Digital Educational Resources As Part of A Digital Educational Space For A Future Computer Teacher

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Abstract*: Our research theoretically and methodologically rationales the use of digital educational resources as means of differentiation used in relation to student's learning in computer science. In this context, the purpose of this article is to identify and disclose the issue of using specialized software. This article allows analyzing the learning and giving assignments to students depending on the analysis and their knowledge. We provide the teacher and/or the students with the necessary digital educational materials. The methodological basis of the research involves the fundamental provisions of the theory of knowledge, logic and science; the system approach and the appropriate psycho-educational analysis of the activity concept.*
We have developed the structure of a digital practice and training, identified instructional possibilities of this complex, as well as a methodology for using it with differentiated instructions. We have defined factors relevant in the context of differentiated learning based on digital practice and training. This is a significant contribution of this research, as they can be used in teaching practice. Materials of this article are of practical value; research results were discussed at the meetings of the National Center of Information Technologies. They were presented at international scientific conferences and published in the republican scientific and educational editions.

Keywords: *information technologies, digital educational resource, electronic educational resource, electronic coursebook, practice and traininges*

1. Introduction

Information and Training Environment of Educational Facility

The current stage of society development is characterized by the rapid development of means of information and communication technologies (ICT). The ICT development leads to the increased informatization of education. All these factors cause changes in the content of the Computer Science Course and other disciplines – extended use of information and communication technologies. Accordingly, methods of computer science teaching are being developed. Nowadays, there are several other areas that have proved to be effective along with the traditional computer environment [1-2]

On the one hand, implementing ICT capabilities allows solving the problems of independent learning by quickly providing necessary digital educational resources both to the learners and to teachers based on their needs. On the other hand, ICT allows using various teaching modes and methods adequate to students' abilities and skills. This contradiction determines the relevance of the research topic [3-5]

Global development of information technologies and their rapid introduction in education have been shaping the growth of educational establishments in number over the past few decades. This involves the process of training qualified professionals and improving the general rate of computer literacy. The new stage of educational system development is also associated with new challenges – training the teachers to use computer devices. Currently, learning basic computer skills is not enough — the new agenda requires the use of serious methodology and techniques to be able to harness information resources to aid the teaching process, and at the same time, incorporate them seamlessly and effectively into the traditional teaching process. The teachers must be able to create their own educational module, their own teaching plan,

and to be have a good knowledge of specialized methodology [6-8**].**

Currently, we are able to single out six levels of computer skills that teachers use in the context of information and training environment. *Level one*: teachers have acquired basic knowledge about computers and are using them as "typing machines". *Level two*: teachers learn the desktop software and its capabilities; learn to use CD disks. *Level three*: logging on to the network and Internet-connected teaching and learning process – teachers get access to a virtually limitless pool of information to search in. *Level five*: new information technologies are gradually introduced into the lesson and form an integral part of it. *Level six*: teachers feel the need to systemize and modernize the accumulated teaching experience, including the one that used to be part of teacher's initial professional background [9].

However, little attention is ever paid to the *seventh level*, which is about teachers creating their own digital educational resources (DERs).

This issue is of great importance, as teachers are poorly informed of the opportunities to create, use and further apply DERs in their day-to-day professional activity.

Modern educational institutions strive to integrate into the high-tech environment. In contrast to about a decade ago, when the educational process used to be dominated by learning how to use computers and do basic programming, this space has started to be occupied by information technologies over the last few years. These technologies are methods and ways to acquire, process, transfer, store and use information during the teaching process [10-12].

In education, information technologies are the most crucial components of modern educational systems. The process of implementing information technologies (IT) in education has created new opportunities for all members of the learning process — from the reduced time spent on searching and accessing the right information, to faster updating learning content, improved customization and student-based approach to training.

In modern schools, there are many use cases of using IT throughout the teaching and learning process, including:

- preparing and giving lessons;
- creating copyrighted multimedia manuals;
- assisting with individual and team projects;
- managing the learning process.

Using IT at school is necessary as teachers should be up to date with the current information culture. The solution of the problem of helping teachers to master computers and information technology is as much important as helping pupils to develop computer skills.

Information objects that a teacher can use in the learning process can be broken down into three levels: information available from the Internet; resources available from the school's digital library; software developed directly by the teacher.

The purpose of the article is to develop an e-textbook for second level informatics in an elementary school.

2. Methods

Methodological basis of the research involves the statement of dialectical materialist philosophy on the theory of knowledge, the leading role of activity in personality development, and the dialectical unity of theory and practice.

We have used a complex of complementary research methods:

- *theoretical methods*: study and analysis of specific philosophical, psychological, educational, scientific-methodical literature; analysis of methodological documentation, analysis and synthesis.
- *general logical methods*: study and generalization of pedagogical experience in the research issue, educational practice conceptualization.

There is an increasing demand for highly qualified specialists in computer science in the context of the growing demand for processing large amounts of information in all areas of professional activity. An electronic textbook was developed with the modern software.

Data, Analysis, and Results

2.1. Digital Educational Resource

There is a number of existing common psycho-pedagogical theories that allow considering the scientific results comprehensively. They are significant when it

come to forming basic research concepts, since the technique was developed and tested for using digital educational resource while differentiating the learning process based on personal, activity, student-oriented, system and innovative approaches. We have substantiated the basic features and conditions for implementing the differentiated approach based on the use of digital educational resources. This is a considerable contribution to the methodical science.

We would like to make a point of the way teachers use IT and to find at least a partial answer to the question that goes: "What is a teacher's educational space comprised of?"

In order to answer this question, we have to define the "digital educational resource".

Currently, there is number of definitions for digital educational resources:

1. Digital educational resource (DER) is essentially any piece of educational information stored on digital media [13]

This definition is a short description of DER, but does not fully interpret the concept.

2. DER stands for a "digital educational resource" – a certain object, independent in terms of its content, intended for educational purposes and presented in digital, electronic, or "computerized" form [14]

This definition provides a more comprehensive interpretation of the concept.

