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RESEARCH ARTICLE

ELECTRONIC-LEARNING AND THE VIRTUAL REALITY IN BIOLOGY

***Mariana Iancu**

Bioterra University of Bucharest, Gârlei Street, No. 81, District 1, Bucharest, Romania

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****Corresponding author:***

ABSTRACT

This research presents the results obtained with students from BIOTERRA University in Bucharest and with pupils from "Ion Luca Caragiale" National College in Bucharest, with whom the university is in partnership, by applying of Electronic-learning (E-learning) and of Virtual Reality (VR) with aid of Information and Communication Technologies (ICT) in Biology. Such, has been applied the Computer-Assisted Instruction (CAI) through the "High School Educational Assistance" (HSEA) software application, by means of software educational presentations such as PowerPoint slides, Display Video Disc (DVD), demonstrated with the help of computer, of projector, smart board. Also has been applied the Internet, through YouTube videos, chat rooms, discussion forums on professional sites, Video Conferencing. In E-learning through VR in biological sciences a techno centric model based on technique and equipment was experienced, alongside with a computer-focused strategy and various methodologies made up by combining a variety of teaching methods such as CAI, demonstration, simulation, experiment, observation, modeling, working with electronic school book, electronic Interactive System of Noting for Efficiency of Reading and Thinking (ISNERT), computer discussions and debates. This research on E-learning and VR in Biology contribute to this area by numerous examples of biological learning units, lessons and courses based on them, but also by the functions, advantages, disadvantages, limitations of E-learning and Virtual Reality, as well as by ways to counteract these limitations identified in Biology. The E-learning and Virtual Reality bring a cognitive and affective plus, contribute to sustainable education, demonstrated by the results of the tests.

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INTRODUCTION

Globalization and technological change are transforming university and preuniversity education. Organization for Economic Co-operation and Development (OECD) showed in 2015 that "advances in information and communication technologies (ICTs) are bringing about new opportunities with impact on teaching and learning methods, mainly through what is commonly known as e-learning." The beginning of the third millennium is marked by a Society dominated by knowledge, by the development of Smart Technologies which has triggered about substantial changes in education, both in teaching and learning and which contribute to Smart Sustainable Education and to sustainable environment and society. "Every society has its own knowledge assets. It is therefore necessary to work towards connecting the forms of knowledge that societies already possess and the new forms of development, acquisition and spread of knowledge valued by the knowledge economy model. The idea of the information society is based on technological breakthroughs." (United Nations Educational, Scientific and Cultural Organization 2005). In Knowledge Society, it is necessary to study the role of e-learning and of the new information and communication technologies in the potentiality of the didactical methodologies, to increase the level of the pupils'/students' competences. "The intervention of science in the underpinning of the educational process has increased so much and has reached so far that it has succeeded in making it an area in which the newest information and communication technologies are successfully applied. Conversion into training and education strategies of these cutting-edge technologies is already required being established as one of the major, revolutionary trends that characterize the evolution of education at this beginning of the century, which has a major impact on increasing the quality and efficiency of activity from framework of school institutions. (Ceghit 2002). As Lytras *et al*. (2017), have showed, the evolution in Virtual and Augmented Reality is challenging the Learning domain since some of its significant value propositions are related to several inefficiencies of Science, Technology, Engineering and Mathematics Education. In this research we have asked several questions from which we started our research efforts on E-learning efficiency and Virtual Reality in Biological Sciences such as: "In the digital era, wouldn't it be more appropriate and efficient to use a teaching model and a didactic strategy based on E-learning and VR, computer-based methodologies, educational software and Internet ?". "What can pupils / students and teachers do with computers? Which learning pathways can be addressed in the educational process with these modern means?". We have got the answers to these questions, but also to others, through the research of the application of E-learning and of Virtual Reality in the biological educational process. In this research, we promote the techno centric focus in lessons and courses. As has showed Davis (2017), these maturity models have a range of indicators

(including digital infrastructure and policy) arranged into stages that tend to conceptualize an early emerging stage sequeing into an ongoing movement towards an organization transformed because of its (again assumed) fully embedded digital tools. The technocentric focus of these models serves to promote increased adoption of digital tools simply by presenting the benefits these tools provide for enacting various tasks. Also, in this research, we have promoted the computer-focused strategy. "Over the course of the entire lesson, the HSEA platform (computers, servers, software, other information and communication technologies) alongside using a computer, a set of teaching methods and procedures such as independent and systematic observation, the didactic experiment, simulation, demonstration, modeling, etc. we can talk about the computer-focused strategy in the realization of lessons." (Ciobanu 2008).

