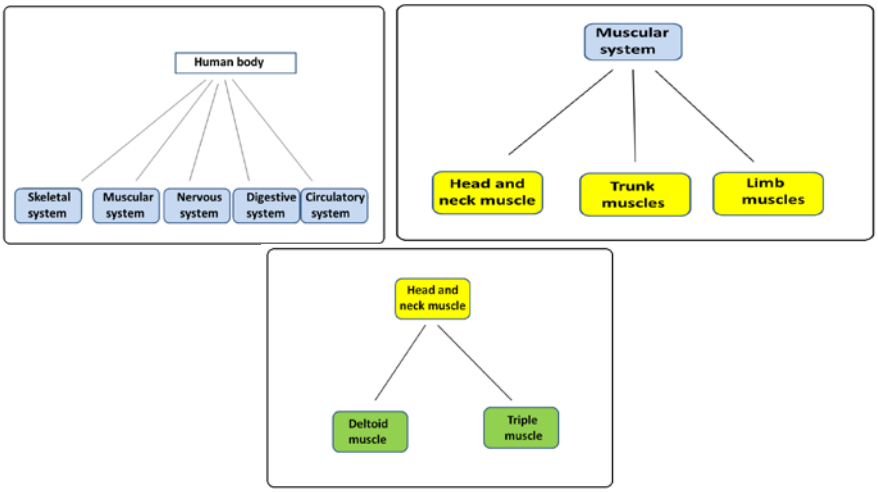


Fig. 8. Word maps (electronic form - hypertext) - The human body systems. (source - own creations).

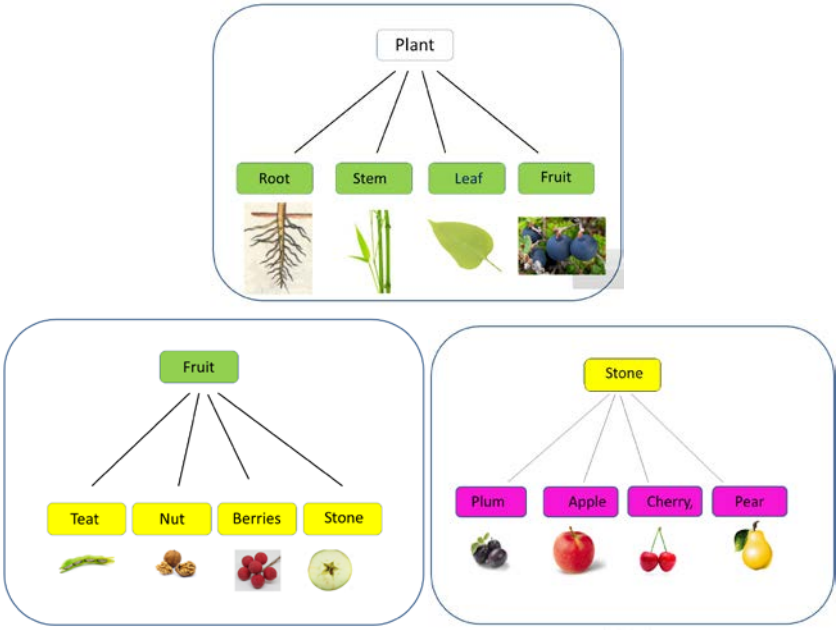


Fig. 9. Word maps (electronic form - hypertext) - Plants**.** (source- own creations)

II.3 Orientation graphs (transported diagram)

Orientation graphs are particularly useful for the record of the logical structure of curriculum resulting from the transport nature of the phenomenon. Graphic shape is the oriented line (arrow) from the source to the target place of transport. Along the orientation line, there is usually recorded the essence of the transport mechanism (e.g. chemical equation) or transported (movement of transport particles, time relations of transport - shifting and their causality in time - slowing down or accelerating, or shifting the course of flows in time).

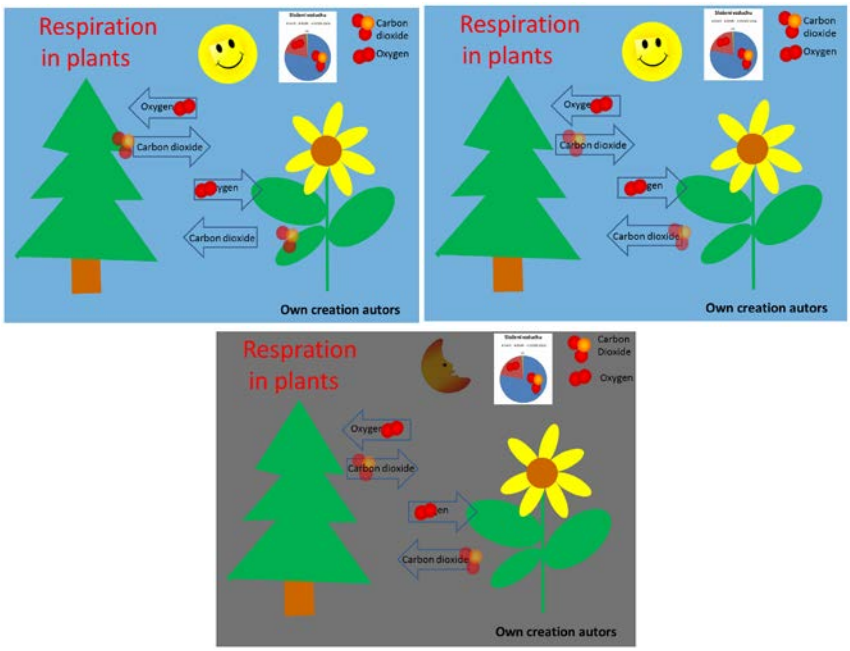


Fig. 10, Orientation graphs (transported diagram) – Respiration in plants

II.4 The development diagrams

In the development diagrams, the record consists of a decision block, in which the condition for branching and orientation of lines (arrows) entering into and exiting from the decision block (branching alternatives) is recorded.

