ITHEA

International Journal

INFORMATION TECHNOLOGIES & KNOWLEDGE

2008 Volume 2 Number 5

International Journal
INFORMATION TECHNOLOGIES & KNOWLEDGE
Volume 2 / 2008, Number 5

IJ ITK is official publisher of the scientific papers of the members of the ITHEA International Scientific Society, the Association of Developers and Users of Intellectualized Systems (ADUIS) and the Association for Development of the Information Society (ADIS)

IJ ITK rules for preparing the manuscripts are compulsory.
The **rules for the papers** for IJ ITK as well as the **subscription fees** are given on ***www.foibg.com***.
The camera-ready copy of the paper should be received by e-mail: info@foibg.com.
Responsibility for papers published in IJ ITK belongs to authors.

General Sponsor of IJ ITK is the **Consortium FOI Bulgaria** (www.foibg.com).

International Journal "INFORMATION TECHNOLOGIES & KNOWLEDGE" Vol.2, Number 5, 2008

Edited by the **Institute of Information Theories and Applications FOI ITHEA**, Bulgaria, in collaboration with the **V.M.Glushkov Institute of Cybernetics of NAS, Ukraine**, and the **Institute of Mathematics and Informatics** and the **Institute of Information Technologies, BAS, Bulgaria**.

Publisher: **Institute of Information Theories and Applications FOI ITHEA**
Sofia, 1000, P.O.B. 775, Bulgaria. www.ithea.org, www.foibg.com, e-mail: info@foibg.com
Printed in Bulgaria

ISSN 1313-0455 (printed) **ISSN 1313-048X (online)** **ISSN 1313-0501 (CD/DVD)**

WEB INTERFACES DESTINED FOR PEOPLE WITH DISABILITIES

Laura Ciocoiu, Ionuţ Petre, Dragoş Smada, Dragoş Nicolau

***Abstract**: One of the main characteristics of the world that we live in is the access to information and one of the main ways to reach the information is the Internet. Most Internet sites put accessibility problem on a secondary plan. If we try to define this concept (accessibility) we could say that accessibility it's a way to offer access to information for the people with disabilities.*

For example blind people can't navigate on the Internet like usual people. For that reason Internet sites have to put at their disposal ways to make their content known to this people. Accessibility does not refer only at blind people the web accessibility refers to all people who lost their ability to access the Internet sites.

The web accessibility includes every disability that stops people with disabilities to access the web sites content like hearing disability, neurological and cognitive. People that have low speed Internet connection or with low performance computers can use the web accessibility.

***Keywords**: Accessibility, Adaptability, Adaptable interfaces, Interactive database*

***ACM Classification**: H 5.2. Information interfaces and presentation (e.g., HCI): Miscellaneous.*

Introduction

"A society that eliminates some of his members it's a poor society"

In the entire world exists over 500 millions people with disabilities that are in-title to have the same rights like normal people. The first article of the Universal Declaration of the Human Rights says that all human beings are free and equal in dignity and rights.

The web accessibility is a different procedure to structure and organize a web page after strict accessibility criteria for people with disabilities. And like this people with disabilities can easily navigate on web and understand their content.

The Internet represents a important information source in most of our life aspects like commerce, health, education and job finding. From this point of view web accessibility helps disability people to integrate more easily in to the society.

Expediently – induced by user satisfaction and navigation facility and retain the structure of the site. Expediently is a quality: you realise her absence only when is not available anymore.

Accessibility and Expediently they are in strong relationship because both improve the efficiency and the satisfaction of the viewer. While the accessibility tends to make a product more accessible to the visitor, Expediently targets to please only a category of visitors that use that service or product.

The transformation of a web site that didn't respect the aspects related with accessibility into a site that respects those aspects could be an easy task or a hard one depending of the complexity of the site.

The interactive data base- represents a model of the real world and can only represent a limited number of characteristics necessary in different applications. No matter how perfect this application is, there are some applications that we can conceive that could not be satisfied by the database.

For building a database corresponding with a real system we must make a general appreciation of the system. This appreciation contains information regarding the structure of the system and essential system elements that are contained in a sketch.

For the relation model of the data base choosing the relations that are contained in the data base it's very important. The information contained in the database cannot be randomly chosen from the domain associated with their attributes. This kind of errors can be detected imposing some restrictions over the data. There are two kinds of restrictions:

- that depend on semantics of elements domain's
- produces by comparative values.

The realisation of the web interface

Starting page

An web site well made is loading very fast, and offers to the visitors a very well functionality, a complete content, the architecture of the information what is simple and clear and assures a intuitive navigation, quick access to the information that you were looking for. A quality design means a pleasant look that shows the site functionality. Will use for exemplification the site of the National Authority for People with Disabilities site made by this team, www.anph.ro

The first page must contain links to the main sections of the site; those are most interesting for the user and permit the user to detail in other pages the wanted sections.

That's way is preferred that the structure of the database based on hierarchical decomposition. For example divisions like Categories – under category –Details were the category represents the main entity and contains the under categories and the detail represents the lowest entity and is a part of under category.

The first page must contain links to the main sections of the site; those are most interesting for the user and permit the user to detail in other pages the wanted sections as we can see in figure 1.

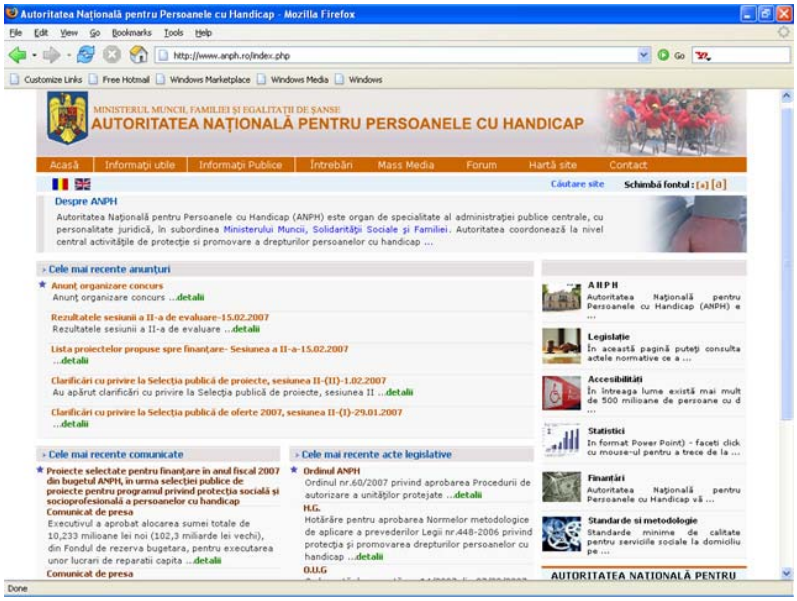

Figure 1. Starting Page

On the first page we have to find most recent information, for example last minute regulations announcements, press communicates and anything that is new for the site visitor.

Site menus

In this case in the horizontal menu we find the links that goes to the main sections that very important for the user, Useful Information, Public Information, Frequent Questions, Forum, Site Map. In the vertical menu are sections that are not very important and they are addressing to a restrained area of users and contains the to the Legislation, Statistics, Financings, Standards and Methodology, Accessibility and General information about National Authority for People with Disabilities.

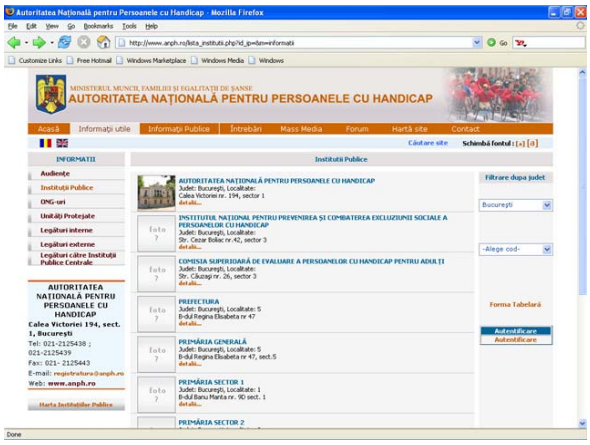

Figure 2.a. Useful Information

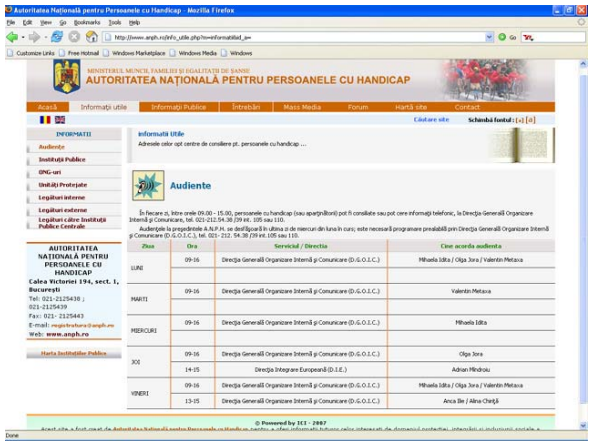

Figure 2.b. Useful Information

Sections

By accessing from the menu of useful information the user can find information about the units and institutions all over the country that the main occupation to treat people with disabilities, and they access information for every unit as we can see in figure 2.a.

Beside all this lists and units details, the visitor can find out the schedule for audiences contact addresses for the personal of this units and other links for same category sites as we can see in the figure 2.b.

In every page of this site there exists a box that contains National Authority for People with Disabilities contacts and a link to a sensitive map for every unit in the country.

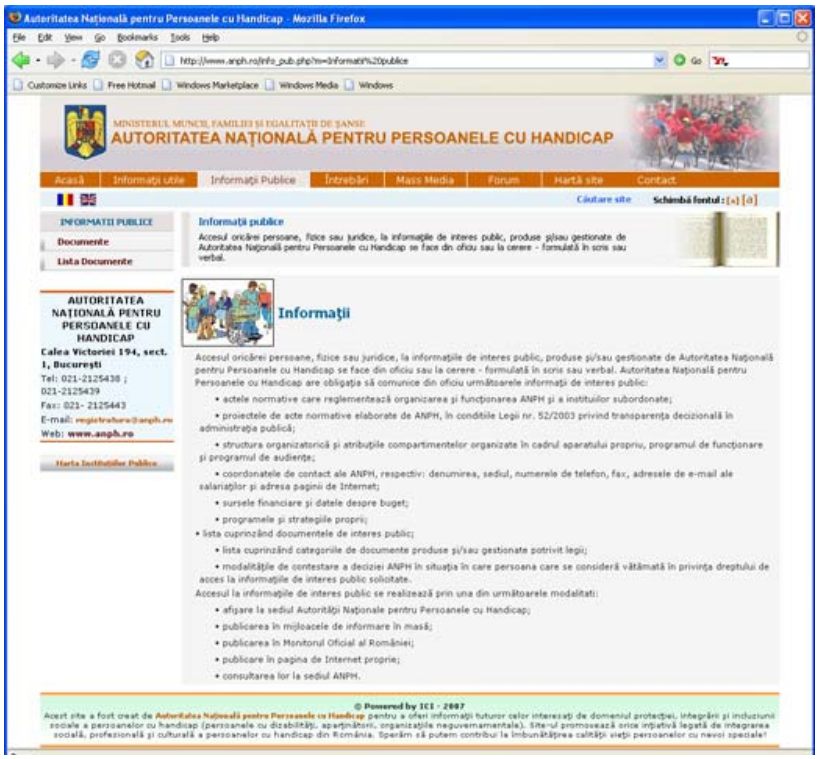

Figure 3.Public Information

In the Public Information sections we find petition models, forms and other documents of this type and information about all kind of documents that National Authority for People with Disabilities elaborates and those are public interest information (figure 3).

Forum sections is very important for the visitors of the site because you can use it to find out useful information and you can discuss on every subject with other visitors

Specific Facilities

During the development of this project we respected all the accessibility and usability rules that a site for people with disabilities must obey.

For blind people the applications must supply equal access of all content and visual aspects of technology wherewith we wish to transmit the information. We used the description of the text (alternative text) of all static pictures for example (pictures, logos).

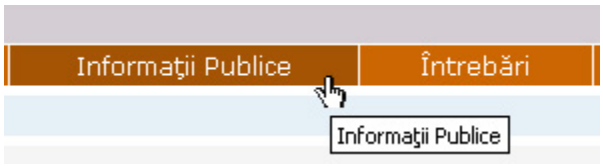

Figure 4. ALT Option

Thereby the text can be read with screen readers and Braille machines (figure 4).

There are programs that synthesize the text and read the text with loud voice. The screen reader technology has limitations doesn't recognize graphic elements like buttons or other image elements without having a text attached attribute compliance "alt" and "title". We used a long description of the images that are very important we have left a considerable space between all the items we avoided t use ostentatious colours. Another facility of this site is that you can make fonts larger.

People that have sight deficiency can make fonts larger on every page of this site but in any moment they could turn back to normal size fonts as we can see in the picture below (figure 5.b).

Figure 5.a. Normal Fonts

Figure 5.b. Enlarged Fonts

Administration page

Represents an entire section of pages and web forms, used for introducing and for modification of the site content. The access in this section is restricted (see figure 6), divided on more levels and the access is based on a username and password. Some of the administrators have limited rights over the site.

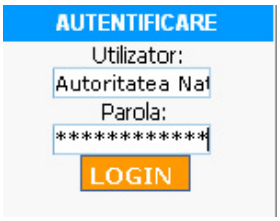

Figure 6.Administrator Authentication

Data Insertion

This section permits to right new information and data in the database. We can insert text type details for every category and we can upload files and images (see figure 7).

After we introduced the data it can be made actual from the section.

Data modification

This part is more complex accountable the data insertion section. Because assumes the partial or total change of already existent files (figure 8).

We can add additional data or we could eliminate certain data or we can totally erase a category from the database. We can modify the pictures that are attached to categories.

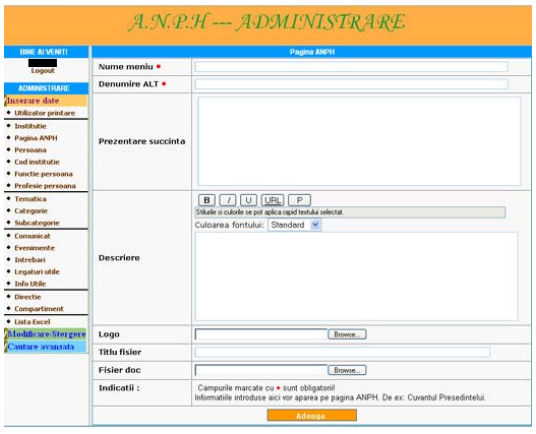

Figure 7. Data Insertion

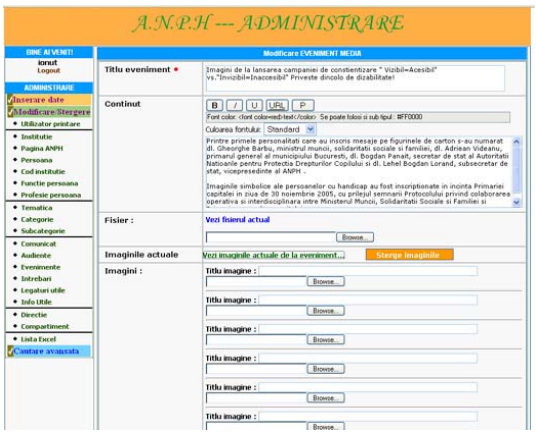

Figure 8. Data Modification

Conclusion

Web interface must be made in such a way that will offer equal access to all the people, whatsoever if they are persons with disabilities or normal people. We noticed that the information is different understood.

Online navigation permits to every user to interact with the material and preferred way supporting his strong points and trying to reduce weal points.

Bibliography

L.Ciocoiu, I. Petre, D. Smada, D. Barbu, D. Nicolau – Multimedia Portal dedicated for people with disabilities for National Authority for People with Disabilities – 2006; http://www.anph.ro

L.Ciocoiu, L.Constantinescu, I. Petre, D. Smada, D. Barbu, D. Nicolau - eBiMuz - Integrated multimedia system for access to the multicultural thesaurus of the areas inhabited by Romanians, as integrated part of the European culture – CEEX 142/2005; http://ebimuz.ici.ro

L.Ciocoiu, I. Petre, D. Smada, D. Barbu, D. Nicolau – eMeditur – A tool for delivering information for online services in the medical assistance and tourism - R2130/2005 – http://emeditur.ici.ro

Authors' information

Laura Ciocoiu *– senior researcher; National Institute for Research and Development in Informatics; 8-10 Averescu Avenue, 011455 Bucharest 1 Romania; e-mail: ciocoiu@ici.ro; http://intelligent-agents.ici.ro*

Ionuţ Petre *– researcher; National Institute for Research and Development in Informatics; 8-10 Averescu Avenue, 011455 Bucharest 1 Romania; e-mail: ipetre@ici.ro; http://intelligent-agents.ici.ro*

Dragoş Smada *– researcher; National Institute for Research and Development in Informatics; 8-10 Averescu Avenue, 011455 Bucharest 1 Romania; e-mail: dsmada@ici.ro; http://intelligent-agents.ici.ro*

Dragoş Nicolau *– senior researcher; National Institute for Research and Development in Informatics; 8-10 Averescu Avenue, 011455 Bucharest 1 Romania; e-mail: dragos@ici.ro; http://intelligent-agents.ici.ro*

ELECTRONIC PRESENTATION OF BULGARIAN EDUCATIONAL ARCHIVES: AN ONTOLOGY-BASED APPROACH

Anna Devreni–Koutsouki

Abstract: *The paper presents an ongoing effort aimed at building an electronic archive of documents issued by the Bulgarian Ministry of Education in the 40ies and 50ies of the 20th century. These funds are stored in the Archive of the Ministry of the People's Education within the State Archival Fund of the General Department of Archives at the Council of Ministers of Bulgaria. Our basic concern is not the digitization process per se, but the subsequent organization of the archive in a clear and easily-searchable way which would allow various types of users to get access to the documents of interest to them. Here we present the variety of the documents which are stored in the archival collection, and suggestions on their electronic organization. We suggest using ontologies-based presentation of the archive. The basic benefit of this approach is the possibility to search the collection according to the stored content categories.*

Keywords: *digitization, archives, history of education, ontologies, SWP.*

ACM Classification Keywords: *H.5 Information Interfaces and Presentation, H.3.3 Information Search and Retrieval, H.3.7 Digital Libraries*

Introduction

Digitization of cultural and scientific content in European countries is important field of work which results should contribute to the development of The European Library portal (TEL)[1]. Currently, there are numerous ongoing digitization projects and initiatives in libraries, archives and museums.