The theoretical framework of research

E-learning: E-learning literature identifies the most used concepts associated with the use of computers in learning contexts, e.g. computer assisted instruction (CAI), computer assisted learning (CAL), computer-based education (CBE), e-learning, massive open online courses (MOOC), and so on. All these concepts have two aspects in common: learning and computers. In Knowledge Society, e-learning can also mean massive distribution of content and global classes for all the Internet users. In the mid-1980s, the more of meta analyses (Kulik *et al.* 1980; Kulik 1983; Kulik *et al.* 1983) found consistently positive and moderately high achievement gains atall educational levels from computer mediation in traditional subjects, studies that also suggested that C.A.I. was more effective in lower educational levels and with lower-achieving students. E-learning is achieved within a technocentric learning model that "is based on the rationalization of the teaching-learning process in terms of the decomposition of learning in its operations and its evolution through the use of everything modern: training assisted by new information and communication technologies and e-learning." (Petruța, 2009)
"HSEA" application means High School Educational Assistance, which is conducted by interactive lessons in high school, from different disciplines of education achieved by electronic communication, by computer and educational software, i.e. this "Biology Interactive Lessons". The educational content of the software is sequenced according to mental operations and can be approached in the software's framework such a strategy rigorously structured by training scheduled, algorithmic, but also a heuristics strategy or problematization strategy, rediscovery by pupils / students through their own efforts of the scientific truths already established by the scientists, namely finding solutions to the problem situations. For example, in a rigorously structured strategy for biological sciences, didactic methodology can be based on CAI in correlation with programmed instruction, algorithmization method, student-computer-specific dialogue, demonstration, independent observation, modeling, as in lessons "The chemical composition of living matter", "Cell cycle", etc. In a strategy of learning by discovery, judiciously correlate CAI with experiment, simulating, independent exploratory observation, modeling, investigation, as the "Nucleic acids and nucleoproteins" biochemistry course or the "Anatomy and physiology of the endocrine glands" learning unit.

Virtual reality and software: Electronic Learning Experiences with a Virtual Reality "is characterized by sensations of immersion and presence which enable the subject to feel as if s/he is part of the environment in which s/he is functioning. In a virtual environment it is also possible to present abstract concepts and novel points of view which cannot be presented in this way in the real world (Passig *et al*. 2016). "Can softwares environments and comunication tools enrich opportunities to learn and play a large variety of epistemic games?Our simple answers to this qustion is yes-but only if the software environment support, and are supported by, a community of practice in wich the social contruction of knowledge in the context of authentic goal-directed projects in the dominant activity" (Wilson, 1998). The impact of these technologic methodologies on the training is increased, but provided that the recordings, the educational software are of good quality, namely scientific, pedagogical, didactic, grammatical, being constituted by a balanced and judicious combination of the different static-image elements, graphics, text and dynamic elements-video techniques, audio techniques, animation. After their pedagogical and didactic role, the types of educational software used in Biology are: for the transmission of specific scientific content in an expository-receptive way, for the interactive presentation of biological contents, for the formation of intellectual skills by exercising mental, for stimulation of creativity, for openness to interdisciplinary and transdisciplinary, experimental-investigative, demonstrative (images, models), for problem-solving, for motivation stimulation, for initial, current and summative assessment, simulation, modeling, etc.

Organization and methodology of the research

Organization of the research: The research has been implemented in many years, between 2013 to 2017, with 340 research subjects, respectively 160 students, in framework of the Specialized Department with Psychological-Pedagogical Profile and of biochemistry laboratory at BIOTERRA University in Bucharest, and with 180 high school pupils from the "Ion Luca Caragiale" National College in Bucharest, which is in partnership with the university, in framework of the Biology laboratory and Laboratory of Informatics "HSEA".

Methodology of the research: The research methods used are data collection methods and data processing methods. The most important data collection methods:

- The study of specialty bibliography;
- The pedagogical experiment; during the years of research, the technique used in the pedagogical experiment was that of research with unique group, whereby in several classes of pupils, at the same level of schooling, for each one was watched the evolution of the school progress made by the students starting from the initial assessment test (from pre-testing) to the current (periodic) and final (summative);
- The pedagogical observation; the researcher have conducted systematic pedagogical observations of student behavior in experimental lessons. In the systematic pedagogical observation the researcher observed the rules of an investigation, i.e. started from the hypotheses of research, resorting to their verification during the research; to increase the efficiency of using this method of pedagogical research, the researcher used grids to

observe pupils ' behavior during lessons, which were previously prepared for lessons, including, among others, tracking students' skills with computer, their ability to simulate experiments, systems, biological processes and phenomena, the modeling ability, the application of didactic games, the ability to solve items, the progress made by the students in the e-learning and virtual reality lessons, with the help of CAI, of the Internet, of applying the technocentric model; as attitudes, the researcher watched the pupils' attractiveness towards ICT, the satisfaction of activities, curiosity and epistemic interest, etc;