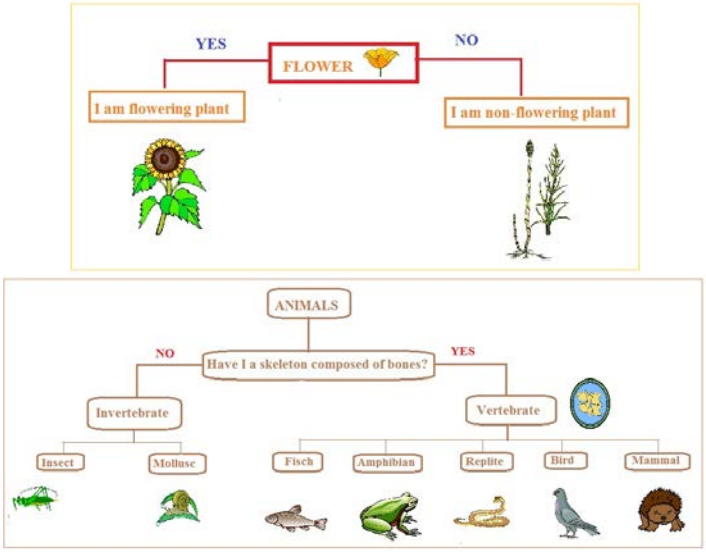


Fig. 11. The development diagrams (print form) - The animal kingdom, flowering plants (source - own creations).

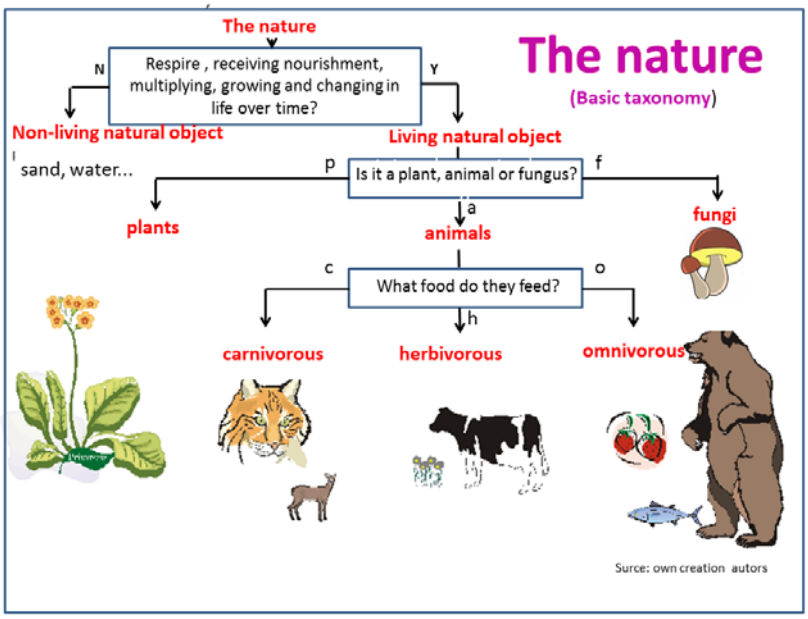


Fig. 12. The development diagrams (print form) - The nature (source - own creations).

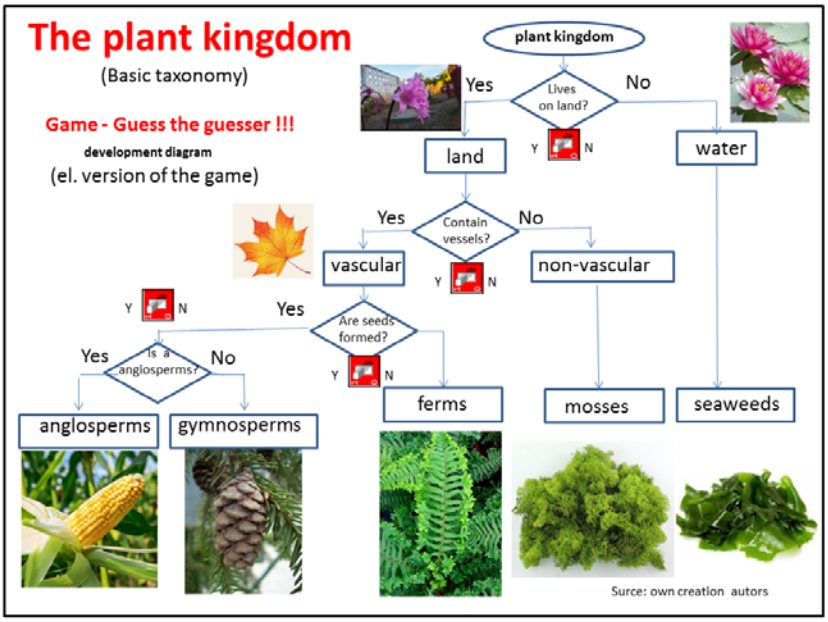


Fig. 13. The development diagrams (electronic form- Java) - The plant kingdom (source - own creations).

