THE PEDAGOGICAL MODEL OF INTEGRATING INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE PROCESS OF TEACHING-LEARNING OF BIOLOGY

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Abstract. Educational researches and policies recommend the implementation of information technologies in teaching-learning process. Biology, as a part of sciences curricular area, is a field that requires a lot of illustrative material, video, that ICT can offers. ICT integration in the biology education process must be theoretically and methodologically based. That why this article presents a pedagogical model of integrating information and communication technologies in the process of teaching-learning of biology, describe and highlights its peculiarities.

Rezumat. Cercetările și politicile educaționale recomandă implementarea tehnologiilor informaționale în procesul de predare-învățare. Biologia, ca parte a ariei curriculare a științelor, este un domeniu care necesită o mulțime de materiale ilustrative, video, pe care TIC le poate oferi. Integrarea TIC în procesul educațional la biologie trebuie să fie fundamentat teoretic și metodologic. Iată de ce, acest articol prezintă un model pedagogic de integrare a tehnologiilor informaționale și comunicaționale în procesul de predare-învățare a biologiei, îl descrie și evidențiază particularitățile acestuia.

The analysis of the specialized literature on the topic of the research, emphasized the need to integrate the Information and Communication Technologies (ICT) in the biology educational process in the Israel secondary schools and allowed to highlight the research problem: *determining the theoretical and methodological foundations of the efficiency improvement of the teaching-learning process of the biology in the gymnasium through the information and communication technologies*. In order to solve the research problem, the goal of the research was advanced, which is summarized in *the theoretical foundation and elaboration of a pedagogical model of integrating information and communication technologies in the process of teaching-learning of biology*. Therefore, one of the objectives that will contribute to reaching the goal and solving the research problem is the *elaboration of the pedagogical model of integrating information and communication technologies in the process of teaching-learning of biology*. The necessity of this model also resides in the fact that, researches in this area does not attest the pedagogical models theoretically and practically based, that would approach the process of integrating ICT in the study of biology, or the existing ones focus on some separate topics from this curricular area, or they are not adapted to the specific of educational policies and the high school curriculum in Israel.

The input cell in this model (Figure 1) represents the information and communication technologies that have revolutionized all spheres of modern life, including education. ICT, representing the technologies used for the reception, presentation and electronic distribution of information, requires from the members of the 21st century society, the information age, specific competences such as:

- high-order thinking, which includes creative thinking, critical thinking, ingenuity and problem solving skills;

- collaborative work skills, involving teamwork, independent learning and ethics;

- skills for handling digital and media information, which refers to information literacy, media and ICT literacy [1].

The imperative of these competences, on the one hand, and ICT, on the other, have determined the character of educational policies in most countries, including Israel, which launched the national program for adapting the educational system to the 21st century. Also called ICT national program, because it focuses on the implementation of information technologies in education, it has led to modernization of the school curriculum in general and that of biology in particular.

The education system in Israel aspires that all schools to implement technology-based optimal pedagogy, becoming a school lifestyle. However, the implementation of the ICT-based curriculum in the school depends on five factors, that complement each other and whose combination guarantees the success and achievement of the objectives of this process. Therefore the factors involved in the integration and assimilation of ICT by the educational system are:

1. *Organizational-administrative dimension* - this dimension refers to school's management policy and supervision, which is expressed by supporting the processes of continuous training of teachers, by directing the process of ICT implementation, by cooperating with non-school factors, and by determining the team to get involved in the process.

2. *Teaching staff and level of pedagogical knowledge* - teacher support is another significant factor in introducing change in school. The impediments on the part of teachers could result from various reasons such as: failed attempts, lack of adequate reward, mixed signals, fear of the unknown and requests from different interest groups.

3. *Structure and processes within the school* - refers to the reforms of the organizational structure of the school (division into classes, study groups) and learning processes (teaching, learning and assessment methods). In the absence of these reforms, essential changes in education cannot be achieved.

