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DIDACTIC MODELS FOR APPLYING ICT IN EDUCATION

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ABSTRACT
The globalizing world and the rapid development of information and communication technology (ICT) challenge modern educational systems which promptly seek how to apply appropriate teaching methods in practice. The article presents a summary of didactic models for the application of information and communication technologies in education. The main structural elements of the model belong to three areas - technological, pedagogical and organizational.

Key words: information and communication technologies, didactic model for learning.

DEVELOPMENT OF ICT AND EDUCATIONAL MODELS

As we track down the development of ICT and the relevant educational models, we have observed five consecutive stages. The distinction of the stages is based on the development of innovations which have had an impact on educational development**. (Figure 1)**
First stage – the introduction of algorithms for programmed learning (1950s). During this stage a system for algorithmic programmed learning was implemented around the world, and this initiated the development of innovations in support of education and training. Up to now, there have been two models of the educational process: the teacher-student model and the group study model. The American psychologist B. Skinner (1) developed a model based on behaviorism in pedagogy and psychology for the application of knowledge acquisition programs via linear computer programs. Another representative of the American technologies for programmed learning Norman Crowder developed branching style programs. This model allowed individualization (adaptation) of learning, considering both the individual pace of students, and the complexity of the learning material. In case of error the learner got the opportunity to individually follow another link of the learning program. The research of scientists such as Bespalko and Nikandorov contributed to the methodology of programmed learning by formulating the stages of development of an instructional program (2):

- Formulation of learning objectives
- Drawing a theme plan for subject learning
- Selection and compilation of non-programmed text
- Compilation of theme plan of slides with learning content
- Development of introductory and conclusive lectures and methodological teacher guides
- Checking and improvement of the program

Second stage – emergence of automated technologies for assisting education (1960s)

The emergence of electronic computational machines called “learning machines” led to the rapid development of computer technologies.

A search for maintenance systems was launched which led to a second wave of innovation in the industry for education and training support. Among the well-known were System PLATO (Programmed Logic for Automated Teaching Operations) – the first programmable logical system for automated learning which was a result of the joint effort of engineers, physicists, psychologists and instructors from Illinois University. For the first time such a learning system was adopted by users with different functions – students, instructors, course developers, system administrators. In the early 1970s PLATO entered into its second developmental stage with the emergence of big computers using graphic terminals with the impressive resolution of 512 to 512 points and keyboard. After a few developmental stages in the late

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1970s the system comprised of several thousand terminals and more than a dozen mainframes connected in a network. The courses in PLATO were developed by using the TUTOR language, which was replaced later on by Macromedia Authorware. It is believed that PLATO was the first author environment for developing computer-based learning materials. The next automated system TICCIT (Time-Shared Interactive Computer Controlled Information Television) – an interactive computer information television system with time distribution was developed by MITRE at the end of 1960. In the late 1960s information society was beginning to emerge.