Within this general picture, extensive work on digital capture and exposure of educational archives has not been undertaken so far, according to our research. In the educational field most attention is concentrated on the development of e-learning applications while historical documents of the educational institutions and the governmental bodies shaping the policy in education and research field are still not digitized on mass scale.

[1] http://www.theeuropeanlibrary.org/portal/index.html, date of last visit March 21, 2006.

However, such documents could be of interest not only to the researchers who study the development of the educational system (in one country or on comparative basis). Educational archives contain documents which could be of interest to the local historians, and to the general citizen.

Therefore, we decided to undertake an effort which would present in the electronic space the documents from the archive of the Ministry of Education of Bulgaria. We decided to start this effort with practical work on the documentation from the 40ies and 50ies of the 20th century, since this was one significant period of reform of the educational system in Bulgaria.

The presentation of educational archives also imposes some challenges.

1. Digitisation and metadata.

This type of archive contains quite diverse documents - official documentation, letters, notes, photographs, various documents, newspapers. The text documents can be printed, typewritten or handwritten. On the one hand, the digitization requires the application of different workflows. On the other hand, the metadata for these various documents, if detailed, should follow different structures.

2. Presentation and use

There has been a standing issue coming from the past – the problem related to the storage and access provision to already created materials, which were not designed for computer processing. We envisage the vast amount of documents, forms, protocols, letters/correspondence, photographs, maps, images and other objects which could be found in private or public museum collections or state, local or personal archives. The educational archive is a typical example of such a diverse collection. How should this collection be organized in the electronic space? If it just follows the traditional archival structure, the search of documents would be very difficult – one would have to browse everything, or search for the exact document. The general user does not necessarily have this information, neither should he (she) be knowledgeable about the metadata used. Thus our work is directed to looking for better and more user-friendly ways to provide access to the electronic collection.

The Archive and its Presentation

The idea for this effort was coined within a group of historians and education specialists from the University of Ioannina, Greece who work on comparative study of the Greek and the Bulgarian educational systems in the middle of the 20th century. Till now, the archives of the Bulgarian Ministry of Education (Ministry of the Enlightenment in the studied period) have been studied within 1940-1945. The sources are stored in funds 798k and 177k. of the Ministry of Peoples' Education 1879-1944.

Digital copies of several thousands of documents have been made. They are not sufficient for the purposes of the comparative study of the educational systems, but are sufficient for our purposes to suggest the organisation of the electronic collection and its use. The collected materials are interesting for the variety of types of sources they present. The next table summarizes the available document types which can be found as separate archival units. Here we do not discuss the issues of creating metadata on the whole inventory of documents, but rather describe the issues of describing the separate archival units.

DOCUMENT TYPE	EXAMPLE	METADATA AND CONTENT PRESENTATION PROBLEMS
Handwritten texts (general purpose documents, orders, notes, etc.)	This type of documents is typical for all archival collections.	Metadata for describing archival units can be applied. If we aim full text presentation, we have to face a massive amount of hand text entry. Typical elements appearing in these documents are names (personal and place names), dates, affiliations. Such documents are interesting for study of the problems which circulated in the educational administration.

Typewritten documents (general purpose documents, orders, notes, etc.) in some cases with handwritten resolutions	This type of documents is also typical for all archival collections. We place it separately from the group above, because digitisation and processing of typewritten documents may involve OCR and the workflow would be different.	The same as above; OCR can be tested for text recognition.
Handwritten documents presenting records related to the educational sector, in some cases with signatures and stamps	 Sample from Fund 798 k, inventory list 2, archival unit 98. Book of orders of the Seres High School	Here we can use again the general metadata. If we aim to present the full text we should re-create the structure. Additional issue is how to present structured data on stamps and signatures.
Typewritten documents presenting records related to the educational sector, in some cases with signatures and stamps	This type of documents is also typical for all archival collections. As with typewritten generic texts, we place these documents separately from the group above, because digitisation and processing of typewritten documents may involve OCR and the workflow would be different.	The same as above; OCR can be tested for text recognition.
Individual documents with signatures, postal stamps, state fee stamps	 Sample from Fund 798 k, inventory list 2, archival unit 114. Certificate for a completed educational degree, Seres High School	Here we can use again the general metadata. Again, an issue is how to present structured data on stamps and signatures. State stamps might be of interest, for example, to philatelists, i.e. in a very structured approach we should encode data on these objects too in order to make the information on them searchable.
Newspapers *(The newspapers contain orders of the Ministry of education, reports, letters of local administrations, materials about a cultural week of the village, etc.)*	 Sample from Fund 177 k, inventory list 2, archival unit 2251. Certificate for a completed educational degree, Seres High School	Here we can use again the general metadata for the archival unit, but then we should decide how to present the contents of the newspaper. A highly structured approach would require to present the content in detail, and/or provide full text search capabilities. The photographs in the newspapers also should be considered as a separate object.

Photographs	 Sample from Fund 177 k, inventory list 2, archival unit 2251. Certificate for a completed educational degree, Seres High School	The description of photographs differs from description of documents. Currently we study projects which deal with electronic presentation of historical photographs in order to suggest what metadata to use within the frameworks of our endeavour.

Table 1. Samples of documents from the archives of the Bulgarian Ministry of Education, 1940-1945

This brief presentation illustrates some of the problems which we face:

- How detailed should be the presentations of the various types of documents? On the one hand, we might be tempted to provide full text for all documents, but is this effort justified?
- How exactly to present multimodal objects (as we see in the examples, we have special layouts in some cases; stamps; signatures; marginal notes, etc.).

We believe that one approach which makes such collections searchable even without the application of very detailed and fragments presentations is the proper use of ontologies. Below we will present briefly the concept of ontologies and then will present one possible practical solution, SWP.

Ontologies

In philosophy, ontology (from the Greek ὄν, genitive ὄντος: of being (part. of εἶναι: to be) and -λογία: science, study, theory) is the study of being or existence. It seeks to describe or posit the basic categories and relationships of being or existence to define entities and types of entities within its framework. Ontology can be said to study conceptions of reality. It is often confused with epistemology, which is about knowledge and knowing.

According to recent artificial intelligence research “an ontology is a shared and common understanding of some domain that can be communicated across people and computers” [Gruber, 1993], [Guarino, 1995], [Borst, 1997] and [van Hejlst et al., 1997]. Ontologies can therefore be shared and reused among different applications [Farquhar et al., 1997]. “An ontology can be defined as a formal, explicit specification of a shared conceptualization” [Gruber, 1993], [Borst, 1997]. “Conceptualization” refers to an abstract model of some phenomenon in the world by having identified the relevant concepts of that phenomenon. “Explicit” means that the type of concepts used, and the constraints on their use are explicitly defined. “Formal” refers to the fact that the ontology should be machine-readable. “Shared” reflects the notion that ontology captures consensual knowledge, i.e. it is not private to some individual, but accepted by a group.

The concept of ontology is defined even narrower within the famous project *Ontolingua* of Stanford University [Ontolingua project]. It suggests that the ontology is an *explicit specification of some topic*. This approach presupposes formal and declarative presentation of a given topic, which includes the vocabulary (or names) for referring to the terms in that subject area and the logical statements that describe what the terms are, how they are related to each other, and how they can or cannot be related to each other.

Ontology describes the subject matter using the notions of *concepts, instances, relations, functions,* and *axioms*. Table 2 presents the requirements to which ontology has to be compliant.

Necessary properties of an ontology	Typical but not mandatory properties	Desirable properties, but not mandatory nor typical
Finite controlled (extensible) vocabulary Unambiguous interpretation of classes and term relationships Strict hierarchical subclass relationships between classes	Property specification on a per-class basis Individual inclusion in the ontology Value restriction specification on a per-class basis	Specification of disjoint classes Specification of arbitrary logical relationships between terms Distinguished relationships, such as inverse and part-whole

Table 2. Properties of ontologies.

From the practical point of view, in the simplest case an ontology is „a formal explicit description of concepts in a domain of discourse (classes (sometimes called concepts)), properties of each concept describing various features and attributes of the concept (slots (sometimes called roles or properties)), and restrictions on slots (facets (sometimes called role restrictions))" [Noy, McGuiness]. If we take accept this as a rule of thumb, an ontology together with a set of individual instances of classes indeed can be seen a *knowledge base.* However, in reality, there is a fine line where ontology ends and the knowledge base begins – the latter can be more sophisticated presentation of a subject domain while ontology is always hierarchical and follows certain requirements as described above. From technological point of view, ontologies can be seen as knowledge bases of special kind, which can be "read" and understand, and could be shared between users and/or developers.

The basic reasons to create ontologies are summarized in [Noy, McGuiness] as follows:

- To share common understanding of the structure of information among people or software agents
- To enable reuse of domain knowledge
- To make domain assumptions explicit
- To separate domain knowledge from the operational knowledge
- To analyze domain knowledge

The development of ontologies is still a difficult and challenging task, because so far there are no common platforms and verified methods which would prescribe what procedures should be followed in the process of creating ontology. As [Jones et al.] explains it, „at present the construction of ontologies is very much an art rather than a science". This situation needs to be changed, and will be changed only through an understanding of how to go about constructing ontologies. In short what is needed is a good methodology for developing ontologies.

While there is no common methodology for building ontologies, there are principles for design and implementation suggested in [Gruber 1995]:

- **Clarity** – the ontology should present the terms included efficiently and without ambiguities. The definitions should be objective as much as possible, although the motivation for adding a term might be driven by the circumstances and the requirements for computability. A clear formalism should be used, and it is recommended to present the definitions in the form of logical axioms.
- **Coherence** – the definitions should be logically disambiguous, and all statements derived from the ontology should not be in disacordance with the axioms.
- **Extendibility** – the ontology should be designed so that the dictionaries of terms could be enlarged without revision of concepts already defined.
- **Minimal encoding bias** – the conceptual abstraction implemented in the ontology should be developed on the concept level instead of the level of the symbolic representation.
- **Minimal ontological commitment** – the ontology should contain only the most essential assumptions on the modeled world, so that there is enough space for making it wider or narrower.

How do ontologies relate to our archival presentation task? We believe that the use of ontology could be a good solution which would allow users to make a variety of searches within the collection of electronic documents while these documents are still not available in searchable full text format. If we incorporate as an element of the data several relevant ontological references, based on the assumptions for typical requests for information, the results returned to a query would include all documents which metadata are matching the concept from the ontology.

Definitely, this requires extra human effort: first, to develop a subject domain ontology (covering *educational administrative documentation*) – to the best of our knowledge such ontology does not exist, and moreover it would be specific for the Bulgarian documentary system; and second, to add references to the concepts from the ontologies within the archival units metadata. Compared to the creation of full text and sophisticated search tools, we believe that this approach will lead to fast and reliable results and will implement it in the nearest future.

A Possible Practical Solution Involving Ontologies: SWP

Over the past few years, various approaches have been proposed to effectively organise digital content on the Web. Traditionally, these have included techniques such as building keyword indices based on image content, embedding keyword-based labels into images, analyzing text immediately surrounding images on Web pages, etc. Nevertheless, current Web technology presents serious limitations to make information accessible for users

in an efficient manner. The general problem to find information on the Web is summarized in [Ding, Fensel 2001]: „searches are imprecise, often yielding matches to many thousands of hits". Moreover, users face the task of reading the documents retrieved in order to extract the information desired. These limitations naturally appear in existing Web portals based on this technology, making information searching, accessing, extracting, interpreting and processing a difficult and time-consuming task.

More recently, there has been a research focus on the Semantic Web technologies in different domains. The purpose of the Semantic Web is to create a universal medium for the exchange of sharable and processable data by automated tools, such as software agents, as well as by the users. "The Semantic Web is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation" [Berners-Lee et al., 2001].

One solution to these problems is the use of Semantic Web Portals (SWPs), known also under the names *Knowledge Portals* or *Community Web Portals*.

There are different views in the research works on SWPs and their definition. An earlier study defines them as „portals for the information needs of particular communities on the web" [Staab et al., 2000]. According to [Gorcho, 2006] "a Semantic Web Portal is a Web application that offers information and services related to a specific domain, and that has been developed with Semantic Web technology". The same author emphasizes that the primary difference with the traditional Web Portals "is based on technological aspects: traditional Web portals are based on standard Web technology (HTML, XML, servlets, JSPs, etc.); semantic portals are based on that technology plus the use of Semantic Web languages like RDF, RDF Schema and OWL".

The SWPs which are well developed and functioning are not too many; also they are prone to various limitations. In [Karvounarakis et al, 2000] they are defined as Web applications that "provide the means to select, classify and access, in a semantically meaningful and ubiquitous way, various information resources (e.g., sites, documents, data) for diverse target audiences (corporate, inter-enterprise, e-marketplace, etc.)."

[Lausen et al., 2005] and [Lara 2004] offer more strict definition, which states that SWP has the following characteristics:

- It is a web portal. A web portal is a web site that collects information for a group of users that have common interests
- It is a web portal for a community to share and exchange information
- It is a web portal developed based on semantic web technologies.

The briefest but clear explanation is to view SWPs as "portals that typically provide knowledge about a specific domain and rely on ontologies to structure and exchange this knowledge" [Hartmann, Sure 2004]. The accent here is on the most typical feature of SWPs – their application in specific subject domains and the use of one or more ontologies as a backbone of the application.

Currently „SWP are still at their very early stages" [Lausen et al., 2005]. The benefits of implementing these Semantic Web technologies can be easily identified or foreseen as Semantic Web technologies have the potential to increase the information consistency and the information processing quality of portals. On the other hand, Semantic Web technologies themselves are still under development and most of the theoretical issues are no easy to be employed into real world applications.

Conclusion

The national strategy of many countries, including private institutions, which possess such collections and archives, is making them widely-spread and accessible. The common practice is the creation of repositories of images or digital copies which can already be accessed through the Web [Hyvönen et al., 2004]. The management of such resources aims to reach maximum effectiveness of search in the sea of various forms of the stored information. Many of such collections currently exist and users are increasingly faced with problems of finding a suitable (set of) image(s) for a particular purpose. Each collection usually has its own (semi-) structured indexing scheme that typically supports a keyword-type search. However, finding the right image is often still problematic [Hollink et al., 2003].

In this paper we present a brief analysis of the types of documents in one particular Bulgarian archive (educational documentation from the 40ies and 50ies of the 20th century). We also made a brief overview of ontologies and SWPs which could help in structuring the electronic surrogates of archival documents. In our

future work we will suggest ontology designed especially to present the documents from this archival collection and the implementation via SWP of search tools for use of the archive.

This collection of documents in the archive presented is highly fragile – already now the documents are deteriorating as it could be seen from the illustrations in Table 1. We hope that our effort will help to preserve for the future these documents which could be of interest to various groups of users.

Bibliography

[Berners-Lee et al., 2001] Tim Berners-Lee, James Hendler and Ora Lassila, The Semantic Web - A new form of Web content that is meaningful to computers will unleash a revolution of new possibilities, Scientific American, 2001 (Visited 02-03-07) http://www.sciam.com/article.cfm?articleID=00048144-10D2-1C70-84A9809EC588EF21

[Borst, 1997] W. N. Borst. Construction of Engineering Ontologies. PhD thesis, University of Twente, Enschede, 1997.

[Ding, Fensel, 2001] Ding, Y.; Fensel, D.: Ontology Library Systems. The key to successful Ontology Re- Use. In: Proceedings of the First Semantic Web Working Symposium. California, USA: Stanford University 2001; S. 93-112.

[Farquhar et al., 1997] A. Farquhar, R. Fikes, and J. Rice. The ontolingua server: a tool for collaborative ontology construction. International Journal of Human-Computer Studies, 46(6):707–728, June 1997.

[Gorcho, 2006] Corcho, O.: A Platform for the Development of Semantic Web Portals In Proceedings of the 6th international conference on Web engineering, Palo Alto, California: ACM International Conference Proceeding Series Pages 2006; P 145 - 152

[Gruber 1995] Gruber, T., "Toward Principles for the Design of Ontologies Used for Knowledge Sharing", International Journal of Human-Computer Studies, Vol. 43 (1995), pp. 907-928

[Gruber, 1993] T. R. Gruber. A translation approach to portable ontology specifications. Knowledge Acquisition, 5:199–220, 1993.

[Guarino, 1995] N. Guarino. Formal ontology, conceptual analysis and knowledge representation. International Journal of Human-Computer Studies, 43(5/6):625–640, 1995. Special issue on The Role of Formal Ontology in the Information Technology.

[Hartmann, Sure 2004] Hartmann J., Y. Sure, "An Infrastructure for Scalable, Reliable Semantic Portals" IEEE Intelligent Systems 19 (3): 58-65. May 2004

[Hollink et al., 2003] Hollink, L., Schreiber, G., Wielemaker J., and Wielinga. B. Semantic Annotation of Image Collections in Knowledge Capture - Knowledge Markup & Semantic Annotation Workshop (2003)

[Hyvönen et al., 2004] Hyvönen, E., Mäkelä, E., Salminen, M., Valo, A., Viljanen, K., Saarela, S., Junnila, M., Kettula, S., MuseumFinland—Finnish museums on the semantic web in 3rd International Semantic Web Conference (ISWC2004, Hiroshima, Japan 07-11 November 2004)

[Jones et al.] Jones, D., Bench-Capon, T., Visser, P., "Methodologies for ontology development", (Visited 06-03-2007) http://www.iet.com/Projects/RKF/SME/methodologies-for-ontology-development.pdf

[Karvounarakis et al, 2000] Karvounarakis G, Christophides V, Plexousakis D, Alexaki S (2000) Querying community web portals. Technical report, Institute of Computer Science, FORTH, Heraklion, Greece.

