Policy Brief
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NEW-GENERATION ELECTRONIC EDUCATIONAL RESOURCES

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INTRODUCTION

Tell me and I'll forget;
Show me and I may remember;
Involve me and I'll understand
Chinese proverb

The importance of enhancing quality, effectiveness and accessibility of education has been discussed all over the world for many years. Fast-paced information production and the necessity of continuing upgrade of skills are no longer a subject of debate in newspapers and magazines – the problem has fallen into the background and become a commonplace. The time has come to find a radical solution, which would make it possible to expand access and ensure improved effectiveness and quality of education.

A solution based on traditional approaches and five hundred years of mass education experience would require people to attend classes throughout their lives or to learn with the support of an individual tutor (or better several tutors in various disciplines), which is hardly feasible. The task of adjusting the education systems to the challenges of our times cannot be implemented merely by replication. One could try another approach to tackle the problem – seeking idle resources in the educational process and its backbone elements: educator – teaching/learning materials – educational institution.

Let us distinguish the unique features and advantages of each of the elements to determine the most favourable opportunities for their development and, eventually, for the efficiency improvement of the process on the whole. Firstly, let us consider what hinders the efficient use of these features within the frames of traditional educational technologies.

Educator

Creative ability is undoubtedly one of the most important features inherent exclusively to a human being. Live conversation, discussions with students, joint analysis and research activities are the most valuable elements of the educational process, which turn a common learner into a Student. However, teachers cannot afford to spend much time for communication with students during a traditional lesson. In 45 minutes, they have to assign quiz, deliver new material to the class, support it with visual materials, etc. Most of these activities are one-way communication. From technological perspective, a teacher often acts as a repeater that has also to maintain discipline in the classroom.

Teaching materials

For five centuries this sphere has been dominated by Its Majesty the Book. An absolute advantage of a text is its universality. The world consists of objects, processes and abstract objects; and texts can describe all elements of the world. However, the universality of texts in printed textbooks is limited by paper medium. As usual, disadvantages are closely linked to advantages: textual form of data presentation in books is poorly suited to demonstrate various objects, for instance, works of art, physical processes, the sequence of operations. It is difficult to catch an image and almost impossible to hear music through the text. To remedy the situation, illustrations – images of static objects, can be inserted. However, it failed to ensure the adequacy of textual description of dynamic processes.

Educational institution

A school, college, and university are, first of all, the arena for communication with teachers and fellow students, which supports education, upbringing, socialization and general human culture. Collective training has undeniable advantages that can be used later both in professional activity and in everyday life – from 'brain storming' to family council. An educational institution comprises laboratories and workrooms to conduct experiments and acquire professional skills.

The above unique features of educators and educational institutions should be coupled to provide conditions for full materialization of their capacity. These conditions will allow teachers to change the pattern from repeating lectures to discussions with students and educational institutions to perform their functions beyond classrooms. Interactive multimedia educational resources may help to create such conditions and intensify educational activity.

TYPES OF ELECTRONIC EDUCATIONAL RESOURCES

At the turn of the twenty first century, electronic learning materials have become frequently used along with the printed ones. Before praising success of informatization, we should first assess where and what kinds of electronic educational resources (EERs) are really effective. Nowadays, there are three main types of EERs: textual-graphical, basic audiovisual and multimedia resources.

Textual-graphical resources are the simplest type. They have the form of digital text with illustrations. Substantial similarity of EERs with a book resulted in the term 'digital manual'. EERs are not very useful for general and vocational education, because students of secondary and vocational schools are provided with traditional textbooks. Textual-graphical EERs are appropriate when data is being accumulated from multiple sources and the content of a resource is being systematically updated. The first case is a digital library – no time is spent to be physically there and handle bibliographic cards. This solution is based on the Internet, the advantages of telecommunication access and search engines. The second example is typical of rapidly growing fields of knowledge: the latest research findings and technical achievements are placed on the Internet and are available for almost any target audience. This level of operational efficiency and purposefulness at extremely low cost is unattainable for printing materials. Advantages of digital texts become evident at the highest levels of vocational education and in professional activity which require processing information from diverse sources and familiarity with the latest achievements in science, technology and production.