3. DER is a set of digital data suitable for using in the learning process [15].

This definition is incomplete, it lacks specific features.

4. Electronic educational resources (EER) are such teaching materials that can be reproduced using electronic devices. In the most generic case, EERs include training video films and audio recordings that can be played with a consumer-grade tape recorder or a CD player. The most up-to-date and educationally effective EERs are played back on computers. Sometimes, they are called digital educational resources (DERs) as a subcategory of EERs, as the computer uses digital means of recording and playback [16].

This definition is based on the definition of electronic educational resources (EERs), thus it does not offer the complete picture of DERs, but at the same time, it defines DERs as a subcategory of EERs.

5. Digital educational resources are digitally recorded photographs, video clips, static and dynamic models, virtual reality objects and interactive models, mapping materials, audio recordings, symbolic objects and business graphics, text documents and other educational materials required to streamline the learning process [17].

This definition reflects the contents of DERs, besides it can be more easily understood and remembered. This is the reason why it stands out from other definitions in a positive way.

None of these definitions touched on such important concept as best practices. In our opinion, it is a key component of any DER, since best practices help teachers to find their way through the diversity of DERs.

There are various classifications of DERs. Let's take a look at the two basic ones.

The first classification breaks DERs into four lines by their educational and practical functions: electronic coursebooks, electronic workbooks, electronic practice and traininges and electronic tools for rating knowledge and skills.

An electronic coursebook is an educational product, which the only difference from a traditional textbook is that it is available only on computers. An electronic coursebook, as well as a usual textbook, must be in line with all approved teaching plans [18].

We provide some guidelines that should be followed when creating an electronic coursebook:

1. *Discretization principle*: break the information into sections consisting of modules minimal by volume and self-contained by the content.

2. Entirety principle: each module must consist of the following components:

- theoretical core;
- test questions on the theory;
- examples;
- problems and exercises for independent solution;
- test questions on the entire module, with answers;
- test;
- historical feedback.

3. *Visualization principle*: each module must consist of a collection of frames with a minimum volume of text for visualization simplifying the understanding and remembering of new concepts, statements and methods.

4. *Forking principle*: each module must be linked to other modules with hypertext references, so that the user can choose to jump to any other module. The forking principle encourages creating recommended links that facilitate the sequential learning.

5. *Regulation principle*: students can switch the frames on their own, they can open any number of examples on their screens (the word "example" here has a vast number of meanings: it includes the examples that demonstrate the studied concepts and statements, the sample solutions for certain problems, and even counter-examples), solve a required number of problems, as well as to undertake a self-test by answering test questions.

6. *Adaptability principle*: there must be the possibility to adapt the electronic coursebook to the needs of individual users during their studies; to adjust the depth and complexity of studied material and its application areas depending on the student's future specialty; based on the user's needs, to generate additional illustrations, provide graphical and geometrical interpretations of both the studied concepts and the problem solutions.

7. *Computer assistance principle*: at any given moment, students can expect to have access to the computer that will free them from their trivial tasks and allow them to focus on the very essence of the material they are studying in order to review more examples and solve more problems. In this case, computer performs not only tedious transformations, various computations and graphical drawing, but also mathematical operations of any degree of complexity (learned earlier) and checks the results at any stage.

8. *Compilation principle*: electronic coursebook (and other learning packages) must be designed in such formats that will allow compiling them into single electronic complexes, expanding and enhancing them with new chapters and topics, as well as putting together electronic libraries on certain subjects or personal electronic libraries for students (in accordance with their specialty and grade), teachers and researchers.

An electronic workbook is a workbook based on computer technologies where a computer is the primary learning tool.

The following items are the major learning components, information and procedural guidelines that regulate the teaching system:

- handout training materials;
- control and test materials;
- practical tasks;
- methodology for group, individual and self-organized classes;
- strategic and tactical use of each teaching tool, their combination, as well as the possible replacement or duplication of each of them;
- aligning all training information materials with teaching tools and class methodology.

A computer workbook should be designed in line with the requirements for the entire teaching system. Besides, its information and methodological base should be based on the materials listed above. Computer workbook development as a training software should be considered as an interdisciplinary task that is possible to accomplish only through engaging specialists from different fields.

Practice and training complexes (PTCs) for a certain subject are a set of training materials that assist students in mastering the given subject according to the corresponding plan of study [19].

PTC can include lecture notes, workbooks, practice guidelines, virtual laboratory works, electronic learning courses, self-assessment tests, extra materials, as well as information tools and software required for a particular course.

Electronic tools for rating knowledge and skills may include various testing systems.

The second classification is based on information types. The major flaw in this classification comes from the fact that some DER subcategories include several types of information. Thus, coursebook can be regarded as both a DER with text information, with combined information, and as a DER with a complex structure. At the same time, this classification flaw turns into its advantage, as it can be concluded that a coursebook may

contain only text information, or combined information, or have a complex structure (Diagram 1).