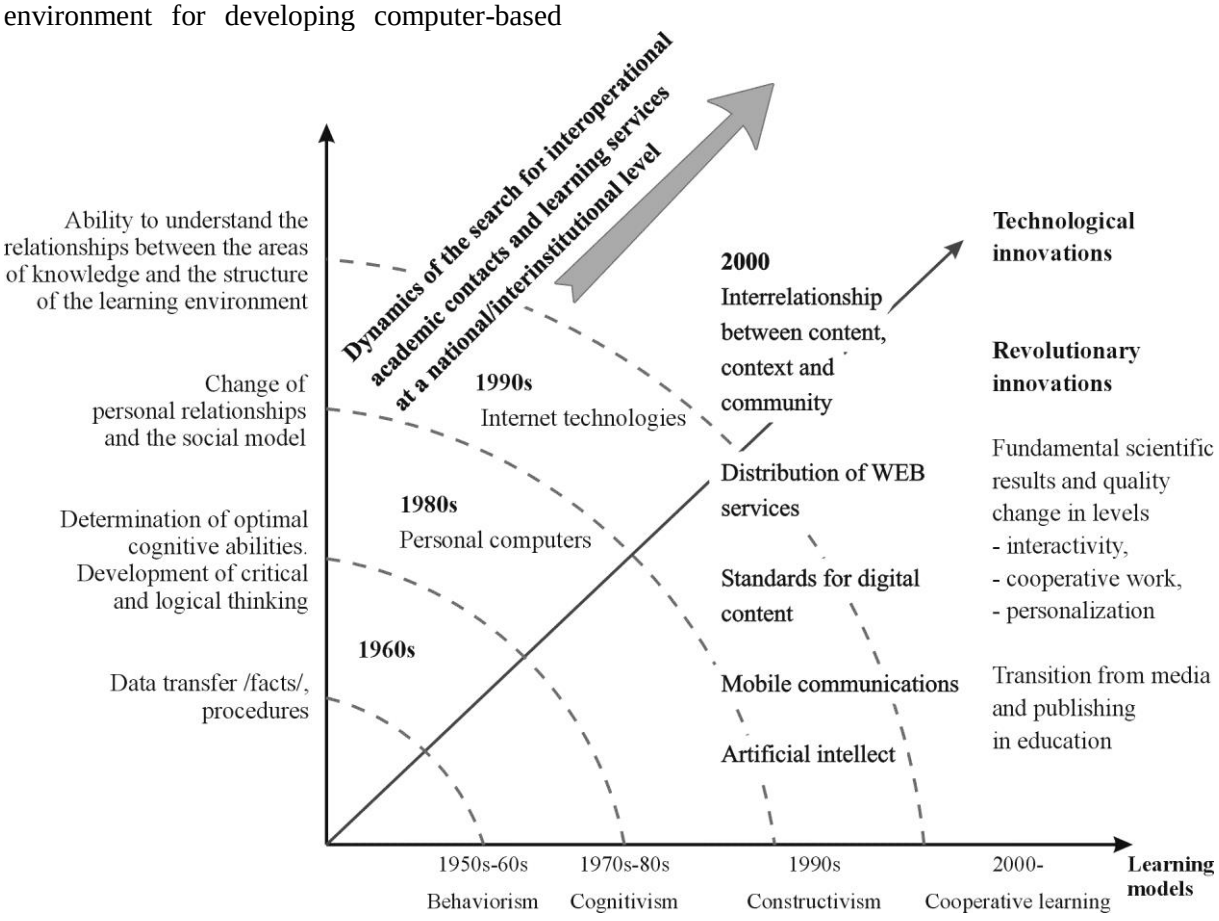

Figure 1. Development of Learning Technologies

As we track down the development of computer-aided learning from this period it is necessary to mention Seymour Papert. On the basis of Piaget's theory he positions the child in the stimulating world of Logo, where she can freely discover the world of mathematics.

Third stage – the birth of the first computer learning environments (1970s). A significant leap in computer-aided learning was made by creating computer environments for learning. A key contributor to this was the development of local networks which were actively being used in education. Naturally, there was a lack of specialists trained both in pedagogy and in computer science. In this way the development of integrated areas led to a third wave of innovation and a need for acquisition of new skills by teachers and researchers. The major problem of didactics was the absence of pedagogical theories and learning models for technology applications. Psychologists were forced to reconsider their views on perception, memory, and imagination and to see them through the prism of computer metaphor of the brain as a device for information processing and storage – and that was the cognitive revolution. Thanks to the success of the development of microelectronic and semi-conductor industry in the first half of 1970s processes such as computer technology and communication convergence, and information and communication system integration were defined. The relevance of the problem of creating programmed learning means which can work on any computer system, be mobile, take smaller memory space, and be easy to learn and use became more expressed.