- The testing method; the initial testing consisted of an assessment test of the biological knowledge studied in the previous year, given at the beginning of the first semester, during an assessment lesson; throughout the research, applied current assessment tests in lessons based on E-learning and Virtual Reality, and at the end of the research the researcher applied a summative (final) assessment test of the biological knowledge assimilated during the study, in which was researched the E-learning and Virtual Reality; tests were also administered to check the scientific knowledge of biochemistry laboratory work of students from this research;
- The discussions; the discussion is an interactive and attractive methods, in which students from this research have argued for or against of some advantages and disadvantages of didactical activities based on E-learning and Virtual Reality, with the aid of the computer and Internet.

The data processing methods used in this research were:

- Mathematical methods: calculation of overall average, of frequency of scores; the percentage calculation method; has been calculated the overall average of initial assessment sample, the overall average obtained from current assessment samples and the overall average of final assessment sample;
- Graphical methods: diagrams;
- Logical methods, allowing the selection of the material, its ordering: analysis, synthesis, induction, deduction, analogy, method of difference.

Research results and discussions

Statistical data of applying of E-learning and of VR to Biology: Electronic learning (E-learning), as the activity of pupils and students with the help of computers and Virtual Reality, is achieved mainly through CAI and Internet. In 2016-2017, at College, has been applied the e-learning and the Virtual Reality by CAL in the biology laboratory and the HSEA informatics laboratory, with the help of the computers, of the educational software "Biology Interactive Lessons", of the video projector, of the smart board, but also with the help of the Internet in realization of the themes, of the projects, of the reports, i.e. the report of the project "Anthropic impact on natural ecosystems" at XIIth C, D, G classes, the overall average of the summative assessment is higher than the overall average of the initial assessment, increasing from 8.05 to 8.70, at XIIth C class, from 8.30 to 9.03, at XIIth D class, from 8.27 to 9.05, at XIIth G class (Fig. 1), and also, increasing the overall average of currents assessments compared to the overall average of initial assessment which show the efficiency and the functionality of e-learning with ICT.

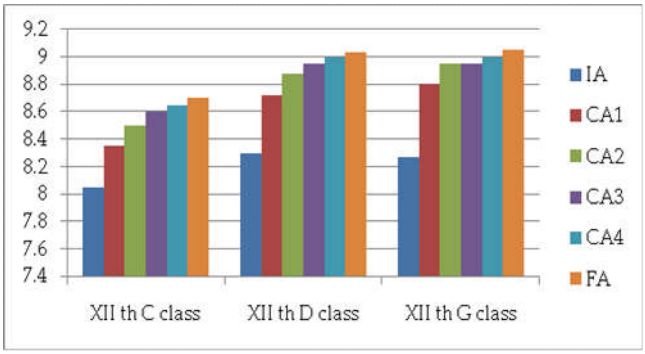

Fig. 1. Histogram of the results obtained for the initial assessment, currents assessments 1, 2, 3, 4 and final assessment, through e-learning and VR of the "Nucleic acids'' and "Anthropisation ecosystems" contents, at XIIth C, D and G researched classes

IA-overall average of initial assessment sample (8.05-XIIth C class, 8.30-XIIth D class, 8.27-XIIth G class)
CA-Current assessment
CA1-overall average obtained to current assessment sample 1 (8.35-XII C, 8.72-XII D, 8.80-XII G)
CA2-overall average obtained to current assessment sample 2 (8.50-XII C, 8.88-XII D, 8.95-XII G)
CA3-overall average obtained to current assessment sample 3 (8.60-XII C, 8.90-XII D, 8.95-XII G)
CA4-overall average obtained to current assessment sample 4 (8.65-XII C, 8.95-XII D, 9.00-XII G)
FA-overall average of final assessment sample (8.70-XIIth C class, 9.03-XIIth D class, 9.05-XIIth G class)

Other results, also obtained at same College, in 2013-2014, through applying of ICT, the overall average of the final (summative) assessment has been higher than the overall average of initial assessment, increasing from 9.18 to 9.48, at XIIth B class, from 8.07 to 9.00, at XIIth C class (Fig. 2), and also, increasing the overall average of currents assessments compared to the overall average of initial assessment, which show the efficiency and functionality of e-learning with ICT.