[Lara 2004] Lara R., Sung-Kook Han, Holger Lausen, Michael Stollberg, Ying Ding, Dieter Fensel, " An Evaluation of Semantic Web Portals", IADIS Applied Computing International Conference 2004, Lisbon, Portugal, March 23-26, 2004

[Lausen et al., 2005] Lausen H., Ying Ding, Michael Stollberg, Dieter Fensel, Rubén Lara, and Sung-Kook Han, "Semantic web portals: state-of-the-art survey", Journal of Knowledge Management, 2005, Volume: 9 Issue: 5 Page: 40 – 49

[Noy, McGuiness] Noy, N, McGuinness, D, Ontology Development 101: A Guide to Creating Your First Ontology, http://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.html

[Ontolingua project] (Visited 06-03-2007) http://www-ksl-svc.stanford.edu:5915/doc/frame-editor/what-is-an-ontology.html

[Staab et al., 2000] Staab S., J. Angele, Stefan Decker, Michael Erdmann, Andreas Hotho, Alexander Maedhe, Hans-Peter Schnurr, Rudi Studer, York Sure , „Semantic Community Web Portals", In: Computer Networks (Special Issue: WWW9 - Proceedings of the 9th International World Wide Web Conference, Amsterdam, The Netherlands, May, 15-19, 2000), Elsevier.

[van Hejlst et al., 1997] G. van Heijst, A. T. Schreiber, and B. J. Wielinga. Using explicit ontologies in KBS development. International Journal of Human-Computer Studies, 46(2/3):183–292, 1997.

Author's Information

Anna Devreni–Koutsouki *– PhD student, Sofia University, Bulgaria; e-mail: annadevreni@hotmail.com*

COMPLEX ADAPTIVE ON-LINE LEARNING SYSTEM "THEORY OF AUTOMATIC CONTROL"

Yuriy Bezgachnyuk, Leonid Zamikhovskyy, Roman Matviyenko, Larysa Savyuk

Abstract. *The controlled from distance teaching (DT) in the system of technical education has a row of features: complication of informative content, necessity of development of simulation models and trainers for conducting of practical and laboratory employments, conducting of knowledge diagnostics on the basis of mathematical-based algorithms, organization of execution collective projects of the applied setting. For development of the process of teaching bases of fundamental discipline control system Theory of automatic control (TAC) the combined approach of optimum combination of existent programmatic instruments of support was chosen DT and own developments. The system DT TAC included: controlled from distance course (DC) of TAC, site of virtual laboratory practical works in LAB.TAC and students knowledge remote diagnostic system d-tester.*

Keywords*: system, theory, management, content, algorithm, testing, diagnosing, laboratory stand, animation, device, knowledge control.*

ACM Classification Keywords*: H.1.1 Systems and Information Theory: Value of information.*

Introduction

In the present time in Ukraine large attention is spared the problems of introduction of modern of informatively-communications technologies (ICT) in higher education. In formation of humanitarian direction the proof tendencies of growth of rates of passing were set to modern computers technologies and use of methods DT.

DT in technical education, because of the special methodological and algorithmic approaches, integrated considerably slower.

Development of the systems of diagnosing of knowledge's of bases of technical disciplines is related to realization of difficult algorithms of testing, such as organization of answers in a free form by built-in formula editors, testing is based on the methods of matrix calculation, multilevel questions which are not included in the standard set of the developed systems DT [1].

It is necessary also to take into account that planning of the effective system DT must be based on a careful analysis and search of modern pedagogical approaches during its organization.

At development of the system DT discipline of TAC bases of social structural pedagogics, which are foundation of Learning Management Systems (LMS) Moodle, were incorporated, to modern textual criticism and two-parameters theory of interpretation Rasch testing results.

Informative maintenance of DK TAC has the developed multimedia support as 3D and Flash-animations, laboratory practical work is built on the basis of the use of virtual mathematical models and recordings devices.

System structure

The system is built on principle of adaptive control. On a fig. 1 the flow diagram of the system is represented. In obedience to the modern theory of management connections are synthesized between the participants of educational process. Adaptation of students in the process of mastering of course TAC is provided testing of initial level of knowledge's, intermediate diagnosing and feedbacks between a teacher, students, informative content and system of d-tester.

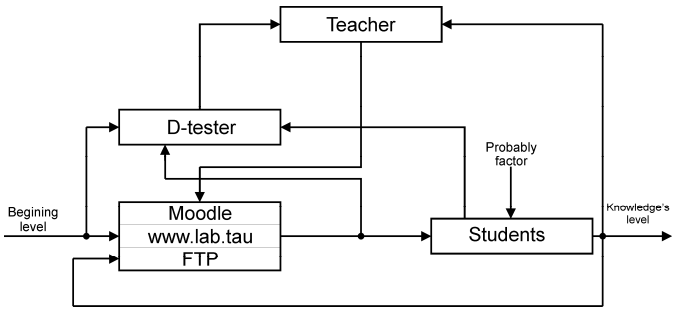

Fig. 1. The flow diagram of the system

Results of students teachings are latently structural parameters and depend on complication of information and set the problems, and also from the level of course participant knowledge's.

The distance course of tac in LMS MOODLE

A course is built on the basis of social structural pedagogics which is basis of LMS Moodle and the most strong side of project ì. Doudzhyamosa.

The method of creation of DK of TAC is presented on fig. 2. A teacher is the moderator of course and executes a role function in a student collective.

Basic functions of teacher: development of card of conceptions (plan) of course, organization of independent work of students, their discussions, and joint projects. A teacher carries responsibility for creation of effective scale of evaluation of results of activity of teaching subjects, support of operative feedback with a student audience and transforming of maintenance of DT, in accordance with the current results of teaching process.

Students must in time execute all tasks of teacher. Teaching results are in direct dependence on their executiveness, efficiency of work and creative initiative.

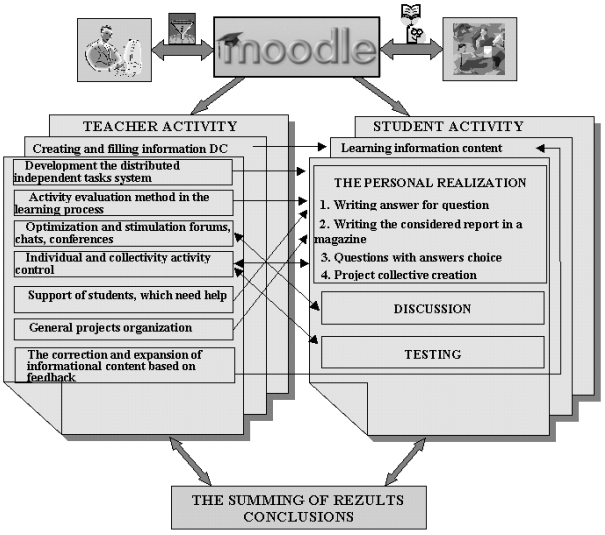

Fig. 2.The method of creation of DK of TAC

Fig. 3. The educational page of DT TAC in a SCORM-format

On fig. 3 the educational page of DT TAC is presented in a SCORM-format. On a page a multimedia resource, which illustrates work of steam Watt engine, is placed.

Conclusions: The presented adaptive control teaching system is in the process of forward dynamic development. On the real stage its filling goes informative materials; the library of models of simulations of technological objects and systems broadens on the basis of adequate mathematical models.

In the stage of development and realization there is the module of the adaptive diagnosing of level of knowledges of students on the basis of statistical treatment of results of testing of latently structural analysis and parametrics theory of Rasch methods.

The informational technologies using during the laboratory employments concluding of «Theory of automatic control on discipline»

Presently there are plenty of modern programmatic facilities of animation presentations during conducting of laboratory employments on technical disciplines. At the design of the difficult systems motion of objects is examined not on a plane, but in space. That is why among basic and the most popular programs for creation of three-dimensional objects it is possible to select the system of 3D Studio MAX.

By this program videos-rollers, which allow students it is better to understand principle of work of the classic automatic control systems, in an evident form present (to represent) motion of executive mechanisms

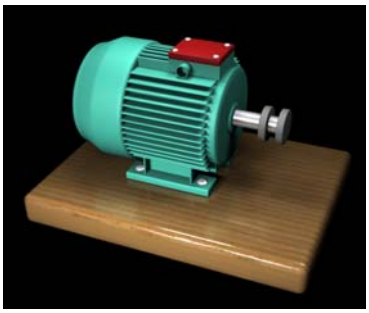

Fig. 4 The three-dimensional model of engine of direct current

(engines, reducing gears), regulators and other components of the system, are created. On a fig. 4 the three-dimensional model of engine of direct current is shown. Video-roller is also created, which shows work of engine in a cut air-cooled.

Another popular graphic program is Macromedia Flash. The program Flash in essence is multitask: it and illustration program, editor for graphic arts and sound, mean for animation and machine for writing scripts which are incorporated in one program [2]. Its advantage is in that she allows creating interactive laboratory trainers, games.

By Macromedia Flash the row of rollers of animations was created for the study of others that the disciplines «Theory of automatic control». Process of they is creation very much stand: at first it is necessary to create the row of static pictures, put in order them and create an animation file.

On a fig. 5 the last shot of animation roller that demonstrates the order of creation of model for the construction of phase plane of the automatic control system is resulted.

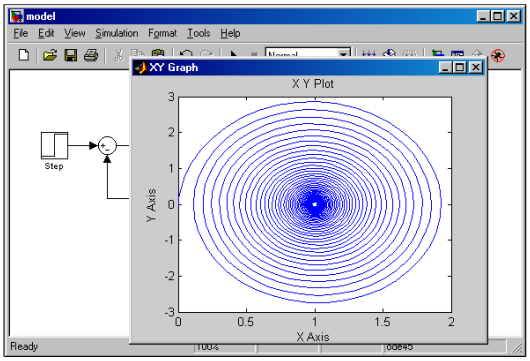

Fig. 5 Construction of phase plane of the automatic control system

Next to Macromedia Flash there is plenty of the small programs for creation and editing of animations (Timer Lock, Advanced Gif Animator). Their advantages are simplicity, high speed and small volume of initial files.

Virtual laboratories as inalienable part of the controlled from distance studies

Virtual laboratories are important part of educational process. A virtual laboratory can be created for the study of certain discipline or section of discipline. She must consist of virtual laboratory stands, each of which must provide a study and practical mastering of lecture material. A purpose of creation of virtual laboratory stands is conducting of research of the phenomena and processes in a situation, near to reality.

Experiments on virtual laboratory stands in essence are researches of theoretical models. Such stands allow in an evident and usual for an experimenter form to represent the results of theoretical calculations.

A laboratory stand is named virtual because from one side a researcher sees him, can by a mouse manage conducting of experiment, to get the results of measuring with some degree of convention. From other side, this stand does not exist physically in nature, his image is created by a computer on the screen and elements execute the functions because in accordance with the program a computer is changed by an image on the screen, creating at a researcher the illusion of participating in the real experiment [3].

The analysis of results of experiments is conducted with the purpose of exposure of dependences between different factors and sizes, which characterize the explored process, object or phenomenon, establishing reasonable following connections between them.

Basic advantages of creation of virtual laboratories:

cheapness - a dear equipment is replaced the computer program;

a compactness is scaling of equipment of largeness, placing on one computer of plenty of “virtual” equipment;

speed is a change duration both too slow and too rapid processes;

safety - at a design potentially of dangerous equipment, for example, nuclear a reactor.

Among the products of software of the virtual measuring devices and systems intended for creation it is needed to select the applied package of the graphic programming of LabVIEW 8.0.

LabVIEW, like programming in PASCAL or BASIC, is a programmatic package for development of the application programs. However, unlike the programming languages indicated higher, LabVIEW uses a graphic programming of G (Graphics), intended for creation of the programs in the form of diagrams of flows language. LabVIEW contains the vast libraries of functions and tools, intended for creation of the systems of capture of data and automated control systems. LabVIEW also includes the standard tools of development of the programs, allows to set the points of controls, use computer animation for implementation of the program, to see that information pass through the program, to carry out incremental implementation of the program, for facilitation of development and program debug [3]. A presence in the system of LabVIEW special Simulation Module does her maximally suitable for a design and research of the difficult dynamic systems.

The programs in LabVIEW are named virtual instruments (VI), as the real measuring devices imitate their kind and functioning.

In the environment of LabVIEW 8.0 a stand is created for the calculation of parameters and research of descriptions of sentinels of executive DPS. The frontal panel of stand has three insets (fig. 6).

On an inset “Choice of type of engine” in a block “Weekend an user can set information” value of parameters of management (PM) (static moment of loading of PM, moment of inertia of PM, high angular speed and maximal angular acceleration of PM and speed of change of static moment of loading of PM) object in obedience to a requirement specification. In a block the “Technical parameters of DPS” it is possible by a switch “Choice of engine” to carry out the choice of certain engine, thus the values of technical parameters (nominal power, nominal tension, nominal speed of rotation of billow of engine, nominal current of anchor of engine, moment of inertia of anchor, resistance of puttee of anchor, CUA of engine) in the proper fields change automatically. In a block the parameters of “Calculations of DPS” enter parameters: nominal angular speed of engine, nominal moment of engine, optimum gear-ratio of reducing gear, total moment of inertia, inductance of engine, parameters of calculations. Parameters over of transmission function of DPS are brought in a fourth block: amplification of engine factor, amplification of engine factor in relation to loading, electro-mechanics and electromagnetic permanent time of DPS.

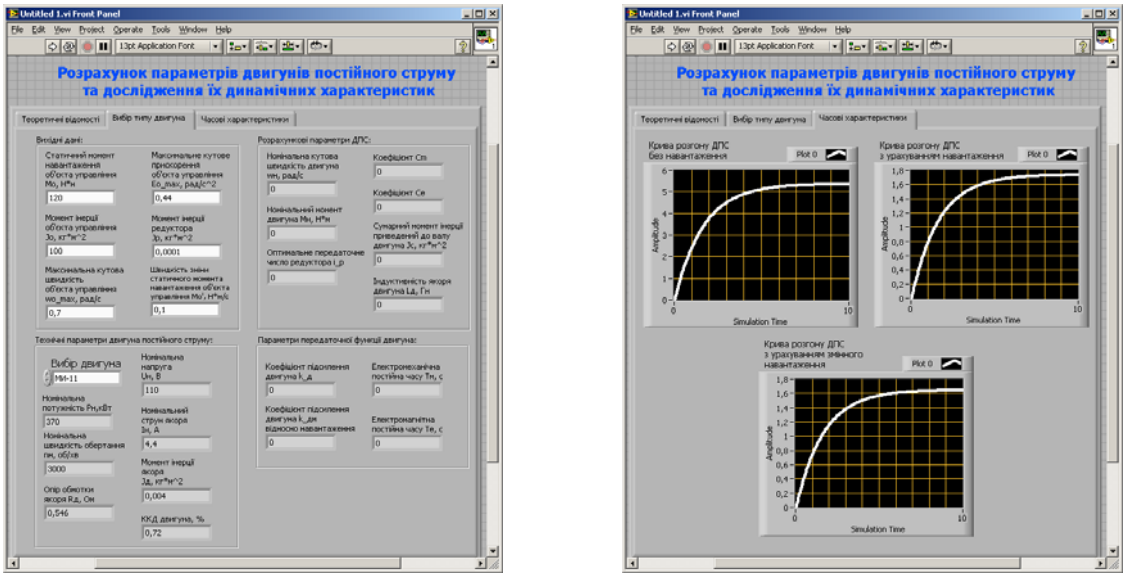

Fig. 6 The frontal panel of stand has three insets

On the third inset descriptions” of “Sentinels are resulted curves of acceleration of engine of direct current without loading, with a quiescent and variable load. Comparing the graphs, draw conclusion, that at the variable loading frequency of rotation of billow of engine is the least, and in default of loading - most frequency is set accordingly.

Consequently, the programmatic package of LABVIEW allows easily creating virtual devices for research of dynamics of the control and their separate elements systems.

Students knowledge remote diagnostic system d-tester

D-tester 1.1 is the most powerful system, designed for providing testing in different high schools; it has the all necessary abilities and functionalities for making testing process simpler and faster. This testing system is developed for using in different operation systems and it is based only on the most popular free web-technologies such as Apache web server with PHP + MySQL. D-tester 1.1 has the rich couple of different statistics that make analyzing results faster and easier.

The system consists of two subsystems: administrative subsystem and testing subsystem. The scheme of the system, external links and scheme of administrative subsystem is showed on a fig. 7.

