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

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Abstract. The paper presents the practical landmarks of the pedagogical model of ICT integration in the teaching-learning process of biology, developed in the research with the theme: *Integration of Information and Communication Technologies in the teaching-learning process of biology within middle school education from Israel.* The methodological and digital tools that the teacher can use in biology lessons for teaching-learning-assessment are analysed, and the digital resources that can be used by students are presented.

Keywords: teaching-learning process of biology, information and communication technologies, Digital Portfolio, Project-Based Learning, animation, simulation.

Rezumat. În lucrarea se prezintă reperele practice ale modelului pedagogic de integrare a TIC în procesul de predare-învățare a biologiei, elaborat în cadrul cercetării cu tema: *Integrarea Tehnologiilor Informaționale și Comunicaționale în procesul de predare-învățare a biologiei din cadrul învățământului gimnazial din Israel*. Sunt analizate instrumentele metodologice și digitale pe care le poate utiliza profesorul la lecțiile de biologie pentru predare-învățare-evaluare, dar prezentate resursele digitale ce pot fi utilizate de către elevi.

Cuvinte cheie: proces de predare-învățare a biologiei, tehnologii informaționale și comunicaționale, portofoliu digital, învățare bazată pe proiecte, animație, simulare.

Introduction

The information technology revolution has changed face of earth. The information online continuously multiply systematically and it increasingly becomes more and more approachable, hence, in the teaching qualification today there is no longer the need for the teacher to pass down information. The educational paradigm has changed in different aspects: no longer a "knowledgeable" teacher and an "ignorant" student, no longer "imparting" teacher and "acquiring" student, no more lessons in which the teacher actualizes a predetermined script of a meticulously planned "lesson course" moving systematically and consistently from targets to evaluation. In the learning process called "deep learning" there is a special place for dialogue, a special role for collaborative learning and a special value to mental and creative flexibility and coping with occasional, relevant and challenging things [1]. The science teaching in schools is in a constant process of change, in the attempt to contribute to the formation of citizens' character, capable to deal with a world that is increasingly influenced by science and technology [2]. The main goals of teaching science in recent decades are developing scientific literacy and higher-order thinking among the students. Achieving these goals is attainable via contextual learning and a learning of scientific terms and processes, which bases on analysis of everyday problems through processed scientific articles and case studies [3].

A systematic growth and availability of digital information and ICT create unique opportunities to learn and teach in high school and middle school biology curriculum. Digital

technologies allow to develop significant knowledge and understanding of biological processes that were very difficult to teach and understand in the past. As it appears, a large part of life sciences can be passed efficiently via digital technology, since its representative and symbolic forms are found in digital formats [4].

In recent years a significant progress of ICT development in schools has begun, in terms of the ability and the availability of fine quality digital resources. This assists science teachers, who go through this professional development, to start significantly use of ICT to improve the learning. The use of ICT should allow to teacher or to student to obtain something that they could not achieve without using it, as well as allowing the teacher to teach and the student to learn or something else more effectively than without the use, it should add value to teaching [5].

Teacher's ICT use in the process of teaching biology

The potential of the internet use in education is great and diverse, due to its interactivity; possibility of teachers to use convenient tool for simultaneous engagement of different students in various activities; the accessibility, what mean everyone can be connected, and everyone can be available to anyone, (teachers, students, parents, study material, assessment people etc.); the policy on which the internet is based: rules and regulations known and accepted all over the world. The great advantage of internet use is the richness of information, means of demonstration, illustration, means of operation, texts, pictures, animations and simulations, movies and virtual labs.

ICT integration in teaching, as we know today, mainly bases on browsing in the different websites, collection information and processing it in a relatively simple level. According to the teachers, digital material for study purposes, do make the learning updated, authentic and more relevant to the learner's life. However, the way they are used does not lead to the expected pedagogical change. The implementation of the second stage of teaching - updated digital learning, bases on complex study behaviours, requiring learning in a cooperative and social context, while using the potential technology holds. This stage is performed in practice via the tools for sharing and constructing the knowledge provided by Web 2.0 technology. These tools allow a wide range of possibilities for cooperative work, as well as personal, by following the learning objectives with which the teacher faces the class. Tools of knowledge construction, connectivity and modern digital communications, such as Wiki, Google Docs, Moodle, and Office 365, enable the learners to share with peers details of information in various textual, visual and audio media. It allows learning peers to add, edit, comment and response to details of information brought by the learners cooperatively or personally. These technology capabilities enable to actualize numerous opportunities for innovative-socio-constructivist learning in which the students are involved and active participants in the learning process. ICT integrated innovative learning allows a redesign of processes, tasks and definitions of learning products, as well as enables modifications in the teaching methods, in the roles of both students and teachers, in the way in which the teacher uses as an instructor

and learning advancer and not necessarily as the exclusive source of information in the class (Table 1) [6].

