ICT INTEGRATION IN STUDYING SCIENCE FROM THE PERSPECTIVE OF INNOVATIVE PEDAGOGY

INTEGRAREA TIC ÎN STUDIEREA ȘTIINȚELOR DIN PERSPECTIVA PEDAGOGIEI INOVAȚIONALE

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Abstract. The following article focuses on the subject of integrating ICT in the process of teaching-learning-evaluating science and biology, following the constructivist approach that encourages the development of students' cognitive and meta-cognitive thinking and abilities. and increases their motivation to study science.

Rezumat. Articolul abordează problema integrării TIC în procesul de predare-învățare-evaluare a științelor din perspectivă constructivistă, care stimulează dezvoltarea gândirii și a abilităților cognitive și metacognitive ale elevilor, contribuind astfel la sporirea motivației lor pentru studierea științelor.

Key words: science, ICT, innovative pedagogy, meta-cognition.

Cuvinte-cheie: științe, TIC, pedagogie inovațională, metacogniție.

Preface

The innovative pedagogy has been developed in the last decades due to a combination of theories and studies in various fields, such as: constructivism, self-regulated learning, motivation, learning styles, exploration and identity formation [10]. Intelligent use of ICT in teaching, may underpin significant learning, increase pupils' interactivity and improve his or her thinking capabilities and social functions [17]. Numerous curricula recommend the use of advanced technologies, among them, the new curriculum in Science and Technology. In the new curriculum, it is recommended to make use of computer as well within current teaching and combine means to illustrate abstract phenomena [2]. The national ICT curriculum sees the students as leaders – "online leaders" and as such they are full partners in leading pedagogical processes at school.

The review of studies [3] that examined the ICT effect on the motivation to study science show that motivation has a major effect on learning and achievements. Challenging instructive materials allow students to progress independently and positively influence on their motivation. The youth, today, is affected by a wide range of digital media, computers, smartphones, and other devices, that enable dynamic reading and creation. Subsequently, digital games and social media have a great weight in their social and academic life [8].

Studies show that the combination of simulations in teaching, along with online tools increases motivation and achievements in comparison to traditional teaching. Today, in an age where digital technologies occupy a major place in our social life, and when technology is inseparable from students' lives, the pressure to assimilate educational technologies within classes is a gaining momentum among educational institutions [18].

The study of Rosen (2009), which examined the influence of the ICT learning environment based on animation videos about Higher Order Thinking and motivation to study science among students from elementary and middle schools, has shown that the experimentation in learning environment that combines Brain pop animation videos significantly increased the motivation to study science and technology. On the other hand, the students of the control group examined in this study experienced a decline in the motivation to study science and technology at the same period. The motivational elements mentioned by the students and the teachers in the experimental classes in relation to the new environment, match the concept of "Optimal Experience": feelings of concentration and pleasure, inner motivation and a tendency to repeat the activity that caused this feeling "I feel as if I were another pupil who understands how to build the video." All of the teachers noted that **the concentration level of all students during the lessons where videos were used was above the concentration level achieved during "regular" lessons.** "Subjects that I didn't even think that the students will be interested in become suddenly interesting due to animation" [16].

The role of the teacher is to stimulate and maintain students' motivation to study science. The act of Motivating is defined as a move that generates the process of learning and preserves it. As long as the learner has no motivation, he cannot learn, and since students differ from one another in terms of learning ability and style, as well as in personal intellectual tendencies, the teacher must adopt diverse teaching methods, that will encourage learners' inner motivation stemming from the actual interest and pleasure from the studied subject [13]. Teaching that uses visual illustration, such as models, animations, graphs, in order to make abstract tangible, and clarify ideas or concepts, increases the motivation and the inner drive of the student.

Rosen's (2009) study shows that following the experimentation in science lessons combined with ICT such as, combination of Brainpop animation videos, a conceptual change began among students regarding studying science and technology. The students perceived themselves as more central to the classroom interactions, felt interested in learning, and put more emphasis on the combination of ICT and experiments during the lessons. A change that occurred among the learners following the experimentation in the new environment does not narrow down merely to the motivational dimension, but rather spread to a conceptual change regarding the essence of learning. The findings brought by Barak's (2012) research show an improvement in the motivation to study science among both study groups: experimented and control, but the improvement among the students of the experimented group was distinctively higher statistically in comparison to the improvement among the students of the control group. Therefore, the combination of ICT via Brainpop animation videos increases distinctively the students' motivation to study science.