II.5 Venn diagrams

Venn diagrams are symbolic record of a set and a predicate logic and create a very convenient connection with other types of components. Connection of Venn diagram and development diagrams is very suitable Fig. 14)

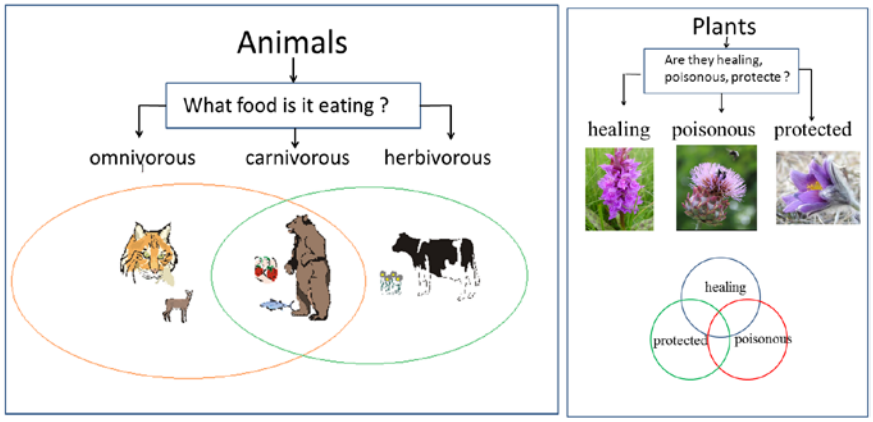


Fig 14. Connection of Venn and development diagrams (Animals, Plants- healing, poisonous, protected) (source - own creations).

II.6 Structure grams

Structure grams form "binder, carrier base, bond or a pillar" between the structures in curriculum. They give to curriculum the "systematic breath", but especially "skeleton" of global structuring of the curriculum (structural elements are not isolated, but form a whole system). They are a simplified variant of the flat block diagram in its graphical nature. In the diagram, every single block is designated generally by rectangular (less circle, triangle, etc.) frame; the lines between the blocks indicate their relationships. The horizontal lines are the signs of equivalence; the vertical lines usually mean inclusiveness. In general, under the structure gram we will understand the link of a set of blocks by the set of orientation lines.

II.6.1 Structure grams (based on anatomical nature)

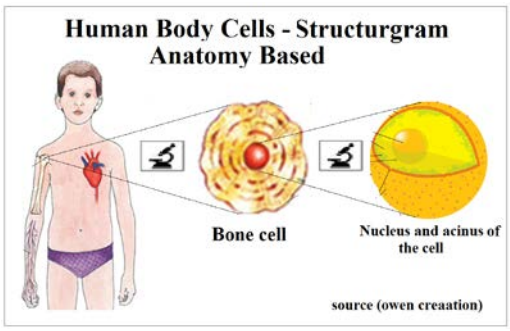
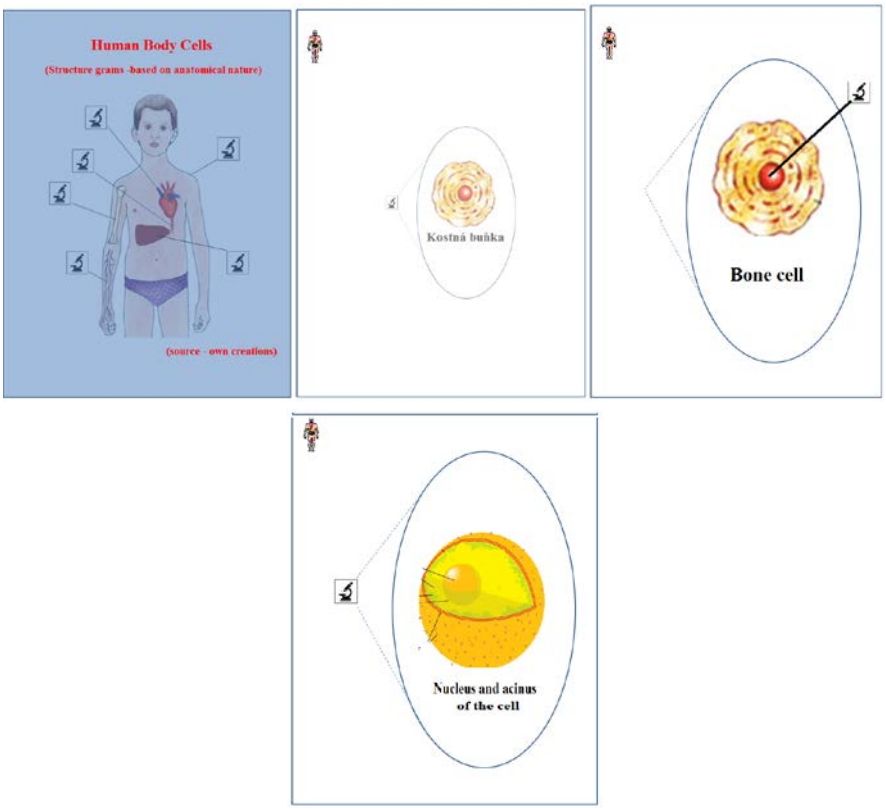


Fig. 15 Print form of structure grams (based on anatomical nature) – Human Body Cells (source - own creations).