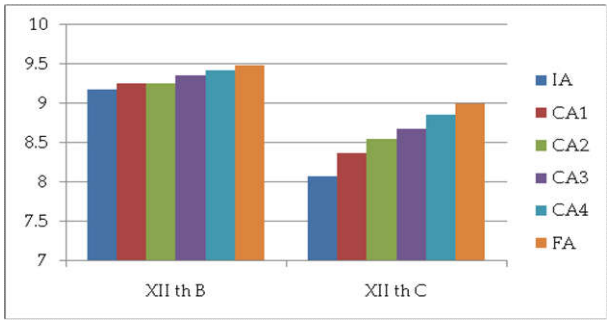

Fig. 2 Histogram of the results obtained for the initial assessment, currents assessments 1, 2, 3, 4 and final assessment, through e-learning and VR of "Nucleic acids'' content by applying of the ICT, at XIIth B and C researched classes

IA-overall average of initial assessment sample (9.18-XIIth B class, 8.07-XIIth C class)
CA-Current assessment
CA1-overall average obtained to current assessment sample 1 (9.25-XIIth B, 8.37-XII C)
CA2-overall average obtained to current assessment sample 2 (9.25-XIIth B, 8.55-XII C)
CA3-overall average obtained to current assessment sample 3 (9.35-XIIth B, 8.68-XII C)

CA4-overall average obtained to current assessment sample 4 (9.42-XIIth B, 8.85-XII C)
FA-overall average of final assessment sample (9.48-XIIth B class, 9.00-XIIth C class)

The application of the percentage calculation method has revealed that 90% out of 105 students from this research, in 2013-2014, have obtained the better scores at biochemistry laboratory work, of the scientific knowledge about "Heteroproteins and Nucleoproteins" and "Protein Biosynthesis" contents, where there were used computers, software and Internet, in comparison with the students who have learned these contents from the book.

The functions of applying of E-learning and of VR to Biology

Research results have shown that in the educational process at Biology the computer together with the educational software can fulfill the following functions in applying of the E-learning and Virtual Reality by CAI and Internet:

- Transmitting or presenting new scientific content in a modern, interactive way;
- Provides rigorous, step-by-step guidance through scheduled, linear and branched training techniques;
- Creates great opportunities for interdisciplinary and transdisciplinary; some concepts can be studied in an integrated way;
- Performs complex, very suggestive demonstrations that cannot be done naturally or through other means of education; there are certain functional aspects, processes, some behaviors of the creatures that become perceptible only in certain moments - flowerting, pollination of plants, reproduction behavior - mating, depositing and squeezing eggs, nest construction by birds, etc. In these cases, Computer Assisted Instruction with the aids of computer, software, Compact Disc (CD's), DVD, but also the Internet have a fundamental role. As shown Papert and Harel (1991), "The presence of computers begins to go beyond the first impact when it alters the nature of the learning process.";
- Demonstration of images of biological systems (plants, animals) in their living environment that cannot be presented to pupils / students in classroom/laboratory, or in the environment close to school;
- Allows the simulation of complex biological processes, phenomena, systems and laws as a communication support and means of interaction on a virtual reality; "Virtual reality is the product of simulations, used in a wide variety of situations: when the presentation of "real" is not possible, it becomes too dangerous, too difficult or simply inaccessible due to time, distance, of size, etc. Virtual reality techniques can provide new solutions to all the problems of simulation of command, control and communication (flow of information), moments indispensable to the learning process." (Cerghit 2002); in this case, virtual reality comes as a notable improvement of simulation, argues Bruillard (1997);
- Performing practical activities such as creating models, virtual experimental devices;
- Has substantial effectiveness in the application of educational games, which requires perspicacity, intelligence, distributed and focused attention, but also stimulates students' creativity;
- Stimulates and increases cognitive constructivism by asking students in data searches, scientific documentation, analyzes and comparisons, selections and processing of information, essentials;
- The computer stores important, accessible, flexible data to stimulate scientific curiosity;
- Ensures the application of the pedagogical principle of differential treatment of students in training, allowing individualized training, adapted to the needs, interests and learning possibilities;
- Stimulates independent self-study, helping students prepare for applying didactical methods, e.g. "mosaic" method, "fishbowl" technique, reading techniques, "ISNERT" technique, as well as drafting independent scientific documentation or independent scientific research papers, in particular via the Internet;
- Ensuring an interactive environment, facilitating a type of machine-student conversation, electronic brainstorming;
- Allows immediate feedback, increasing the efficiency of the instructional-educational process through rehearsals, exercises, learning support, additional tasks;
- Provides a modern assessment by computer, through problems, problem-situations, progress tests, etc.; among the most important functions of the application of information technology to Biology are: providing feedback in training of pupils / students, indicating immediate results, the mistakes being reported and corrected, self-assessment and capacity for self-regulation of learning; with the help of the computer, the formative, progressive assessment can be made by verifying, appreciating and grading the simulation of processes, phenomena, complex biological laws, by the practice of educational games that require thinking, observation, attention, students' creativity and so on carrying out practical activities such as creating models, designing biological systems of different levels of integration and organization of living matter; the computer can be an assessor of students' cognitive acquisitions, using numerous and varied assessment tools, such as a grid test; provides feedback on pupils' training, promptly indicating the results obtained, alerting and correcting possible errors, consolidating the data received, stimulating learning, self-assessment and self-regulation ability of the learning process;
- Strengthens and stimulates self-assessment, self-control, teaches students in the sense that "Validation of cognitive approach helps pupils learn how to learn, to realize the effects of their own efforts, to evaluate each step taken, to achieve a certain level of metacognitive development, self-control capacity, and self-evaluation. There are aspects that ultimately contribute to the responsibility of those learning for their own learning, helping them take control of learning." (Cerghit 2006);
- Contributes to lifelong learning, while supporting distance learning, as showed Cerghit (2006), Jalobeanu (2001), Mucchielli (1998), Pelgrum (1992);
- Allows access to electronic libraries, especially via the Internet;
- Allows the exploration of a virtual world;
- Discussions and debates can take place via chat;
- The electronic school book can be quickly used;
- The computer offers possibilities for collective pedagogical management through histograms representing pupils' results, through distribution curves,

