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THE CONCEPT OF THE EDUCATIONAL COMPUTER MATHEMATICS SYSTEM AND EXAMPLES OF ITS IMPLEMENTATION

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The article deals with the educational computer mathematics system, based in Kherson State University and resulted in more than 8 software tools to orders of the Ministry of Education, Science, Youth and Sports of Ukraine. The exact and natural sciences are notable among all disciplines both in secondary schools and universities. They form the fundamental scientific knowledge, based on precise mathematical models and methods. The educational process for these courses should include not only lectures and seminars, but active forms of studying as well: practical classes, laboratory work, practical training, etc. The enumerated peculiarities determine specific intellectual and architectural properties of information technologies, developed to be used in the educational process of these disciplines. Whereas, in terms of technologies used in the implementation of the functionality of software, they are actually the educational computer algebra system. Thus the algebraic programming system APS developed in the Institute of Cybernetics of the National Academy of Sciences of Ukraine led by Academician O.A. Letychevskyi in the 80 years of the twentieth century is especially important for their development.

***Keywords**. educational mathematics computer system, automation of development, mathematical methods, educational software.*

1. INTRODUCTION

Informatization of social activities, including informatization of educational and research activities is one of the key technological challenges for the development of the information society in Ukraine. Methodological, scientific, technological, psychological and pedagogical problems associated with the use of information and communication technologies (ICT) in education, particularly in the educational process, have been in the focus of Ukrainian scientists since 60-ies of the XX century.

The recognized center of scientific research in Ukraine on problems of information science, in particular, on the use of ICT in the education and science is V.M. Glushkov Institute of Cybernetics of NAS of Ukraine. Mathematical and software tools of wide application large systems created by the institute, were used in the hundreds of organizations [1,2]. Among them one can recognize the complexes of programs for computer-aided teaching and scientific research. The problems of ICT in the education are the main focus of researches of the International Research and Training Center of Information Technologies and Systems of NAS and MES of Ukraine, which is part of the Cyber Center of NAS of Ukraine.

In many universities of the country scientific groups were created and work actively in issues related to the use of ICT in the education. Note, first of all, universities MIT, Carnegie Mellon, Berkeley, Stanford, Taras Shevchenko National University of Kyiv, V.N. Karazin Kharkiv National University, KNTU "Kyiv Polytechnic Institute", KNU "Kyiv-Mohyla Academy», Dragomanov NPU, Kherson National Technical University, "Kharkiv Polytechnic Institute", "Kharkov Institute of Radioelectronics", Kherson State University. We could continue this list.

2 THE OUTLINE OF THE PROBLEM

Among specific results of these programs, other state efforts in this direction we can outline the regular mass supplies of modern computer classes and other information technologies to educational institutions, the organization and budget funding of developments of educational software for both secondary and professional institutions in Ukraine, and other measures [3].

In this regard, general scientific, methodological and technological problems, related to the organization of processes of creation, maintenance and effective usage of educational software during its life cycle, acquire the special importance. The relevance of these problems is caused by the following main objective reasons:

- Currently there are no industry standards for educational software, and existing recommendations concerning quality indicators of both the products and processes of creation of these tools are primary in nature, because they haven't still passed the practical tests.
- Several dozens of educational software, that have been designed to orders of MESYS, have passed certification and methodical testing and have been implemented in the educational process, are developed by different teams of developers, so there is a difference in concepts, architectural approaches, technologies, software components and reusing "alien" technologies on the legitimate basis. нет глагола
- Almost all groups of educational software developers were essentially formed during working on projects, they require advance training and experience exchange, effective monitoring of their software by users.

The analysis of educational software in mathematics showed that there is a contradiction between the potentially broad intellectual properties of modern professional computer mathematics systems (PCMS) using symbolic conversion and computer algebra methods, and the practical impossibility of effective enforcement PCMS in the educational process. This contradiction can be solved by the development of educational computer mathematics systems (MECMS), in which intelligent capabilities of PCMS will be focused on solving specific problems of the educational process support. We can expect that this will lead to the creation of educational software systems of a new type. Namely, MECMS should have well-defined intellectual capabilities, focused on supporting the practical activities of users – students and teachers.

Thus, the research problem can be formulated as a study of the theoretical and methodological foundations, functional requirements, mathematical models and methods, technologies and tools of the creation of MECMS, that will meet conceptual methodological requirements.