Table 1. Technological tools applied by teacher during the biology and science lesson

Tools	Presentation tools	Way of applying
Word	Pictures, tables, texts	During the lesson and homework: submission paper
Excel	Graphs, formulas, math calculations, tables	In biology lesson or any other science lesson in which the will is to present information by graph charts
Power Point	Image, video, animations, graphs, text	For the teacher: presentation of a topic - introduction and summary of the lesson.
Learning software	All presentations	During the lesson
Internet - databases, content sites	All presentations	During the lesson
Tools for sharing - blog, wiki	All presentations	During and outside the lesson
School website	All presentations	During and outside the lesson
Education game's	Content-related	During the lesson
Video clips	All presentations	A short clip opens to display the subject. Part of the lesson or all of it, in summary. Learning beyond the lesson.
Projector + computer	All presentations	Throughout the lesson
Smart board	All presentations	It is used at the beginning and at the end of the lesson, and of course throughout the lesson instead of the usual board.
Computer stands	All presentations	Students: during the lesson
Digital Indicators	Choice questions	Subject summary

ICT may lead to a revolution in education and promote empowerment of the learning, as long as there will be a paradigmatic change in the teaching's character, educated integration in the learning and use of assimilation strategies fitted to the school's character and its cultures. An additional elementary condition is to pose the teacher as a leader of the educational change [7]. Project, called 3D LAB in cooperation with Greece, Australia, Slovenia, supports the system of teaching and learning biology, and it focused on developing Electronic Learning courses (e-learning) regarding the subjects, such as: human body, especially on the brain and the eye, for all ages, elementary middle school and high school. The project was mainly destined for biology teachers in order to be familiar with the ICT's advantages and integrate them in their teaching as well as for pupils and students to use ICT-based methods in biology classes. The main goal for this project is developing a new model for a successful application of e-learning, implementation of 3D and 2D computer simulations in teaching/learning biology in all levels of education and developing cutting edge and quality 3D simulations for teaching/learning biology as well as for the ICT exams. Additionally,

project's purpose was the evaluation of their impact on the learning achievements of students and pupils. The general evaluation for the project was very positive in terms of efficiency and improvement on the part of teachers and students [8].

ICT specific tools used by pupils for learning Biology

One of primary goals of biology teaching is that the pupils will learn the subject in a meaningful way, which is possible when the learner associates a new knowledge he or she learns to their prior knowledge [9]. One way to accomplish meaningful learning is teaching by various means of illustration. Animation is considered as a tool via which it is possible to improve and progress the meaningful learning skills. Teaching that encourages illustration-based learning is aided by visual illustration (models, animation, simulations) in order to clarify ideas or abstract concepts. The human ability to easily remember visual means describing information could aid in the learning process. With illustrations, the teachers and the pupils can represent thoughts, discuss ideas and share the knowledge with others. In order to aid the learning process by visual tools integration, there are recommended the forms of activities that will be part of the scientific curriculum obligating high level thinking, such as solving problems or conducting laboratory experiments [10]. Nowadays teachers are required to allow the pupils not only knowledge construction, but acquiring tools for handling information as well. For example: nurture their ability to ask questions and find suitable solutions, look for information, deeply understand new information, knowing how to criticize the degree of its relevance and credibility, integrating different resources, making conclusions, arguing well-reasoned claims, and more require complex learning abilities. Thus, in order for the school to be relevant to the 21st century society, paying considerable attention to the pupils' development of thinking is essential [11].