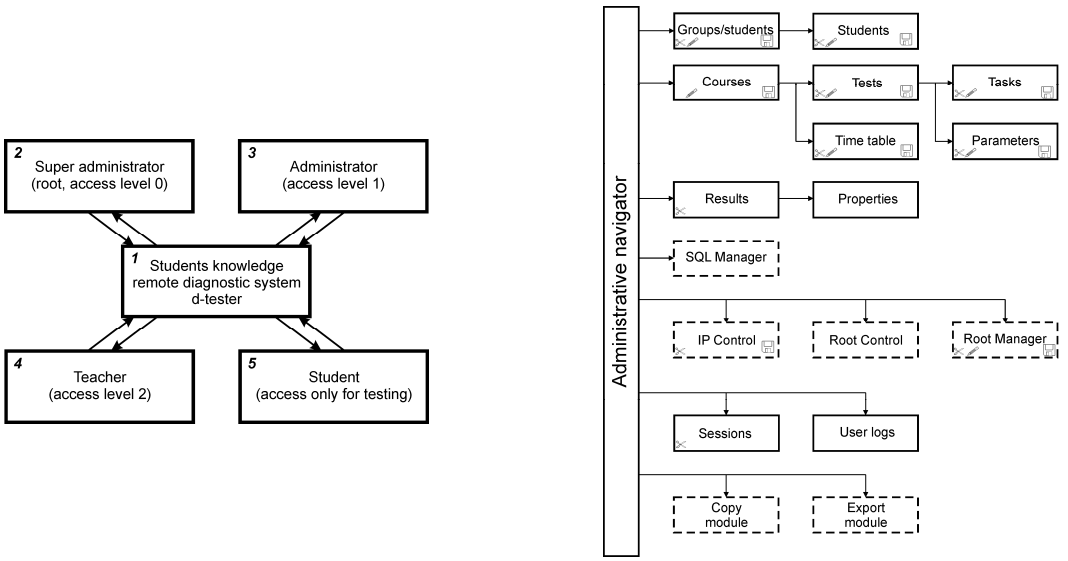

Fig. 7 The scheme of the system and external links and scheme of administrative subsystem

The administrative subsystem owns next possibilities:

- creating tests blocks;
- registration new students and groups of students;
- analyzing results of testing;
- active sessions control.

Three levels of administrator's privileges are foreseen in the system:

- Zero level – foresees possibility of complete access to all modules, and also direct access to the system database with using the SQL manager module;
- First level – foresees possibility of complete access to all modules, except for SQL Manager, IP Control, Root Control, Root Manager, Copy module, Export module;
- Second level – foresees access only to that part of the system, which is certain by a quota. Information about proper quota is kept in a database. A quota consists of identifier of course – unique number of course in a database, and also privileges of access:
- SB_READ is revision of information about courses;
- SB_WRITE is adding/modification of information about objects;
- SB_DELETE is deleting information about courses;
- RES_READ is revision of results of passing of test control;
- RES_DELETE is deleting of information about the results of passing of testing.

It should be noted that in this case under a course not only a course but also all is understood subcategories are tests, tasks are related to him.

Description of modules:

- groups/students – management students and group of students information;
- courses – management courses and subcategories tests and tasks;
- results – generating reports about results of testing;
- SQL manager – direct access to system database using SQL queries;
- sessions – active session control functions;
- IP control – functions of LAN computers control;
- user logs – user logging information functions;
- root control – admin logging information functions;
- root manager – management system administrators functions;
- copy module – copy tasks functions;
- export module – export tasks functions.

The system supports the task in the IMS QTI 2.0 standard. Next types of test tasks now supported:

- simple choice (simple choice text & images);

- multi choice (multi choice text & images);
- short answer;
- numerical;
- alternative (partial of the simple choice question) [4].

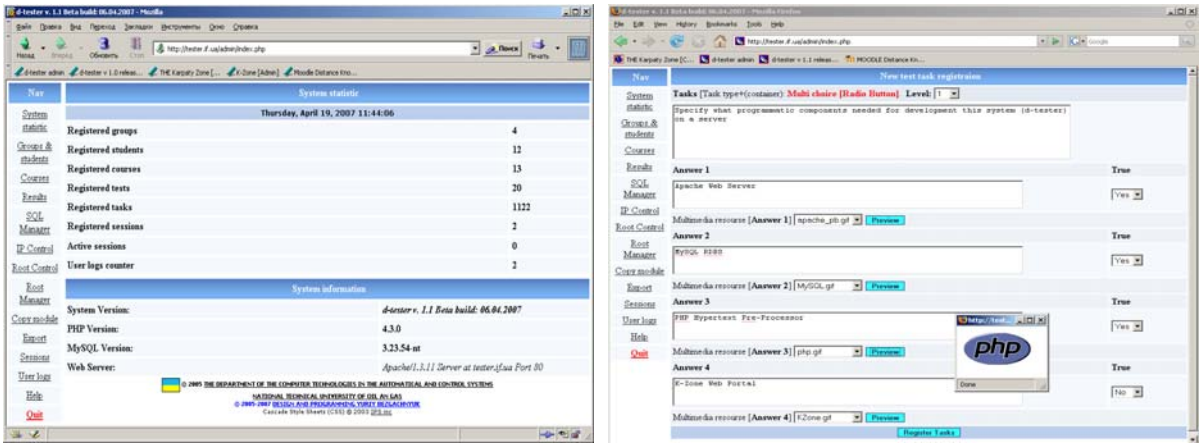

Fig. 8 Start page of administrative subsystem and task editor

The system has a simple and intuitively clear interface projected so, that you can conduct its localization for any language package. Some web pages of administrative subsystem are shown in fig. 8 - start page of administrative subsystem and task editor. For registration task you can use some tags of the HTML language. In a next version of the system the TINY_MCE editor, which considerably will simplify the process of registration of test task, will be used in the task editor.

One of important functions of the system is possibility of conducting of analysis testing results.

You can also generating some histograms about the testing results.

The testing subsystem is intended for providing student's test control. It owns next possibilities:

- show testing questions;
- time control;
- checking user answers;
- generate and show result of testing.

User can simply distinguish the type of task, which is offered him. For example: simple choice type of task is shown using radio buttons, multi choice type – check boxes.

A page with report and a page with question (multi choice [images]) is shown on fig. 9.

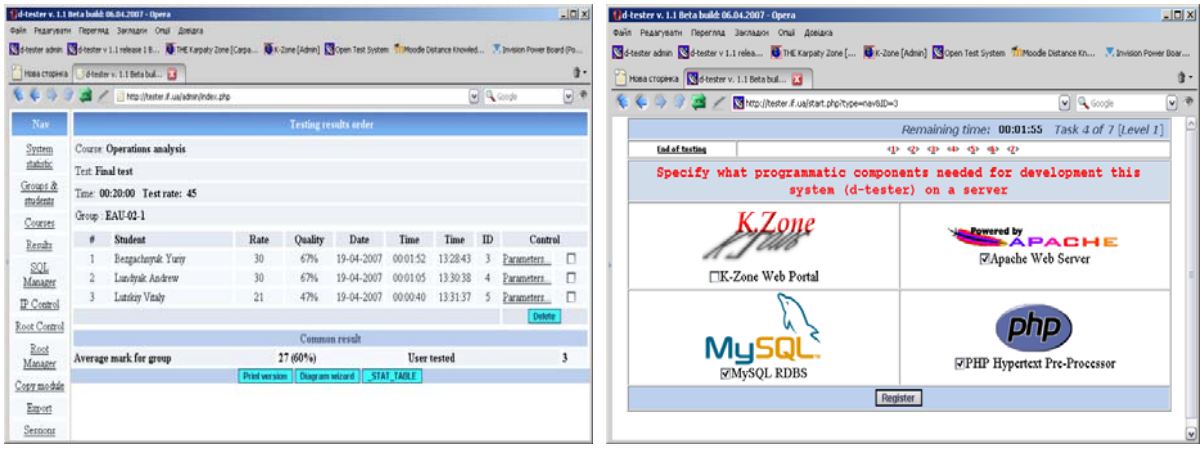

Fig. 9 A page with report and a page with question

Conclusion

Informative content for organization of Web-teaching technical specialties requires a considerable reinforcement mathematical conclusions, multimedia materials, models of simulations, interactive trainers, virtual laboratory stands. Software for development of similar educational materials often is inaccessible educational establishments in a price relation.

Acknowledgements

Results of planning of the adaptive system of studies bases of discipline are “Theory of automatic control” and development of its functional modules were presented on:

1. Of the International scientifically-methodical conference “Modern educational technologies at high school”, on November, 1-2 2007p., Kiev.

2. 11 to the International conference of the Ukrainian association of the controlled from distance studies “Education and virtualness”, on September, 17-21 2007p., Yalta.

3. Of the 5th of International Conference on of Emerging Telecommunication Technologies and of Applications (ICETA 2007), (4th year of Learning Projects Competition "e-Learning in Praxis") September 6-8, 2007, Slovakia.

The system of the controlled from distance diagnosing of level of knowledge got testifying to registration of copyright on work № 20763, 31.05.2007.

Bibliography

[1] L. Zamihovskiy, L. Savyuk Problems of creation of universal educational shells are for the controlled from distance studies of students of technical specialty. East-European magazine of front-rank technologies. №6/2(18). Kharkov, 2005, p.71-77.

[2] Reynhard G., Daud S. With. Macromedia Flash MX 2004. Bible of user. S.Petersburg : Dialectics, 2005. 1312 p.

[3] R. Matviyenko R. Products of Software’s for creation of virtual laboratories on providing of technical specialty . Scientific news of Ivano-Francovsk IME are the “Galichina academy”. Ivano-Francovsk. 2005. Issue №2(8) . p.89-93.

[4] Bezgachnyuk Y. System of the controlled from distance verification and evaluation of level of knowledge’s of students.- 10th to the International conference of the Ukrainian association of the controlled from distance studies “Education and virtualness - 2006”. Collection of scientific labors of the conference. Kharkov-Yalta. 2006. p.434-440.

Author's Information

Yuriy Bezgachnyuk *– master's degree on the control and automation systems. Certificated learning management systems administrator (Moodle). PHP/MySQL Developer. Developer of the students knowledge remote diagnostic system. e-mail: bz_yuriy@mail.ru*

Leonid Zamikhovskyy *– Doctor of technical science, professor. Manager by the department of the document knowledges and information activity. Pro-rector from the science. Academic of the Ukrainian Oil-Gas academy. e-mail: **LeoZam@ukr.net***

Roman Matviyenko *– master's degree on the control and automation systems. Assistant of computer technologies department in the control and automatic systems. LabVIEW developer. Virtual laboratory stands developer. e-mail: romanager@rambler.ru*

Larysa Savyuk *– technical science candidate. Manager by the UNESCO department. Certificated Ukrainian Distance Knowledge Association specialist. Certificated learning management systems administrator (Moodle). e-mail: lorasavuk@rambler.ru*

Organization: Institute of economy and management “Galitskaya Academy”, Ivano-Frankovsk, Ukraine

Tel.: +380(342) 772095; Fax: +380 (3422) 65598; e-mail: ime@ime.if.ua; www.imega.edu.ua

AUTOMATING EXERSISES VALIDATION IN E-LEARNING ENVIRONMENTS

Antonio Ortega, Rubén Álvarez

***Abstract**: E-learning is supposing an innovation in teaching, raising from the development of new technologies. It is based in a set of educational resources, including, among others, multimedia or interactive contents accessible through Internet or Intranet networks. A whole spectrum of tools and services support e-learning, some of them include auto-evaluation and automated correction of test-like exercises, however, this sort of exercises are very constrained because of its nature: fixed contents and correct answers suppose a limit in the way teachers may evaluation students. In this paper we propose a new engine that allows validating complex exercises in the area of Data Structures and Algorithms. Correct solutions to exercises do not rely only in how good the execution of the code is, or if the results are same as expected. A set of criteria on algorithm complexity or correctness in the use of the data structures are required. The engine presented in this work covers a wide set of exercises with these characteristics allowing teachers to establish the set of requirements for a solution, and students to obtain a measure on the quality of their solution in the same terms that are later required for exams.*

***Keywords**: E-learning, Computer Science, Data Structure and Algorithms, Abstract Data Type, Test Case Generator.*

***ACM Classification Keywords**: testing tools, mechanical verification, diagnostic, trees, list, stacks, queues.*

Introduction

Nowadays e-learning systems allow, among other services, support students while carrying out the study of a subject. The mythology considers a wide spectrum of services which allow the communication between students and teachers, thanks to the existing tools, such as different utilities for content management and visualization, chats for on -line mentoring, or forums in which students and teachers share opinions on the matter.

Some enterprises provide e-learning services such as tools for supporting the definition of test-like exams so that students may solve these exercises, providing marks and lists of errors, some of them give also a brief explanation on the correct solution, based in links to theory contents. However, we suggest that tests are no the correct choice for some materials, and that a wider kind of exercise or exam type is a must in many environment. In the one hand theoretical exams may be supported through test-like exercises, in the other, practical knowledge and skills require a more complex service, complaining not only the final solution given by the student, but also the goodness of the solution itself depending on complex criteria.

We expect to demonstrate that it is feasible to design such a service, and present a specific validator in the field of data structures and algorithms (DSA), which include the concepts of Abstract Data Types, such as stacks or queues, dynamic structures, e.g. binary trees, linked lists of some types, etc.

This system could provide students a repository, accessible through Internet, containing exams which could be solved by students, and automatically validated in exactly the same terms that teachers do in real exams. Each student could get not only a mark, but a complete list of errors, including conceptual mistakes committed while developing the solution, and then acquire the knowledge on how the code shall treat all data structures properly and how the algorithm shall look like.

Teacher collaboration is a strict requirement for the system to provide best possible results. Teachers are encouraged to manage contents, administer exercises, specify solution constraints and basic test cases that provide a way to compare program outputs.

Test case automation

The engine, we propose within this paper, is really a test case generator that automates test case definition for each program. Then the test cases are to be executed obtaining the outputs for each solution provided. The novelty is that later the evaluation is also automated, based on academic criteria. Note the similarity to general software testing.

We must keep in mind that in the software testing stages of software development we do not really desire to verify if the program works correctly, furthermore we expect to find errors. A successful test is the one which finds errors. Software testing includes different kinds of tests that allow the evaluation of different aspects of the product. Depending on the goal of the product testing is to be more or less exhaustive, e.g. fault tolerance level. For instance, testing a video game shall be different from testing a flight navigation system or the controls of a nuclear power plant.

Glen Myers [1] establishes three rules as the goals for a test:

1. A test is a process involving the program execution with the intention to find errors.
2. A good test case is the one in which there is a probability of finding an error not yet discovered.
3. A test is successful if a new error has been discovered.

The ideal cycle in a test plan should be: discover a bug, repair the bug, and finally commit again with the tests prior to fault detection. This is called regression testing, and it is used to check that the changes made while correcting bugs do not generate new bugs.

Our work is oriented to validate exam solutions that usually are reducing to little size programs, with simple structure and not much subprogramming. In this sense, and considering a subprogram as a portion of a unit to test, or as maximum a unit itself, the research is focused in unit testing, validating design and behaviour of the result [2].

Regarding unit testing two different approaches may be found. The first allows the validation of the behaviour or interface of a unit (black box test) and the other allows evaluating the structure and testing all execution paths (white box).

In [3] we can find several paradigms for test automation:

- Random generation [4], in which inputs are generated until a useful one is found.
- Symbolic testing (static analysis) [5], in which symbolic values are assigned to variables in order to obtain an algebraic expression with the goal of representing the program processing.
- Dynamic test generation [6], in which a direct search for test cases is done through program execution.

[7] enumerates and explains the ten most important challenges in test automation, still not solved. Another way to afford the problem is based in metaheuristic techniques. Among the works in the matter, we can find [3], where three types of algorithms are discussed: genetic, simulated annealing and tabu-search. More information on this issue is found in [8], where the authors consider not only metaheuristics focused on white box testing automation, but also the automation of black box testing. It has been considered that all works in the matter are focused in reducing the costs and effort while developing industrial systems, the complexity of this kind of projects is out of the scope of our work.

JUnit [9] is a tool that provides facilities for testing java software. It does not automate test case generation, but executes provided tests automatically. The research work in [10] presents a framework for automated verification of object oriented programs. The kernel of this system is composed of a repository of classes in XML format. In this proposal a parser or syntax analyzer inspects the source code in the selected programming language and extracts relevant information which feeds the repository. XML is used as a metalanguage for creating abstract syntax trees which provide programming language independence. Test cases are created using this repository.

Exam validation engine

Basing the solution in all mentioned issues, we relay in a lexical analyzer generator. Flex [11] is used to extract, from the plain text sent by students, the structure of the program. With this structure we can define the test cases that are required as well as input data for generate the cases.

For testing the program we can execute it, providing the proper inputs. Checking that the internal processing of the solution is correct relays in the scope of black box testing. Finding automatically the proper input data for the program is in the scope of white box texting. For this purpose to be achieved we can use a lexical analyzer generator. This implies not only generating a lexical analyzer, but a tool which, together with the analyzer, provides the capability of recognizing each part of the source code (conditions, assignments, calls to other functions, etc.).

The latest tests to be executed on the solution are black box tests. This is the reason for analyzing the code, because once parameters for the functions are known, the code manipulating the parameters is located, and equivalence classes may be calculated for each input data.

Keeping in mind that we are interested in validating subprograms (functions or procedures), due to the kind of exams in the area, and thinking of reducing the complexity of the engine, only parameters in the main function of the program are to be taken into account for black box testing.

Flex is capable, as written in its specifications, of generating test cases automatically. The question then is: Are we automating test cases or we want to achieve a further goal? If so, which is that goal?

The answer is that we want not only to generate tests automatically, and obtain inputs and outputs from programs. Our goal is to determine how good a solution is, the goodness of the programming style, properness of data structures management.

In this sense, we found in Flex a set of constraints. For solutions that require ADTs, it is necessary to count on the declaration of the structures and operations for knowing which data type are contained in each structure. On the other hand, if the solution for the exercise requires of external libraries, information about them is needed. Specifically information about the expected results for each operation in the libraries, as long as the source code of the library is usually not available.

Validating an exercise about DSA implies also checking specific aspects of the implementation, such as number of times each data is accessed. These are aspects out of the scope of Flex.

Working with Flex only provides to create a hypothetic tool that generates test cases, to execute tests on a program looking for errors, but does not guarantee the correctness of the solution in academic terms.

By that time, we decided to abandon the support given by this tool, and started evaluating the possibility of creating the engine from the scratch.

In order to provide students a validation service, we have developed a system which receives, only, the solution requested in the exam. Note that in many exercises it is assumed that a set of libraries is available, but we do not demand this additional code, only the function(s) or procedure(s) required by the statement.

We needed a tool capable to generate a complete program, compliable and executable, so that we shall add to the student's code, a set of sentences, declarations of data types and structures, ADTs, initialization values, and functional verification support to obtain the outputs. Also we shall be capable to detect and check that the code provided by students is compliant with the constraints defined by teachers.