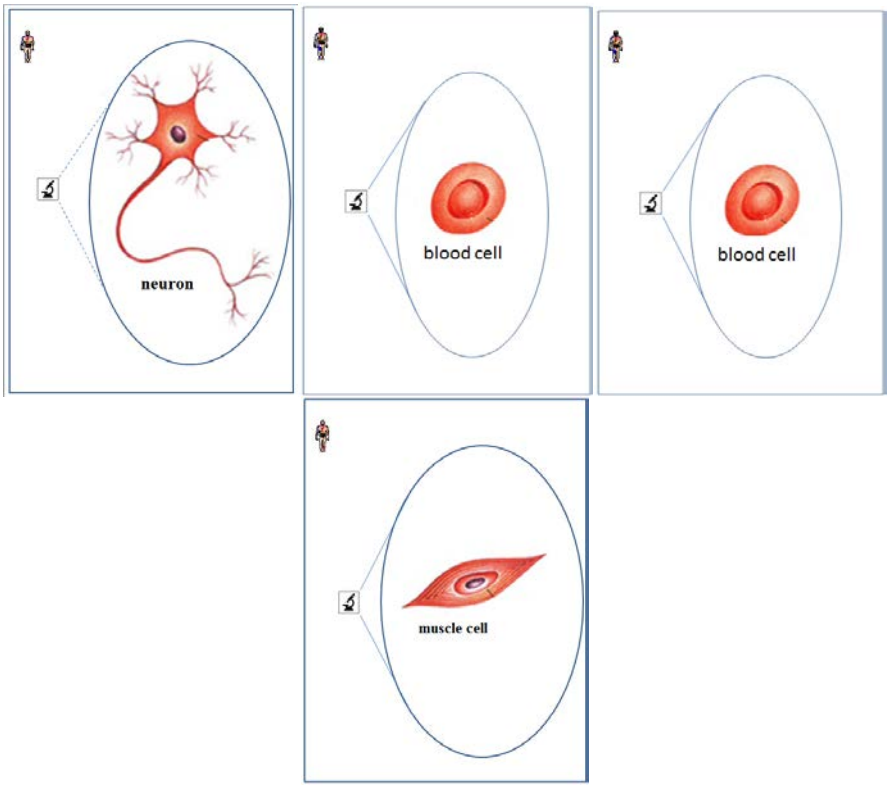


Fig. 16. Electronic form (hypertext) of structure grams (based on anatomical nature) – Human Body Cells (source - own creations).

II.6.2 Structure grams (based on physiological nature)

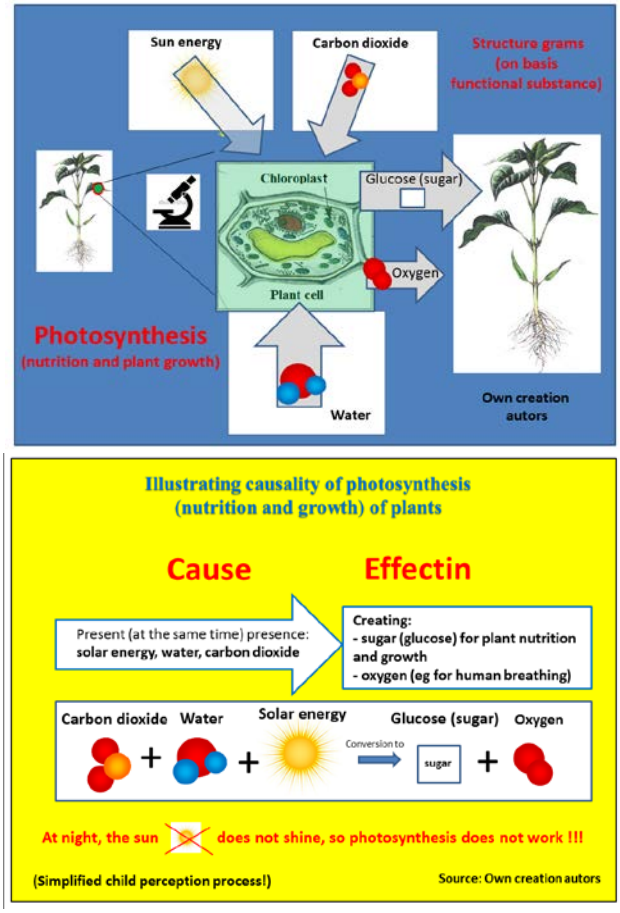


Fig. 17. Structure grams (based on physiological nature) - Photosynthesis

2.7 Other components

Other components include eg. sequence diagrams (Fig.18), interactive computer graphics components (hypertext, drag and drop, etc.). usable eg. for the creation of anchors, crosswords, etc. but also graphs, tables, etc. In recent years, the use of regulatory techniques has also been used in physiologically oriented curriculum [physiological regulation in schemes].

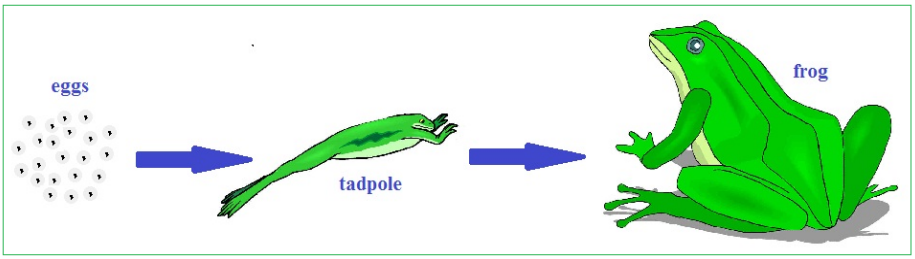


Fig 18 Sequence diagrams – Frog life cycle.

III. The Research - Pedagogical Experiment to Verify of The Effectiveness Teaching With The Applied to The Visualization of The Logical Structure of The Biologically and Ecologically Oriented Curriculum

These findings of psychological research projected into the applied (didactic) level as well as the above-mentioned theoretical work in the field of teaching, emphasizing the structure of the subject, led us to create our experimental teaching system. **(hereinafter referred to as NESVL).**

We have created a database of graphically visualized logic optics of the system of learning curriculum (Fig.1- Fig. 18) of thematic units (TABLE 1, Fig. 3.1). To design an experimental teaching system (**referred to as NESVL)** applying visualized logic support to the course structure system for a particular course - teaching and learning biological and ecological sciences oriented subject curriculum of Natural Sciences at lower secondary education **(hereinafter referred Natural Sciences at LSE).**

III.1 Targets and hypotheses of research

The main target of the experimental research was to explore the possibility of applying the visualized logic of the system of the structure of the curriculum to increasing the efficiency of the educational process.