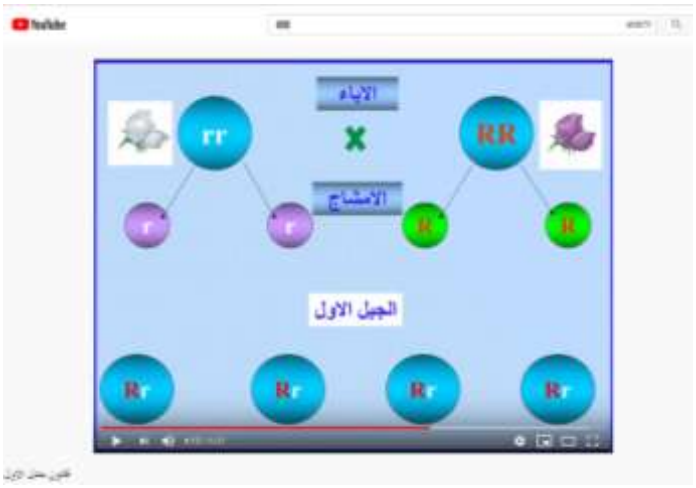

Figure 1. Example of animation tool about the hereditary information

Animation enables to visualize the biological principles without pupils having to memorize concepts. For example, in a lesson about the hereditary information, the teacher was assisted by animation. She presented the pupils with an experiment held by biology researchers, a test that examined the function of the cell nucleus. The pupils were asked to follow the animation and fill an assignment sheet [10].

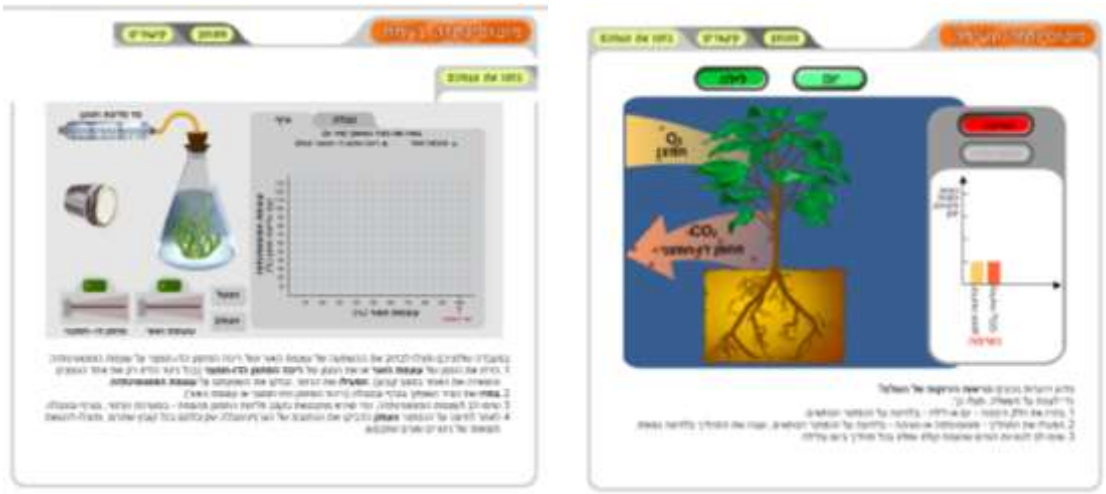

Figure 2. Example of animation tools about photosynthesis and the respiratory process

The national science curriculum includes many ways and methods for the student use of ICT in science studies, such as: using a software for handling data in order to analyse the fieldwork data; using in a simulation software for sampling changes in populations of bacteria under different conditions; using sensors to record factors affecting photosynthesis (fig. 2); searching database for information on material characteristics; using the internet in order to find updated information about environmental subjects; using video or cd to learn the solar system; using spreadsheets for recording, analyse and evaluate information about diet; using a temperature sensor when checking how the temperature changes when two liquids cool down; asking students to find the air's boiling point (liquid air) in a book or database etc. The multimedia means accessibility increases the various dynamic situations in front of students. V. Oldham [5], divides the aforementioned uses of ICT into four major categories:

- *Research and exploration*: for instance, a research about science and scientists (internet, e-mail, CD's database, video conferences).
- *Collecting data,* handling and interpreting / data analysis (data logging, use of software such as Excel and Insight for spreadsheets and graphs).
- *Assistance for understanding / explanations of concepts*, especially simulation of abstract concepts and processes (using models, simulations, games, digital video and multimedia).
- *Presentation* of the findings and the understanding, that is to say, passing on ideas (using presentation software such as: Power Point, Digital Video, Desktop Advertisement, Internet Advertisement).