Basic audiovisual resources are simple computer files containing photos, videos, music, etc. As there is no didactic basis in this case, such resources can be considered as conventionally educational. Usually, they play the role of visual aids used by a teacher during the lesson to enhance 'pictorial realism' as requested by pedagogical standards. This type of resources is used as a supplement to textbooks - a CD containing illustrative materials. The trick is that any student can hardly read a book and look at the screen simultaneously. Certainly, basic audiovisual resources have not contributed much to the enhancement of availability, effectiveness or quality of education. In the framework of traditional educational technologies, they may lend slight variety to educational activity. The problem is a teacher might decide that ICT achievements are used to the full, whereas this is just a starting point, when a computer is just a subsidiary tool, which does not influence didactic, methodological, organizational and other aspects of the educational process.

Multimedia resources embody the highest capacity and potential for education. Let us define the term 'multimedia EERs'. The word 'multimedia' is frequently used nowadays, that is why it is important to understand what exactly it refers to. For instance, a well-known multimedia player is called 'multimedia' because it can successively reproduce photos, video films, sound records and texts, but every object reproduced at a time is simple, or 'one-media'. By multimedia EERs we mean resources that ensure simultaneous playback of a coordinated assembly of textual and audiovisual elements that presenting objects and processes by various means, on screen and in sound. A peculiar feature of multimedia content is its interactivity, and the interaction types can be diversely complicated. It should be emphasized that such an interactivity in textual and graphic resources is possible only as links, and in basic audiovisual resources is non-existing. With no doubt interactive multimedia EERs are the most difficult-to-make; they include multiple content elements and a scenario of their interactive presentation. In this case, the popular aphorism is valid: the easier and more straightaway a programme looks, the more complicated it is.

Leaving aside the difficulties faced by producers, let us focus on the problems that users have to address due to the complexity of the product. Firstly, until now, interactive multimedia content was produced mostly on CDs. Its distribution over the Internet was prevented by technological obstacles. Secondly, there was no unification: every producer used his own software, presentation methods and user interfaces. As a result, mastering the use of multimedia educational resources on CDs often demanded much more effort and time than dealing with the content.

In its turn, the wide application of multimedia resources in education was restricted by two factors. First, it was not clear how CDs could be integrated into the teaching process. Each student had to be supplied with a full set of CDs for individual use. Selection of electronic publications was complicated selection criteria were not set and it was advisable to avoid duplication of existing textbooks. For teachers, the use of CDs in a classroom did not seem to be a good idea: what would be their role in a computer class, if students are dealing with computers.

The second factor is delayed adoption of student-centered approach. The most complicated and advanced computer products hardly meet expectations related to this change of the paradigm. High cost, lack of unification and protection of products against modification are still the major obstacles. Producers try not to make similar products (it is not profitable); competitors create absolutely different products; thus users can not rearrange parts of various products or change their content. Nevertheless, advantages and educational prospects of interactive multimedia EERs provide a strong incentive to remove the mentioned disadvantages. The new-generation electronic educational resources, which combine advantages of the interactive audiovisual content with the opportunities of the online distribution and comprehensive use in the educational process, were elaborated during the recent few years.

The development of the online EERs with interactive multimedia content necessitated the design of new system architecture, unification of the structure of digital educational products and elaboration of a unified software framework. The ultimate result of these efforts was the development of the **open educational module multimedia system (OMS)**. Electronic educational resources elaborated in the OMS environment are called the **new-generation EERs**. The EERs are not just another step on the way to developing electronic educational materials; the 'new-generation' means another level, at which EERs become a full-fledged tool for educational purposes.

NEW TOOLS FOR STUDENTS AND TEACHERS

The conceptual framework for the new-generation EERs is the module architecture of an electronic educational resource. An aggregate content of a subject area is split into modules which correspond to thematic elements and components of the educational process. Furthermore, each module may have an analogue – a variative – which has different content elements of content and is based on the use of different methods and technology (Figure 1).