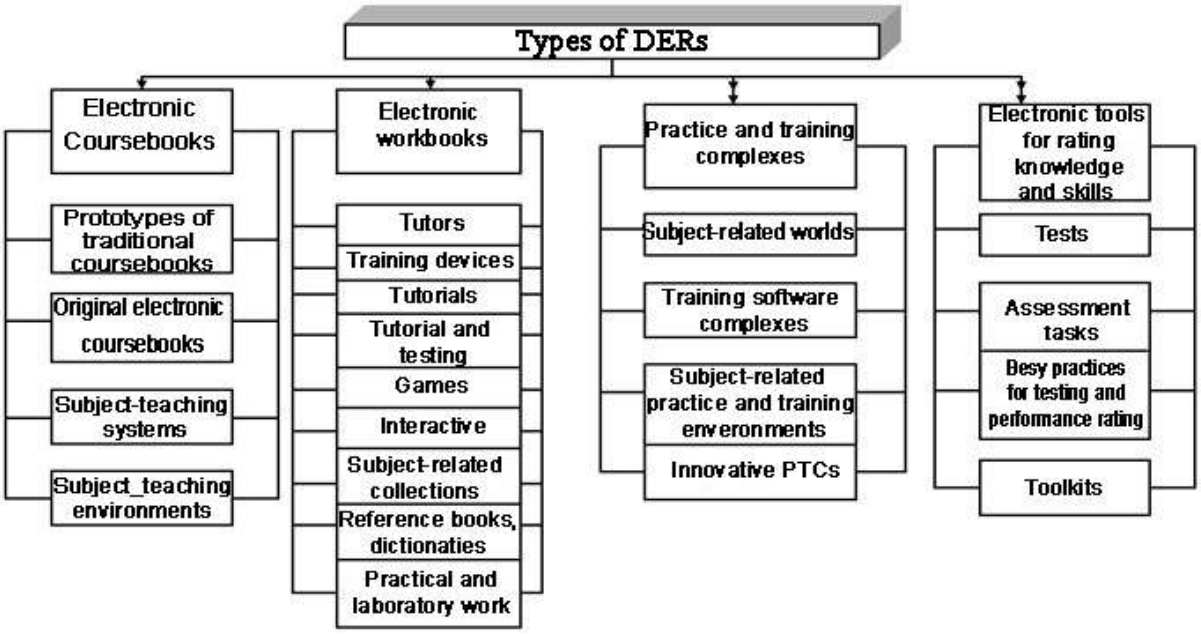

Diagram 1. Classification of and application areas for DERs

The multitude of digital educational resources can be split into the following conventional blocks:

• interactive components – questions and problems, tests and independent tasks, interactive models and animations;

• visualization graphic materials – illustrations, animations, video clips;

• text – paragraphs of text, text with audio, biographies of scientists, tables;

• materials intended for teachers – presentations and lessons.

Interactive components.

Assessment tasks and *self-assessment quizzes* are interactive components to assess student's performance. A set of DERs for a coursebook should normally include six types of tasks:

- single-response questions;
- multiple-response questions;
- free text questions (whereby the student enters a word or a phrase);
- point & click (pointing to the right object in the picture);
- drag & drop (dragging and dropping objects, and overlapping them);
- questions with a combined answer (several different types in the same task).

The computer will automatically check the answers in the majority of cases. If the answer is incorrect, the computer can offer a feedback with a hint, so that the student could try to answer again. The text of the hint depends on the answer chosen by the student.

Tests and self-assessment tasks can be used at various stages of learning process to help control the student's performance. They are also good for providing feedback.

Here are a few DER use cases:

- finding a solution for a problem while working on a new topic, discussing correct and incorrect approaches to the process of solving this problem;
- reinforcing the learned material: performing 2–3 tasks over 5–10 minutes;
- homework or independent classroom work;
- preparing for topical tests.

Exams, self-assessment tasks and tests can be a carefully selected set of 5–10 questions and various tasks on the topics outlined in the DERs. Students can choose to answer those questions consecutively or arbitrary by jumping from task to task. There should be a special window for displaying the number of tasks performed and the number of correct answers (the score represents the percentage of the

maximum grade). These interactive components allow students to arrange self-assessment, to control their knowledge independently, without the teacher.

Interactive models. The use of interactive models can significantly speed up the process of explaining new educational material and makes it more efficient, especially in the case of basic-level classes, where pupils experience a pronounced lack of study time and tend to perceive the ideas they are taught in "linguistic and visual" ways, particularly when it comes to biology. Images of various phenomena produced using models and animations stay in memory for a long time. "

Visualization graphic materials. Visualization graphic materials as part of DERs involve diagrams, graphs, pictures and photographs, including portraits of scientists. Graphical objects do not serve as mere substitutes for traditional illustrations that can be found in coursebooks, instead they complement the material, make it richer in terms of didactic value and suggest apt ideas about the studied objects.

Text. The term "text" here means a digitized illustrated text intended for reinforcing the material provided in the coursebook. The electronic form makes searching for textual information much easier. Such text may include brief lecture notes, law definitions, and biographies of scientists. Text objects can be seamlessly integrated into all training forms and methods and used at various stages of teaching process by both teachers and students.

Texts accompanied by audio narratives can be a very effective tool for pupils to practice class materials at home. The teachers can also use them as part of their lecture or presentation to illustrate a new topic. Audio narratives can prove to be very efficient for physically challenged children.

Materials intended for teachers. Apart from individual digital resources, the DER package has ready-for-use presentations and lessons that will provide the teachers with methodological help during their classes.

Lesson. An example of a lesson is an HTML page with a sequence of objects arranged in the lecture-defined order, which the teacher demonstrates in the class and specifies the estimated time that can be spent on each. The lesson can also outline the lesson model: its objectives, goals, interdisciplinary links, homework, etc. The ready-to-use lessons will contribute to the teachers' intellectual equipment, help them get ready for the lesson and explain new information.

2.2. General Requirements for Electronic Educational Editions (EEE)

An EEE combines digital, textual, graphical, audio, video and other training information made of a collection of scientifically grounded facts, claims and rules, as well as properties of and relations between objects, phenomena and processes studied within the given course.

1. EEEs may not contain information that does not directly help achieve learning goals, namely – irrelevant to the content and distracting the user.
2. The interface must be visually compelling, intelligible, unambiguous and presented in a way as to convey the operation logic of the EEE as a whole and of its separate parts in order to prevent users from making obvious mistakes and give them an opportunity to interact with the tool.
3. An EEE's computer simulation models must be furnished with user-friendly options for setting or changing the structure and parameters of the studied objects, processes and phenomena, and for simulating external stimuli. The potential issues associated with dealing with computer models must not distract the students from the problems they are solving, they must substantially minimize the intellectual effort spent on their digestion.
4. EEEs must be available for both internal and external use. Internal EEEs can be stored on portable media and operate as executable programs both on individual computers and across the local network. External EEEs are deployed in the World Wide Web and require browsers for operation.
5. An EEE must provide the option of automatic installation on a particular version of an operation system, including open source systems, without asking for any additional software. The installation package must include all components necessary to ensure the standalone operation of the EEE, such as fonts, drivers and software suites in compliance with government or international standards.
6. The contents of an EEE must be easily updated and upgraded without the need to change the program's source code once it has been tested. Also, EEEs must incorporate certain instruments for preventing the

unauthorized access to training materials and statistical data.