Fourth stage – an integrated development of computer technologies and the emergence of distance learning technologies (1980s- 1990s). At this stage the growing calculating power of computers and the implementation of computer networks were most evident. The process of creation of computer learning programs took off. The emergence of Web technologies and societal needs led to the rapid development of

a wide range of ICT in support of education and learning and thus stimulated revolutionary and interactive innovations. During this period the first technologies for Internet-based distance learning were launched and studies for the use of multimedia in distance learning were embarked on. The concept of open education was introduced as a system for providing educational services via existing information-educational environment selected by the user and adapted to their personal needs. Thus, in the 1990s two learning directions developed – computer technology and a system for assisting the management of the learning process (Learning management Systems – LMS), which later became known as learning platforms. Hardware, system and applied software development made way for the growth of educational applications of computer technologies. Hypercard, hypermedia and computer presentation systems appeared.

A typical system for computer-aided learning includes: preliminary testing of learners' skills, presenting the learning material in navigational form, providing repetitive exercises for improving learner knowledge and skills, introduction of game-based exercises to boost the entertaining character of learning, registering the learner achievements by a post-test, "routing" the learners through a series of learning programs, recording results and learner development. (2).

Since the end of 1990s social constructivism has influenced the field of e-learning. Constructivists see cooperation, cognitivism and independent learning as the most important elements in cognitive activity. The theory of social constructivism is the basis for LMS Moodle (Modular Object-Oriented Dynamic Learning Environment).

Fifth stage – development of technologies for Web-based learning and other learning technologies (2000).

With the emergence and fast development of WWW technologies, the prospects for provision of electronic resources in Internet also flourished. This innovation changed the perceptions for the forms, methods and content of education in the conditions of massiveness and continuity. Web 2.0 technologies led to fast processes of recruitment of specialist (non-specialists in programming), who would update the world of knowledge and information, the creation of Wikipedia and other such resources. This stage has also witnessed the enhancement of social networks. Virtual cloud (distributed) data storages – the most popular model for cloud computing SaaS (Software as a Service), which is an external server software available to users as internet services – holds an increasingly influential position. Together with the tools for development of learning content, there are additional instruments for the development and control of the system, and the new technologies, such as mobile learning, e-learning, and others, as well as of means of support, for instance virtual classrooms with an option for webinars (or web-based seminar).

A number of researchers are developing new pedagogical ideas and theories of educational activities (such as connectivism, parapegdagogy, etc.), independent of the concept of the traditional pedagogy for "horizontal" (decentralized) learning activity and shared learning.

Web technology development has allowed the growth of fundamental studies in the field of electronic scientific and educational space for creating a communicative environment, called personal (individual) learning environment PLE (Personal Learning Environment). The learner becomes an active element of the system, which not only controls, and guides his activity, but also influences the functioning and the contents of the system. Since 2008 this practice has been largely distributed through accessible distance learning courses such as MOOC (Massive Open Online Course). Leading universities around the world helped develop platforms such as EDX, Udacity, Coursera, FutureLearn, etc. - projects, which are offering principally new possibilities for knowledge transfer and are gaining in popularity among people from all corners of the world. (3).

MODELS FOR INTEGRATING ICT IN EDUCATION

In this part we are going to discuss two typical models for integrating ICT in education.

Model for integrating ICT in the learning and formative process (4)

The model is based on the understanding that ICT integration in the learning and formative process advances gradually by noting the characteristics in the organization of learning in each subject. Each element of the system is defined by the following aspects:

- **Initiation** – studying problems and possibilities for their solution; preliminary assessment of the situation;
- **Analysis and evaluation** – setting the objectives, analysis of the entry level,

evaluation of the state of the learning system, determination of the directions for implementation;

- **Choice of ICT tools**– searching or creating multiple possible solutions, evaluation of solutions in accordance with the objectives, choice of ICT and method of application;
- **Integration design** – planning learning activity, designing the control on learning, providing resources, preliminary testing of ICT;
- **Project realization** – preparation of necessary materials and documents, instructor preparation, program availability;
- **Monitoring and adaptation** – continuous integrative assessment; adaptation of ICT and the other elements of the learning system;
- **Realization assessment** – preparation of a formal and informal assessment.