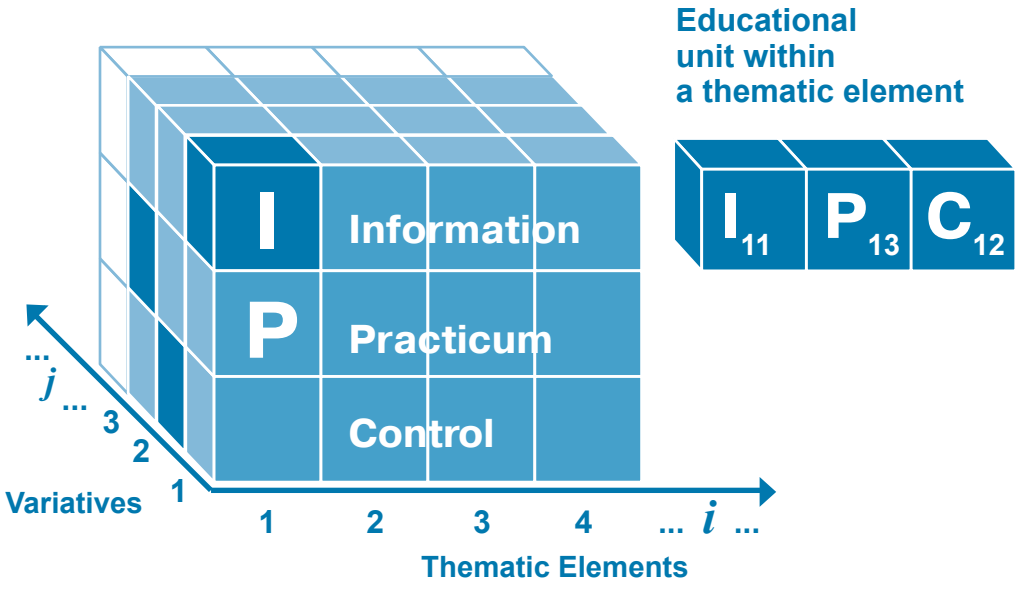

Figure 1. Structure of New-Generation EERs

An electronic learning module (ELM) is an autonomous educational resource, full in its content and functions, designed to solve a certain pedagogical task. The data volume of an ELM is about 10 MB. Therefore it can be easily downloaded even in case of low-bandwidth communication. When creating an electronic learning module, one can use any of the tools available for the design of multimedia components in any formats; organize interaction of a user with content elements, including the use of complicated imitation modules. Creativity is limited by methodical practicability only.

ELMs are uploaded to network servers, the repository can be accessed and ELMs can be downloaded online in background mode. The downloaded module is stored at a user computer for further use. Operations with a set of the selected ELMs and their management are implemented through a special tool – **a personal organizer**.

A special **OMS-player** is used to play the modules. Its specific features suggest that it facilitates the compatibility of the level of complexity and possibilities of modification of the downloaded objects. On the one hand, the player solves the problem of playing complicated multimedia content, which allows adequate presentation of almost any educational object and process. On the other hand, the content and organization of the interaction in ELMs, allow for changes and modifications.

The player and the organizer comprise client software. A user of the new-generation EERs shall first install them upon downloading the installation package and educational modules from the Internet.

Major advantages of the new-generation EERs are as follows:

- no content and technological limitations (sophistication of the educational content of the module is unlimited to the point of virtual reality);
- option of online distribution (the contradiction between the maximum functionality and the Internet accessibility of EERs has been eliminated);
- unification of the structure of modules, ways of their storage and playback, as well as the content-independent part of the user interface (for users, this suggests independence from a company-producer, time and place of production of an educational resource);
- modifiability and upgradability of modules (software solutions (computer scenarios) in the new-generation EERs are based on interpreted programming languages, so the user gets access to original texts of programmes; the open texts along with the unified of the structure of ELMs allow users whose ICT-skills are less advanced to modify the content);
- autonomy of ELMs from a software and hardware platform (for instance, transition from Windows to Linux demands just installation of a new software package including a player and an organizer);
- capability for student-centered education (through the use of the existing variable ELMs or modernization of the modules by users).