Under MECMS we understand educational software systems in exact, natural and other educational disciplines that use mathematical models and methods of subject areas, based on the technologies of symbolic conversion and computer algebra methods.

The research should cover MECMS for users of all educational qualification levels, including undergraduates and graduate students

3 RESULTS

The analysis of information and model software of EIS and MECMS determines the use of appropriate mathematical models, informational technologies and developing tools of EIS in general and MECMS in particular.

Modern ISEP, including DLS, have to meet the following system requirements:

- support for work on any platform, over any network,
- standardized Internet-compatible interface,
- data storage in the standardized layout of educational information saving.

Therefore, it is important to follow the common standard for e-learning content and management, particularly for saving layout of electronic teaching resources. The existing state standards, ISO 9001 define general requirements to the development of information technologies. International standards are developed by the generally accepted Institute for Standardization and are recognized by developers de facto. At the moment such standard is one, developed by IMS Global Learning Consortium [4]. IMS Standard provides open specifications for software and e-learning resources development, as well as the support of activities within the distributed learning. The main directions of IMS specifications development are metadata, content packaging of electronic learning resources, tests and evaluation of the educational process as well as the content and educational process management.

To maintain electronic teaching resources databases one should consider, while developing, the possible conversion of data files in the specific format for easy transfer of these information resources to other ISEP. Therefore, all metadata fields should be defined by the IMS specifications. To enable communication between EIS (DLS), which are built on different technologies and platforms, they use IMS-LDP (Learning Design Packaging) and IMS-CP (Content Packaging) specifications. These specifications are described in the XML format. Standards for metadata define the set of attributes, required for creating, saving, evaluating of educational objects. The specifications describe such attributes of educational objects as type, author's name, owner's name, date of creation, the format of the object and so on.

IMS Enterprise Information Model describes data structures that specify the operation and interaction of distributed educational systems, namely: educational process management, administration of students, administration of the library, human resources management.

The information management model supports the following 4 processes required for the interaction of education systems with administration systems:

1. Personal data storage.
2. Learning groups management.
3. Registration management.
4. Processing and storage of final results (rating of student group, test results, implementation of the course work program, etc.).

Information management model is created to define a standard set of structures that are used for the exchange of electronic educational resources.

In MECMS testing with using simple types of tests is not the main form of knowledge control. However, the overall process of mathematical knowledge evaluations meets the IMS definition and therefore subjects to standardize “Kherson Virtual University" DLS is implemented with all types of IMS QTI specifications. Because IMS is an open standard, the work is underway to expand it to the "mathematical" tests.

Specifications of SCORM standard. Many IMS specifications were used in the development of reference models, standards and national profiles. Thus, the Content Packaging, Metadata and Simple Sequencing specifications became the part of the reference model in the content object of SCORM standard, the Metadata specification established the basis of the IEEE LOM standard, and became the part of Canada and Singapore national profiles as well. The Learner Information specification became the part of the UKLea profile in the UK.

IMS specifications is the most supported and developing initiative of standardization in the field of e-Learning. Among the IMS members – Oracle, Microsoft, Cisco, Blackboard, WebCT corporations; Great Britain, Canada, Australia, U.S. governments; MIT, Carnegie, Mellon, Berkeley, Stanford universities and many others.

SCORM (Sharable Content Object Reference Model) is an initiative of the ADL (Advanced Distributed Learning) association, the project of the US Ministry of Defense, which aims to create conditions for the development of reusable content objects for e-learning [4,5].

The current version of SCORM 2004 includes three IMS specifications: Content Packaging, Metadata and Simple Sequencing. In addition, it includes the access model of the content object in the process of reproduction, inherited from the AICC (Aviation Industry Committee on Computer-based training) standard.

Thus, SCORM is the most popular on the e-learning market unifying standard for specifications of various organizations. Also SCORM is one of the IMS specifications profiles.

Now SCORM is widely supported by developers of e-learning technologies in the U.S.A. and Europe.

The presence of clear eligibility criteria makes SCORM ideal for commercial organizations and the presence of open to general use software testing tools rules out the manipulation of facts while choosing a system or content.

The current version of SCORM is the "mandatory minimum" of specifications support in the new versions of e-Learning software. Like the IMS specification, SCORM is an open free standard.