2.3. Requirements for the Content of the Electronic Educational Edition

The content of an EEE must involve the following components: its title, table of contents, content itself, utilities, manual and documentation.

1. The EEE's title must include its imprint data. The requirements to EEE imprints are given in the corresponding section of this standard.

2. The table of contents must provide a preview of the EEE's structure and the names of all semantic units used for training purposes throughout that EEE.

3. The content must represent the entire array of training data that is relevant to the goals and targets of that particular EEE, which will be used as a base for the subsequent performance rating. The wording of the training materials must contain scientific terms and be comprehensible, accurate, complete and consistent.

4. The utilities are intended for registering users, issuing statistical data, viewing content and determining the learning approach, as well as for actual studying and performing current, intermediate, milestone and final testing according to the chosen approach.

5. The manual must provide information on managing the EEE, and it must be accessible from the moment this EEE has been launched.

2.4. Requirements for the Functions of Electronic Educational Editions

EEEs must be able to perform the following functions: user registration; data protection; navigation; preview of the table of contents; choosing the learning route; teaching and performance rating; testing; statistical monitoring.

1. The user registration function must implement the entry, amendment and erasure of EEE user data.

2. The data protection function must ensure the integrity of EEE contents and test results, as well as user authentication for accessing certain data and limiting the access to the rest of the data.

3. The navigation function must provide the option to move across the EEE's structure in any direction.

4. The purpose of the function for previewing the table of contents is to enable the user to get the idea of what is inside the EEE without actually doing all the tasks, answering questions and going through the current performance rating.

5. The option for choosing the learning route must help the users to arrange the sequence of mandatory lessons for further performance rating by offering them to choose from a custom, test or full set of lessons.

5.1 The custom set of lessons allows the users to manually include into the learning route different modules, blocks and lessons by ticking their corresponding numbers in the EEE's table of contents.

5.2 The test set must allow the users to automatically include all the modules, blocks and lessons into the learning route where the students failed to score the required number of correct answers when tested across the entire scope of this EEE's materials.

5.3 The full set must allow the users to automatically include all modules, blocks and lessons of this EEE into their learning route.

5.4 The function of teaching and performance rating is designed to help learn theory, perform interactive tasks, answer questions and pass current, intermediate, milestone and final testing along the learning route. In case the students underperformed and did not score enough correct answers to the questions, they must redo the current EEE study unit. The study process may include a computer simulation model. Learning can be suspended and resumed from the point where it was suspended.

6. The testing function should be able to provide automated testing tools for the entire scope of the EEE, with the option to record the results as required, and to limit the time spent on working on the tests. Multiple-choice questions are randomly chosen from a database of questions on the given course. The test results are displayed on the screen. If the student fails the test, she must be given an opportunity to arbitrarily jump to any question she answered incorrectly.

7. The statistical monitoring function must return objective information about the student's level of mastering the given study

units, as well as other statistical data related to the student, depending on the particular query.

2.5. Requirements for the Structure of the Contents of Electronic Educational Editions

EEE content must be broken down to three levels of semantic learning units: level 1 is for modules, level 2 – for blocks, level 3 – for lessons.

1. Module is a large-scale syntactic, semantic and pragmatic learning unit consisting of a sequence of logically bound blocks tied together with semantic links based on the increasing scope and information richness from one block to another.

2. Block is a mid-scale syntactic, semantic and pragmatic learning unit consisting of a sequence of logically bound lessons tied together with semantic links based on the increasing scope and information richness from one block to another.

3. Lesson is the smallest syntactic, semantic and pragmatic learning unit consisting of several learning components. Theoretical material, examples, tasks, Q&A and tests are all mandatory learning components of a lesson. Among optional learning components are reference guides, graphics, audio and video files, which help perceive, comprehend and remember the learning material, as well as provide additional information consistency.

3.1 Theoretical material must contain the up-to-date information on the selected learning course and be sufficient for self-guided studying, performing tasks and doing performance tests without reiterating on the knowledge already acquired in the previous lessons. Theoretical material must accommodate for special didactic tools such as underscored or colored text.

3.2 Examples are to provide a detailed breakdown of certain key aspects of the theoretical material through solving problems, putting forward answers to questions, etc.

3.3 Tasks must be about discovering the underlying links between the studied objects, processes and phenomena; studying their functional characteristics in response to various external stimuli; and about developing practical skills of solving problems. The wording of each task must be accompanied by the outline of the clear order of expected steps, as well as requirements for expected outcome and the ways they must be presented.

3.4 Q&A's purpose is to help to consolidate the knowledge and acquire practical skills. Questions should vary by complexity, nature and way of choosing the answer in order to stimulate the students' cognitive activity. The entry of answers must be simple enough. The student must be able to answer the questions, not contemplate the method of entering it. There must be also a mechanism for confirming the correctness of an answer, so that the students could know whether their answers are correct.

3.5 Tests must include questions and answer alternatives. Tests should not include questions that can be answered without fully comprehending their sense in order to rule out a trivial guessing of the right answer. Incorrect answers must be distractors by their nature, close to correct answers, so that the student would have to have deeply mastered the learning materials in order to find the right answer. Tests may include warnings against typical errors in the students' behavior and answers, and offer caveats on the importance of avoiding and/or correcting them.

3.6 Reference guides must contain textual, tabular, graphical and other practice and learning data related to the learning material, as well as the rules and guidelines on the procedure of doing practice tasks, solving problems and carrying out experiments, preparing term and graduation papers, and other works.