In Randall's [15] research, regarding the issue of students' involvement in "Problem-based learning", 11 environmental elements were found as evoking motivation: authenticity, challenge, cognitive involvement, capability, choice, fantasy, identity, interactivity, novelty, sensory involvement and social relationships. The research mainly examines the change made in learning science and the connection between motivation and learning after using the problem-based learning called Alien Rescue: the goal of learning in the Alien Rescue ICT environment, is to draw students to solve complex problem that require the use of tools, procedures, knowledge about space, sciences of the planets and the solar system. The main mission presented in the Alien Rescue program: six kinds of aliens, with unique qualities, arrived to planet earth since their planet was destroyed. Students take upon themselves the role of scientists and they need to find a home for the aliens and thus assure their survival. in order to do so, the students need to study a range of problem solutions, collecting information, and activities that include investigating all of the aliens' requirements and factor analysis, such as life-bearing temperature ranges and basic atmospheric composition for survival. the research's conclusion regarding the use of Aliens Rescue as a problem- based learning: a substantial increase in the scientific knowledge among students; students have acquired sufficient understanding of scientific concepts by self-directed learning, discussions in class or discussion with peers while using the app; the students saw this mission as a different scientific project and eventually they had a really good time; students are driven to solve problems when they are challenged and have control over the learning processes, as a result, a learning took place on the base of solving the suggested problems; students dealt with planning and making decisions as well as determining how to use the available resources efficiently.

The use of ICT educational technologies can cause a better learning due to the fact that there is a better access to information. This access allows teachers and students to use the opportunity for a joint learning with experts, for sharing information and conduct self-investigation more effectively. In addition, technologies that support content based teaching which focuses more on the student, and is mostly based on asking questions and enables receiving a better picture of the complex processes, has a higher potential to make a positive change in studying scientific subjects [18].

Integration and assimilation of ICT will affect the learning quality, will open the students' thinking and improve their academic achievements. Learning in this way will evoke interest in them and increase their motivation to study. The extent of the student's belief in the mission's success may grow due to ICT learning and thus his self-esteem will strengthen which will affect his motivation to study. The key to the success of ICT learning is related to our ability to create high motivation in the student.

The constructivist approach and its influence on Higher Order Thinking in ICT usage

The core of innovative pedagogy is grounded in the constructivist approach, according to which there is no realism and the truth is relative, and thus, the emphasis on imparting skills in the 21st century is on online environment. The interest of this teaching conception is to improve teachers' skills and provide the essential necessities for effective learning, so that the future adult will be able to function efficiently and independently in a competitive, global, dynamic and high-tech reality [16]. In order to fit in the public space and the changing reality, knowledge and new skills are required, hence, the early requirements from the students are of a cognitive, meta-cognitive and motivational nature, and they are dependent on his ability to- organize his studies and regulate them [14]. IN this context, the ICT program underlies the technological and pedagogical infrastructure for the imparting of these skills, the skills of the 21st century, for the design of the education system graduate who is prepared for the challenges of the Age of Information, who knows how to use his acquired skills, both to his personal needs and in order to serve the society and the country when coping with future, local, global, economic, cultural and security challenges they face with.

The constructivist theory is a conceptual frame that aids to deal with the search after a profound understanding. Many people of education today embraced this world view in relation to educational activity. According to this theory, the learner is perceived as an active agent who creates meanings and forms incites regarding educational situations. The constructivist point of view cancels the conception that the learner absorbs information passively from the book or the teacher. Even when the chore that the student has to preform obligates memorization alone, the learner fills an extremely active role. He struggles to understand, form experimental perceptions and then examines and changes them. A teacher cannot simply instill conceptual understanding to his student. This kind of understanding has to be constructed while making an effort [7].

The curriculums in science teaching emphasize that the science teachers must use strategies that develop thorough scientific understanding while combining research skills, problem solving and providing answers to complex questions. According to the standards, the science teachers' roles are to guide the learner, encourage construction of new knowledge based on prior knowledge, as well as assisting the learners to take responsibility for their learning. The science teachers are required to encourage learning by having discussions between the scholars and encourage collaboration and the creation of learning communities [11]. Numerous studies show that the technological revolution brought to pedagogical and organizational extensive modifications in the schools, therefore, the national ICT program was meant to produce a change and turn the school to a learning ICT organization optimally imbedding the ICT technologies. The technological abilities of gathering, managing, creation and sharing information allow to fulfill multiple opportunities for constructivist innovative learning in which the students are involved as active partners. In the learning process the learner is at the center, and the