4. *Factors in the school's environment* - perceiving the school as an open organizational system, having interactions with its environment, gives a lot of room to external entities that can positively influence the course of change.

5. *Infrastructure* - essentially contributes to the advancement of innovation in education. This refers to the availability of adequate infrastructure resources: hardware, measured by the number of computers in schools, available to students and teachers for teaching and learning purposes, the quality of the equipment and their functionality. It is very important that the hardware be accompanied by technical and pedagogical support.

The guide of an ICT-based school, published by the Ministry of Education [2], describes, among other things, that the new teaching methods are aimed at developing ICT-focused education that combines traditional teaching with the technological means and services at the

teacher's disposal in a lesson. There are four models of ICT integration in the classroom, whose details and description of optimal pedagogical application follow:

1. *Basic position of the teacher* - in the classroom there is only one computer connected to the Internet, projector, screen and ICT content, the cheapest and most used (basic) model. In this model, the computer environment is focused on the teacher, which actively uses ICT and integrates it into his teaching act. The teacher has access to information on the Internet whose content is expertized, uses digital materials online, elaborates digital content himself using specific devices (camera, video camera), uses digital tools for manipulation and processing in the content of the lesson and manages learning in the own digital space: the teacher's website, the class's website.

2. *Teacher computer connected to the internet, projector, smart tablet and computerized content* - in this model the computerized environment focuses on the teacher as well, but in addition to model 1, the teacher acts interactively with the computerized surrounding and integrates in his or her teaching. He uses pre-made tablet pages and creates own tablet pages while teaching and saving them, visualizes and demonstrates materials on the tablet, while sharing with the students during the lesson, uses custom templates for content, predefined and saved in the tablet software, records the lesson on the tablet, according to its documentation.

3. *The position of the teacher (model 2) in addition with a smaller number of computer stands than the number of learners*- the computerized environment focuses both on the teacher and on student, the teacher operates an active and interactive learning, manage the lesson in accordance with the number of computers both physically and technically.

4. *The position of the teacher and additionally computers to all the learners during the lesson* - the teacher and the student manage their work in the computerized environment spaces. Similarly, to model 3, the computerized environment focuses both on the student and on the teacher, while the learning is active and interactive.

The components of the model described above represent the conceptual benchmark for the teaching-learning methodology in biology lessons with ICT integration. This elaborated methodology is based but also requires the respect of the principles of meaningful learning, in which the subject has an active role, since it must restructure and organize information, by connecting new knowledge with previous ones. The significant learning elements addressed in the study of biology with ICT integration are:

1. Valuable for the learner and the society: occurs when the learners sense that the studied material is meaningful to them on a personal and social level (directed and self-directed learning);

2. The learner's and teacher's involvement: occurs when scientific and technological studies are based on constructivist approaches: students are actively, emotionally and cognitively involved in the process of knowledge building (cooperative and constructive learning), actively experimenting with methods in which knowledge and scientific researches are developed (active learning);

3. *Relevant to the learner*: it requires that the sciences and technologies curricular area, of which biology belongs, engages with current issues and problems valuable for society and the individual (authentic learning).

The theory of meaningful learning of David Ausbel has strong influences from the constructivist theory in which the true knowledge is built by the individual on the basis of his own experiences. The constructivist approach represents the core of the innovative pedagogy, which has the responsibility to train creative citizens, who face the changes, analyse and manage the information. ICT-based learning represents an innovative pedagogical infrastructure for meaningful learning in the 21st century.

Within the innovative pedagogy, several theories such as: constructivism, self-directed learning, motivation and learning styles intersect. According to her, the contents taught and the knowledge are relevant for the constantly changing reality, the teaching is adapted to the diversity of the students, it allows the evaluation and feedback in real time, the teaching-learning-evaluation process focuses on the individual and highlights the development of the learner by the self-directed learning. The informational and communicational technologies in the innovative pedagogy are: of visual multiplicity, interactive, dynamic, constantly updated, playful, linked-in, publicized in the social networks [1]. The intelligent use of ICT contributes greatly to the updating of innovative pedagogy and makes it more relevant for students.