3.7 Graphics, audio and video are intended as additional didactic materials, needed to further develop and demonstrate the most important aspects and states of objects, processes and phenomena studied within the course.

3.8 Thesaurus must contain a dictionary of terms and abbreviations related to the EEE's subject domain.

2.6. Requirements for the Learning Components within Electronic Educational Editions

The following are the learning components of an EEE: "Theory," "Examples," "Tasks," "Questions," "Tests," "Thesaurus," "Reference Guide," "Graphics," "Audio" and "Video."

1. "Theory" learning component must provide access to the rich-text description of the theoretical material within the studied lesson.

2. "Examples" learning component must provide access to examples and the corresponding explanatory text.

3. "Tasks" learning component must provide access to the description of practice tasks and problems, as well as to help doing them.

4. "Questions" learning component must provide access to questions, with the option to check the corresponding answers and display them prior to starting the test on the current lesson.

5. "Tests" learning component must provide access to testing tools designed to help with self-assessment:

- at the lesson level – current performance testing;
- at the block level – intermediate performance testing;
- at the module level – milestone performance testing;
- at the level of the entire EEE – final performance testing.

6. "Thesaurus" learning component must provide access to a dictionary of terms and abbreviations used throughout the EEE, with hyperactive links to their definitions.

7. "Reference Guide" learning component must provide access to the essential information about the current lesson.

8. "Graphics," "Audio" and "Video" learning components are to provide access to additional teaching materials.

9. "Graphics" learning component must provide access to diagrams, charts, drawings, pictures, photographs and other images, including animated ones.

10. "Audio" learning component must provide access to audio tracks associated with the essential concepts, facts, statements and rules related to the studied lesson.

11. "Video" learning component must provide access to films facilitating the learning process by demonstrating the properties of and relations between objects, fragments of processes and phenomena, as well as speeches by renowned scientists, politicians and other famous people.

2.7. Requirements for the Feedback in Electronic Educational Editions

The feedback provided by the EEE to the user must have specific format and content.

1. The format of feedback must ensure the means and volume of the provided feedback are preserved in their original state. This format determines the way feedback is given to the user.

2. If the users made a mistake during data entry, the EEE must provide some corrective and informative feedback to help the users enter their answers in the right format.

3. The users must not spend time looking for the feedback location — it must be presented in an obvious, appealing form.

4. The feedback must be removed only after the users have confirmed that they have finished using it by choosing the corresponding action.

5. The feedback must utilize the most instructive formats (text, graphics, sounds, tags, etc.).

6. The feedback content must convey the type of information the users are given through that feedback.

7. The feedback must support students in their learning process. It should not humble students for an incorrect answer under any circumstances. On the contrary, it should encourage them to improve their future results by providing them with necessary information.

8. The feedback must be informative. If the chosen answer is incorrect, the feedback must offer reasons as to why it is incorrect; whereas if the answer is correct, the student must see why it is indeed correct.

9. The feedback must be professional-looking and serve to correct the answers.

10. The feedback must be clear, free from slang and unambiguous.

11. The feedback must not be random — it must be relevant to the answer. In the course of testing, the most common mistakes can be identified. EEEs must incorporate such feedback that would account for these types of answers, so that students do not confuse with similar-looking, but semantically different concepts.

2.8. Requirements for the Way Electronic Educational Editions Look and Feel

1. EEE must present the learning material in visually pleasing and user-friendly way in order to speed up its digestion. The number of words must be limited to not cause excessive tiredness with the volume of text.

2. Test fonts must be chosen in accordance with ergonomic standards of GOST 7.83-2001. The font's properties, such as its

look and size, can significantly affect the readability of the information available in the EEE. The number of drastically different, contrasting fonts on an EEE page must be minimal. It is recommended to use sans-serif fonts (such as Arial) for the page body. Fixed-pitch and decorative fonts are only suitable in cases when they are really necessary. The encoding of the chosen fonts must conform to the general standards for symbol encoding.

3. The EEE's color palette must ensure complete and non-tiresome cognitive perception of information and facilitate the visually agreeable and easily comprehended presentation of material. The use of light text on a dark background is only acceptable provided it is clearly visible, and this can be achieved through making it bold. Pages where text information occupies most of the space must have a light background. A black background is not acceptable under any circumstances. It is a good practice to use standard black or dark-blue color for the font. Red font should only be used in some titles or for highlighting the most crucial information.

4. The EEE's basic content that has an immediate relevance to the EEE's goals and targets must be found in the focus of reader's attention. Indents in the main body of that content should not be too wide — this way it'll be easier to visually grasp the learning material.

5. The EEE's graphical content has a complementary role and must expedite the mastering of the learning material instead of distracting from it. It is crucial to take every care when selecting pictures for publications on religious, political and other topics involving national and cultural diversity. Audio and video materials must be provided as an option for the student to link to the main body of the lesson.

6. Page controls must be straightforward, unambiguous and simple enough as to not distract the student's attention from the core learning material. They must have hints in the main language of the EEE.

7. With externally published EEEs, the number and size of graphical objects and audio & video files must be kept to a minimum, as they take up too much space in computer memory, and the speed of communication over the channels between network computer is critical to their delivery.

8. Any animation within the EEE to which playback speed is critical, should be independent of the computer type and model.

9. Colors in EEEs must stay the same. When designing an EEE, it is recommended to take into account the color associations listed in Table 1 below.

Table 1. Color associations

Color Palette	Associations
Red color	It causes the most stimulating effect. It is the most active color. Active colors are easier to percept and remember.
Red-orange colors	It leaves a warming sensation. Capable of causing agitation, they stimulate in humans interest towards the external world, socializing and activity.
Orange color	It imparts the sensation of maximum warmth.
Yellow-orange colors	Make objects looks closer than they are.
Yellow color	It gives a user a feeling of ease and vivacity. It looks like the most light and ethereal color.
Green color	It adds visual balance, combines the ease and vivacity of yellow with calm and gravitas of blue.
Light-blue color	It gives the feeling of cold, as well as the perception of time and space. Has an inhibiting effect. Calms down and relieves agitation. Introduces reason and rationality to a person's behavior. This color is considered the most difficult for perception.
Dark-blue color	Gives the feeling of calmness.
Polar color schemes	Goes very well together when mixed on a gray background or in separate planes.
Gray color	Neutral color. It does not attract attention, nor does it spur any reaction, at the same time it creates the feeling of stability.