The architecture of the educational modules supports further development of the new-generation EERs. Both programme and content components of ELMs allow for modification. Changes in software components defining the screen layout and the interaction usually required more advanced skills than modification and replacement of separate content elements. To provide equal access to users with different background, **tools for modernization/development of electronic educational modules by non-professional developers** have been included into the OMS instrumental complex.

From the educational perspective, the new-generation EERs have the following innovative capacities:

- Support to all components of the educational activity taking into account individual preferences

Indeed, electronic modules allow acquisition of curriculum and theoretical data, practical training and assessing learning achievements. This favours the implementation of an individual-oriented model of education: teachers can design their individual courses, while students can follow their individual educational trajectories. By comparison, textbooks have unified content and support information acquisition activity only.

- Implementation of active forms of education

Due to the high level of interactivity and saturation by multimedia components, EERs allow students to undertake a virtual journey, to carry out an experiment, to observe three-dimensional objects, to modify a procedure or a process, or to try doing things in a different way, etc. These diverse opportunities, as compared to reading long texts, show more promise for increasing the efficiency and quality of education.

- Diversification of functions and enhanced efficiency of individual learning

The new-generation EERs allow students to do out of the classroom those kinds of activities which used to be available only in the class: laboratory experiments, practical work, quizzes, professional competence tests using situation modelling and so on. It should be emphasized that the efficiency of learning is much higher than that in traditional education because teaching materials are presented in interactive audiovisual formats, which provides supports active learning and the use of variatives based on individual preferences.

The modular structure support efficient administration of the educational process. A software tool **Records of Learning Achievements (RLA)** has been designed to assess students' progress. When students work with ELMs, their success rate indicators are generated in accordance with the international specification SCORM RTE. The organizer transmits the information to RLA, which makes it possible for the teacher to assess the results of students' self-study. Complete data on operations with each module – from the time spent on each module to the number of mistakes and repeated actions, as well as the results of the preliminary self-test (C-type module) can be used to grade students and save teachers' effort and time.

The new-generation EERs are hosted by the Federal Centre for Information and Educational Resources (FCIER). Its Internet-servers (http://eor.edu.ru) provide free access to 30,000 electronic educational modules for the secondary school curriculum and the most demanded courses for primary and secondary vocational training.

DEVELOPMENT OF MODERN EDUCATIONAL TECHNOLOGIES

Special tools are usually provided with manuals describing the operation mode and technologies used. Sometimes creation of an innovative tool stimulates the development of new technologies. Let us consider the ways of instruction for the sake of appropriate and effective use of new educational tools.

EERs are teaching materials derived from textbooks. Although none will be reading a textbook during the whole lesson, continuous efforts are being undertaken to use electronic resources in the classroom. The motives are clear: the teacher is ruling the class, and, of course, is trying to improve, diversify and make easier his work. It works when audiovisual aids (basic audiovisual resources) – either separate, or sequentially arranged in a thematic presentation – are used. However, interactive multimedia products are self-sufficient for the implementation of learning activity. They do not need to be guided by a teacher, the same way as students should read textbooks or make laboratory works on their own.

Presentation of interactive educational products for a group of students has proved its inefficiency. A prerequisite for comprehensive use of all innovative aspects of interactive EERs is the use of computers, which at school can be done in a computer classroom. However, if students will be absorbed in the work with EER, what would be teacher's role? It is very important to ensure a balance between human-human and human computer interaction: **the interaction of students with a Teacher is the most valuable part of the learning process that cannot be replaced by interaction with a computer.**

A perfect electronic educational resource inevitably looses in comparison with a teacher in all parameters. Even perfect EERs cannot be compared with human abilities to organize interaction and to think creatively. For instance, a teacher can give a clear answer even to any question and find a non-trivial solution to a task, and a computer programme will fail to do that as it runs under strict algorithms.