We transformed the main goal into a partial goals system:

- to design an experimental teaching system **(hereinafter referred to as NESVL)** applying -visualization of the logical structure of biologically and ecologically oriented cCurriculum to the course structure system for a particular course.- teaching and learning biological and ecological sciences oriented subject curriculum of Natural Sciences at lower secondary education **(hereinafter referred Natural Sciences at LSE).**
- to compare the effectiveness of NESVL with the effectiveness of traditional teaching in our schools.
- to identify and statistically analyze attitudes and views of pupils and teachers at NESVL.
- to find and express assumptions about the possibility of introducing NESVL into school practice.

NESVL's proposed and implemented platform was the application of media containing graphically visualization of the logical structure of biologically and ecologically oriented curriculum (logical support) to the learning structure system in conjunction with Socrates interrogation in teaching (in the phase of repeating, consolidating, and refining the subject).

The basis (essence) of NESVL, as we have suggested and realized to it, can be characterized as follows (Fig. 3.1) :

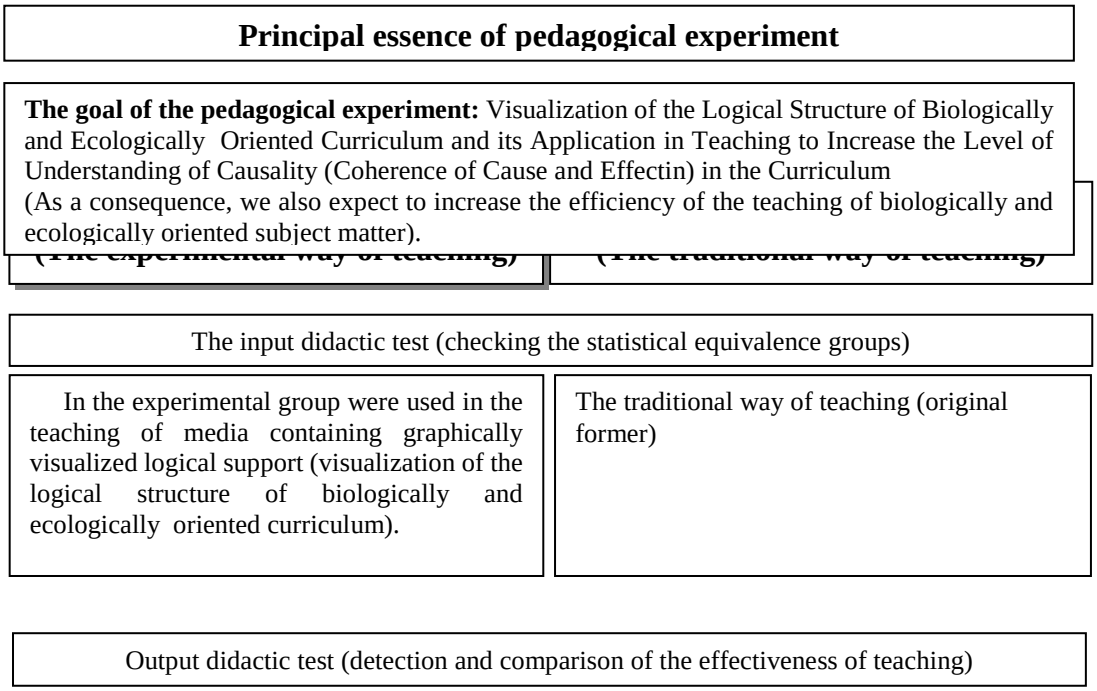


Fig. 3.1 Principal essence of pedagogical experiment

Comment:

- In the control group, the traditional way of teaching was applied at all stages of teaching. (both in the first phase of the curriculum, as well as in the phase of repetition, consolidation and deepening of the curriculum of the given thematic unit applied by the traditional way of teaching).
- In the experimental group, in the initial stage of learning, both the traditional way of teaching as well as the control group was implemented. The difference was in the phase of repeating, consolidating and deepening the curriculum of a given thematic unit (usually at the last lesson of each thematic unit). And that was the experimental hit. In the experimental group in the mentioned learning phase, the application of media containing graphically Visualization of the Logical Structure of Biologically and Ecologically Oriented Curriculum (visualized logical support) to the learning structure system was linked to the Socratic problem interview.

TABLE 1 THEMATIC UNITS TAUGHT IN PEDAGOGICAL EXPERIMENT

. I. THEMATIC UNIT	DIVERSITY OF NATURE AND ITS KNOWLEDGE
II. THEMATIC UNIT	BREATHING AND NUTRITION OF PLANT, FUNGUS
III. THEMATIC UNIT	THEMATIC TOTAL: WATER CIRCULATION
IV. THEMATIC UNIT	THEMATIC TOTAL: MAN AND ITS ENVIRONMENT
V.. THEMATIC UNIT	LIVING AND HUMAN HEALTH

III.2 Initial Hypothesis of the Research

Theoretical knowledge and empirical experience presented in the theoretical part of the thesis led us to the determination of 12 hypotheses. For the broadest reasons, we have only the most important (in terms of purpose):

H1 The pupils teaching in NESVL will achieve higher performance in cognitive learning (in the final didactic test) at the end of experimental lessons as pupils traditionally taught in Natural Sciences at LSE.

H2 The pupils teaching in NESVL will achieve higher performance in cognitive learning (in each of the monitored parameters (remembering, understanding and applying information by Nemierko) at the end of experimental lessons as pupils traditionally taught in Natural Sciences at LSE.

H3 The pupils teaching in NESVL will evaluate the progress of the teaching process in the Natural Sciences at LSE. more positively than the students traditionally trained in this subject.

H4 The upils teaching in NESVL will have a better relationship with Natural Sciences at LSE than students traditionally trained in this subject.