Development and implementation of MECMS is carried out:

- on the basis of the functional requirements;
- in compliance with national standards of quality [6,8,9];
- taking into account the peculiarities of the development of educational software systems;
- according to the technologies of development and support during the lifecycle of medium and large software systems [7-9];

First of all, it concerns the informed selection of the development process model. We'll consider this reasoning on the example of MECMS for secondary schools.

The selection of the development process model is caused by the following factors:

- Requirements of compliance with the national standards of quality.
- Requirements of compliance with the international IMS, SCORN standards.
- The peculiarity of the user's requirements, which lies in the relative independence of the major subsystems, modules and system components.
- The presence of the first versions of software modules and software components of general use that should be incorporated into the subsystems of "Student's Workplace" and " Teacher's Workplace" levels.
- The presence of the first versions of such CASE-tools as editors of certain types of electronic didactic materials.
- Terms of the agreement for scientific and technological developments lying in the fact that the work is carried out in two year's stages.

Note that the enumerated factors are typical for the development process of distributed software systems. Therefore, the decision to select the development process model can be recommended as the default one.

Considering stated above, we chose the hybrid development process model, which is based on the following principles:

1. Each of the major subsystems (MWP, TWP, SWP) is developed independently from the previous specification of interfaces based on standard network protocols of data exchange and XML (eXtensible Markup Language) technologies of electronic documents representation [10]. To represent the mathematical formulas we used XML language extension – MathML language.
2. MWP subsystem is developed by the evolutionary model. The first version of MWP is developed by a separate team according to the cascade model, then attested and implemented on the server. Further development of the subsystem is carried out according to the evolutionary model.
3. TWP subsystem is developed by a separate team according to the evolutionary model on the basis of previously designed components, then attested and implemented on the server. Further development of the subsystem is carried out according to the evolutionary model.
4. SWP subsystem is developed by a separate team according to the hybrid model on the basis of previously designed components (for the TerM system), then attested and implemented on the KSU server. Further development of the subsystem is carried out according to the hybrid model and consists in bringing of already developed educational software products to the system standards and development of new software products according to the system standards.

Selection of system platforms and implementation technologies. The educational software market is dominated by such system platforms: MS Windows, MacOC, Unix. Thus, there is an objective basis for using of cross-platform programming languages such as Java. However, in practice, such a decision can be taken only under the conditions of software projects "from scratch". Our projects use essentially software modules, components and technologies developed previously for projects ordered for OS MS Windows

At the planning stage of the MECMS development process we used "MS Visual Project – 2002" tool, and "MS Visio" during the design process. The practice has shown the appropriateness of its use, while simultaneously performing a project on the Microsoft platform. For the simultaneous development of multiple software products on the cross-platform, it is more acceptable to use SVN (Subversion) open system.

Actually the design was carried out by the technologies of object-oriented development [11] and programming at MS Windows [12].

Analysis of the literature and our own experience have shown that the critical issue from this point of view is the algebraic programming technologies supporting adequately the analytical transformations and methods of computer algebra. Actual requirements to MECMS involve the use of algebraic programming systems implemented under OS MS Windows. However, the prospects require such technologies for other platforms as well. Thus, the central point in building a cross-platform EIS of our architecture is the problem of implementation of algebraic programming cross-platform technologies.

The implementation of the described architecture software and functionality has its own peculiarities:

1. Implementation of MWP subsystem requires the database and Internet technologies. Thus, the DBMS has to support remote administration via web interface. In addition, data tables of users and messages, and other data tables should support data export in XML and SQL. Therefore, we have chosen MySQL DBMS with the PHPMyAdmin web interface [13].
2. Implementation of SWP subsystem requires networking technologies on the level of the operating system. Thus, it is just enough to use MS Windows API, including Socket technology, as well as XML and MathML technologies for data transmission and processing [14].
3. Implementation of SWP (object-oriented PMC) requires a wide range of tools of different object-oriented modules and PMC components, which, in turn, have to use processing technologies for all forms of media – text, graphics, multimedia. The practice has shown that the most effective data storage technology for our purposes is XML technology.
4. Separately, we highlight the mathematical information processing technologies that allow to create EIS quickly and efficiently, focused on the math, information and natural sciences. In our opinion, the algebraic programming technology is the most adapted for these tasks.
5. The separate tasks of the PMC technologies are the implementation of editors for mathematical formulas and geometric objects, editors for specialized physical objects and chemical formulas editors.