2.9. Requirements for the Documentation for Electronic Educational Editions

1. EEE must be supported by comprehensible, consistent and complete documentation, prepared and published in accordance with the ST RK 1087 standard. It is also needed to automatically include EEE data into the digital library directory.

2. EEE documentation must include an installation and operation manual, user manual and the instruction guide.

3. Installation manual must describe the ways of installing the EEE. It must contain the information about system requirements and specific drivers, if any. That information must be clear, concise and ample. The manual describes how to install the EEE and how to launch it. All instructions must be straight and accurate in order to enable users to follow those instructions without any additional questions. The instructions must be easily understood by a user without any professional background in computers, and must not use jargon. If some data is supposed to be generated by the tool, the manual must explain the backup procedure.

4. User manual must contain conventional chapters that simplify the process of working with the manual, such as a table of contents and help. The manual must provide a brief reference guide describing the key items of the manual, so that users could quickly go ahead with the launch of the EEE. The user manual must list all possible help sources, such as mailing addresses, email address, website URLs, telephone numbers and other data.

5. Abstract must contain an introduction of all requirements and the summary of contents in order to help the teachers to quickly evaluate the EEE's contents and decide how well it fits the learning purposes.

6. Other sources represent links to other materials in the user manual. All materials specified in the link must be either included in the manual or be readily available in the Internet.

7. Technical instructions must be part of any EEE. They can be either printed out or stored online. If technical instructions are provided in real time, e.g. in a readme file, this file must come with the EEE. Print-out instructions must refer to detailed online instructions and explain how to access them. If website links are incorporated into the EEE, the teachers must have a way to view them in a separate list. This will give the teachers an opportunity to check the list before their students start using the product.

2.10. Requirements for the Imprint Data of Electronic Educational Editions

1.1The contents and location of the EEE's imprint are determined by its type, number of physical storage media and formatting. Discrepancies between the same items of data located at different places of the EEE are not allowed. The imprint items common for all EEE editions must be free from discrepancy, in accordance with GOST 7.4.

1.2 Below are the key components of the EEE imprint:

– title;
– data at the head of the title;
– author credentials;
– classification indices;
– copyright symbol;
– barcodes;
– sub-title data;
– imprint;
– system requirements;
– state registration number;
– list of literature;
– abstract.

1.2.1 The title, data at the head of the title, author credentials, classification indices, copyright symbol and barcodes are presented in the EEE in a certain form.

1.2.2 Depending on the type of the EEE, sub-title data may include the following:

- information explaining the title;
- information about the type of the tool;
- information about the purpose of the tool;
- number of bundles in a multi-bundle EEE;
- sequential number of the bundle;
- information about the type of data medium and its identification code for local EEEs.

1.2.3 EEE imprint data should include the following data:

- publisher's name, mailing address and email, telephone number;
- developer's name, mailing address and email, telephone number;
- data size in Mb;

- duration of audio and video clips in minutes;
- components of the tool (number of media, availability of supporting documentation, etc.);
- number of copies for local EEEs;
- number of the license for publishing the EEE, date of its issue.

1.2.4 System requirements must include:

- computer requirements (model, CPU, processing speed; HDD capacity, RAM volume);
- operation system;
- audio system;
- graphics and video.

1.2.5 The state registration number of the electronic tool is assigned to it by an authorized government agency.

1.2.6 The list of literature is compiled based on the GOST 7.82 standard.

1.2.7 The annotation should be prepared and formatted according to the GOST 7.9 standard.

1.3 The publisher may, at their own discretion, add any other information about the EEE as they see fit to reflect certain important details of the tool.

1.4 The imprint data in serial and multi-bundle tools must be given in accordance with the GOST 7.83 requirements.

1.5 Apart from its own imprint, an EEE serving as a substitute of a printed educational publication must include the imprint of the corresponding printed publication.

1.6 In EEEs published in languages other than the official ones, the imprint data (except the authors' names) must be given both in the main language of the tool and in translation into the official language, with an indication of the original EEE's language. Names should be transliterated. These data should be inserted above the imprint data on the main screen, on the inside of the primary packaging and on the back of the secondary packaging.

1.7 The imprint data should be presented on the title page (main screen). The title page can consist of several interlinked parts.

1.8 The imprint data of locally published EEEs must also be placed on the following parts of its distribution package:

– on the label attached directly to the digital medium;

– on the front, the inside and the back of the primary packaging (the packaging container in direct connect with the digital medium that protects it against dust and moisture);

– on the front, the back and on the sides of the secondary packaging (the packaging container where the digital medium covered with the primary packaging is stored);

– in the supporting documentation on paper.

1.9 In the case of locally published EEEs, imprint data and system requirements may be specified on the outside. Table 2 gives a breakdown of what should be specified in terms of imprint data and where it must be located.