The basic requirement of the curriculum is to place the student in a variety of situations of dealing with problems, that is enabled by high speed of receiving data, graphical or other representations, for a student with basic skills of dialogue with the software, and who knows what to ask [12]. The Internet is associated with the use of a wide range of multimedia devices, using of which enables the development of cognitive skills directly relevant to the goals of

the biology curriculum such as: observation, data organization, analysis and interpretation and problem-solving skills.

ICT evaluation of biology knowledge

Along with the integration of these teaching skills, it is essential to update the way to evaluate and integrate alternative assessment methods in learning management. An alternative assessment is a process shared by the teacher and the students. The evaluation program is accompanying the studied project, or the teaching unit built with full transparency to the students and sometimes in dialogue with them. The result is a full understanding of what is required of the student and his or her increased responsibility for meeting the goals set.

According to A. Herschkowitz [13], there are two main approaches today combining the different conception regarding evaluation:

1. *Quantitative approach*, according to which the evaluation is perceived as an "*evaluation of the learning*". The targets according to this approach are a conclusion or a report concerning the level of achievement of the learners, usually a numerical assessment. This evaluation is made in order to make sorting decisions, and dictates the use of objective tests with one correct answer.

2. *Qualitative approach*, according to which the evaluation is perceived as "*evaluation for learning*". The targets of the evaluation by the alternative approach are giving a detailed feedback to the learner in the purpose of the learning and teaching progression and prevention of constant mistakes. This approach that refers importance to the context in which the learning was conducted, perceives the evaluation as an ongoing process. It also assesses the process (as well as the product) and it is exclusive in the hands of teachers or outside specialists. The evaluation is an inseparable part from the learning and teaching, and thus the learner is obliged to this evaluation no less than the teacher is.

The types of knowledge that can be evaluate in science studies are:

1. *Declarative knowledge* is a factual knowledge in a certain field on which the learner can overtly declare. This is a knowledge existing in the individual in the same field. Democracy, bacterium, punctuation rules, game rules are examples of declarative knowledge. Declarative knowledge is detailed in the curriculum with central ideas of the main study subjects and in the milestones (specification of content for each year of age);
2. *Procedural knowledge* is knowledge of procedures uses for problems solution in a certain field. These procedures (a series of specific rules and regulations) guide us to attach the elements of the task in the same field in order to achieve the optimal solution to the problem (reading a map, making long division, conducting an experiment, designing a product, editing an article and building a graph are examples of process knowledge). The procedural knowledge is detailed in the skills chapter of the curriculum;

3. *Contextual knowledge* refers to a situation and the circumstances under which a declarative and procedural knowledge is used. For Instance, this knowledge addresses to social and cultural contexts as well as to the interrelationship between science, technology and society, and it is detailed in the tables of contexts of the main subjects of the curriculum [14].

The use of ICT for evaluating information is possible in the following ways:

Multi-choice test or an open test with Goggle Docs: the studies in this field noted the effectiveness of this tool regarding the following achievements: developing research skills; perceiving biology as a quantitative empirical science; raising the cognitive ability of the student; the teachers' and students' content with the diversity and interest added to the lessons; developing skills relating to "the computer culture" of the student; handling information and a more meaningful use of the computer for the learning in general and for science in particular; development of an independent learner; discussions among students. The ICT test is an example of utilizing modern technological means to improve the assessment of examinees' achievements. The measured accomplishment level meets the biology teachers' aspirations of our time.

Project-Based Learning (PBL): The pedagogical approach of PBL supports the development of the skills required in the scientific era. This obligates students to use ICT for research purposes and for developing a shared product, which requires from the teachers to deal with embracing technological-pedagogical innovation, as well as coping with project-based teaching and alternative ways of evaluation [15]. Through it, the learners acquire skills relevant to the 21st century, including ability to work in a team, abilities to handle information and acquiring knowledge, apply research processes, producing products in a high level, and finally – acquiring profound understanding in the academic knowledge and dominating the learning skills, acquiring skills such as teamwork, brainstorming, locating and processing information and the ability to present their ideas to the audience - in the presentation (a public presentation in front of an audience), in which they explain the product, protect it and perform a replication, which means mirroring the learning process [16].