The learning by the constructivist approach is encouraged by teaching strategies such as:

1. *Teaching based on illustration*: visual illustration in biology lessons is essential for meaningful learning.

2. *Problem-based teaching*: the learners are presented with an open problem, which must have several solutions or no solution, that solving by students will contribute to knowledge building.

3. *Research-based teaching*: students are offered an activity that develops the knowledge and understanding of scientific concepts, allows the student the opportunity to experiment looking for an answer to a significant phenomenon from his point of view.

4. *Project-based learning*: refers to learning through experiment and experience that allows for the development of 21st century skills, such as: creative thinking, active learning, teamwork, peer feedback and improving motivation for learning.

5. *Reflective teaching*: The student undergoes a process of internal evaluation training, which helps to improve his / her current performance.

The central methodological components of the pedagogical model of integrating information and communication technologies in the process of teaching-learning of biology, are in bidirectional interaction not only with the conceptual landmark but also with the practical components. These refer to the hard and soft devices and tools available to both the teacher and the students in the teaching-learning-evaluation process.

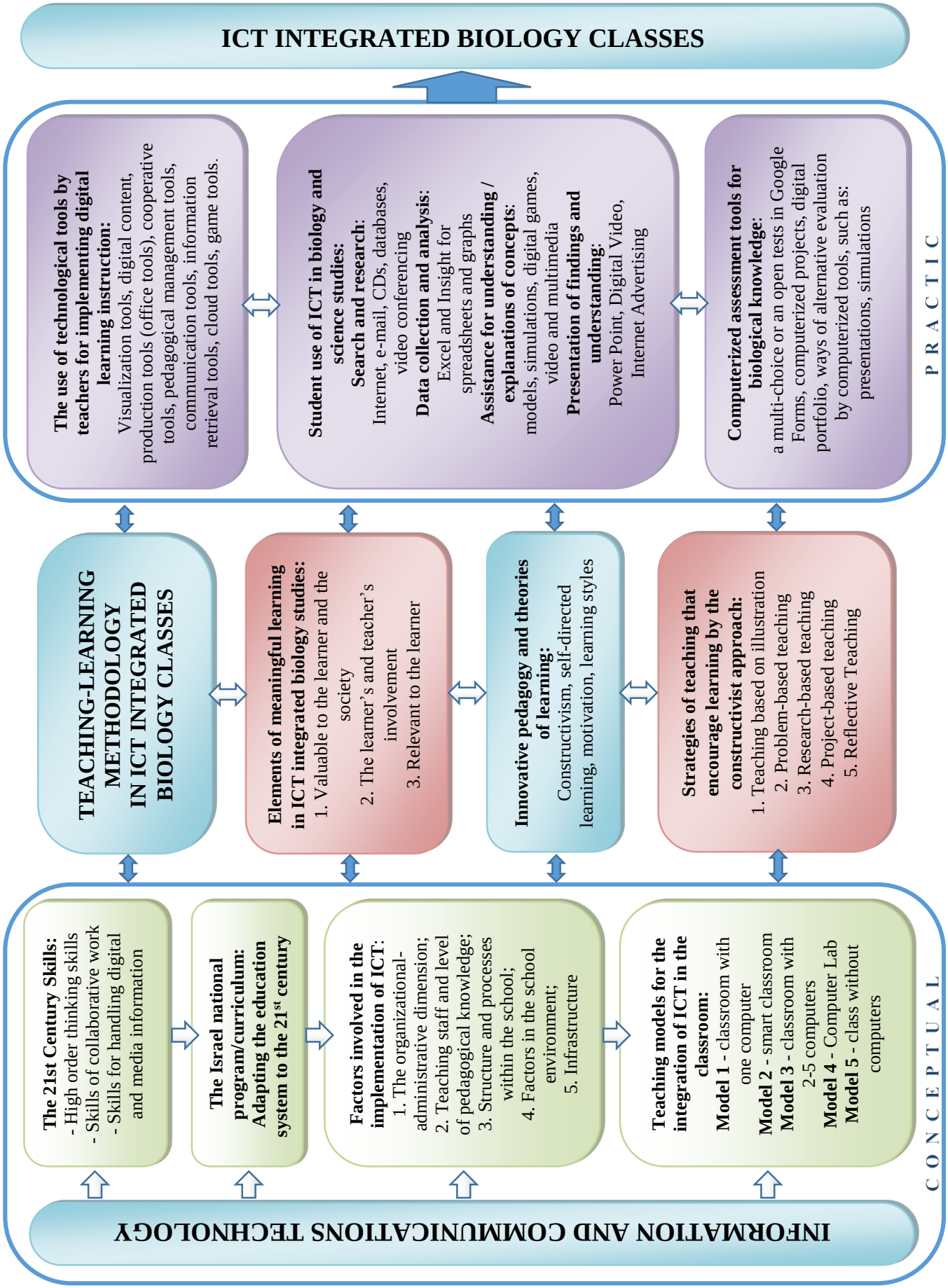

Figure 1. Pedagogical model of integrating information and communication technologies in the process of teaching-learning of biology

The hardware was reflected in the ICT integration models in the classroom. These, along with the software, are decisive factors in improving the teaching-learning-evaluation processes, and the intervention program for the integration of ICT in the biology lessons includes: videos, animations, presentations, exercises and tasks on the computer.

Biology teachers have several categories of ICT tools that allow them to integrate it into the teaching process, these being: visualization tools; digital content, production tools (office applications); collaboration tools; pedagogical management tools; communication tools; information retrieval tools; cloud tools and educational game applications.

Regarding the students, they need to use technological tools and means in order to base and develop self-learning, because in a digital world they must learn to manipulate with essential tools for daily life and for productive work in the future. The 21st century literacy is not only reading, writing and computer skills, but also the competence to use information, knowledge and skills in relation to modern life or, as Alvin Toffler said, "The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn" [3]. Therefore, the tools that students use to study biology are divided, by destination, into tools for:

- search and research: internet, e-mail, CDs, databases, video conferencing;
- data collection and analysis: Excel and other spreadsheet and graphs applications;
- assistance for understanding / explaining concepts: models, simulations, digital games, video and multimedia;
- presentation of knowledge and findings, conclusions: Power Point, digital video, internet advertising.

Hence, student evaluation also needs to be in accordance with the information age, which requires standards and tools of alternative assessment in line with 21st century skills, such as: open or multiple-choice tests developed using Google forms, computerized projects, digital portfolios, presentations, simulations etc.

The intelligent connection of the components of the model allows as a finality the construction of an biology educational process with adequate integration of the Information and Communication Technologies.

The developed model is characterized by *originality*, from the perspective of its specific components of the biology secondary school education from Israel, the invoked educational policies and the relationships established between the conceptual, practical and methodological components.

The *innovative character* of the model is highlighted by the modern educational concepts integrated at the level of innovative pedagogy, constructivism, meaningful learning, high-order thinking and modern teaching-learning strategies.

The *adaptability* of the developed model lies in the fact that the national ICT program from Israel and the specific skills of the 21st century cover most of the curricular areas, which allows its implementation in other school disciplines.

The model also has an *evolutionary character*, open to updating, dictated by the dynamic changes in the education system, by the information overload, by the numerous technological developments, but also by the revolution of the Information and Communication Technologies. This fact allows the updating at the conceptual, methodological level, but the easiest at the practical level, by replacing the digital applications and tools with new ones, according to the technological evolutions.

Finally yet importantly, the model is characterized by *integrity*, due to the connections established between the modern educational imperatives (policies, curricular documents, factors involved), the strategies and methodology invoked and the technological aspects regarding the hardware and software needed by the actors of the educational process.

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