The situation is different when it comes to individual learning. Until now, this activity has been reduced to memorizing information, composing texts and formulas and other operations with symbols. Interactive audiovisual content of the new-generation EERs offers absolutely new opportunities.

First of all, 'homework' with EERs acquires comprehensive character; its functional ability is at least tripled due to the modules of I, P and C types. It should be noted that the efficiency of individual learning activity enhances dramatically: acquisition of knowledge, skills and competencies is much faster in active learning than while studying texts and doing practical exercises with symbols.

The modular structure of EERs supported by the options of saving, copying, delivering, sending and uploading ELMs via network and using any data carrier offers unique opportunities for such complicated resources to implement a closed cycle of the educational activity using a computer support and saving time for teachers. The cycle of educational activity is presented in Figure 2.

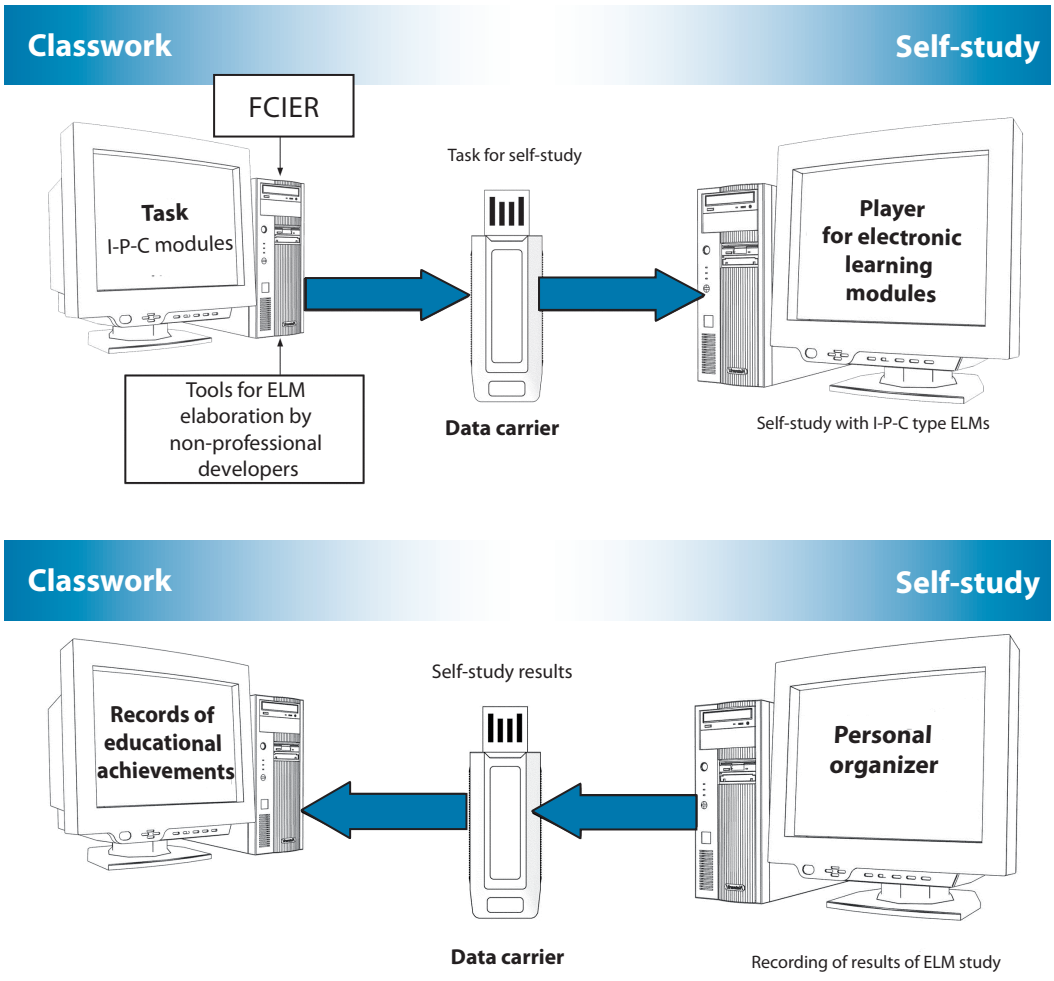

Figure 2. Educational Activity Cycle Based on Modern Technologies

A provisional removable storage shown in Figure 2 operates as student's diary: it keeps tasks (a set of electronic modules) and information on the results of the self-study. If there is an Intranet or an option of using the Internet, no removable carriers are needed, a school computer can be used as a server providing all operations online.

As it is shown in Figure 2, one can skip quizzes from the lesson plan, as the Records of Educational Achievements is in charge of complete control, which requires few time. Another part of teacher's classroom-based work – presentation of new educational material, should be also transferred to the individual learning activity. This seems reasonable because the Imodule provides students with information in interactive multimedia formats, which is much more effective than lecturing. Individualization of the pace of learning and of the methods of presenting educational materials under the correct choice of the ELM variative is the additional argument in favour of preliminary preparation for the classroom-based work. As a result, the situation in the classroom changes: teacher interacts with well-prepared students, classroom time can be spent for collective discussion and analysis, on creative communication with Students.

One of the prerequisites for the development of educational technologies is in the least case preservation and/or better extension of the potential of an educational institution, especially with regard to its unique functions mentioned above. It should be noted that a laboratory or a workroom are timeless values. The importance of real experiments and productive work increases in the new environment for wide application of virtual practical lessons. The right combination of new and traditional practices may considerably improve quality indicators and practical aspects of education.