H5 The teachers of educational at NESVL say at the end of the experimental period that this system increases the efficiency of the teaching process in the Natural Sciences at LSE.

III.3 Selection of research samples

The research was attended by 366 pupils of the Natural Sciences at LSE of the Prešov district. The research took place throughout the second half of the school year 2017-18.

By analyzing the variance at a significance level of 0.01 (F-test), we checked the statistical equivalence of the sample sets in the following indicators: the overall benefit of the pupils and the benefit of the experimental subject at the end of the last completed year, the initial didactic test and the entry questionnaire for pupils. The analysis showed that there was no statistically significant difference in either of the indicators, so that the selected groups could be considered equivalent.

III.4 Selection of the research methods

We used the following pedagogical and pedagogical and psychological methods for research:

1. Natural pedagogical experiment - the main method,
2. Didactic tests - to verify the hypothesis H1, H2, H3, H4, H5, H8,
3. Questionnaire method - to verify hypotheses H6, H7, H9, H10, H11, H12,
4. Interview - to verify hypothesis H6, H7, H10, H11, H12,
5. Observation,
6. Statistical methods of processing research results - for statistical verification of research hypotheses,

III.5 Natural pedagogical experiment - the main method

We have implemented a two-tier pedagogical experiment project. One group - experimental (consisting of experimental classes) was taught in NESVL, the second - the control (created from the control classes) was taught by the traditional teaching system.

The independent variable with which we manipulated was the system of teaching in the experimental group - NESVL, in the control class the traditional teaching system.

The pupils 'performance was the dependent variable in our experiment: knowledge - memorization, understanding and application of information, pupils' attitudes towards teaching. From the point of view of the validity and reliability of the experiment, it was extremely important to control the intervening variables - the pupil's personality, the teacher's personality, the learning objectives and the subject matter, the time of teaching, the technical teaching means.

III.6 Method of the questionnaire

The goal of the pedagogical research conducted by the questionnaire method was to obtain and evaluate information:

- about the attitudes and relation of pupils to the Natural Sciences at LSE at the time of the pedagogical experiment,
- the relationship of pupils and teachers to NESVL (teaching and learning in experimental research classes).

III.7 The Major Experimental Research Analyses Results

The statistical interpretation of the research analyses findings is concise as the graphs are explicatory enough – (Fig. 3.5 and Fig. 3.13). They include the digital data related the values in question as well as the basic characteristics of the statistical ensembles arranged into the tables. As we find them sufficiently descriptive we do not provide any additional verbal explanations – (Tab 3.34)

For easier and more targeted analysis, we analyzed the output didactic tests from the point of view of the level of educational goals (the taxonomy of the educational goals of B. Niemierko). Output didactic tests divided by experts into e disjoint subtests (Fig. 3.6-3.13**):** Subtest N1: Memorizing information, Subtest N2: Understanding Information (Knowledge), Subtest N3: Application of information (use of knowledge).

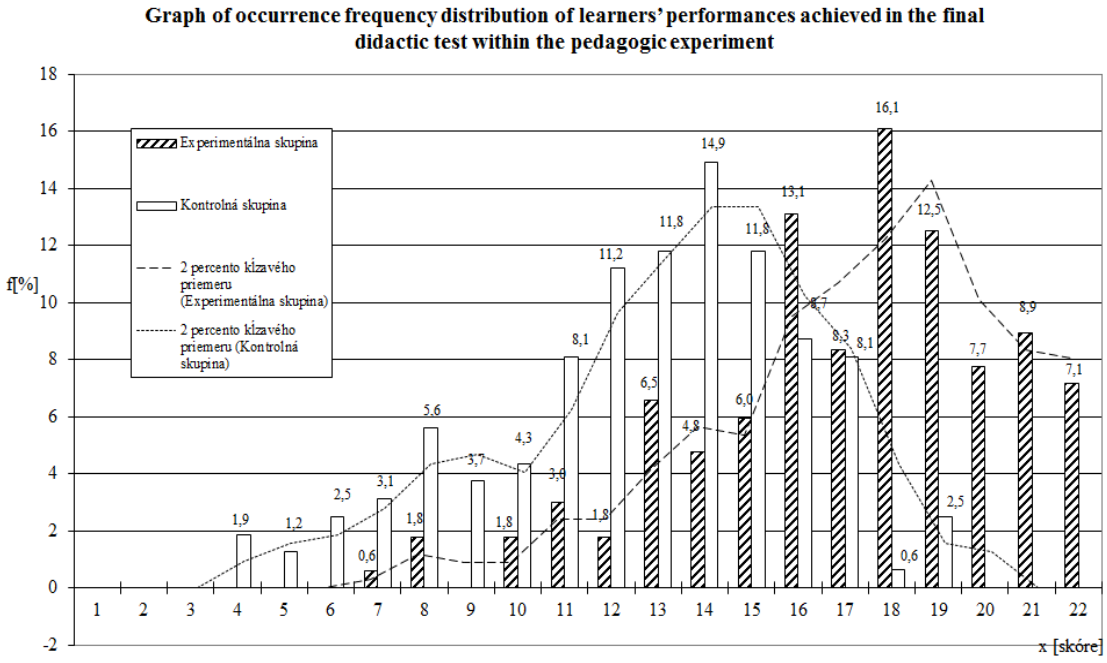


Fig. 3.4 Frequency distribution of learners' performances achieved in the final didactic test within the pedagogic experiment

TABLE 3.I DESCRIPTIVE AND INDUCTIVE STATISTICS

Štat.charakteristiky:		n_e =	168	n_k =	161								
$X_{max\,E}$ =	22	$X_{MAX\,K}$ =	19	$priemer_E$=	17,08929	test normality:	vyhovuje			$modus_E$=	18	$modus_K$=	14
$X_{min\,E}$ =	7	$X_{MIN\,K}$ =	4	$priemer_K$ =	12,68944	test normality:	vyhovuje			$median_E$=	17	$median_K$=	13
Štat.výz.diferen.(E-K)		k=	2	ni1=	1	ni2=	327	Fkr=	6,76	F=	164,2182	signifik.	