level curves, comparisons between pupils' learning outcomes, comparisons between results of different classes, between results from one semester to another, etc.;
- In university education it enables the participation of students and teachers at forums organized on websites, where a topic can be discussed with Internet users from all over the world;
- E-learning enables students and teachers to participate in Video Conferencing through the Internet, the video projector being used, video tutorials, PowerPoint slides, computer.

The "Teacher" Computer

The E-learning and Virtual Reality that have been submitted to the research imply a change of dimension in the teacher's and professor's role, in transition from traditional stage, "key player in the lesson" to a secondary role on "didactical scene", most of his roles, of functions and tasks being taken by computer and other hardware and software resources (Fig.3).
In E-learning and V.R. "The roles of teachers, students and universities are also being transformed."(OECD 2015).

The roles of E-learning and Virtual Reality in education to Biology

As an object of study of Pedagogy, education (Latin, "Educo-educare-educere" to increase, to grow, to guide, "Educatio"-growing, guidance, education) is a socio-human phenomenon that contributes to the students' and pupils' general culture and to their professional training. Fowler (2015) indicates, that in most cases when researchers talk about Virtual Education (VE) mainly taken into account the technological perspective, specifically through the identification of learning benefits that arise from the technical affordances, but there is no deep analysis of pedagogical benefits. We focused our research on the pedagogical benefits of E-learning and Virtual Reality, on education contributions, and on their pedagogical paths. By applying the E-learning and Virtual Reality to Biology, it contributes to specific aspects of education, e.g. bioethical education, ecological education and education for environment, health education or hygienic-sanitary education, education for first aid and so on. The bioethical education is the education for the application of the laws of ethics in the correlation with the laws of life. E-learning and Virtual Reality contribute to bioethics education at the lesson "In vitro fertilization, therapeutic cloning, gene therapy and bioethical considerations" at Biology in high school through the following learning sequences:

- Students watch a movie "What does life mean to you?" posted by the Family Coalition on YouTube (Association of Orthodox Christian Students 2017);
- Students chatting on the morality of applying scientific research such as ending a life by surgical abortion practiced in women who may have children in antithesis with in vitro fertilization, a technique used for procreation in infertile couples; it discusses about ethics and bioethics;
- Students work with the electronic biology school book, where they observe the model (scheme) with the place of fertilization process in humans;
- The teacher organizes the ISNERT electronic technique, asking students to read the text about infertility and in vitro fertilization in the electronic biology school book, then mark the electronic text as the passages that confirm what they already know or contradict what they already thought they knew, on those that offer new, unexpected ideas and those on which they have questions, using the unanimously accepted symbolism that is written in the paragraphs:

- **V :** what they already know;
- **+ :** new information;
- **- :** information that contradicts what they already know;
- **? :** information they have questions about.