"Mathematical Editor" (ME) and "Graphs" (GR) general purpose components are the components of ActiveX. The ME component provides the user (client) with two interfaces for interaction. One of them (_DMathEditor) provides with opportunities for the direct invocation of methods and properties control. Another one (_DMathEditorEvents) is used to process events, which are caused by the user. The component is the MathEnv7_9.ocx file. To implement it, we use the wrapper, generated by the Visual Studio standard tools.

Let us consider the functions of the CASE-tools in software modules. CASE-tools include Textbook Editor, Taskbook Editor, Exercise Editor, Handbook Editor. The purpose of CASE-tools is to provide the user, who does not possess the professional programmer’s competencies (teacher, methodologist), with an opportunity to edit and format the content of the appropriate software modules. The main functions of these software modules are described below.

Textbook Editor. The electronic textbook is created by XML-technologies according to the SCORM standards. XML-documents define its structure, and the structure of the main menu, TOC, Contents, Exercise fields.

The functions of the common interface (main menu).

The functions of the File Menu:

- Create Textbook creates a new textbook with an empty content.
- Open Textbook opens an existing textbook (the special format file) to edit it and make changes.
- Save Textbook, Save Textbook as… saves the textbook in a file system.
- Save Paragraph saves the textbook paragraph.
- Print Paragraph prints the highlighted paragraph due to selected printing options.
- Exit saves textbook and closes the Editor.

The functions of the Edit Menu:

Support the editing process, namely: text moving (Cut-Paste) and text copying (Copy-Paste).

The functions of the View Menu.

With these functions, you can show or hide:

- the main toolbar (Main Toolbar command);
- the content window of an electronic textbook (Content Window command).

The functions of the Textbook Menu

Content Editor initiates editing the content of the textbook.

The contextual menu functions in the content window support the creation of new paragraph sections, reordering of sections (paragraphs) in the content window and the textbook language change function.

Save and Close saves the changes, made by the user and closes the edit window. Undo and Close is used to undo last changes.

Title Editor allows you to edit the title of the electronic textbook.

The functions of Textbook Language menu manage to change the current language for editing the contents of the electronic textbook (Current Language command) or to add/delete languages of the electronic textbook (Textbook Languages command).

To edit the contents of the textbook section (paragraph) one can use any free distributed editor that supports the Reach Text Format (. Rtf) in a separate edit window. The use of different paragraph styles makes the text structured and automates the process of creating the appropriate XML-documents.

The "Insert Formula" function creates a formula window and activates the mathematical editor. To close the formula window one should click a mouse anywhere in the text field outside the formula window.

Exercise Editor is designed to create and edit the contents of exercises offered in each textbook section. Exercise Editor is created in a separate window of the Textbook Editor. The following items can be edited:

- Text field of the exercise.
- Instructions field of the exercise.

Exercise Edit functions include:

- Create Exercise.
- Save Exercise.
- Edit Exercise Contents.
- Delete Exercise.
- Copy Exercise.
- Paste Exercise.

Taskbook Editor is designed to create electronic Taskbook contents and modifications of already created tasks. Taskbook Editor is created in the general Editor Interface of the electronic textbook.

To edit the task one creates the special Task Editor window. Task Editor supports:

- Task Number.
- Task Contents.
- Task Type.
- First Task Formula / Hidden Task Model.

Editing the task terms is carried out by means of the Task Contents Window, including the Insert Formula function.

Besides the task terms field, depending on its type, the first task formula or hidden task model is stored and edited in the appropriate field.

Task Type is defined by whether the user should independently determine the formula, which begins its solution (task model), or the formula automatically becomes the first formula in solving the task, when the user performs the Start Solving function in Solution Environment. (Of course, Task model is an attribute of so-called text tasks.)

Handbook Editor is designed to create and edit electronic handbook contents. Handbook Editor is created in the general Editor Interface of the electronic textbook.

In many subject domains the solution of an applied task requires the transformation of mathematical objects. The typical situation is as follows: the mathematical model of the object is specified as a constructive mathematical object and the subject domain (training module) is described as a list of allowable transformations of mathematical objects.

The applied task solution consists of logical valid transformations of an object, bringing it to the necessary (simple) form – the answer. For example, the mathematical model of the object is a system of linear equations, structurally defined by the augmented system matrix. Valid transformations are elementary transformations of the matrix lines. In the task one has to find the exact solution of the system.