The proposed conceptual structure of the model of integration of ICT in the learning and formative process is presented schematically on **Figure 2.**

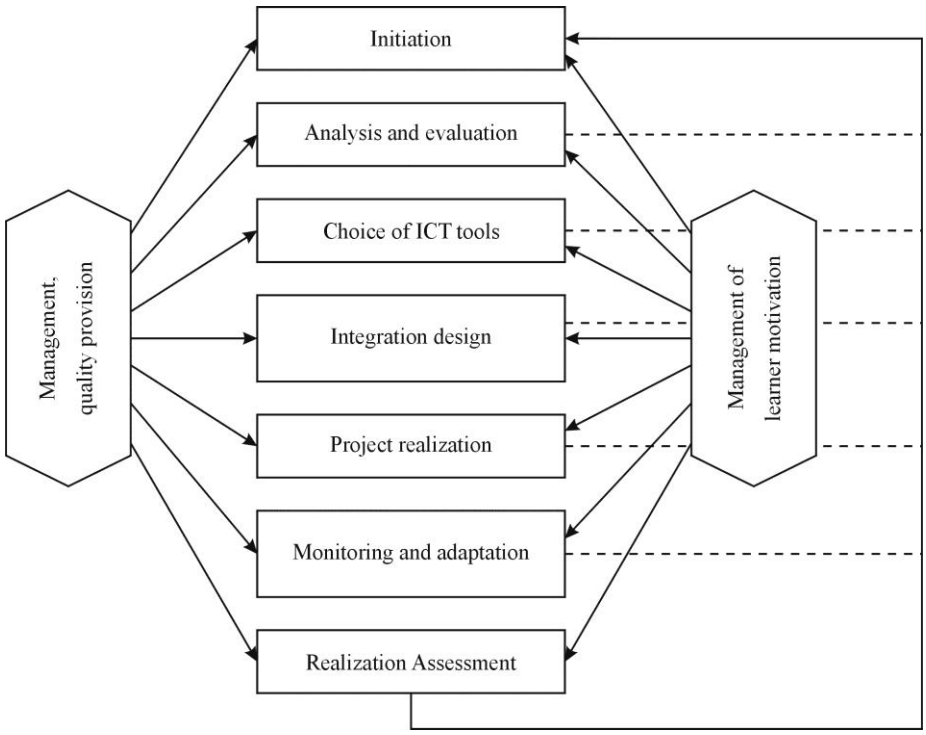

Figure 2. Model for integrating of ICT in learning and formative process (Zaharova, 2008).

Polat's model

Another **multimedia learning model** is Polat's model **(Figure 3)** (5)

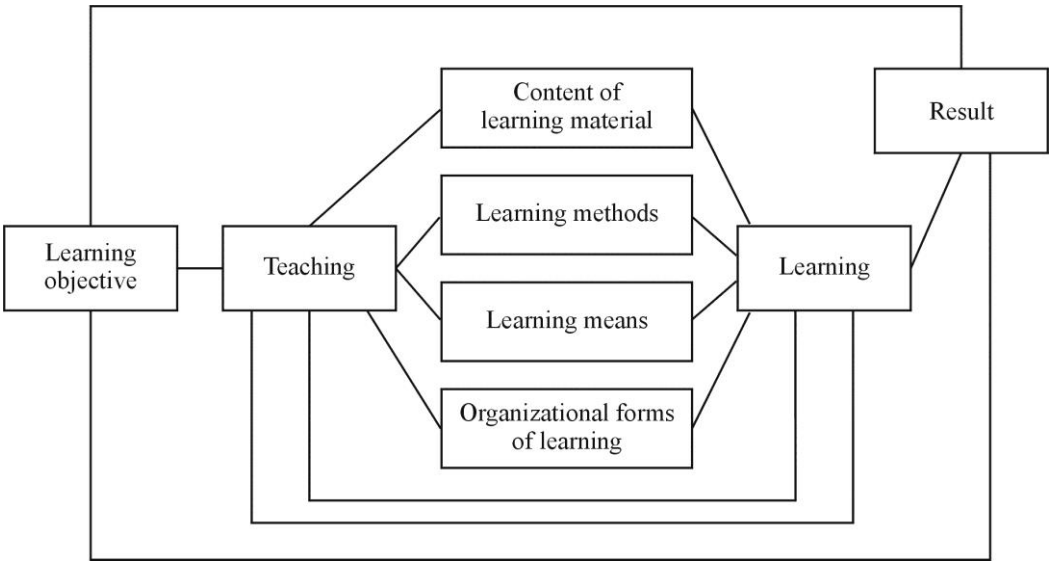

Figure 3. Polat's multimedia learning model

The main characteristics of this model are:

- Educational/ scientific disciplines are based not on printed learning materials, but on electronic libraries and object-oriented multimedia materials. The World Wide Web (WWW) offers students a huge amount of information resources and thanks to its endless variety, it can cover complete areas of the cultural heritage and knowledge of humankind. Every user can be an author and publish materials available to all.
- Learners do not receive already processed facts and interpretations, they must construct and learn individually according to their abilities, interests, preferences and cognitive abilities. They are learning how to learn.
- Students can participate in defining learning objectives and take responsibility for achieving them. Learners can control the learning process, do team work, take part in discussions and look for effectiveness of learning, even to choose their teachers.

Instructors are mere assistants of students, their senior classmates, who help learners acquire the skills for most effective use of the abundant information resources in the global information system, and not only find the most suitable learning materials, but also structure and assimilate them.

- The so-called project pedagogy is prevalent. It is applied largely in universities and for professional specialization, yet recently it has become more and more common in schools. Learner achievements are assessed on the basis of produced results, which can be presented, defended and published locally and globally. Self-assessment is also encouraged.
- Collective learning and work are preferred to competitive learning. Global information environment offers different software applications which can aid cooperative learning and work. Instructors can work both individually, and with small groups of students. Learners can be assistants of their instructors and help their classmates learn new software tools or tackle a specific problem.

The school and the university are open to the world – the problems which are being tackled come from real life and are often defined by students themselves. Problems are solved collectively with the help of instructors (5).

A summarized didactic model for ICT application in education

In this part we are going to present a summary of the didactic model for ICT application in education in its innovative and creative aspect. The main structural elements of the model branch into three directions – technological, organizational and pedagogical innovations. **(Figure 4)** The unifying structural units are Innovative and creative ways of learning; Individual achievement enhancements, Networking and community building, Institutional support, Inclusive opportunities for lifelong learning in the society. Innovative and creative ways of learning are related to New multimedia tools, supporting creativity, Participative learning and teaching approaches, New learning paradigms, teaching methods, and skills.

Individual achievement enhanced by: Addressing different sensory channels, just-in-time learning; Peer support, reflective organizations; Increasing motivation, authorship & reflection;

Networking & community building give rise to: New identity building &establishing presence; Borderless learning communities, teacher & staff collaboration; New collaboration &knowledge sharing.

Institutions can support and provide diversity by: Bridging distances and differences between learners; Inter-institutional cooperation; Personalisation, ownership.

Inclusive opportunities for **lifelong learning in the society** with: Multiple channels to access and participate; Opening up resources, promoting transparency; Embedding life experiences into institutional learning.

CONCLUSIONS

As a result of the analysis of the separate aspects of ICT application in teaching Mathematics, the following CONCLUSIONS can be drawn:

1. Social demands, resulting from transformations of the information society, together with the competition for quality and effectiveness in all spheres of life have catalyzed the massive creation of ICT;
2. With the development of hardware and applied and system software the learning application of computer technologies are also progressing;
3. Latest research convincingly shows that the dominant theoretical and methodological platform of e-learning around the world is constructivism in its deeply humane and developmental aspect;
4. The problem of knowledge management in respect to ICT-based learning must be studied at different levels using situational analysis, and the production of typical solutions in the electronic scientific and educational space, keeping in mind national, international and individual specifics of knowledge acquisition and skills, as well as innovative teaching strategies;