Students complete an electronic table with that symbol (Table 1) and inventory ideas on a Word page. Students are asked to formulate conclusions on in vitro fertilization and bioethics issues raised on this page, based on the application of the ISNERT electronics technique. The health education is the education for avoiding unfavorable factors contributing to the disease, but also for the appropriate approach of the factors favoring body growth and development, health and life. E-learning and Virtual Reality contribute to health education and first aid education (to help people in the deadlock of an accident or sudden illness) through the Internet, the computer, YouTube, and PowerPoint computational presentations. For example, in the "Hygiene of intellectual life; risk factors-tobacco, alcohol, coffee, and drugs" lesson, at Biology, gymnasium, health education and the first aid education through the following E-learning modalities and VR (Table 2): The ecological education is the education for the integrated ensemble of the biotic and abiotic environment, which at the ecosystem level is the integral ensemble of the biotope and biocoenosis, is the education for the interrelationships between the trophic links of the biotic environment (with life), for the interrelationships between them and the abiotic environment (without life) in the sense of their protection and preservation. Formal Ecological Education through E-Learning and Virtual Reality in the "Introduction to human ecology. Aquatic anthropisation ecosystems" lesson, at Biology, in high school, can be achieved through E-learning ways, such as "HSEA" Program applications, through the computers and "Interactive Biology Lessons-Volume I" software, electronic presentations using PowerPoint slides, DVDs, video projector, computer, electronic board, as follows (Table 3).

Advantages of E-learning and Virtual Reality

E-learning and Virtual Reality through CAI and the Internet provide a wide range of benefits to be fully exploited in the educational act, with the following benefits:

- Increases the efficiency of learning and, implicitly, the level of school and university results, illustrated by the results of the tests administered within the scientific research, contributing to the achievement of the cognitive objectives of the biological education;
- Improves the education, contributing to bioethics education, ecological education, health education and the education for first aid, respectively to achieve the affective goals of biological education;
- Provides both passive learning by reading, viewing, listening, but especially active learning through computer-pupil / student dialogue by means of the educational software, through speaking active by email, chat, site forums;
- Ensures the realization of distance learning;

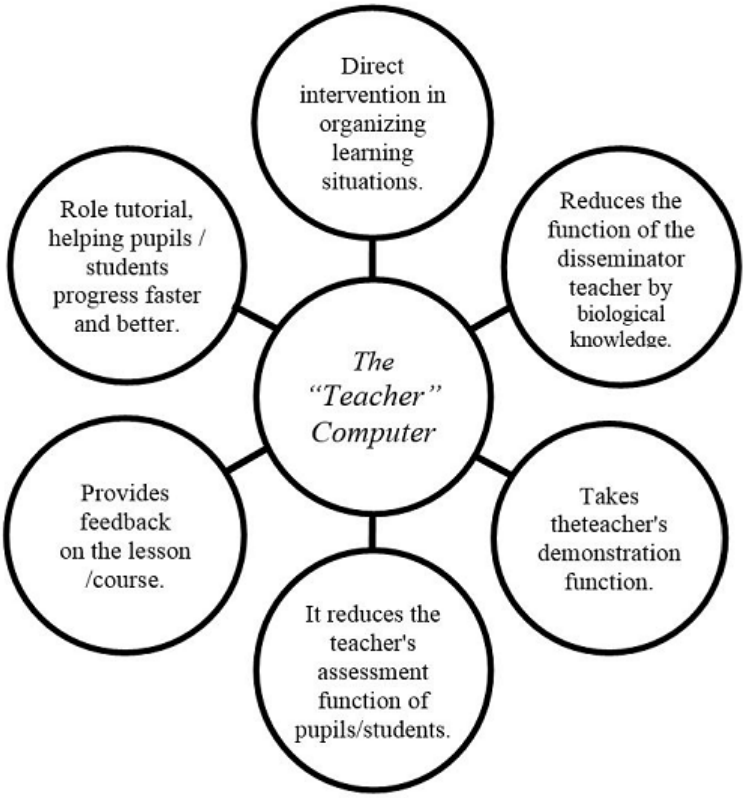

Fig. 3. The computer taking up some of the teacher's functions and tasks

Table 1. The ISNERT electronic technique-table with spaces to fill in

Information already known (V)	New information (+)	Unknown information, in contradiction with known information (-)	Information raising questions (?)