The full list of mathematical models and methods of mathematical subject domains transformations is defined by the functionality of corresponding PMC, which, in turn, supported by the PMC architecture.

The typical example is a PMC TerM model. The basis of this model is a three-tier logical architecture "client-server": Introduction – Educational Task – Algebraic Computation. Such tasks are naturally solved by the algebraic programming methods. The most adequate systems of algebraic programming are those, using copying technologies.

For years, APS have been used for prototyping various algebraic algorithms in scientific researches. For tasks that arise, while developing MECMS, APS was used at the first time in the development of AIST – the prototype of modern MECMS The experience of APS using for this purposes showed its effectiveness as a production system of MECMS kernel programming.

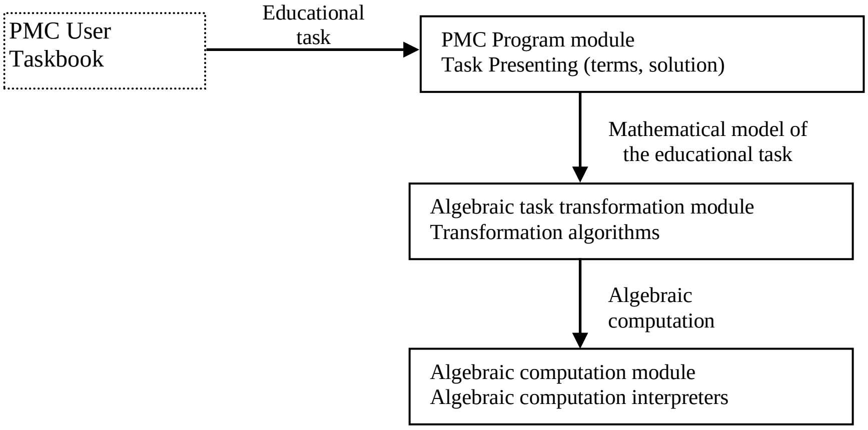

Fig. 1. The object model of solving educational tasks.

Transition to MECMS programming on MS Windows set the task of APS implementation as the cross-platform system, developed for MECMS tasks. This problem was solved by V. S. Peschanenko [15]. The practice of algebraic calculations programming showed the need to formalize common approaches, to develop the mathematical model of algebraic computations and methodology of its application. MECMS is a set of interacting software modules. The interaction concept of MECMS modules is presented in Fig. 2