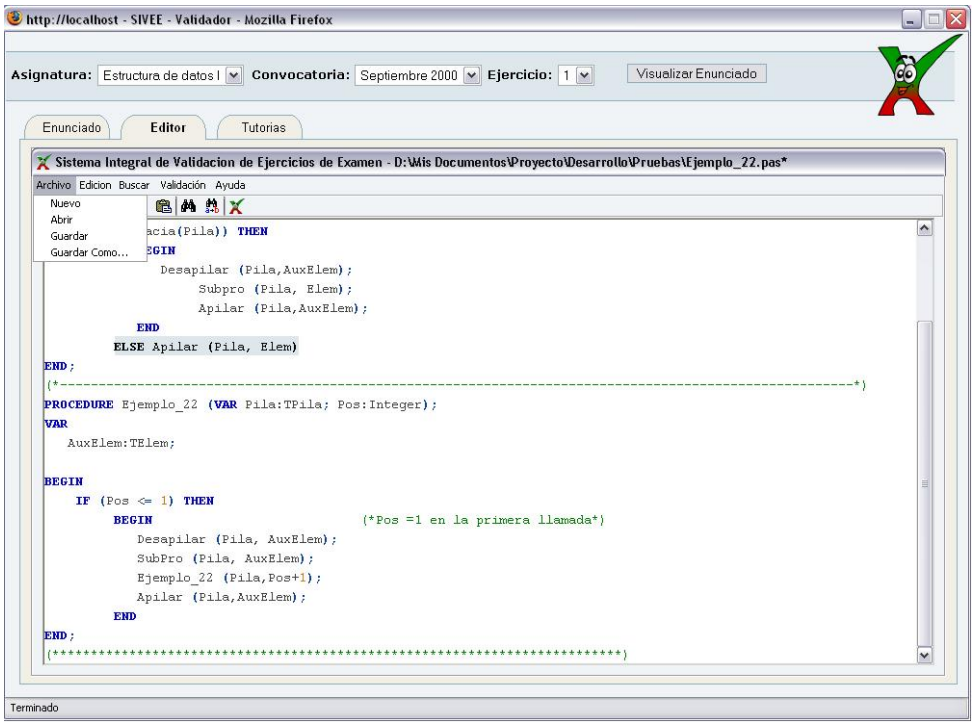

Figure 1. Interface provided to students

The tool is capable to generate dynamically complex data structures, while teachers are free to define any kind of list or tree, for instance, as a part of the scope of the software to be produced.

The basic architecture of the product is shown on figure 2.

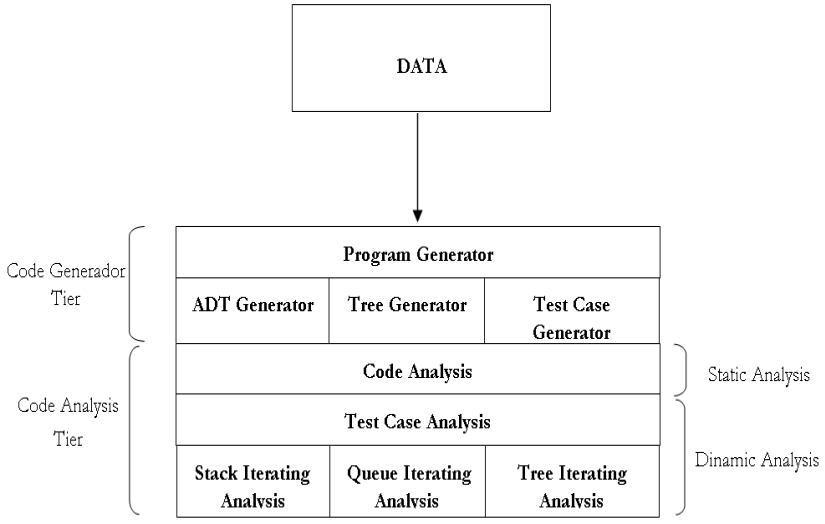

Figure 2. System architecture

The student only must complain about respecting the constraints defined for correct solutions:

- If the exam statement specifies that a subprogram is expected, and that the subprogram shall have same parameters specified by teachers, we expect students to provide a function or procedure which considers strictly the specification, in other case the exam is failed.
- The user has no limit respecting the amount of subprograms that can be written to get a proper solution, while the previous point has been respected this does not have consequences regarding the mark.
- The user must respect the names of the different data structures provided by the statement, otherwise the engine is to fail during validation, since the system is going to complete the program basing the generation in the given specification.
- The user shall provide, together with the solution, the set of initialization values for variables and parameters that make the solution work.

The engine performs also the generation of ADTs, automatically, for all simple data types and some complex homogeneous data types. It may be thought that instead generating the ADTs they could be provided by teachers, we suggest that generating them is also a base for further extensions of the system.

Static constraints to consider that a solution is valid and correct are as follows:

1. Check if the student uses auxiliary data structures that are not allowed.
2. Control the use of pointers when these are not required.
3. Validate the kind of subprogram, it shall meet the specifications (procedure, function, or any of both).
4. Guarantee that the main subprogram receives necessary parameters, in the correct form (by value, by reference), and that there are no more or less parameters.
5. If the problem request a function, ensure that the solution returns the correct data type.
6. Check the implementation, some problems request or forbid iterative or recursive solutions.

In order to verify all items mentioned above, our engine analyzes the code of the solution that shall be free of compilation errors. This reduces significantly the complexity of the system, with no lose of functionality, compilation may be carried out in local computer using some of the common compilers. After inspecting the code, relevant information is stored (subprograms used, their names and parameter names and types, whether the parameters are passed by value or by reference, main subprogram location, kind of algorithm…). This information is used to support the verification of the solution, and permits the detection of forbidden data structures and pointers (for instance looking the ^ symbol for Pascal programming language) or if the solution is based on a procedure or a function.

Dynamic constraints are the following:

1. Check the number of iterations on a data structure.
2. Track that the solution does what is expected to do while and after execution.

Code in the same language of the provided solution is generated to build a complete program, free of compilation errors and capable to be executed. Then the student's solution is aggregated to this code. All the information required for code generation is extracted from system data store. The data in this store are provided by the teachers before publishing an exercise.

The complete program is then instrumented, adding traces that are written to an output file containing the memory addresses of the nodes in the dynamic structures. Once these addresses are know, and after executing the program, the engine calculates the number of accesses per node in the structure. If some of the addresses have been accessed (non consecutive) more times than those allowed by teachers, or in an incorrect order, we can determine that the algorithm is not correct.

In the case of Queue ADT, the output of the traces points the number of *enqueue* and *dequeue* operations, and the number of times *size* service has been called. Also the operations requested from user code are tracked to check this.

The code generated by the system is in charge of requesting to the queues the number of elements at a given time. Once the file is written, a first algorithm is responsible for separating the traces depending on its kind.

Let the system know the number of queues available for an exercise, and the number of accesses to each node inside, then another algorithm is capable to verify the correctness in treating the structure.

This algorithm calculates the maximum number of iterations on each queue in the problem as follows: calculate the number of times that dequeue is requested per each structure, divide that amount by the number of elements in the queue. If the rest in the calculus is zero, then the number of iterations on the queue is the quotient of the operation, in other case the number of iterations is the quotient plus one.

In the example above a queue containing three elements is shown. Following the described algorithm, if we dequeue three times we can observe that 3 dequeue operations divided by 3 elements equals 1, rest=0. The queue has been iterated once. Instead, if we dequeue and enqueue four times 4 dequeue operations divided by 3 elements equals 1, rest 1. The queue has been iterated more than one time, because one of the elements has been read twice (producing also a change in the order of the nodes of the structure, which may be also a constraint). Note that if we unqueue 4 times, without enqueueing, then the forth operation fails, and does not compute in terms of a second iteration, because no element has been extracted.

The output of the traces introduce for the exercises using Stack ADT indicates the number of calls to *pop* and *push* operations. When the execution finishes, an algorithm extracts the traces for pop and push, in same terms that was done for enqueue and dequeue. In order to determine the number of iterations on the stack, the algorithm looks up for the number of consecutive times that pop or push operations are requested. The succession of maximum length is the base to calculate the number of iterations.

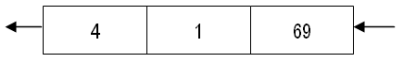

Figure 3. A queue

When validating that the program does what it is expected to do, the engine is supported by the information provided by teachers. The engine generates an executable program in which the declarative sentences and initialization values for parameters, from teachers, are added to create an execution of the student's program. Apart from these sentences, final values for parameters, especially those by reference are checked.

Conclusions

Once the work described has been finished, we consider that it is feasible to carry out the design and implementation of this kind of system, and that only a study for each kind of exercise and data structure is required. The basic engine, implemented during the research stage, demonstrated that automating the correction of exams and exercises, maintaining the constraints of each subject, are possible and provide a great help to students on data structures and algorithms.

As many other computing systems, of course, ours has limitations and constraints. The engine detects and reports on compilation errors or faults during execution. Regarding specific constraints, teacher dependent, we are capable to specify the kind of error committed by students, but we cannot specify which part in the code of the solution is producing the error. Either it proposes the student how to avoid this issue.

In spite of a number of types of exams on DSA cannot be solved by the engine, because of the use of ADTs not yet implemented, we consider that the engine is very useful, and supposes a great step in the matter, and that covering more ADTs is only a matter of time, once the kernel has been developed successfully.

Bibliography

[1] Myers, G., The Art of Software Testing, Wiley, 1979.

[2] Métrica 3. Ministerio de Administraciones Públicas. http://www.map.es/csi

[3] Eugenia Díaz, Raquel Blanco, Javier Tuya. Comparación de técnicas metaheurísticas para la generación automática de casos de prueba que obtengan una cobertura software. ADIS 2002

[4] Ntafos, S., On random and partition testing, Intl. Symp. On Software Testing and Analysis, 1998

[5] DeMillo, R.A., Offutt, A.J., Constraint-based automatic test data generation, IEEE Transactions on Software Engineering, 17(9).1991.

[6] Korel, B., Automated software test data generation, IEEE Transactions on Software Engineering, 16(8), 1990

[7] Rice R.W. "Surviving the top 10 challenges of software test automation." CrossTalk: The Journal of Defense Software Engineering (Mayo): 26-29. (2002).

[8] Dr. Macario Polo Usaola. Curso de doctorado sobre Proceso software y gestión del conocimiento. Pruebas del Software. Departamento de Tecnologías y Sistemas de Información. Febrero 2006.

[9] http://www.junit.org/

[10] Pedro Jesús Vázquez Escudero, María N. Moreno García, Francisco J. García Peñalvo. Verificación con XML. Departamento de Informática y Automática. Universidad de Salamanca. Noviembre 2001.

[11] Flex, version 2.5. A fase Scanner Generator. Editor 2.5, march 1995. Ver Paxson.

Authors' Information

Rubén Álvarez González – *BSC in Computer Scence; Spain. e-mail: ruben.alvarez.gonzalez@gmail.com*

Antonio Ortega Manchón – *BSC in Computer Scence; Spain. e-mail: antonio.ortega.manchon@gmail.com*

SPECIAL FEATURES OF MUSICAL EDUCATION IN DISTANT LEARNING (TRAINING OF INTONATION THINKING)

Larissa Kuzemina

Abstract*: The problem of using modern technologies in distant learning of intonation thinking is described in this article. An importance of intonation learning for musician students and the possibilities, provided by World Wide Web and multimedia technologies are the main point of this article.*

Keywords*: Intonation thinking, distant learning, fortepiano learning*

Urgency and the formulation of the problem

Nowadays, in musical education the vital problem of learning musician students is intonation thinking. New possibilities opened due to rapid development of students' self-study and methods of distant learning, which differ from traditional ones with great possibilities of applying multimedia and Internet technologies.

In the process of learning students a fortepiano, technical equipment, as a rule, is used in traditional forms (audio and video recording). Different records of music with subsequent analysis depending on the concrete theme or individual lecture are used. During process of distant learning of teacher and student's with sound, techniques and polyphony fragments of video records are used. Listening and comparative analysis of best performers are used to show to a students particular features of musical composition intonation sounding. The educational methods sound-recording benefits adapt for training of students for the seminar studies. For the purpose of more complete disclosure of training intonation thinking the records of the concerts of the outstanding performers are used.

For the most qualitative training of intonation thinking it is **proposed** to widely use contemporary resources of distant learning:

- obtaining by the students information about the problem of intonation thinking in the interactive regime with the aid of the multimedia teaching;

- obtaining additional information on this problem from the Internet (musical and note libraries, musical anthologies, article, training publications);
- the possibility of self-verification (test tasks);
- the possibility of consultations with the instructor online;
- tracking training materials by note and audio samples;
- the forums (seminars), organized on the assigned themes.

Since the intonation thinking is the most important direction of professional training of musician, let us examine, first of all, however, what is included in this concept and what possibilities of distant learning can be used in the solution of this problem. "Think about intonation - means to hear life in the sounds through the generalized intonation of lyric hero, to feel his soul, to look at the world by his eyes" (V. Medushevskiy). Out of the emotions the music expresses nothing, through them - all! Emotional and psychological attitude of composer, performer, teacher, student, student, their aesthetical, ideological positions are transferred by means of and with the aid of the intonations: speech, motion, respiration, etc. This is why close attention to a question of training and self-education of intonation thinking is necessary.

What methods of operations in this direction are known?

1. First of all, it is necessary to have at least general ideas about the intonation, theories of intonation thinking and their authors.
2. It is necessary to manage information about the introduction to this theory into the practice of musical formation, into musical pedagogy and performance.
3. Knowledge of principles of intonation thinking theory, qualitative sides of intonation and development of these concepts in the historical aspect is required.
4. In the self-work the preferred system of sensory orientation, on the basis of the specific features of thinking and perception must be selected.
5. Modern information technologies in the work on musical material with the use of multimedia teaching aids for the independent instruction and the self-control

Let us examine consecutively each of the enumerated methods.

Musical intonation, intonation thinking, culture of intonation - these concepts play the predominating role in the creation and performance pedagogy. By their introduction into the musical science and the practice we are obliged to the outstanding musician - the researcher B.L. Yavorskiy (1877-1942).

Even at the end of the XIX century B.L. Yavorskiy established the connection between the sonic side of verbal speech and the expressiveness in the music. Studies led scientist to the development of the concept of intonation. Specifically, intonation, i.e., the sonic side of verbal speech, is the basic decisive factor of its expressiveness.

The intonation of human speech marked the beginning of development of the science about the music - the theory of the musical thinking of Yavorskiy.

To questions of the expressiveness of intonation it dedicated the article "text and music", fragment from which is cited:

> *"When we hear conversation in the incomprehensible for us language, we, without being in the state to determine the object of conversation, very frequently guess mood, sense of conversation itself; when we hear after the wall or generally hereabout the sounds of human voice, we, without investigating words, always error-free determine - conversation whether this, story or reading aloud."*

In the second case the rumour is guided by presence or absence the characteristic for the living speech intonations of increase and reduction, strengthening and weakening, quickening and tension, connection and separation, pause and stoppage. In the first case - on the relationship of the same modifications the rumour determines the mood or the overall meaning of conversation.

Performance of one and the same dramatic work by different artists produces different impression from one utterance alone of the words of this work, independently of the extrinsic ethos of executors and their mimic and plastic game. Yes even the separate persons possess the ability to repeatedly pronounce one and the same word, each time, giving to it another sound.

And further B.L. Yavorskiy makes the conclusion that the sense of speech give the intonation of human voice, they determine the content of our speech; specifically, by intonations we, in the limits of our skill and our

resourcefulness, mentally allot that read by us. In the living human word its essential attribute is not glasnost and concordance, but sounding, which transfers the intention spelled by us words; word itself, which consists of the combination of open and the consonants, only fixes this expressiveness with respect to the specific object, to the definite phenomenon. The selection of open and consonants, their relationship can emphasize only the concrete sense of word itself and simultaneously it can give grateful material for the expressiveness of intonation itself.

B.L. Yavorskiy indicates that, after imprinting in the phonograph human speech and after destroying in the record concordance and glasnost, leaving only one sounding, we in this phonograph will reveal the record of some intonations, the melody of human speech - musical composition. Each speaking person during the speech becomes a composer, and a good dramatic artist differs himself from mediocre only in terms of the fact that he is the best composer plastic (since plastic is also speech, speech of nonverbal).

Without being creator the "literary" (from the word of "warrant" - letter) side of work, artist he is for this stage idea the creator of the intonation, musical side of this work, allotting word by sound, by time, by dynamics, timbre and by emotion, using in the majority of the cases only by insignificant author's indications.

If we listen ourselves to the interrogative and affirmative sounding of one word (for example, "At home?" and "home"; "is it prepared?" and "it is prepared"; "is it understandable?" and "it is understandable" and the like.) that it is possible to note that the intonation of a question derives rumor from the state of rest and stability and converts it to the state of instability, gravity. In the instability the direction of gravity is most essential, while the stability of any direction does not have any. The answer in such a case will only satisfy rumor, if it restores broken auditory stability and carry rumor in the required direction.

Briefly, the intonations of a question, complaint, request, conversion, irritation, anger - are unstable. The intonations of answer, order, story - are steady. B.L. Yavorskiy emphasizes that independent stability there does not exist. There is only a completely definitely gravitating towards instability, nevertheless remaining relations are indifferent, i.e., they can produce one or other impression or another depending on that to the rumor, from what they are sonic they consist - steady or unstable.

It is possible to make the following conclusions:

1. about the presence in speech it is sonic different functions - unstable, that gravitate towards in the determinate direction to the permission, and steady, relatively their solving (in the subsequent period B.L. Yavorskiy it connected the concept of instability - stability with the general psychological law of excitation - braking).
2. about connection of two it is sonic different functions between themselves, which in gravity conditions forms the double parted intonation of speech. Functional difference it is sonic between themselves easily it obtained by all people, which possess normal rumor. For this it is necessary under the conditions for the simplest auditory tuning to only carry out by voice or on the tool the unfinished construction: listener will immediately reveal this incompleteness, and itself will solve unstable sound with voice, or it will ask to solve it on the tool. Hence it follows that the sensation of instability it is sonic there is an organic property of human rumor. It is basic agent in the organization of musical thinking.