Table 2. Characteristics of imprint data

Imprint item	***Location***				
	Title Page	Label of the information medium	Primary Packaging	Secondary Packaging	Separate Supporting Documentation
Title	R	R	R	R	R
Data at the head of the title	R	O	R	O	***R***
Author credentials	R	R	R	R	R
Classification indices	O	O	O	O	O
Copyright symbols	R	R	R	R	R
Barcode	U	O	O	O	U
Sub-title data	R	O	R	O	R

Imprint	R	U	R	R	R
System requirements	O	O	R	R	R
State registration number	O	O	O	O	O
List of literature	O	U	R	R	R
Annotation	O	U	O	R	R
U – unnecessary R – required O – optional					

Therefore, **the primary objectives of DERs are:**

- helping teachers to prepare lessons:
  - lesson compilation and modelling based on individual digital objects;
  - providing large volumes of additional information, including reference data, for a deeper knowledge about the subject;
  - effective information search across a set of DERs;
  - help in preparing tests and self-guided learning tasks (optionally);
  - help in preparing creative works;
  - help in preparing per-lesson plans related to digital objects;
  - collaboration with other teachers via the Internet and portable external media.
- help with teaching lessons:
  - demonstration of prepared digital objects using a multimedia projector;
  - the opportunity to use virtual laboratories and interactive models inside the suite as frontal lab works;
  - computer-based testing of students and help in performance rating;
  - research and creative work individually conducted by students during lessons and involving dealing with DERs;
- helping students with their homework:
  - stimulating in students interest to a particular subject due to a new format of the presented material;
  - automation of self-assessment by students and making it available at any suitable time;
  - vast database of objects for using in talks, reports, annotations, presentations, etc.;
  - prompt retrieval of additional reference information;
  - development of the students' creative potential in a virtual subject-oriented environment;
  - helping students study the subject at a preferable pace and at the chosen instruction complexity level based on their individual perception capacity;
  - engaging pupils in modern information technologies, encouraging them to want to master IT and work with them on a regular basis [20].

At the request by the Ministry of Education and Science of the Republic of Kazakhstan and in accordance with the government standard for education and the standardized plan for teaching algebra, Aytugan Alzhanov, PhD in Pedagogy, has developed an electronic educational edition for learning algebra intended for the pupils of the 7^{th} grade attending comprehensive schools and specialized schools with enhanced education in mathematics [21].

The EEE's purpose is to teach pupils mathematics using computer, to train them in various methods of solving mathematical problems and to nurture in them the ability to study mathematics on their own.

Thus, the author had to complete the following steps:

- presenting learning material in structured way by breaking it into study units through identifying individual modules, blocks and lessons;
- preparing learning material, examples, tasks and tests for each lesson, block and module;
- preparing animation, multimedia, audio and video materials in order to lay open the inner nature of presented learning material;
- designing an interactive program that could be used to browse through the learning material on a unit-by-unit basis or for the entire subject scope;

- designing an interactive program for teaching each study unit separately as well as provide a general training in the subject;

- designing an interactive program for running self-assessment test on each study unit and on the knowledge of the subject as a whole;

- preparing the reference guide and thesaurus for the given subject.

These goals have been fully achieved with modern multimedia and intelligence tools associated with computer systems and information technologies.

In this particular EEE, learning information is accumulated in the following order: first, it presents simple facts and concepts within the given topic; then, they are used as a base for new assertions, which in turn can serve a foundation for the acquisition of a higher level of knowledge, etc. In this case, the assembling of educational material implies determining semantic relations between the study units, and its implementation must observe the logical links between separate units, which enables the student to quickly navigate between the units. This way the student can keep an eye on several units at a time, while moving forward and inward across these units.

The electronic educational edition on algebra for the 7-grade pupils of comprehensive schools provides information about algebra in an intelligible form. The proposed EEE is based on the basic course containing a compulsory general education minimum for teaching algebra to pupils. It aims to help students master methods and tools of IT-assisted problem solving, acquire skills in voluntary and rational use of computers first in their studies and then in their professional activities.

The EEE has a maximum regard for the audience's needs and the capabilities of available computers.

The EEE's objects include digital, textual, graphical, audio, video and other educational information compiled from a set of scientifically grounded facts, statements and rules, as well as the properties of and relations between objects, phenomena and processes that are normally studied within the scope of algebra lessons in the 7^{th} year. The EEE also contains a user guide and control tools, while it is free of any information that fails to directly serve the purpose of achieving learning goals or distracts users.

The EEE's interface is visually compelling, intelligible, unambiguous and presented in a way as to convey the operation logic of the EEE as a whole and of its individual parts, in order to prevent users from making obvious mistakes and give them an opportunity to interact with the tool.

The EEE's computer simulation models (problem solving algorithms) are furnished with user-friendly options for setting or changing the structure and parameters of the studied objects, processes and phenomena, and for simulating external stimuli. The potential issues associated with dealing with computer models must not distract the students from the essence of the practical problems they are solving using those models.

The EEE is available for use both internally and externally. Internal EEEs can be stored on portable media and operate as executable programs both on individual computers and across the local network. External EEEs can be deployed in the World Wide Web and require browsers for operation.

The EEE provides the option to automatically install on a particular version of an operation system without asking for any additional software. The installation package includes all components necessary to ensure the standalone operation of the EEE, such as fonts, drivers and software suites in compliance with government or international standards.

The EEE will operate in set modes in the absence of disruptions (such as power failure, hanging of the operation system, etc.), besides it is programmed to continue the EEE's operation after the disturbances caused by the aforementioned disruptions. The tool has been designed inside a framework that allows assembling learning files on a unit-by-unit basis. Therefore, the EET can be easily amended or upgraded during operation, while it also provides protection against unauthorized access to learning resources and statistical data.

This article presents the didactic possibilities of digital educational resources as a means of differentiation;
the levels of student's personality development during differentiated training are highlighted through the use of digital educational

resources. This article discloses the structure of digital educational resources as a means of differentiation. Ainash Davletova, the PhD in Pedagpgy, has designed an electronic PTC (EPTC) that contains a set of various teaching materials and educational resources (materials for learning, practice and training, as well as additional information and reference materials presented in various forms) (Figures 1, 2).