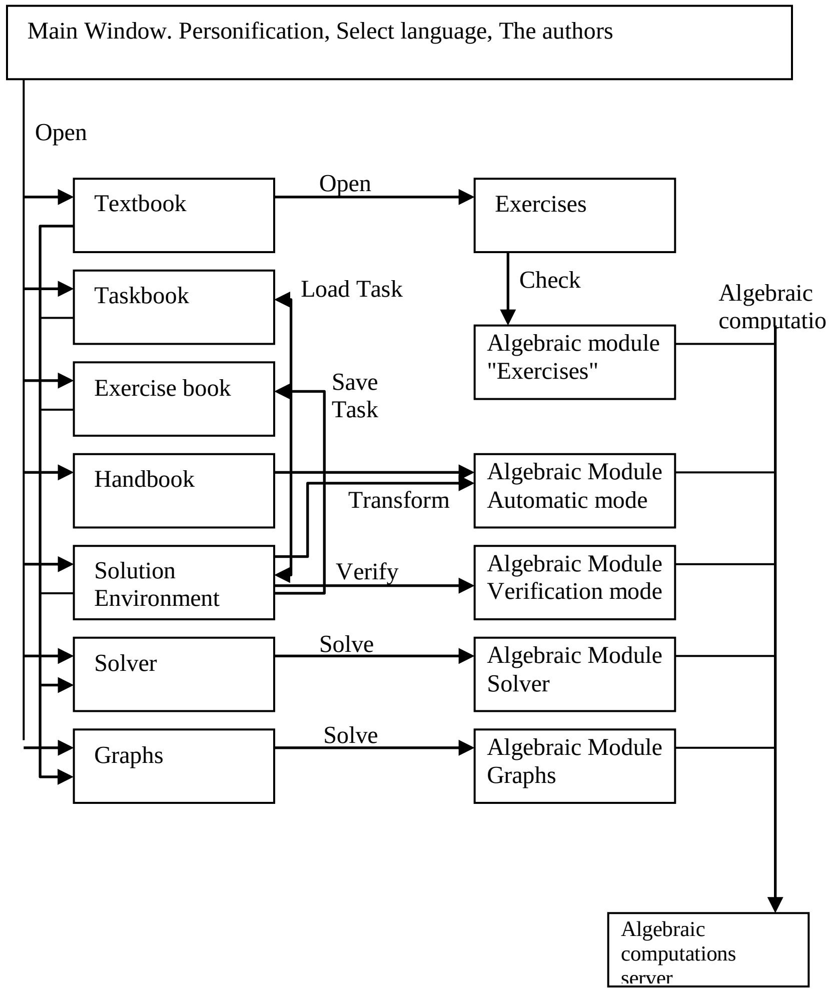

Fig. 2. MECMS modules and their interaction.

The principle of reusing software components in the architecture of key educational process participators' workplaces can be specified as follows (Fig. 3): MECMS software components classified as:

1. Software modules, designed for reusing:
   1.1. without contents and functionality changes;
   1.2. with contents changes;
   1.3 with functionality changes.
2. Software components for general use.

The program modules of 1.1 type include: Methodist's WP as a whole, TWP: "Group journal" PM, "Generator of educational tasks" PM, "Checking educational tasks" PM, "Methodical consultant's Help" PM, SWP: "Personification" PM, "Notebook" PM, "Help" PM.

The program modules of 1.2 type include the following object-oriented PM: TWP SWP: "Textbook" PM, "Taskbook" PM, "Handbook" PM, "Exercises" PM.

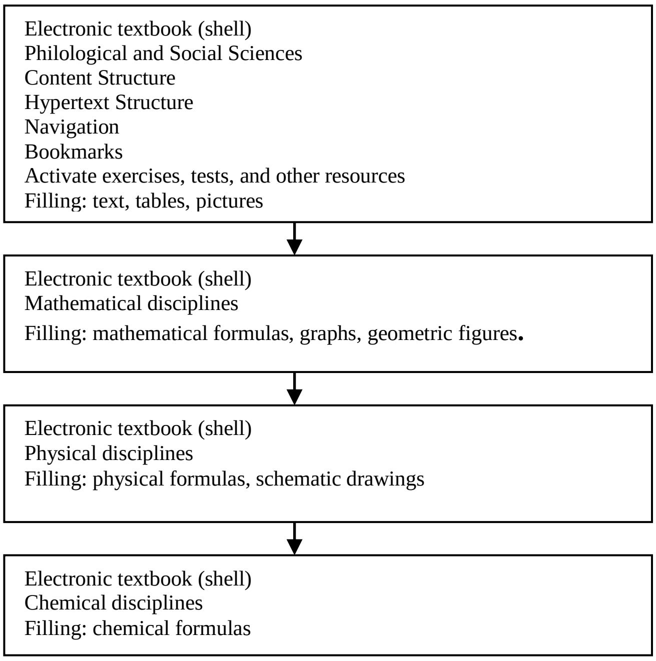

Fig 3. Form hierarchy of information representation, depending on the electronic textbook subject.

- The program modules of 1.3 type include: TWP, SWP, "Mathematical Editor" PC, "Solution environment" PM, "Solver" PM (both server and client), "Graphs" PM (both server and client side).
- General software components were developed by the logical "client-server" architecture and the implemented server Active X component.
- The MECMS development was conducted jointly with the Institute of Cybernetics of NAS of Ukraine. During the period of MECMS development and implementation at KSU they defended 5 PhD theses. 1 doctoral thesis and 3 doctoral thesis were prepared for defense in the physical-mathematical and pedagogical sciences. They published more than 70 articles and methodical guidelines and got 10 author certificates. The total circulation of discs with software products that were designed at KSU and received by Ukrainian schools is about 8 thousand.
- The main MECMS, developed at KSU for the Ministry of Education, Science, Youth and Sports of Ukraine:
- Program methodical complex "Videointerpreter of searching and sorting algorithms" Certificate UA1.092.85967-02. MESU Seal (letter № 1/11-3418 from 16.10.2002).
- Software environment "Systems of linear equations". Certificate UA1.092.111723-03. MESU Seal (letter 1/11-2671 from 02.08.2002).
- Program methodical complex "TerM VII» for the practical mathematical educational support. Version 1 Release 05, version 2 release 03. Certificate UA1.092.84377-04. MESU Seal (Minutes № 8 from 20.04.2004).
- Software tool "Electronic visual library. Algebra, the 7-9 forms of secondary educational institutions of Ukraine". Certificate UA1.003.0203239-06. MESU Seal (letter from 27.12.2006 № 1/11-7722).
- Teaching software tool "Algebra, 7th Form". MESU Seal (MESU letter from 21.12.2007 № 1.11-9225).