Briefly, the intonations of a question, complaint, request, irritation, anger - are unstable. The intonations of answer, order, and story - are steady.

B.L. Yavorskiy emphasizes that independent stability there does not exist. There is only a completely definitely gravitating towards instability, nevertheless remaining relations are indifferent, i.e., they can produce one or other impression or another depending on that to the rumor, from what they are sonic they consist - steady or unstable.

It is possible to make the following conclusions:

1. about the presence in speech it is sonic different functions - unstable, that gravitate towards in the determinate direction to the permission, and steady, relatively their solving (in the subsequent period B.L. Yavorskiy it connected the concept of instability - stability with the general psychological law of excitation - braking).
2. about connection of two it is sonic different functions between themselves, which in gravity conditions forms the two-part intonation of speech. Functional difference it is sonic between them easily is heared by all people, which possess normal rumor. For this it is necessary under the conditions for the simplest auditory tuning to only carry out by voice or on the tool the unfinished construction: listener will immediately reveal this incompleteness, and itself will solve unstable sound with voice, or it will ask to solve it on the tool.

Hence it follows that the sensation of instability it is sonic there is an organic property of human rumor. It is basic agent in the organization of musical thinking.

To the concept of "intonation" scientist in the different periods gives these definitions:

1. Intonation is the smallest sonic form in time; these are the motion of unstable sound to the side of gravity, into its resolving steady, and also - destabilization by sound unstable, to the side reverse to gravity. Intonations can be steady and unstable.
2. By intonation should be understood all possible cases of smallest sonic part, which can reproduce human sonic organ with the concrete internal auditory tuning. Indication of sonic construction signifies by itself not variation, but relationship it is sonic when energy of overcoming gravity force is present.

Thus, sound is received in two ways: as phenomenon is physical and intonation- expressive.

Auditory regularities, instability and role of intonation predetermined the historical study of sound in two directions: acoustic and "living" sound as material of music. In one of the letters B.L. Yavorskiy notes: "musical skill could arise only if was organized the mental labor of man, when appeared its process, i.e., musical speech. To the known stage of their development the sounds, used by human, are subordinated to acoustic laws, but, as soon as sounds they reach the stage of public expression, i.e., they become musical feature, acoustic laws cannot envelop the complexity of new phenomenon, and they become secondary; however, the main things are the laws, brought out from the the public of process"[2].

A quantity of number of fluctuations it is sonic not there is a basis of music. The dead overtones of linear- straight body existed as physical phenomenon, also, before the appearance of man on the earth. Sounds, as the phenomena of acoustics, cannot become the material of musical creation and science about the music. Realization it is sonic acoustic in contrast to it is sonic "living", that are been the material of music, it is extremely important both for understanding of the theory of musical thinking and for the orienting in the contemporary pedagogical practice and performance. The rumor of the musician OF B.L. Yavorskiy constructed on the basis of intonation thinking. Arpeggio is the phenomenon second, formed from the music functionality, by means of the arrangement it is sonic by way of height. If we in the exercises, intended for the development of musical rumor, and in the training repertoire (especially for the children) proceed from this "second-rateness", from the composition moment, then rumor is dulled. Mechanical displaces from it creative beginning. The result of training the rumor on the faceless arpeggios is most lamentable for any of the sides of the musical process: for the listener, the executor, especially for the composer. Since, if it by the force of the innate endowment does not overcome the habits, inculcated to it, it will not be able to sensitively recover the special features of reflection of the historical present. B.L. Yavorskiy wrote: "artistic work reflects the diagram of public process. Progressive-minded composers those, which transfer by the foremost of process, rest reflected different stages of the decomposed already public processes. Abstract "inspiration", which creates infinite beauty, does not exist.

In the process of investigating the strained working traffic of men its working respiration for its best organization wires for sound. This sonification is achieved by the introduction of resistance in the path of exhaled air.

Sonic speech arose as the passage of organized by physical working forces - motions respiratory- muscular, strained working traffic - in the sonic relationships - intonation, in the reverberating relationships of respiration.

Working sonic relationships, transmitted into the sonic reflexes, became the basis of the sonic motions, which organize (but not organized) contact with the working way of life, with the working behavior. As examples we can serve the working songs "Dubinushka", "31 years before", songs with the forging into two hammers, with the threshing dances, marches.

So B.L. Yavorskiy based the appearance of "living" sound, which in its development became the material of musical skill.

The history of the centuries-old sonic practice of musical art testifies that this sonic scale constantly advances depending on development both sonic scientific mind and musical- artistic practice technique. This evolution of the sonic scale attempts to reveal ever larger possibilities of the external sonic manifestations of the processes of internal sound thinking and internal rumor.

Although the discoveries of B.L. Yavorskiy were made at the end of XIX - the first of fourth of XX century, they did not lose urgency and practical expediency at present. B.L. Yavoskiy succeeded:

1. to investigate intonation in the historico-semantic aspect.
2. to reveal the interrelation of vocal and musical intonations (vocal and instrument) and to determine five qualitative aspects of word- intonation (sonic, temporary, dynamic, timbre, emotional).

3. to determine to the very concept of the intonation: "intonation is the smallest (by construction) sonic form in the time, this is speech itself and at the same time its sense, its expressiveness, its character.
4. to develop principles of intonation thinking theory (theory of musical thinking).

In the work of B.V. Asaf'ev we find continuation and development of ideas and positions of B.L. Yavorski connected with the intonation. In the work "Glinka" such properties of the intonation are stated:

1. intonation - "... the form of contact and transfer of feeling and musical laws governing the human speech and talk", i.e., the means of communication.
2. intonation – is a transmission medium of the intention of author
3. intonation – is a characteristic of defined musical style
4. intonation - many-valued concept, which expresses the sonic embodiment of musical thought, which treats as the manifestation of the socially and historically determined human consciousness [5].

According to Asaf'ev the intonation does possess a whole series of the properties, whose complex does form intonation culture, namely:

- emotionalism (or emotional fullness);
- tension;
- pre-determiness;
- semantic overloading;
- intuitiveness.

In this case the intonation can come out as the characteristic of:

- musical direction;
- human communication;
- the experience of the aesthetical of enjoyment;
- the internal world of man;
- its self-realisation in the creation;
- the method of existence of work; t
- the embodiment of existence in the art

Thus, an intonation theory of B.L. Yavorski- B.V. Asaf'ev was fundamental achievement in music science from the positions of the materialist dialectics:

- intonation - carrier of the social content;
- intonation is caused by social-historical processes, culture, way of life;
- intonation possesses communicative- semantic properties, fulfilling today systematic function.

It is known that each person studies the surrounding peace with the aid of the sensory systems, acquiring the individual life experience, which determines his sensory orientation. In the process of remote instruction, independent work on musical material it is necessary to reveal preferences in the perception of the music: visual, audio or digital. The tests to the determination of the leading system of perception are developed for this. After revealing the preferable system of perception, it is possible to pass to the use of modern information technologies, namely:

- to the use of traditional printed publications in Internet;
- new systematic developments for this problem;
- the electronic musical libraries (reference), in which besides the musical material, is built the system of its perception (description – performers - sounding).

Bibliography

1. Yavorskiy B.L. Text and music // Muzika. 1914. №163, 166, 169.
2. Yavorskiy B.L. Dialectics. - the manuscript archive CGMMK of M.I. Glinka, f. 146,310.
3. Yavorskiy B.L. Community and skill. - the manuscript archive CGMMK of M.I. Glinka, f. 146,297.
4. Kuzemina L.A. About the performer intonation. - Systematic recommendations for the students regarding the pedagogical practice., Kharkiv 1990.

Author's Information

Kuzemina L.A. *– Prof. of Kharkiv State University of Arts named by V.N. Kotlyarevsky, Ukraine, Special fortepiano chair, kuzy@kture.kharkov.ua*

COLLABORATIVE LEARNING AND AUTHORING IN THE FRAME OF E-PROJECTS

George Totkov, Daniel Denev, Rositsa Doneva, Mariana Sokolova

Abstract: *It is presented a research on the application of a collaborative learning and authoring during all delivery phases of e-learning programmes or e-courses offered by educational institutions. The possibilities for modelling of an e-project as a specific management process based on planned, dynamically changing or accidentally arising sequences of learning activities, is discussed. New approaches for project-based and collaborative learning and authoring are presented. Special types of test questions are introduced which allow test generation and authoring based on learners' answers accumulated in the frame of given e-course. Experiments are carried out in an e-learning environment, named BEST.*

Keywords: *Project management, Virtual learning environment, Project-based learning, Collaborative learning*

ACM Classification Keywords*: K.3.1 Distance learning, K.3.1 Collaborative learning, K.4.3 Computer-supported collaborative work, Automatic generation of test questions*

Introduction

In the modern changing world there is an increasing need that students become better general problem solvers and better group workers [Kurilovas, 2006]. Therefore today an increasing interest for so-called "new pedagogies" exists, which means possibility to use rich, active and open pedagogical scenarios and learning strategies.

In the last years our research interests are related with new pedagogies, but also with their implementation in e-learning environments as PeU 1.0 [Totkov, Somova, 2002], PeU 2.0 [Totkov, 2003] and the newest e-learning platform BEST [Doneva, Denev, Totkov, 2006]. The main results obtained are:

- introducing the concept of e+learning (in BEST);
- modelling of open pedagogical scenarios by planning of the learning process (PeU 1.0, PeU 2.0, BEST);
- cooperative development of learning materials in e-learning environments (BEST);
- dynamical generation of e-courses and learning tests (PeU 1.0);
- implementation of adaptive learning strategies, managed by the model of the learning process PeU 2.0, BEST), etc.

One new direction of the research affects mostly the collaborative approach in all phases of introducing e-learning courses and programmes – from their planning, implementation and management, to supporting active and open pedagogical scenarios for collaborative learning and authoring.

Further we discuss the implementation of a collaborative approach to e-learning and the corresponding experiments in BEST.

Collaborative e+Learning Projects

Generally, under the term 'e+learning project' (***e-project***) we understand the work an educational institution has to perform during all phases of introducing distance education, e-learning courses and programmes, incl. planning, e-content development, administration, implementation, delivery, management, etc. The e+learning project is complex endeavour involving many different activities, events, subjects, rules, resources, constraints, etc.

The e-project consists of a great number of models of real management processes in different institutions, related to e-learning and united by common learning activities, users, events, resources and constraints. An e-project can be comprised of e-projects for different institutions. So, the e-project could be modelled as a specific management process based on planned, dynamically changing or accidentally arising sequences of learning (in this case) activities and events.

BEST (***B***ulgarian ***E***ducational ***Si******t***e) is a software environment used for creating, editing, sharing, storing, reusing and managing e-projects, developed in collaboration between different educational institutions.

BEST offers several structural formats which allow project managers and teachers to control the appearance of the sections (or topics) in their e-project/course. The *course topic format* resembles the structure of a book where one section corresponds to one topic of the course. The *weekly format* resembles the structure of a calendar where one section corresponds to one week of the course. The *social format* simply consists of a single discussion forum without content sections.

The *project format* is similar to the course topic and weekly formats, but allows teachers to define arbitrary durations for the sections (called 'project phases' in this context). The goal of the project format is to facilitate the management of a project for teachers as well as for students. A project phase is realised as a 'normal' course topic with additional characteristics (start / end date, etc.). Elements of the *e-project structure* (Fig. 1.) are phases, activities, checkpoints, etc. Phases are used for logical partitioning of the learning activities (assignments). Apart from project management tools, phases and activities, project developers also have at their disposal tools for content creation of various educational activities and events.

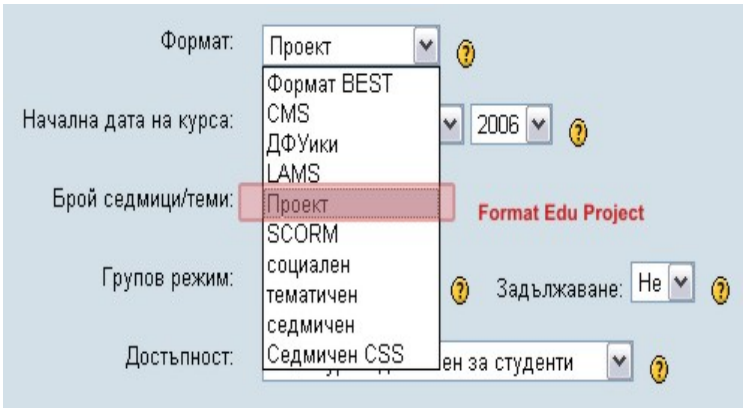

Figure 1. Selecting the 'Project' format

For example, the project leader decides which learning activity or event (for example: creation of the e-course) will be the project phase and edits its parameters (start time, duration, etc.). Converting an activity back into a phase by keeping the description is also possible.

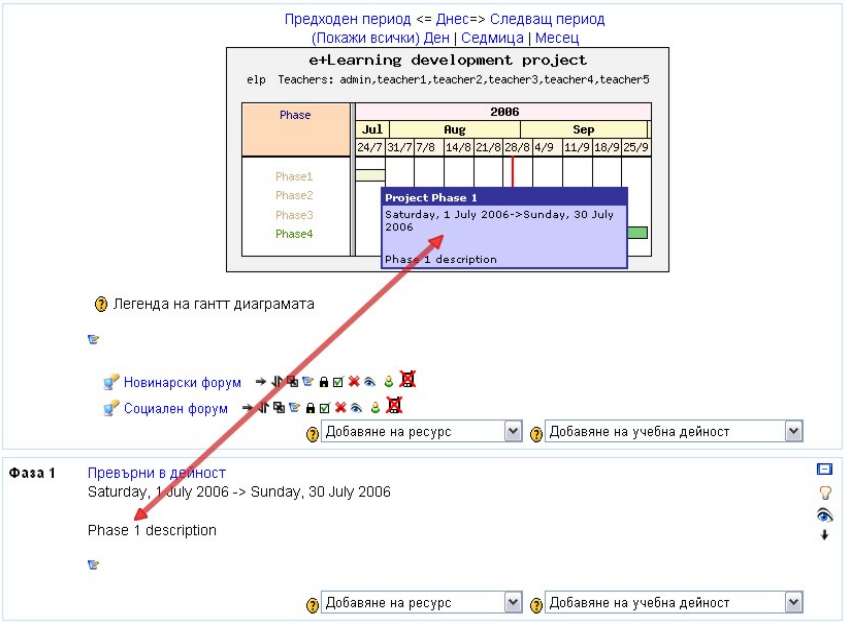

Figure 2. The phase in Gantt diagram

Once created, the phase can be moved, copied, locked or unlocked. In the last case, the input/output state is defined by logic constraints based on evaluations of test assignments, used learning times, learning events, etc.). The phase assignments are added as learning activities with specified time periods for implementation. The activities and the deliverables within the phase and the project are visualized using Gantt diagram (Fig. 2.). This enables a friendly overview on phase durations and deadlines.

It is also of interest for the teachers to know quickly whether all students have submitted their deliverables and whether all students got feedback. To this end, the milestones on the Gantt chart are represented by using a simple colour coding that reflects whether deliverables are *Finished* (green), I*n progress* (orange) or *Missing* (red).

Within each phase, assignments are treated as deliverables for this phase and represented in the Gantt chart as milestones. A project-based course can contain a mix of 'normal' BEST topics and phases.

BEST can be used even in the lack of e-format learning materials or Internet-based resources. In such cases BEST can be used for example as a system for reference and information of the respective educational institution, as a system boosting the organizing of the learning process, a communication system within the institutions, a virtual organizer of the subjects of learning and so on.

The so-called ***meta-project*** in BEST makes it possible to manage the implementation of an educational project or program, comprising other developed e-projects / e-courses. The meta-project is guiding for the rest of the projects and the development of the activities for all projects or courses included in it, is automatically reflected.

Learning, administrative and controlling activities can be included in different learning processes, integrated in an e-project. The results from certain activities (events) can determine the further development of the process; for instance – they can cause the dynamic appearance of a learning scenario (including the adaptation to a particular student), or automatically generate or 'lock' other virtual learning paths and activities, and so on.

Project-Based and Collaborative Learning

The 'traditional' students have trouble for: (a) initiating inquiry, formulate coherent research questions; (b) define a research project; (c) direct investigations; find resources, (d) manage time; keep deadlines, estimate time needed to do a task; (e) collaborate and give feedback; articulate work of others and give regular feedback; (f) follow-up the project; revise products [Schneider, Dillenbourg, Frété, Morand, Synteta, 2003].

The project-based learning/teaching can very well complement traditional instruction and are often the only realistic alternative in today's organization of the school and university system [Schneider, Paraskevi, 2005]. Activity-based, collaborative, and construction-based pedagogies in general require project-based and collaborative learning. Project based learning is a teaching and learning model (curriculum development and instructional approach) that emphasizes student-centred instruction by assigning projects. It allows students to work more autonomously to construct their own learning, and culminates in realistic, student-generated products. More specifically, project-based learning can be defined as [Synteta, 2002]:

- engaging learning experiences that involve students in complex, real-world projects through which they develop and apply skills and knowledge;
- learning that requires students to draw from many information sources and disciplines in order to solve problems;
- learning in which curricular outcomes can be identified up-front, but in which the outcomes of the student's learning process are neither predetermined nor fully predictable;
- experiences through which students learn to manage and allocate resources such as time and materials.

The powerful learning environments that aim at developing skills at general problem, deeper conceptual understanding and more applicable knowledge include the following characteristics [Van Merriënboer, Pass, 2003]:

- the use of complex, realistic and challenging problems that elicit in learners active and constructive processes of knowledge and skill acquisition;
- the inclusion of small group, collaborative work and ample opportunities for interaction, communication and co-operation;
- the encouragement of the learners to set their own goals and provision of guidance for the students in taking more responsibility for their own learning activities an processes.