During the project-based learning activities in science the students use the computer technology as a tool for gathering information, organizing it and presenting it to their peers. The students who conducted a research (via guided research processes), interact with peers, teachers and community via personal interviews and visitations and represent their understanding by presenting webpages [17]. The main product to which the learning is aiming is predefined (for example: an exhibition, building a device or a structure, writing a play, going to a demonstration, teaching a lesson, editing a film). The project, versus the question and the theme, requires imagination and thinking about the final product even at the early stages of learning (for example: how will the final product would look like?).

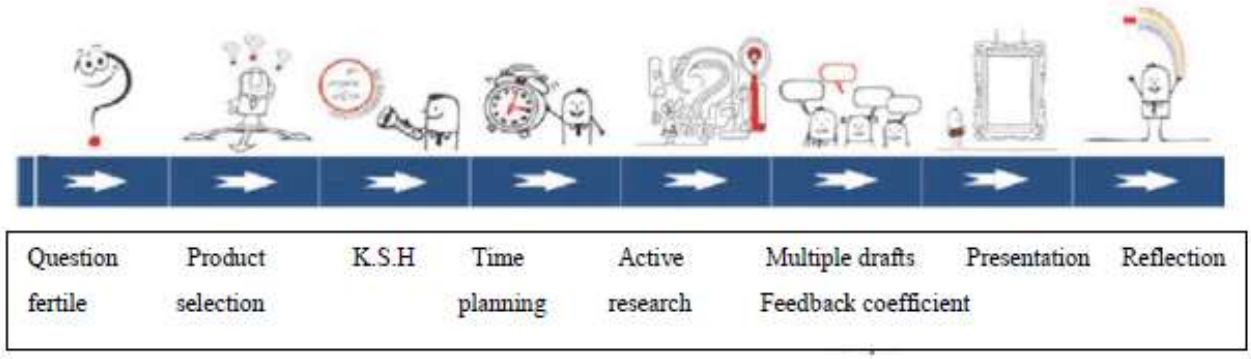

Fig. 3. Milestones in Project-Based Learning [18]

Evaluation in the PBL way does not only addresses to the products of the learning process but to learning process as well. In this process there are chronological stages and transverse processes that occur along all the way and are accompanied by submitting numerous drafts, reflection processes and advancing feedback. All of these should be expressed in the general evaluation of the project. In every stage of the process there will be reference to three evaluation elements: Knowledge, Skills and Habits (K.S.H). Regarding the ICT integration in the project, the evaluation will be in relation to the skills related to the learning process: written communication skills (in various kinds), spoken communication (facing an audience), online communication, unspoken communication; skills of using various technological tools to represent information: advanced use of software such as Word, Excel, presentations, movies, blogs and various personal sites; skills of collecting and processing data: retrieval, organization, analysis, assessment of information sources, digital processing of information (film processing, graphic processing, numerical processing) [18].

Digital Portfolio: An alternative evaluation with a portfolio is common in the level of school evaluation (and mostly elementary) and only a few in the external evaluation on Matriculation Exams. Most of the evaluation through the portfolio is a formative evaluation of the learning process using the tools included in it. When this process is complete, a summarizing evaluation is performed with the complete tool.

The use of digital portfolio ICT tools is thanks to the influence of the Web 2.0 technology that increased the students' involvement in the evaluation process and in gathering information [19]. That tool can be used for collecting and sharing works. Students learn to gather information and construct knowledge and organise it into their portfolio with ICT tools such as EverNote. Among the ICT tools for creating a digital portfolio for the school students, Goggle Sites and Workspaces can assist in the management of students' projects and their documentation on the Internet, create a website for sharing papers and projects. Potential users must be at least 13 years old to sign up. Students can use the "clothing file" option to upload files and the Project Foundry tools. This tool organizes, follows and shares learning in a class trough project-based learning [20]. A new and efficient ICT tool for managing digital portfolio for students or student teachers is called Dropr.com – a platform for creating portfolio. It enables to create a portfolio consisting of a large number of pages, when each

page gets a link of its own. The advantage of it is that every page from the portfolio can be published in a different time, with finishing work on it. The product can be shared in online networks or assimilate in a website / a blog [21]. Goggle tools and Moodle based work enable using of additional digital tools: Smore, Onenote, Thinglink, Spiderscrub, Blubbr [22]. The main goals for using portfolio in science teaching are: development of understanding and appreciation of the science character and the ability to critically assess news regarding science on media and to scientifically communicate with subjects that will develop their scientific literacy [23]. The digital portfolio advances an optimal discourse in a digital environment between the teacher and the student along with optimal accessibility to the studied materials and using digital cooperative tools for the mission [22].