Table 2 E-learning modalities and Virtual Reality in the "Hygiene of intellectual life; risk factors – tobacco, alcohol, coffee, and drugs" lesson

Cur. Nº.	Content (lesson)	E-learning modalities and Virtual Reality
1.	Hygiene of intellectual life; risk factors - tobacco, alcohol, coffee, drugs	Watching a video on "The harmful effects of tobacco, alcohol, and drugs" (Edu Moodle Network 2017), using computer, video projector, board electronic, Internet; (individual activity). Presenting and interpreting data from a table of sleep duration, that is, hours / day of sleep by age, designed by a PowerPoint (frontal activity). Presentation of a PowerPoint slide with some statistical data (e.g. correlation of violence / road accidents / morbidity - alcohol or drug use), their analysis and interpretation (frontal activity). Drawing up conclusions and writing them on a word page (for example: formulating hygiene rules / healthy lifestyle for intellectual hygiene, based on information extracted from film sources, PowerPoint slides, etc.) (individual activity).

Table 3. E-learning modalities and Virtual Reality in the "Introduction to human ecology Aquatic anthropisation ecosystems" lesson

Cur. Nº.	Content (lesson)	E-learning modalities and Virtual Reality
1.	Introduction to human ecology. Aquatic anthropisation ecosystems: dam lakes and reservoir lakes, characteristics, particularities of biotopes and biocoenosis, interspecific relations, determination of trophic structure-chains, networks and pyramids trophic.	Applications of the "HSEA" correlated with introductory concepts such as ecosphere, ecosystem, trophic categories, trophic chain, trophic network, interspecific relations (individual activity), through the computer network, the interactive "Interactive Biology Lessons - Volume I" program. Applications of the HSEA in the observation of the diagram of the hierarchy of ecological systems (individual activity), through the computer network, the computer program,"Interactive Biology lessons - volume I" electronic volume, video projector, electronic board. Presentation and identification of natural and anthropisation, aquatic and terrestrial ecosystems (frontal activity) using computer, video projector, movies, PowerPoint slides, electronic board. Demonstration at video projector and with the aid of computer, DVDs, electronic board of images with dam lakes and reservoir lakes (frontal activity). Demonstration at video projector and with aid of computer, DVDs, electronic board of ponds pictures and waterhole (frontal activity).

- Provides cognitive learning models; Jonassen (2000) says that technologies have intrinsic properties and activate cognitive tools that help students consciously elaborate on what they are thinking and engage in meaningful learning;
- the advantages of computer use in learning are "saving time, cognitive achievement, facilities for simulation of phenomena, processes, shares by computer skills" (Cerghit *et al*., 2001);
- Enriches the specific vocabulary of the biology field, paying special attention to selecting the informative source, especially on the Internet;
- Increases the objectivity of assessment and of grade, and the assessment errors are diminished, reducing the disturbing factors of verification and grade;
- Increases imagination, creativity, resolute anticipation ability;
- Develops information processing strategies, such as compiling a table versus types of animal movements after viewing YouTube videos with movement across different animal groups;
- Allows browsing the Internet, especially with the help of Google's search engine, especially for scientific documentation;
- Can greatly broaden verbal communication, even with pupils / students from other countries of the world, via e-mail, chat, with the help of the Internet;
- Allows building a website for various projects, especially by students, such as building an ecological education or health education site, by requiring and stimulating imagination, creativity, correlations with foreign languages, especially with English;
- Creates new types of relationships and new interactions, such as computer-student, student-computer;
- Increasing the motivation of school learning, stimulating intrinsic motivation through increased attractiveness to computer and other hard work study;
- Allows learning anywhere, anytime; does not necessarily require attendance in the classroom/amphitheatre, pupils and students able to learn electronically and at home;
- Pupils and students are not addicted to a specific time, fixed program, able to learn electronically anytime during the 24 hours;
- performs individualized training;
- Allows imaginary, virtual scenes to be built in games such as adventure games, as showed Cerghit (2002);
- Allows to operate with a wide variety of learning resources, such as text, static and animated images, sound, short films, and multiple hyperlinks;
- Electronic learning being a multimedia system allows video and audio interactivity;
- Influences the opinions and attitudes of pupils and students, especially through the Internet;
- Increases computer literacy and Internet skills for the future of life's active, post-school and post-graduate work;
- It is economical in time, E-learning is faster than teacher-guided learning and classical school manual;
- One significant benefit is that many of these computer and web-based materials launch students on what can be self-guided explorations into related material to reports, to projects, themes, portfolios, necessary for formal education, but and for non-formal education, respectively for extracurricular education.