The project based learning and collaboration between the subjects of e+learning are encouraged in BEST. The BEST system provides the following possibilities that can be used for modelling project-based and collaborative learning:

- *gathering and distribution of information* (teachers and learners share resources; the activities are designed to help them gather information and make it available to all);
- *creation of collaborative documents* (the students can write definitions, analyze cases, solve problems, write documents and create illustrated documents together around specific themes, etc,);
- *discussion and commentaries around productions* (learners identify together facts, principles and concepts and clarify complex ideas; they formulate hypothesis and plan solutions, make links between ideas, compare different points of view, argue, evaluate, etc.);
- *project management activities* (learners can design work plans, share tasks, form groups, realise collaborative tasks, etc.; teachers can distribute and regulate tasks, etc.).

A teacher can introduce such style of learning by inclusion some of so called 'learning activities' into his/her learning scenario. The learning activities palette makes BEST an impressive e-learning environment. This is the most dynamically developing part of the system which now consists of more than *30 learning activities* like: educational lesson, test (including mathematical editor), project, forum, chat, flash activity, forum plus, questionnaire, LAMS-model, learning IMS-object, SCORM-object, 3 Wiki-formats, inquiry, quick test, gallery, test dates, dialogue, journal, assignment, project task, exam, book, feedback, psychological test for identification, research, schedule, resource, dictionary, semantic map, certificate, meeting. Teachers could 'lock' the learning activity (using the abovementioned lock/unlock mechanism). In this way, different pedagogical scenarios, learning materials and events could be offered to students depending on their current progress (test grades, exam marks, degree of his/her communication activity, etc.). Thus, the teacher has to realise very complex adaptive learning strategies and scenarios based on lock/unlock mechanism.

The BEST environment provides, in practice, all used asynchronic and synchronic communication forms for collaborative work (as special kind of learning activities) – not only between teachers and learners, but also between the other users[1].

Collaborative Authoring of Test Questions

In spite of the enumerated advantages, as authors' and other researches' investigation shows, 'new pedagogies' including project-based and collaborative learning, do not guarantee automatic perfect results. True collaborative pedagogy strategies are generally the most difficult to implement, since there must be some degree of symmetry and actors must have a high capacity for negotiation. In other words, situations are difficult to achieve where peers are more or less at the different level, can not perform the same actions, have not a common goal and do not work together [Schneider, Dillenbourg, Frété, Morand, Synteta, 2003].

This is the motivation to do a step towards possible decision of this problem. Here we propose an idea on development of collaborative authoring tools where the content of the learning/teaching activities (reading materials, assignments, assessment questions, messages, etc.) produced by e-learning subjects could be accumulated and used for generation of new ones (self-development). And something more, even wrong or bad content could produced a good one (incl. other types of learning activities).

An experiment based on this idea is realised in BEST. The main idea is related with generation of new test questions) using the students' answers (accumulated in the frame of current e-course) to given 'special' test questions.

To create a classification of the question types which is suitable for computer realization, we can use different approaches. Most of the existing question classifications are according to the type of the answer of the question [Pashin, 1985]. It is also possible to create a classification using the Bloom's taxonomy of knowledge, if the teacher wants to test different knowledge levels [Bloom, 2007]. Other approaches are based on the cognitive goals of the education [Bijkov, 1995], the form of the answer [Ruter, 1978], the cardinality and type of the possible answers [Doneva, Somova, Totkov, 1998], etc.

In order to realise the abovementioned idea, we propose a classification of the test questions, using ***2 (two) parameters*** − the *type of the given answers* (text, images, files) and the *dimension* of these answers (one, two, three,etc.). The proposed classification (Table 1.) is based on the classification already implemented in the PeU 2.0 test system [Sokolova, Totkov, 2005], but ***with very important difference***, reflecting two possibilities:

- a test question of the new test type could accumulate necessary data (during the real e-learning process) in order to generate new test questions (of some subcategory of the given test type), and vice versa,
- a test question of some subcategory type could produce a test question of 'main' test type, and as consequence of 1) – from all others subtypes. The question types possess the above properties we call ***accumulative question types***.

For example, the well-known test type 'Open question with short free text answer' has the following common structure: <name, condition, schema of assessment, free text answer>. A lot of other question types have the same structure, but the last element ('answer') belongs to other data type (for example − set of false/true' short text answers, file, image, etc.). Any open test question could generate other test questions (i.e. types Multiple

[1] The number of user's roles In BEST is unlimited – there are realized 'dynamic' user's roles, organized as taxonomy of classes, depending on the set of privileges (BEST functions), allowed for current user.

Choice, Free Answer, Multiple Answers, True or False, etc.) if we already have on our disposal a set of student answers to this question. In order to automatically generate test questions, we could include new methods in the 'Open Question' class as follows − for collecting the corresponding answers during the current e-course, for producing a set of proper answers (along with frequencies, teacher grades, etc.), for generating test questions of any test subcategory, etc. This 'accumulative' open test question belongs to the class 'Accumulative open question' (Table 1.).

The generation of concrete test questions on the basis of 'Accumulative open question' type is an iterative process, consisting of ***three steps***:

1) The question of type 'Accumulative open question' is formulated by the teacher and is included in some assessment test of the e-course;

2) The test is proposed to the students (in the frame of current e-course). Each student's answer is stored into a data base along with the 'Answer count' (how many students have those answer) and the 'Answer grade' (grading could be done automatically or by the teacher);

3) At any time of the current e-learning process, the teacher could edit the *set of possible answers* and their accompanying characteristics, delete the answers which are preposterous, sort the set according different criteria (depending on counts or grades) and use the set of answers for generation of new test question (from any subcategory).

Dimension	**Data Type**	**Base accumulative question type** / Subcategory **(**accumulated test type)
0	–	**I. Informative (no answer needed)** Embedded Answers (Close)
1	Text/ file/ image	**II. Accumulative open question (text answer)** Multiple Choice; Free Answer; Multiple Answer; True or False; True or False with Help; Multiple Answer with Multiple Choice; Question from File and Text Answer; Text Edit; Calculated; Description; Numerical **III. Accumulative open question (file answer)** File Answer; Question from File and File Answer **IV. Accumulative open question (image answer)** Multiple Choice of Images; Multiple Answer of Images; Area of Image; Areas of Image; Undue Image; Description of Group of Image; Description of a Disappearing Image (with/without Help)
2	Text / image	**V. Accumulative matching of elements (one and the same data type)** Matching of Texts; Matching of Images; Arrange According to the Meaning; Arrange According to the Meaning (after Multiple Answer) **VI. Accumulative matching of elements (different data types)** Matching of text and images; Image description; Arrange images
≥ 3	Text/ image	**VII. Accumulative matching of elements (one and the same data type)** Fill in Blanks; Fill in Blanks with Alternatives; Fill in Blanks with Images; Arrange the Table; Fill the Table; Rebus **VIII. Accumulative matching of elements (different data types)** Crossword Puzzle; Crossword Puzzle with Images

Table 1. The 'accumulative test question' classification

As the BEST learning environment was developed on the basis of the Moodle system, it had inherited a limited number of question types: Calculated, Description, Essay, Matching, Embedded Answers (Close), Multiple Choice, Short Answer, Numerical, Random Short-Answer Matching and True/False.

Following the abovementioned idea, the BEST environment is enriched with:

1) ***Full implementation*** of test type 'Accumulative open question'. On its basis we can generate (Fig. 3.) almost all Moodle's types (8 from 10) − Calculated, Description, Essay, Matching, Multiple Choice, Short Answer, Numerical and True/False (even some doesn't supported in Moodle, e.g. 'Text Edit');

2) ***Some test question (sub)categories*** from Table 1. - Arrange According to the Meaning, Fill in the Blanks, Fill in the Blanks with Alternatives, Text Edit, Arrange after Multiple Choice, Matching Text with Images,

Images Description, Multiple Choice of Images, Multiple Answer of Images and Arrange Images. Some of them are developed in relation with the test type 'Accumulative open question', while the others will serve as a basis for implementation of new accumulative test types.

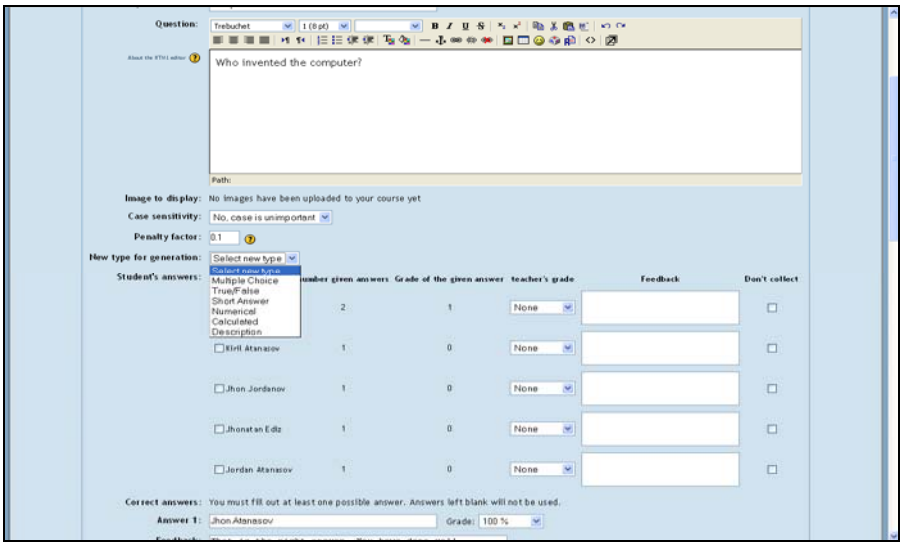

Figure 3. Generation of test question from a choosing subcategory

Bibliography

[Synteta, 2002] Synteta, P., Project-Based e-Learning: The model and the method, the practice and the portal. Accepted PhD proposal, University of Geneva, Geneva, Switzerland. URL: http://tecfa.unige.ch/perso/vivian/, 2002.

[Doneva, Somova, Totkov, 1998] Doneva R., Somova E., Totkov G., Test Paradigms, Proc. of the Twenty-third Int. Conf. Information and Communication Technologies and Programming, Sofia, Bulgaria, 9-13 Jun 1998, c. 155-161, 1998.

[Schneider, Dillenbourg, Frété, Morand, Synteta, 2003] Schneider D. Dillenbourg, P., Frété, C., Morand, S., Synteta, P, TECFA Seed Catalog, URL: http://tecfa.unige.ch/proj/seed/catalog/, Draft version.

[Van Merriënboer, Pass, 2003] Van Merriënboer, J. J. G., Pass F. , Powerful Learning and the Many Faces of Instructional Design: Toward a Framework for the Design of Powerful Learning Environments. Amsterdam: Pergamon, pp. 3–20, 2003.

[Schneider., Paraskev., 2005] Schneider D., Paraskevi S. , Conception and implementation of rich pedagogical scenarios through collaborative portal sites, in Senteni,A. Taurisson,A. Innovative Learning & Knowledge Communities / les communautés virtuelles: apprendre, innover et travailler ensemble", selected papers from ICOOL 2003 /Colloque de Guéret 2003, University of Mauritius (under the auspices of the UNESCO), pp. 243-268. ISBN-99903-73-19-1, 2005.

[Doneva, Denev, Totkov, 2006], Doneva R., Denev D., Totkov G., The BEST e-Learning Practices, ECI 2006.

[Kurilovas, 2006] Kurilovas E., The Conceptual Structure of European E-Learning Delivery Model, Information & Communication Technology in Natural Science Education – 2006, ISBN 9986-38-711-6, 2006.

[Pashin, 1985] Pasniih E. N., A. I. Metin, Automation system for teaching, Ecstern, Moscow,1985.

[Bijkov, 1995] Bijkov G., Methodology and methods for pedagogical approaches, Asconi-Izdat Sofia, 1995y., p.292.

[Ruter, 1978]. Th. Rutter. Formen der Testaufgabe, in Handbuch der Pedagogischen Diagnostik. Düsseldorf, Pedagogischer Verlag Schwann, 1978.

[Bloom, 2007] Applying Bloom's taxonomy, http://www.teachers.ash.org.au/researchskills/dalton.htm (visited February 2007).

[Sokolova, 2005] M. Sokolova, G. Totkov, About Test Classification in E-Learning Environment CompSysTech'05, Rousse.

[Totkov, 2003] G. Totkov, Virtual Learning Environments: Towards New Generations. Proceedings of the Intern. Conf. of Computer Systems and Technologies (e-learning), Sofia, Bulgaria, 19-20 June, 2003, P.2-1 – P.2-9.

Authors' Information

George Totkov *– Plovdiv University, 24 Tzar Assen St., 4000 Plovdiv, Bulgaria, totkov@uni-plovdiv.bg.*

Daniel Denev *– Intelekti Ltd., 1 Arch. G. Kozarov St., 5000 Veliko Turnovo, Bulgaria, daniel_i_denev@abv.bg.*

Rositsa Doneva *– Plovdiv University, 24 Tzar Assen St., 4000 Plovdiv, Bulgaria, rosi@pu.acad.bg.*

Mariana Sokolova *– Webfactory Ltd., 1 S. Vrachanski St., 1303 Sofia, Bulgaria, mariana_sokolova@yahoo.com.*

AN eMathTeacher TOOL FOR ACTIVE LEARNING FLEURY'S ALGORITHM[1]

Gloria Sánchez–Torrubia, Carmen Torres–Blanc, Víctor Giménez–Martínez

***Abstract**: An eMathTeacher [Sánchez-Torrubia 2007a] is an eLearning on line self assessment tool that help students to active learning math algorithms by themselves, correcting their mistakes and providing them with clues to find the right solution. The tool presented in this paper is an example of this new concept on Computer Aided Instruction (CAI) resources and has been implemented as a Java applet and designed as an auxiliary instrument for both classroom teaching and individual practicing of Fleury's algorithm. This tool, included within a set of eMathTeacher tools, has been designed as educational complement of Graph Algorithm active learning for first course students. Its characteristics of visualization, simplicity and interactivity, make this tutorial a great value pedagogical instrument.*

***Keywords**: eMathTeacher, e&bLearning, active learning, interactive Java applets, discrete mathematics learning, visualization.*

***ACM Classification Keywords**: K.3.1 [**Computers and Education**]: Computer Uses in Education – computer-assisted instruction (CAI), distance learning. K.3.2 [**Computers and Education**]: Computer and Information Science Education – computer science education, self-assessment. G.2.2 [**Discrete Mathematics**]: Graph Theory – graph algorithms, path and circuit problems.*

1. Introduction

Education systems cannot keep out of the changes new technologies yield in our society and technological advances should generate a substantial change in our didactical methodologies. Thus, Web based learning technologies play a very important role in the modern education process and extensive research shows increasing use of computers in education. Some investigations have shown that computer assisted instruction has been more effective than traditional methodologies [Waldock 2002] and visualization technologies provide a very positive aid to the learning task [Torres–Blanc 2006]. Furthermore, mathematical concepts and algorithmic procedures as well, are often difficult to be explained in the classroom.. However, comprehensive research is required to determine the best methodology to be applied to the design and development of computer-assisted training, as well as the efficiency of the teaching/learning processes based on this particular method of instruction [Hundhausen 2002].

Furthermore, the big amount of stimuli students are receiving from their environment cause that, in contrast, traditional classes seem less appealing. In this context, it is evident that introducing new incentives in the teaching–learning process is becaming compulsory. It is well known that computer assisted education provides new exciting tools for the development and usage of teaching and learning resources. That is why blended courses, taking advantage of computational aids, are turning into a must especially in computer and engineering education. This way, the power and effectiveness of face to face teaching are enhanced with the flexibility and technical capabilities of eLearning, turning out the students in the major figures of their learning progression.

The background the students bring, both from their previous learning processes and from the social atmosphere, is also transforming their reasoning abilities. Authors' teaching experience shows that Informatics Engineering students have significantly increased their algorithmic reasoning capability, both in comprehension and design, tallying with an important decrease of their formal and algebraic reasoning ability. Thus, fostering graphs' algorithmic approach should be decisive on enhancing students' logical potentials.

2. eMathTeacher tools

An eMathTeacher [Sánchez-Torrubia 2007a] is an eLearning tool that works as a virtual math teacher. In other words: they are on line self assessment tools that help students to active learning math algorithms by themselves, correcting their mistakes and providing students with clues to find the right solution. They can also be used as

[1] This work has been partially supported by UPM under project No. **IE06 1010-092**

complementary material for bLearning [Sánchez-Torrubia 2007b] both for being used by teachers on classroom lectures and by students when learning by themselves.

This kind of tools' main characteristic is the feasibility of being used for practicing with math algorithms while the system guides the user towards the right answer.

Minimum requirements for an eMathTeacher

These are the minimum conditions we consider an eMathTeacher must fulfil:

- Step by step inquiring: for every process step, the student should provide the solution while the application waits in a stand by mode, expecting the user's input.
- Step by step evaluation: just after the user's entry, the eMathTeacher evaluates it, providing a tip for finding the proper answer if it is wrong or executing it otherwise.
- Visualization of the step's changes.
- Easy to use: the students' effort would be focused on learning the topic, not the tool.
- Flexible and powerful: allowing the user to introduce and modify the example and to repeat the process if desired.
- Nice and friendly graphic environment, helping insight.
- Clear presentation: focusing the student's attention on the essential concepts instead of getting spread on minor ideas.
- Platform independency: reaching the widest possible audience and keeping right performance when the platform is updated.
- Full time and place availability, allowing users' utilization when and where needed.

3. Impact of eMathTeacher tools on teaching and learning

Graphs and graph based algorithms are mathematical structures which will take an important role in Informatics Engineer's background. The Polytechnic University of Madrid has included, in its Informatics Engineering first course program, a graph theory introduction as a main section of the Discrete Mathematics subject. Because of it, the authors were stimulated for designing and developing several tools, whose purpose is to enhance the comprehension and learning of this matter to first year course students. Those tools have been designed under eMathTeacher philosophy.