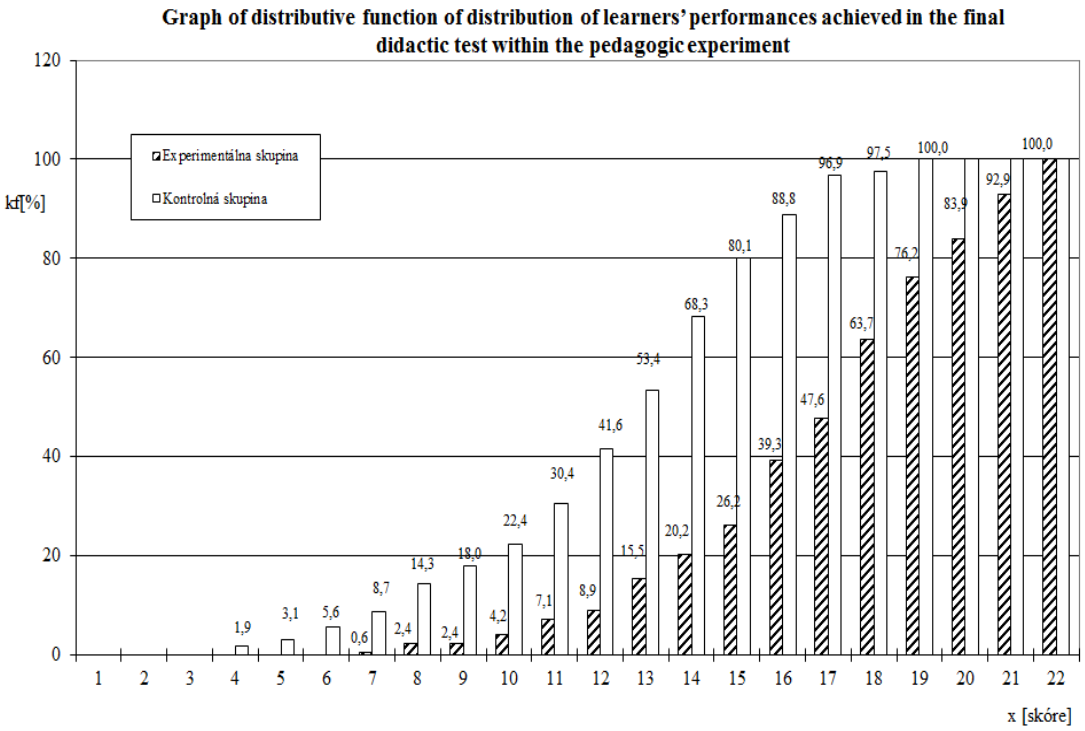


Fig. 3. 5 Distributive function of learners' (scores) achieved in the final didactic test within the pedagogic experiment

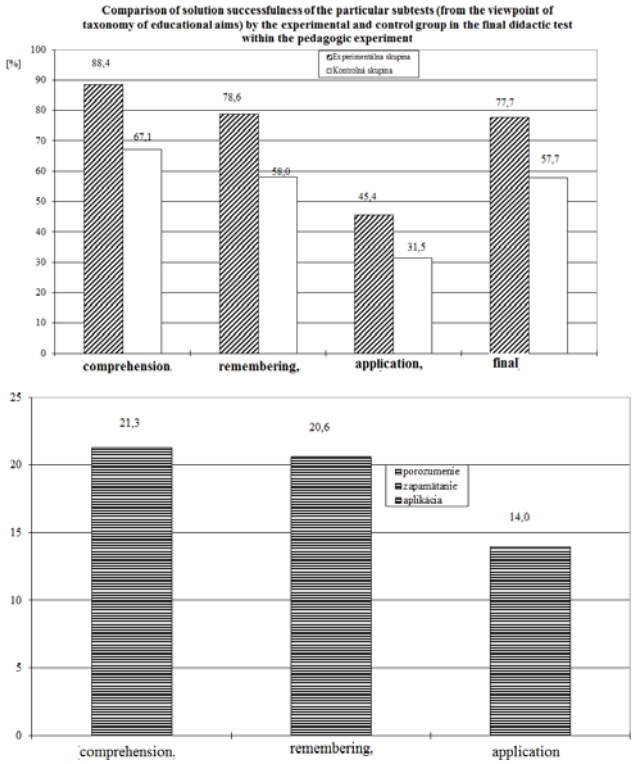


Fig. 3.12 The comparison of the success rate of the individual subtests assessing the learning objectives (comprehension, remembering, application, final) in the experimental and control group in the final didactic test

Fig. 3.13 Differences in Comparison of Successful Solutions of Individual Subtests (from the Point of View of Educational Targets) by Experimental and Control Group in Output DT

From the point of view of relations between the terms Mihalik [10], the didactic tests based on expert judgment were divided into the following disjoint subtests: functional relations, purpose relationships, relationships of inferiority, revelation of the context between concepts, multi-person relationships, exclusion of terms that do not belong to the given logical class , selection of terms according to a given criterion, definition of terms according to characteristics, revelation of the meaning of concepts.