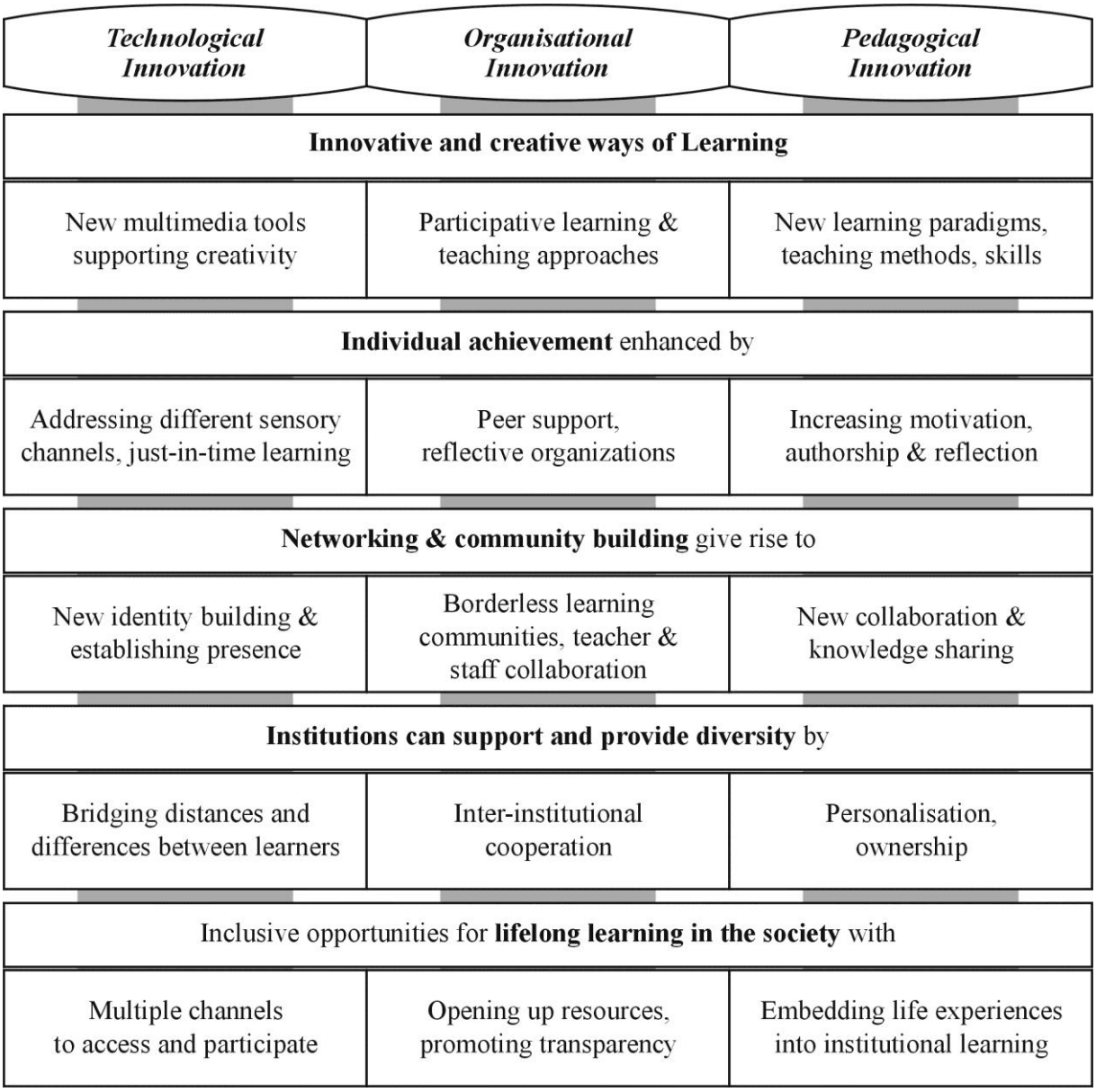

Figure 4. Summarized didactic model for ICT application in education

5. The created models are subject to further improvement which will be determined by the fast technological development and the slow progress of digital competencies;
6. Many of the outlined problems remain to be solved. Despite of that, raising these issues will offer a chance for a complete understanding of the character of the present transformation and for meeting the challenges of the information society.

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