Figure 1. EPTC main page

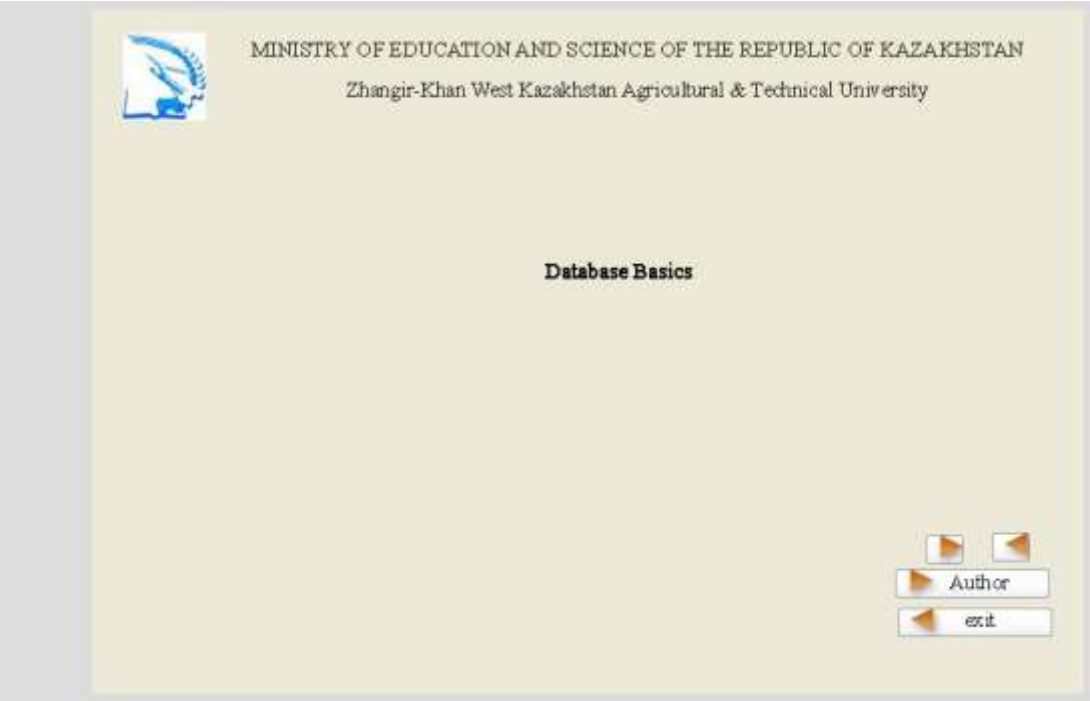

Figure 2. EPTC syllabus

Week	Topic	Lecture	Practicals	SKOP	SRO	Total hours
1.	Introduction to Databases	1	2	2	4	9
2.	Database Architecture	1	2	2	4	9
3.	Principles of designing a relational data model	1	2	1	5	9
4.	Brief description of a software used to create DBMS	1	2	2	4	9
5.	Creating and working with MICROSOFT ACCESS database	1	2	2	4	9
6.	Field reordering	1	2	1	5	9
7.	Establishing the cross table relationship. Creating tables in Design Mode. Lookup field, input mask	1	2	2	4	9
8.	Queries. Creating Queries in Design Mode	1	2	2	4	9
9.	Selection criteria specification. Creating different queries. Crossrequesting	1	2	1	5	9
10.	Forms. Creating complex (hierarchical) forms. Adding images and control buttons to the form	1	2	2	4	9
11.	Reports	1	2	2	4	9
12.	Macros, macro call. Modules	1	2	1	5	9
13.	Database Design	1	2	2	4	9
14.	Developing forms for complex structures	1	2	2	4	9
15.	A small comparative characteristic of the Clipper and Access databases.	1	2	1	5	9
	Total	**15**	**30**	**25**	**65**	**135**

Such PTC should be oriented at the user that studies the subject independently and must feature a special way of data presentation (interactive dialogs with enough questions and self-assessment tasks) (Figures 3, 4).

Figure 3 – EPTC main page

4. Discussion

Diligently elaborated practice tools for an electronic PTC designed for self-guided learning will inspire in students the

appropriate interest and motivation towards independent work, and not only because the course is in electronic form and features computer graphics and multimedia files. Working with such electronic PTC will stimulate students' mental activity: it will enhance their ability to concentrate and focus attention, intensify their sensitivity and observation, enhance their abilities to memorize the learning materials.

Figure 4. Types of lessons within this EPTC, by hours

When working on an electronic coursebook, it is important to start from practical and cognitive goals and targets, the quality and completeness of the prepared didactic tools for electronic educational products since information, education and telecommunication technologies are only the levers for the achievement of practical objectives of education.

Based on our experience, another challenge that the authors and developers of the PTC can face is caused by the nature, specific character, diversity and labor intensity of the associated work which requires from the developers of electronic tools and PTCs to have corresponding skills and knowledge in various disciplines, such as psychology, pedagogics, new information and communication technologies, etc. The difficulty of using diverse expertise and complying with relevant requirements have caused certain problems for the authors and developers of electronic tools at various stages of developing the PTC [22-23].

5. Conclusion

Therefore, DERs are widely used by school teachers for both preparing and teaching lessons; they make a teacher's work significantly easier, which allows us to conclude that they are central to a teacher's educational space.

Digital educational resources may be used by all people involved in the educational process: teachers can use them to prepare and give lessons, students can use them during lessons and self-guided studies; they are also useful to other educators, developers of practice and training materials, education management officers, and parents.

By creating DERs or using those created by others, teachers join in on the rapidly evolving information culture, wherein staying behind means getting lost in the information-driven society.

Storing DERs does not require cabinets or libraries — they take a finite space in a computer memory or on external media. They are much easier to arrange and systemize than printed-out data. This is one of their dozens of advantages, a fairly important one, since after years of collecting DERs, categorizing them and labeling them; teachers can create their own system to rely on in their teaching process. Despite the fact that teachers will initially use DERs on an ad-hoc basis during their teaching career, they will

eventually realize that the system they have begun to build will provide them with an immense help in their practice. This will allow them to collect a database of stored resources, as well as (given a sufficient collection reasonably arranged in directories) set up a quick and accessible search for and selecting of the DER that is the most relevant to the topic of interest, both for the teachers and for her students.

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