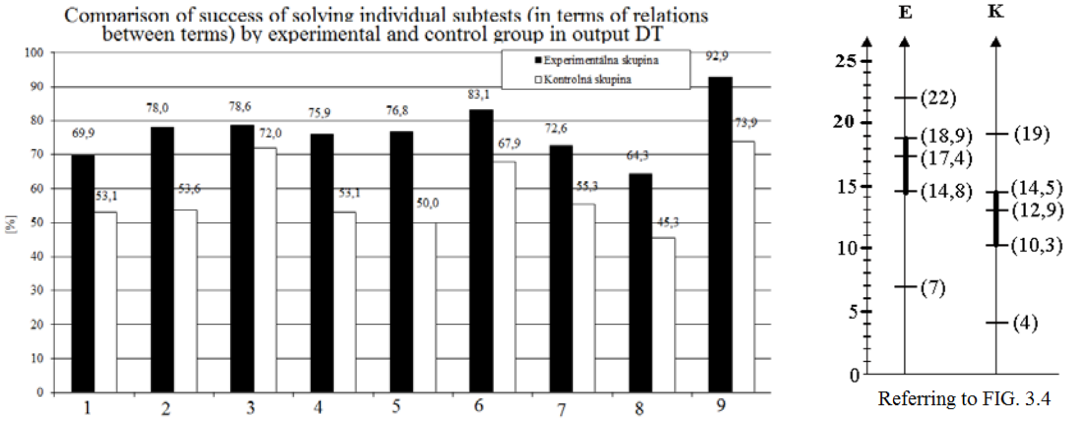


Fig. 25. 1. functional relationships 2. inferiority relationships 3. uncovering the connection between concepts, 4. multi - member relations,. exclusion of terms, 6. choice of terms according to a given criterion, 7. determination of terms according to characteristic features 8. exclusion of terms, 9. revealing the meaning of terms Fig 26. Graphical display of quartile analysis results

III.8 Research results

Based on the statistical verification of the hypotheses of our research, we can list the following research results:

A,Descriptive statistics (Fig. 3.4 -3.14)

There is a statistically significant difference between the performance of pupils taught in NESVL and the pupils traditionally taught in the didactic test of Natural Sciences at LSE. Pupils in NIESL in our experiment have achieved higher performance in cognitive learning compared to pupils traditionally taught at the end of experimental lessons in each of the monitored parameters (remembering, understanding and applying information).

The pupils of the experimental group achieved a 77.68 % success rate in the didactic test of Natural Sciences at LSE, the pupils of the control group 57.68 % (Fig. 3,12). The results show that the differences in the success rate of individual subtests between the experimental and control group are as follows: 20,6 % in remembering, 21,3 % in comprehension, 14 %, in application and 20, % in final didactic test application in favour of the experimental group (Fig. 3,13). Pupils trained at NESVL have evaluated the course of the EEF teaching process of the elementary school more positively than traditional learners. Teachers teaching at NESVL have stated at the end of the experimental period that NESV increases the efficiency of the teaching

process in the EEF learning subject. Teachers teaching at NESVL have received positive the result NESVL.

B, Inductive statistics (Table 31-3.4)

The statistical significance of the performance difference between the experimental and the control group achieved in the final didactic test is demonstrated as a whole in the TABLE 3.1 . Inductive statistics (by the analysis of variance – F test). Calculated Fwas 164,2, Fkr = 6,76, Since F > Fkr, we can say that in the pupils performance achieved in the final didactic test there is statistically significant difference between the experimental and control group at the significance level of 0,05. The interpretation of the subtest results N1 (remembering), N2 (comprehension), N3 (application) is analogical to the previous. (See Table 3.2-3.4) Descriptive and Inductive statistics).

Finally, we dare to say that the proposed experimental teaching system NESVL used during this research appears to be more effective than a traditional teaching system. The pupils who participated in the experiment showed better performance in cognitive learning as well as in all the other observed parameters (remembering, comprehension, application).

IV. CONCLUSIONS AND RECOMMENDATIONS FOR PRACTICE

Nowadays, with the unprecedented growth of information resulting from the dynamic growth of knowledge in almost every field of science, it is particularly important to look for teaching systems that enable broadly spectral involvement, whether in the age of the taught, but also in the level of the teaching management department, sequenced, applications capable, flexible, modular, and the causality of phenomenon-oriented knowledge. They are freely referred to as teaching systems aimed at highlighting the curriculum structure [3].

How does NESVL appear in this optics? The overall analysis of the application of the present innovative teaching system using the logical system of learning in practice proves the good prospects of introducing the innovative system into school practice. Moreover, it proves that the system is a valuable tool for increasing the effectiveness of teaching faculty. In addition, it provides evidence to be a helpful means of achieving positive qualitative changes in the student's knowledge structure. At the end of our experiment, pupils' knowledge was deeply understood and memorized, and had better practice in practice than in traditional lessons. The most encouraging is the fact that the present innovative system can be introduced into the teaching process without any radical transformation of the traditional teaching system (and in our view it is its crucial advantage) as it was fully mentioned in [3].

In addition, the NESVL system is considered to be much more attractive and motivating than the traditional system for the participants of the present research. What's more, the members of the experimental group stated that they were looking forward to being taught through the NESVL system.

Based on the findings of our research, we will try to analyze NESVL with the effort of the complexity of the view to the expected inputs and outputs offered, as well as their ratio. The necessary inputs for the realization of NESVL will be examined in the level of material difficulty, in the level of necessary changes in the traditional system of teaching and in the level of personnel.

Material requirements for NESVL can be considered unpretentious at the current state and prices of reprographic technology.

The model of graphically visualized logic support of the learning structure system we have designed modifies the traditional structure of the learning block over the average time span, ie 1 hour, usually the last in the block of the thematic unit teaching. The "radicality" of this intervention is even milder if one realizes that some teachers also try to "recapitulate the interpretation" on a traditional lesson, but not all teachers, not systematically and not all subjects, but not desired depth and width. NESVL eliminates this lack of material and methodical integration of these efforts.

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