- Teaching software tool "Algebra, 8^{th} Form". MESU Seal (MESU letter from 08.01.09 № 1/11).
- Integrated environment for "Basics of algorithms and programming" studying in higher educational institutions.
- Integrated environment for higher educational institutions for students' knowledge control in economics and mathematics of 6.050100 "Business Economics", 6.050101 "Economic Theory" specialties.
- Development of integrated environment for "Analytical Geometry" studying.

4. CONCLUSION

Considering the changes of educational technologies and, accordingly, the general scheme of ICT application in the educational process, we can offer the following view, formulated in the form of conceptual methodological requirements for educational information systems:

MR1. EIS should correspond with the form of the educational process

MR2. EIS should focus on all participants in the educational process.

MR3. EIS should focus on all types of training activities.

MR4. EIS should be based on the subject knowledge.

The MECMS requirements structure and functionality were considered as the intelligent information supporting system of the educational process. We offered the training module mathematical model as the basic structural knowledge unit, focused on supporting the process of acquiring procedural knowledge. Also this article developed the models of step-by-step solving of the mathematical task as the sequence of elementary transformations of mathematical objects (logical derivation), based on the models of training modules and the classification of elementary transformations of these models. The main problem to be resolved in order to use re-coding effectively is the problem of developing the structure of electronic didactic materials, the contents of which depend on the MECMS subject domain: electronic textbooks, taskbooks, handbooks, which describes the form changes of the submitted information depending on the subject orientation. Fig. 3. Shows the variant of such e-textbook hierarchy.

Thus, the first result of the project should be the e-textbook editor, which is developed to produce textbooks in mathematics (excluding a geometric figures editor). Besides general editing functions, it should use general component "Mathematical editor".

REFERENCES

1. Lvov M. Discovery of invariant Equalities in Programs over Data fields /A. Letichevsky, M. Lvov // Applicable Algebra in Engineering, Communication and Computing. – 1993. – №4. – P. 21–29.
2. Lvov M. Tools for solving problems in the scope of algebraic programming. / J.Kapitonova, A.Letichevsky, M. Lvov, V. Volkov // Lecture Notes in Computer Sciences. – № 958. – 1995. – P. 31–46.
3. Spivakovsky A. E. University as a corporation which serves educational interests/ Spivakovsky, A., Alferova, L., Alferov, E // Communications in Computer and Information Science 347 CCIS , pp. 60. 2013
4. Kravtsov H. Knowledge Control Model of Distance Learning System on IMS Standard / H. Kravtsov, D. Kravtsov // Innovative Techniques in Instruction Technology, E-learning, E-assessment, and Education. – Springer, 2008. – P. 195 – 198.
5. SCORM (2003). Sharable Content Object Reference Model (SCORM), Version 1.3, U.S. Advanced Distributed Learning Initiative. [Електронний ресурс]: Режим доступу: http://www.adlnet.org/. – Назва з екрану.
6. Lvov M. Discovery of invariant Equalities in Programs over Data fields /A. Letichevsky, M. Lvov // Applicable Algebra in Engineering, Communication and Computing. – 1993. – № 4. – P. 21–29.
7. Lvov M. Tools for solving problems in the scope of algebraic programming. / J.Kapitonova, A.Letichevsky, M. Lvov, V. Volkov // Lecture Notes in Computer Sciences. – № 958. – 1995. – P. 31–46.