In Science and Technology studies in Society (STS), the portfolio is an integral part of the teaching-learning-evaluation process for matriculation. The STS portfolio integrates within it: a) two tasks that are based on popular scientific articles: each one of the tasks includes an expression for scientific ideas and/or scientific contents, an expression for understanding and use of skills, assessment of reliability of information source and expression for understanding and use of at least one additional thinking skill (26%); b) a personal task that combines various ways of expression, such as: chart, drawing, presentation preparation, personal writing, concept mapping, dramatization, model construction, camera trip, etc. (14%); c) a group task such as: poster, educational game, wall newspaper, model, presentation, show. The task will present: expression of scientific ideas and / or scientific contents, expression of skills and expression of the group's progress in developing the product (30%), personal page (25%), a general assessment that relates to the student's overall functioning (5%) [116]. The final product, the digital portfolio futures to stand along with the physical portfolio to every STS student and use the benefits and the added value of the digital and physical surrounding (pages portfolio). In these tasks the student is evaluated by both his or her domination in the scientific concepts and contents and by their ability to use higher-order thinking skills and application of the portfolio principles in the digital environment while using Moodle and Google tools [22].

Other ways of ICT alternative evaluation can be trough *presentations*: a group of students addresses a given subject by preparing presentations, brought in a deadline to the classroom forum. The technological ability of the students will affect the level of the presentations' complexity, and their academic level – the quality of the presented subjects. After presenting the presentations, the students will perform a reflection regarding the presentation's quality and point out things to improve in the future. Additionally, *the simulations*, can be used as an alternative way of evaluation: the students build factional scripts mimicking the reality of various fields.

Bibliography

1. BECK, S. Getting off the tree: A new look on the experience in teacher training. In: *MOFET Institute Journal*. 2014, no 53, pp. 6-12. [visited 25.09.2015]. Available: http://www.mofet.macam.ac.il/ktiva/bitaon/Documents/bitaon53.pdf.
2. SCHWARTZ, Y., STERN, L. *Scientific Literacy - Changing Concepts and Approaches in Science Teaching* [online]. Jerusalem: Ministry of Education, Pedagogical Secretariat Supervision of the Teaching of Matav, 2007. [visited 11.01.2015]. Available: http://www.mofet.macam.ac.il/masa/Pages/31/634645008401768884.aspx.
3. HERSHKOWITZ, O., ABERGIL, S., DORI, J. Knowledge of teachers and development of assessment tasks during the implementation of the new curriculum in chemistry [onlne]. In: *About Chemistry*. 2014, no. 24, pp. 21-28. [visited 29.10.2017]. Available: https://chemcenter.weizmann.ac.il/_Uploads/dbsArticles/1694.pdf
4. VAN ROOY, S. W. Using information and communication technology (ICT) to the maximum: learning and teaching biology with limited digital technologies. In: *Journal Research in Science & Technological Education.* 2012, no. (30)1. ISSN: 0263-5143.
5. OLDHAM, V. Effective use of ICT in secondary science: guidelines and case studies. In: *School Science Review*. 2003, no. 84 (309), pp. 53-60. ISSN 0036-6811.
6. MAGEN-NAGAR, N., SHAMIR-INBAL, T. Evaluation of the Contribution of the National ICT Curriculum to the Advancement of Teachers' Work. In: *Journal for Studies and Research in Education, Dapim*. 2017, no. 64, pp. 78-110. ISSN: 5385-1565. Available: http://www.mofet.macam.ac.il/ktiva/Documents/dapim64.pdf
7. FORCOSH, A., MIODUSER, D., NACHMIAS, R. ICT Integrated Innovation in the International Research. In: *Flight and Practice.* 2012, no. 14, pp. 49-22. ISSN: 0793-3355.
8. Education Audiovisual & Culture Executive Agency. *3D LAB support system for biology teaching/learning*. Ljubljana: Univerza v Ljubljani Pedagoška fakulteta, 2008. ISSN 1977-0979 (elektronikus kiadás) ISSN 1725-518X.
9. AUSUBEL, D.P., NOVAK, J. D., HANESIAN, H. *Educational psychology: a cognitive view*. New York: Holt, Rinehart & Winston, 1978. 733 p. ISBN 0030899516, 9780030899515.
10. NISSIM, Y., BARAK, M., BEN-ZVI, D. Perception of the role and teaching strategies of teachers who combine advanced technologies in their classes. In: *Dapim.* 2012, no. 54, pp. 193-218. ISSN: 5385-1565.
11. ZOHAR, A. Developing the thinking in the teaching of science and technology in the spirit of "the pedagogical horizon". In: *Eureka*. 2009, no. 27. [visited 06.12.2017]. Available: https://www.matar.tau.ac.il/wp-content/uploads/2015/02/newspaper27-doc03.pdf.
12. BADARNE G. Use of ICT for the improvement of the teaching and learning within biology class. In: *proceedings of the Republican Teachers' Conference*, March 1-2,