All these advantages point to the need of applying a techno centric training model and a computerized strategy to Biology using E-learning and Virtual Reality through CAI and the Internet and applying computer-based didactic methodologies to streamline the biological education process.

Disadvantages, limitations of E-learning and virtual reality and ways to overcome them

E-learning and Virtual Reality are very useful in educating and training pupils and students, but should not be absolutize, and there are disadvantages and limitations to its use, but also ways to overcome them.

The most significant drawbacks and limitations of the use of E-learning and virtual reality, as well as some ways to overcome them, are presented as follows:

- The psychomotor objectives of biological education cannot be achieved; computer-based learning activities should be alternated with others through which to apply the specific biology techniques such as macroscopic observation, microscopic observation, dissection, etc. and, at the same time, to use the specific equipment, devices, chemicals and laboratory instruments, so that the psychomotor objectives of the biology school curricula in force can be achieved;
- Does not create the atmosphere, the research environment specific to laboratory or field work; the way in which to overcome this problem in using e-learning to make it more productive and to avoid different stereotypes about e-learning is the introduction of computer and of new information and communication technologies in scientific laboratory and the combination and the alternation of activities and of didactical methods, respectively CAI with traditional methods, specific of field;
- Electronic learning and VR are less convincing than using natural teaching material, natural environments or experiences, experiments and laboratory work, which is why the activities with computers and those with natural biological material must be alternated;
- Reduces verbal communication "face to face", the discussions, debates, arguments, counter-arguments, the conclusions are less stimulated, these habits can be lost in time, recommending discussions on Chat Relay, face book, discussions forums on sites, focus group discussions;
- Reduce the interrelation between pupils, between them and teachers, contributing to lower direct socialization, dehumanization of the teaching process; this limitation can be overcome by organizing direct, team-based sociocentric activities integrated into the e-learning lesson. "In order to prevent dehumanization of the didactic act, stimulation of communication between students, one of the important goals of biological education, it is necessary to organize activities in teams, micro groups, pairs." (Ciobanu, 2009);
- Are expensive, requiring funds for the purchase of computers, monitors, educational software, for subscription to the Internet; overcoming this problem

is possible by the implementation of projects for the procurement of computers and others necessary with European Founds for countries from European Union;
- Requires training in computer assimilation for many people; but given the need for permanent education in which we need to be engaged, this limit could be viewed from this angle as an advantage.

Regarding the technical competencies of using computers and other hardware resources of pupils and students, it can be said that they normally have to hold them, as long as they study in the compulsory curriculum in secondary education the Informatics, ICT, but in terms of regarding the possession of these competences by teachers, there are continuous trainings in the field, if they do not have such knowledge, although in the digital age the technology has penetrated even in the rural environment of many countries of the world.

Conclusions and recommendation

Electronic learning and Virtual Reality can be applied to Biology in multiple modalities, of type of CAI, within the "HSEA" computer application, PowerPoint slides presentations, video presentations, but also of type of Internet, by YouTube videos, Chat Relay, e-mail, discussions forums sites, Video Conferencing, with numerous examples of learning units, lessons, courses by E-learning and VR. The didactical models recommended are the technocentric ones, based on technique and virtual reality, or technocentric combined with the empiriocentric model, of rediscovery of biological concepts, the basic didactical strategy being computer-focused or combined, computer-focused and heuristic, the methodology being based on didactical methods as CAI, simulation, experiment, observation, conversation, modelling and so on. Numerous functions, roles, tasks of computer have been identified, which, by taking on many roles and tasks of the biology teacher, could be called the "teacher" computer, E-learning and VR with many advantages, disadvantages and limitations, but with ways to counteract the latter. E-learning and Virtual Reality bring a cognitive plus, as well as an affective plus, contributing to bioethical education, ecological education, health education and first aid education, as aspects of Biology-specific education, demonstrated by the results of research assessment of E-learning and Virtual Reality. The scientific research has achieved its purpose and objectives, its hypotheses being confirmed, numerous E-learning and Virtual Reality recommendations being made, but also correlative in the presented paper with a view to making biological education more efficient, such as: discussions and debates on Chat Relay, on site forums, Video Conferencing to pupil and student groups, organizing direct, team-based sociocentrically activities integrated into the E-learning lesson to prevent dehumanization of the educational process; alternating E-learning activities with others by applying the techniques specific to the study of Biology, so that the psychomotor objectives provided by the biology school curricula in force can be achieved. "New approaches are emerging, with increasing reliance on"blended models" that combine elements of face-to-face education and online modalities in different proportions" (OECD, 2015).

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