8. Львов М. Основные принципы построения педагогических программных средств поддержки практических занятий / М.Львов // Управляющие системы и машины. – 2006. – № 6. – С. 70–75.
9. Lvov M. Austrian-Ukrainian Project CENREC as Example of Information Support of Activity of International Scientific Community. /M. Lvov, E. Kartashova // Інформаційні технології в освіті: Зб. наукових праць / Херсон: Вид. ХДУ. – № 3. – 2009. С. 57–63.
10. Bradley N. The XML companion. [2-d Edition]. – London, New York: Addson Wesley Harlow, 2000. – 566 p.
11. Пол А. Объектно-ориентированное программирование на C++ / Пол А. – [2-е изд.].– С.-Пб.; М. «Невский диалект»–изд-во «БИНОМ», 1999.– 462 с.:ил.
12. Huet G. Equations and rewrite rules: A surway / G Huet, D. Oppen // In V.Book, ed. Formal Language Theory: Perspectives and Open Problems// New York: Academic Press, 1980. – P. 349–405.
13. Дари К. PHP и MySQL: создание интернет-магазина / Дари К., Баланеску Э. – [2-е изд.]. – Изд.дом Вильямс, 2010. – 640 с.: ил.
14. Якобсон А. Унифицированный процесс разработки программного обеспечения / Якобсон А., Буч Г., Рамбо Дж. – СПб.: Питер, 2002. – 496 с.: ил.
15. Песчаненко В.С. Розширення стандартних модулів системи алгебраїчного програмування APS для використання у системах навчального призначення / В.С. Песчаненко // Науковий часопис НПУ імені М.П. Драгоманова: зб. наук.праць.- К.:НПУ ім. М.П. Драгоманова, 2005. – № 3 (10). – С. 206–215. – (Серія «Комп'ютерно-орієнтовані системи навчання»).

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КОНЦЕПЦІЯ СИСТЕМИ КОМП'ЮТЕРНОЇ МАТЕМАТИКИ НАВЧАЛЬНОГО ПРИЗНАЧЕННЯ ТА ПРИКЛАДИ ЇЇ РЕАЛІЗАЦІЇ

У статті розглянуто систему комп'ютерної математики навчального призначення створену на базі Херсонського державного університету, результатом удосконалення якої стали понад 8 програмних засобів, розроблених на замовлення Міністерства освіти і науки, молоді та спорту України. Особливе місце серед навчальних дисциплін як у загальноосвітніх навчальних закладів, так і вищих навчальних закладів займають точні та природничі дисципліни. Вони формують фундаментальні наукові знання, що базуються на точних математичних моделях та методах. Навчальний процес з цих дисциплін має включати не лише лекції та семінарські заняття, а і активні форми навчання: практичні заняття, лабораторні роботи, виробничу практику тощо. Перелічені особливості диктують і специфічні інтелектуальні та архітектурні властивості інформаційних технологій, призначених для використання у навчальному процесі з цих дисциплін. Оскільки, з точки зору технологій, що використовуються у реалізації функціональності програмних засобів вони фактично є системою комп'ютерної алгебри навчального призначення. А отже важливе значення при їх розробці посідає система алгебраїчного програмування АПС розроблена в Інституті кібернетики Національної академії наук України під керівництвом академіка О.А. Летичевського в 80-х роках XX сторіччя.

Ключові слова: система комп'ютерної математики навчального призначення, автоматизація розробки, математичні методи, програмне забезпечення навчального призначення.

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КОНЦЕПЦИЯ СИСТЕМЫ КОМПЬЮТЕРНОЙ МАТЕМАТИКИ УЧЕБНОГО НАЗНАЧЕНИЯ И ПРИМЕРЫ ЕЕ РЕАЛИЗАЦИИ

В статье рассмотрена система компьютерной математики учебного назначения созданная на базе Херсонского государственного университета, результатом

усовершенствования которой стали более 8 программных средств, разработанных по заказу Министерства образования и науки, молодежи и спорта Украины. Особое место среди учебных дисциплин как в общеобразовательных учебных заведений, так и высших учебных заведений занимают точные и естественные дисциплины. Они формируют фундаментальные научные знания, основанные на точных математических моделях и методах. Учебный процесс по этим дисциплинам должно включать не только лекции и семинарские занятия, а и активные формы обучения: практические занятия, лабораторные работы, производственную практику и тому подобное. Перечисленные особенности диктуют и специфические интеллектуальные и архитектурные свойства информационных технологий, предназначенных для использования в учебном процессе по этим дисциплинам. Поскольку, с точки зрения технологий, используемых в реализации функциональности программных средств они фактически являются системой компьютерной алгебры учебного назначения. А значит важное значение при их разработке занимает система алгебраического программирования АПС разработаная в Институте кибернетики Национальной академии наук Украины под руководством академика А.А. Летичевского в 80-х годах XX столетия.

Ключевые слова: система компьютерной математики учебного назначения, автоматизация разработки, математические методы, программное обеспечение учебного назначения.