2019. ISBN 978-9975-76-266-3. Vol. II – Didactics of the natural sciences, pp. 111-118. Ch.: TSU, 2019. ISBN 978-9975-76-268-7.

13. HERSHKOWITZ, A. An alternative assessment kit in chemistry. Israel Rehovot: The National Center for Chemistry Teachers at the Weizmann Institute, 2016. http://meyda.education.gov.il/files/Mazkirut_Pedagogit/Chimya/takzirim2016.pdf
14. DERSLER, M., EHRENBERG, R., SELA, L. Education for Thinking in Science and Technology Studies. In: *Eureka*. 2009, no. 27. [visited 7.06.2018]. Available: https://storage.cet.ac.il/CetForums/Storage/MessageFiles/7250/88800/Forum88800M10I0.pdf
15. DOLEV, O., GOLDSTEIN, O. Implementation of the project-based learning incorporating ICT in elementary school. In: *Proceedings of the 12th Chais Conference for the Study of Innovation and Learning Technologies: Learning in the Technological Era*. February 14-15, 2017. Raanana: The Open University of Israel, 2017. pp 235-237. [visited 19.08.2018]. Available: https://www.openu.ac.il/innovation/chais2017/2017-book.pdf
16. BELL, S. Project-Based Learning for the 21st Century: Skills for the Future. In: *Journal The Clearing House: A Journal of Educational Strategies, Issues and Ideas.* 2010, no. 83 (2), pp. 39-43. ISSN (printed): 0009-8655. ISSN (electronic): 1939-912X.
17. CHANLIN, L. J. Technology integration applied to project-based learning in science. In: *Journal Innovations in Education and Teaching International*. 2008, no 45, pp. 55-65. ISSN: 1470-3297.
18. RAM, A. A project-based learning community - pedagogy for the third wave. In: *Eureka*. 2016, no. 39, pp. 16 – 23. [visited 21.08.2018]. Available: https://www.matar.tau.ac.il/wp-content/uploads/2016/07/04-%D7%9E%D7%90%D7%9E%D7%A8-%D7%A7%D7%94% D7%99%D7%9C%D7%95%D7%AA-%D7%9C%D7%9E%D7%99%D7%93%D7%941.pdf
19. ASH, K. E-Portfolios evolve thanks to WEB 2.0 tools. In: *Education Week Digital Directions*. 2011, no 04 (03), pp. 42-44. ISSN 0277-4232.
20. HERTZ, B. M. Using E-Portfolios in the Classroom. In: *Edutopia*, Israel, 2013. [visited 26.02.2018]. Available: https://www.edutopia.org/blog/e-portfolios-in-the-classroom-mary-beth-hertz
21. MA'ATUF, A. Dropr - portfolio. Small, Large Tools. [online]. Israel, 2014. [visited 27.02. 2018]. Available: https://digitalpedagogy.co/2014/03/15/dropr-.
22. Ministry of Education. Digital Portfolio - The MOTAV Project (Science and Technology in Society). [online]. In: *The educational cloud*, Israel, 2015c. [visited 28.02.2018]. Available: http://sites.education.gov.il/cloud/home/Lemida_Merahok/Pages/ talkit_mutav.aspx.
23. OFERDAHL, E., IMPEY, C. Assessing General Education Science Courses: A Portfolio Approach. In: *Journal of College Science Teaching*. 2014, no. 43 (5), pp. 19-25. ISSN: 0036-8555.