The integrative advantage of educational institutions for collective activity can also be enhanced by means of new tools. There is an opinion that computers disconnect people and substitute live communication and active citizenship by virtual reality. It is just the other way round – smart use of computers and telecommunications allows achieving a new level of cooperation. As an example, let us consider an electronic module designed for collective work on a task. Students as manageable characters are included in the ELM content along with the studied objects/processes. Telecommunications help to coordinate the actions of the students, facilitate exchange of opinions and ideas and sharing learning materials.

New prospects justify the efforts invested in the development of new methods and new (modern) educational technologies which should address the following issues:

- drastic rise in the significance of the self-study through expanded functions and increased efficiency while using active and student-centered forms of education;
- shift of non-interactive components of classroom activities lessons to individual out-of-class activity;
- increase in time to communicate with learners, transition from lecturing to discussion, collective analysis and research;
- new level of interaction among participants of the educational process due to the full-range computer support of the closed educational cycle and distance collective educational activity.

Solving these tasks will provide the transformation of traditional technologies based on the reproductive model of teaching towards innovative technologies of active learning. In traditional education, a teacher is the central figure and the source of knowledge. Active learning suggests that it is a rather student who is in charge of shaping his competences under supervision of a tutor. It is noteworthy that proper application of EERs in the educational process within modern technologies should considerably increase labour productivity of teachers.

Thus, new (modern) educational technologies stimulate the development of creative components of pedagogical activity and transformation of the role of a teacher provided full-scale and highly efficient active self-study under student-centered approach. New educational tools create virtual laboratories and workrooms. They encourage collective educational activity of a distributed group of students, which broadens the educational space of a school, college and university.

The new-generation interactive multimedia Internet-resources open up opportunities for individual educational activity. However considerable expansion of the weight of 'homework' provided through the use of new electronic educational products causes transformation at all levels of the learning process. For any innovation, the human factor is the key one. The consequences of the introduction of new educational materials can be sound only in case of revision of the substance and forms of teacher's classwork. Technological achievements in informatization of education provide new prospects for increasing accessibility, effectiveness and quality of education. Progress in one area usually sets new tasks in allied spheres: only systematic and coordinated advancement of technology, pedagogy and education administration can guarantee success.

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