interactions with the environment are necessary. In the teaching process, the emphasis is on nurturing skills of thinking, searching, information management and processing it whilst increasing the learner's meta-cognitive awareness [10]. In the study of Nissim, Barak & Ben-Zvi (2011), which examined whether there is compatibility between the science teachers' perception of their role and the teaching strategies in which they use combined with ICT. The findings focused on four aspects that characterize the role of the teacher who combines ICT: a guide, a motivator, a partner and an innovator. Additionally, four teaching strategies, that encourage learning in the constructivist approach, were tested: illustration, problem solution, research learning and reflective learning. The research findings indicate that in lessons that combined ICT, the teachers mostly functioned as guiders and motivators of the learning processes, while using teaching strategies that included: illustration, problem solution and research. That is to say, there is a high compatibility between the roles: a guide and a motivator and the aforementioned teaching strategies.

Biology and science teaching by the constructivist approach must include conscious and implicit reference to knowledge construction by the student, that is, active, regarding concepts in three fields: concepts in the field of scientific-content knowledge; concepts in process knowledge and the skills of using them: learning and research skills; and concepts regarding the power and limitations of science in light of the formation of scientific knowledge [5]. Curriculums that base on the students' performances and abilities, rather than merely on their achievements, can benefit greatly from a correct combination of ICT. The ICT allows a diverse and broad access to sources of information, research study of students, problem-centered learning, authentic and relevant learning, and turning the teacher into a mentor and a trainer and less an expert in the field of knowledge. Informative skills and new literacy are of great importance among students.

The method of learning, according to constructivism and through ICT, sets the student at the center (Student-Centered Learning), motivates him to be an inquisitive learner who can find reliable and relevant sources of information across the network and in designated databases. The computer serves the student as a cognitive tool for structuring his knowledge [4].

According to Oliver [12], the power of ICT as a generator of change and pedagogical innovation in the 21st century, affects four elementary questions in the educational pedagogy: (a) what do we learn? (b) how do we learn? (c) where and when the learning occurs? (d) who is the learner and who is the teacher?

An ICT environment, can be used as an" object with which we think" and encourage, constructively, the teachers to make a proactive and authentic use in ICT contents. It can also promote constructivist conceptions and innovative pedagogy, in which the learned knowledge and contents are relevant to the students' world and the

changing reality. The process of teaching and learning, in such an environment, can promote higher-order thinking and adaptation of relevant skills to an optimal function in the 21st century. The innovative pedagogy strives to nurture skills in three central domains: higher-order thinking: creativity, ingenuity, critical thinking and skill in solving complex problems; collaborative learning skills, personal learning, and maintaining ethics; Digital information processing skills [6].

Under the general umbrella of "constructivism," there are diverse views regarding learning that their common key word in the learner's definition is "constructive". In the demonstration of the way that the constructivist views can be implemented in biology teaching, two general principals common to these views are being addressed; the learning is a process of an active construction of knowledge; the teaching is more a process of supporting a construction of knowledge than a process of delivering it to the students. It seems that according to constructivist conceptions, biology "teaching" is not the issue, but rather the student's coping, guided by the teacher, while learning biology [5]. A learning environment that combines ICT means may provide a structured opportunity for integrative learning, in which the students are active, receive feedback (from the teacher and/or from ICT tools), while improving their understanding and constructing new knowledge. Utilizing the potential of computerized tools to improve teaching-learning processes may lead to an interaction in which the student is at the center of the learning, that is done by the teacher [9]. Realization of the constructive approach in education, and according to it the learner is at the center of the teaching process and actively constructs knowledge, is possible, to a great extent, by ICT and the possibilities it embodies. Computational technologies are a toll for cognitive design and structure of the student – an actual interaction takes place between him and the learning material, materials whose volume and quality differ from those learned through any other technology and assistance in understanding broad learning [1].

In conclusion

The ICT opened new opportunities to increase the effectivity of teaching-learning processes. High-tech environments that nurture thinking, along with knowledge construction, are achievable in a learning environment based on updated psychological-educational principles regarding learning and teaching. Multiple researches, Rosen (2009), Barak (2012), show that an intelligent use of ICT increases the motivation among students to study science. The Intelligent use of ICT in teaching science and biology according to the constructivist conception of learning, leads to an increased motivation for learning, transferring the responsibility for learning, on all its aspects, to learners.

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