Computer Aided Instruction may be a significant aid for learning as shown by a comparison study between a control section and a computer-based studio section of calculus-based Introductory Physics performed in Arcadia University (Canada) [Retson 2000]. It showed that the two groups were statistically different, with the studio class outperforming the traditional lecture class in all cases. Collectively, their results clearly proved that the studio model was significantly more effective than the lecture model.

Recent approaches in the aim have shown that visualization aided interactive tools provide a very positive aid to the learning task [Naps 2003a, Sánchez-Torrubia 2006a, Torres-Blanc 2006]. Furthermore, mathematical concepts and algorithmic procedures as well, are often difficult to be explained in the classroom. That is why visualization characteristics of eMathTeacher tools play an important role, increasing insight –an image is worth thousand words–, engagement, memorization and satisfaction for the students. Additionally, the interest and motivation among pupils is increased when the teacher uses those tools.

Visualization is a very important feature when learning graph algorithms, but the main characteristic of the Fleury's eMathTeacher presented here is its full interactivity. This aspect is a good aid for teachers, as user's examples may be exposed and the application gives time for explaining difficult points. However, the major objective when pursuing the full interactivity has been the student's learning task. This way, as will be described in section 3.3, the user must execute the algorithm while the tool evaluates and corrects the process.

3.1. Assisting teacher's task

Graph algorithms are dynamic structures difficult to show in static tools such as blackboards or slides. Therefore, the feasibility of applying dynamic visual tools to represent those concepts shows an enormous potential for achieving high didactical goals [Naps 2003b, Sánchez-Torrubia 2007b, Sánchez-Torrubia 2001].

According to the conclusions of the Working Group "Improving the Educational Impact on Algorithm Visualization" [Naps 2003a], when a group of teachers were asked about the benefits they had experienced from using

visualization, they got, among others, the following results: 90% declared that teaching experience was more enjoyable, 86% noticed an improved level of student participation, 83% had anecdotal evidence that the class was more exciting for students, 76% thought that visualization provided a powerful basis for discussing conceptual foundations of algorithm, and 52% got objective evidence of improved student learning.

Many educators think that visual tools enhance their lectures and produce significant increase in student's comprehension, but such tools are of little effectiveness when students are not actively engaged in the learning process [Naps 2003a, Rößling 2000, Sánchez-Torrubia 2006a] or teachers cannot present their examples. In this sense, eMathTeacher's characteristic peculiarities represent an excellent aid for teachers, offering much better features than other systems.

3.2. Assisting student's learning process

As shown in the previous section, eMathTeacher tools do enhance teacher's lectures, but their best feature lies on the possibilities they reveal when used by the students themselves.

in *Deakin University* (Australia) [Street 1998], it was demonstrated that students who used interactive tools learned 60% faster, and after 30 days the knowledge kept was from 25% to 50% higher than those who did not use them.

Graphical and dynamical visualizations are more appealing for learners than exercises or text books, but, if the students are not required to give some kind of answers or predict what is happening next, they might adopt a passive attitude that is not beneficial at all and might even be prejudicial to their training. It has been verified that learners spend much more study time when visualization is involved, but those who are actively engaged have consistently outperformed the other ones who passively viewed them [Hundhausen 2002]. That is why, during the execution, the program should in some way ask the user which must be the next step to be done, not just show it. Here lays the main difference between an eMathTeacher, like the one presented in this paper, and a simple demonstrative visualization tool.

4. Fleury's algorithm eMathTeacher tool

4.1. Fleury's algorithm

Fleury's algorithm is designed for finding an Euler Path in an undirected graph. The graph has an Euler path if it is possible to start at a vertex and move along the graph so as to pass along each edge without going over any of them more than once.

This problem has its origin in Leonhard Euler's work directed towards the geometry of position which consists of a single paper [Euler 1736], now considered to be the starting point of modern graph theory. In it, Euler undertakes a mathematical formulation of the famous Königsberg Bridge Problem: is it possible to plan a stroll through the town of Königsberg which crosses each of the town's seven bridges once and only once? In this paper, Euler's main result is, in a modern statement, the well known theorem: A finite graph G contains an Euler path if and only if G is connected and contains at most two vertices of odd degree. He also sketches a procedure for finding the path consisting on creating a simple circuit, eliminating the used edges, finding new circuits in the remaining graph and joining the new circuits in the proper vertexes. This procedure, very intuitive in theorem's formal demonstration, is not algorithmically effective.

The algorithm presented here is credited to a mostly unknown French mathematician named Fleury [Fleury 1883]. It starts with a vertex of odd degree —if the graph has none, then start with any vertex—. At each step it moves across an edge which is included in a cycle, unless there is no choice, and then we delete that edge.

4.2. Algorithm's description

The basic idea is that when drawing an Euler circuit, all passed edges cannot be used again. So, at any moment in drawing, with all passed edges deleted, the remaining edges must be in one connected component.

Fleury's algorithm pseudocode might be described as follows:

Input: A connected graph G = (V, E) with, at most, two odd grade vertexes, where V is the set of vertexes and E is the set of edges.

Output: A list P = $v_0e_1v_1e_2,\ldots,e_iv_ie_{i+1},\ldots,e_mv_m$, representing the path which includes each edge in E exactly once.

Procedure:

If an odd grade vertex v_0 exists, ***then***

$P = v_0$ where v_0 is any odd grade vertex of V

else

$P = v_0$, where v_0 is any vertex of V

End if

$\varepsilon = |E|$; $v = v_0$; $i = 1$

While $i \leq \varepsilon$ ***do***:

$E_v = \{e \in V / e$ is adjacent to $v\}$

e_i = any edge of E_v

While e_i is a bridge (an edge which is not included in a cycle) and $|E_v| > 1$ ***do***

$E_v = E_v - \{e_i\}$

$e_i = (v,w)$, any edge of E_v

end while

$v_i = w$; $P = P\ e_i\ v_i$; $E = E - \{e_i\}$

$v = v_i$; $i = i+1$

end while

return P

For deciding whether e_i is a bridge or not, a modification of Depth–First Search algorithm [Sánchez-Torrubia 2006b] should be used.

4.3. Tool's description[1]

The tool contains a theoretical part with definitions, examples and explanations of the basic concepts of graph theory needed for understanding Fleury's algorithm, its pseudocode and an interactive applet, meeting all the requirements for been considered an eMathTeacher, implementing the algorithm.

According to eMathTeacher philosophy, the main feature of this tool is its full interactivity. It means that the user can introduce the graph and execute the algorithm while the application evaluates the inputs provided by the student. In other words: in real time, the applet will only evaluate the input introduced by the user. If it is right, the application will implement the order, and then it will remain in a stand by mode, waiting for a new one. If the input is not right, an error message will appear on the message window, indicating to the user what the error is and waiting for the right one. Once the algorithm has been completed, a successful '*end of algorithm*' message will be displayed.

The application has a message window, used for displaying error messages and providing next step hints.

4.3.1. Introducing the graph

In this applet, graph nodes are introduced by left clicking on the drawing area. The edges are drawn by clicking successively two nodes. At any execution moment, the user may interrupt the process in order to add new nodes and/or edges, and restart it once again.

4.3.2. Executing the algorithm

Once the graph has been introduced by the student and the algorithm is running, the application checks whether an eulerian path exists. If the graph is not connected (see Figure 1) or there are more than two odd degree vertexes (see Figure 2), an error message is displayed indicating the corresponding fault.

If there is an eulerian path, the applet asks the user to click on the initial vertex. Subsequently, in each step, the user should click the next vertex to be visited. if the selected node is not right, the applet displays an error message revealing the mistake and providing clues for solving it. If the entry is correct, the application changes the used edge's color and adds a number indicating the path sequence (see Figure 3).

[1] DMA: Algoritmo de Fleury. http://www.dma.fi.upm.es/java/matematicadiscreta/fleury/

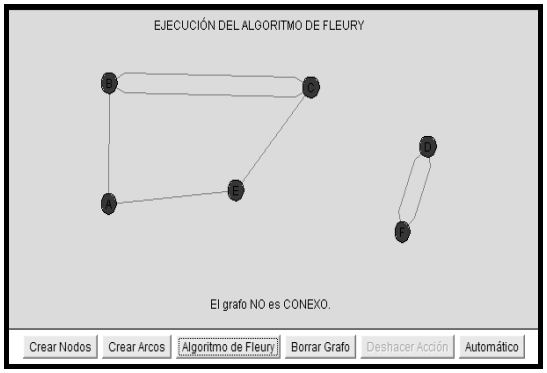

Figure 1: error message "not connected"

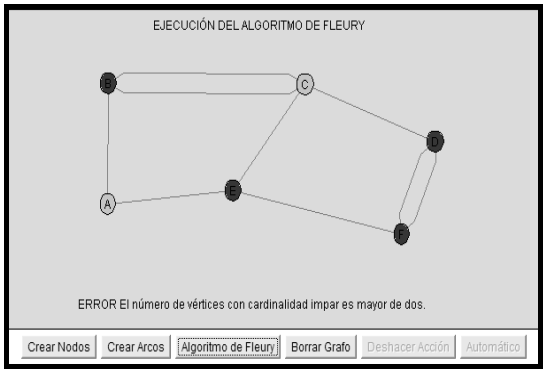

Figure 2: error message "more than two odd vertexes"

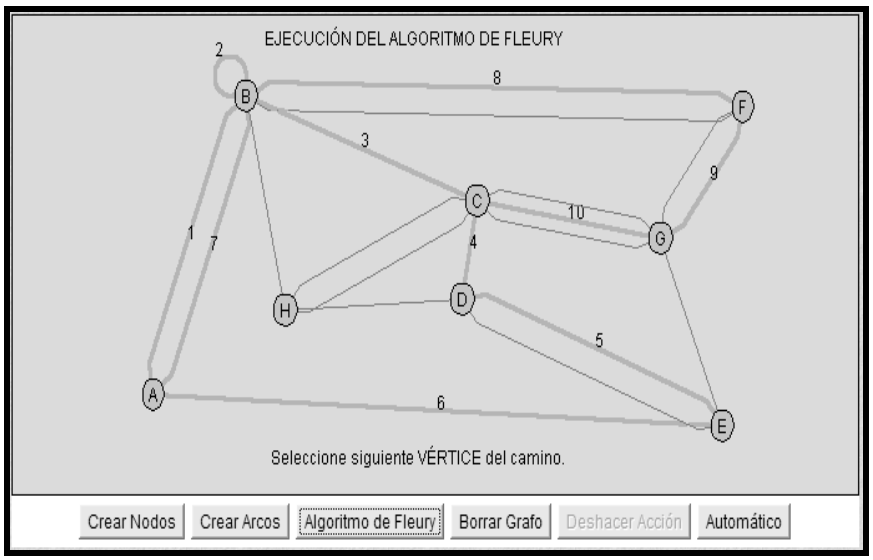

Figure 3: Fleury's applet in the process

5. Conclusion

The application has been designed with the main purpose of supporting active learning. Being fully interactive, easy to use, intuitive and visual are the characteristics kept in mind during design and implementation phases. Actually, these qualities have demonstrated to help achieving increased engagement for the students when attending a teacher's lecture, as well as when working by themselves.

In our experience, eMathTeacher tools are very good aids for learning graph algorithms as they improve comprehension, engagement, memorization and satisfaction for the students, so as the interest and motivation among pupils when the teacher makes use of them.

As mentioned above, Informatics Engineering students have significantly increased their algorithmic reasoning capability, both in comprehension and design. That's why this interactive java applet together with some others also available or in development process in Applied Mathematics Department web site[1] will surely help on teaching and learning graphs' algorithms, a subject that will be decisive on enhancing students' logical potentials.

In our opinion, eMathTeacher active learning tools introduce a new concept in mathematics Computer Aided Instruction and might represent a revolution in this field. These tools pursue a new goal on CAI, so as to acting as genuine virtual trainers extending teacher's hand through the Web, promoting active learning and offering the enhanced insight and appeal provided by graphical and dynamical tools.

[1] http://www.dma.fi.upm.es

Bibliography

[Euler 1736] Euler, L. Solutio problematis ad geometriam situs pertinentis. Commentarii Academiae Scientiarum Imperialis Petropolitanae 8, 128-140 (1736). Based on a talk presented to the Academy on 26 August 1735.

[Fleury 1883] Fleury. Deux problemes de geometrie de situation. Journal de mathematiques elementaires 1883, 257-261.

[Hundhausen 2002] Hundhausen, C. D., Douglas, S. A. and Stasko, J. T. A Meta-Study of Algorithm Visualization Effectiveness. Journal of Visual Languages and Computing, 13, 3, Elsevier, 259-290 2002.

[Naps 2003a] Naps, T. L., Rößling, G., Almstrum, V., Dann, W., Fleischer, R., Hundhausen, C., Korhonen, A., Malmi, L., McNally, M., Rodger, S., Velazquez-Iturbide, J. A.: Exploring the Role of Visualization and Engagement in Computer Science Education. Inroads - Paving the Way Towards Excellence in Computing Education. pp. 131-152, ACM Press, 2003.

[Naps 2003b] Naps, T. L., Lucas, J., Rößling, G. VisualGraph – A Graph Class Designed for Both Undergraduate Students and Educators. Proc. of the 34th ACM SIGCSE Technical Symposium on Computer Science Education (2003) pp. 176-171.

[Retson 2000] Retson, D., Williams, P. J., Simmons, S.: The Effectiveness of Computer-Based Studio Teaching of Physics. http://aitt.acadiau.ca/research/science/PhysicsEdStudy5.PDF (last visited January 2007).

[Rößling 2000] Rößling, G., Freisleben, B.: Experiences in Using Animations in Introductory Computer Science Lectures. Proc. of the 31th ACM SIGCSE Technical Symposium on Computer Science Education (2000) pp.134-138.

[Sánchez-Torrubia 2007a] Sánchez-Torrubia, M. G., Torres-Blanc, C., Castellanos, J. Defining eMathTeacher Tools and Comparing them with e&bLearning web based tools. Proceedings of the 2007 International Conference on Engineering and Mathematics (ENMA 2007). (Bilbao, Spain, 7-9 July 2007).

[Sánchez-Torrubia 2007b] Sánchez-Torrubia, M. G., Sastre-Rosa, M. A., Giménez-Martínez, V., Escribano-Iglesias C. Visualization on Learning Mathematics Concepts for Engineering Education. Proceedings of the The 4th WSEAS / IASME International Conference on Engineering Education (EE'07). (Crete, Greece, 24–26 July, 2007).

[Sánchez-Torrubia 2006a] Sánchez-Torrubia M.G, Giménez-Martínez, V. Java Tutorials: a good tool for teaching and learning Graph Algorithms. Proceedings of the 3rd International Conference on the Teaching of Mathematics (ICTM3). (Istanbul, Turkey, 30 June - 5 July 2006).

[Sánchez-Torrubia 2006b] Sánchez-Torrubia M.G., Gutiérrez-Revenga S. Tutorial interactivo para la enseñanza y el aprendizaje de los algoritmos de búsqueda en anchura y en profundidad. Proceedings of the XII Jornadas de Enseñanza Universitaria de la Informática (JENUI 2006). (Bilbao, Spain, 12–14 July 2006). Thomson, 573-580.

[Sánchez-Torrubia 2001] Sánchez-Torrubia M.G., Lozano-Terrazas V. Algoritmo de Dijkstra: Un tutorial interactivo. Proceedings of the VII Jornadas de Enseñanza Universitaria de la Informática (JENUI 2001). (Palma de Mallorca, Spain, 16–18 July, 2001). J. Miró, 254-258.

[Street 1998] Street, S., Goodman, A. Some experimental Evidence on the Educational Value of Interactive Java Applets in Web-based Tutorials. 3rd Australasian Conference on Computer Science Education. Association for Computing Machinery (1998) pp. 94-100.

[Torres-Blanc 2006] Torres-Blanc, C., Sánchez-Torrubia, M.G., Aguilar, J., Castiñeira-Holgado, E. Analyzing and Applying Computer Algebraic Systems to Engineering Education: an Interactive Digital Control course WSEAS Transactions on Advances in Engineering Education Vol. 3 Nº 2 (November 2006). WSEAS Press, 977-983.

[Waldock 2002] Waldock, J., Gretton, H., Challis, N. Using the web to enhance student learning. Proceedings of the 2nd International Conference on the Teaching of Mathematics (Crete, Greece, July 1-6, 2002).

Authors' Information

Gloria Sánchez–Torrubia *– Facultad de Informática, Universidad Politécnica de Madrid, Campus de Montegancedo s.n., 28660 Boadilla del Monte, Madrid, Spain; e-mail: gsanchez@fi.upm.es*

Carmen Torres–Blanc *– Facultad de Informática, Universidad Politécnica de Madrid, Campus de Montegancedo s.n., 28660 Boadilla del Monte, Madrid, Spain; e-mail: ctorres@fi.upm.es*

Víctor Giménez-Martínez *– Facultad de Informática, Universidad Politécnica de Madrid, Campus de Montegancedo s.n., 28660 Boadilla del Monte, Madrid, Spain; e-mail: vgimenez@fi.upm.es*

USING PHYSICAL QUANTITIES IN APPLIED MATHEMATICAL PROBLEMS WITH MAPLE

Tsvetanka Kovacheva

Abstract. *The present article discusses units of measure and their base units, work environments built in the Units package of the computer algebra system Maple. An analysis is drawn of the tools of the application in connection with the use of physical quantities and their features. Maple's main commands are arranged in groups depending on the function. Some applied mathematical problems are given as examples making use of derivative, integral and differential equations.*

Key words: *conversion, dimension, Maple, unit, systems of quantities, systems of units, Units package.*

ACM Classification Keywords*: G. Mathematics of Computing, I. Computing Methodologies*

1. Introduction

When teaching Maths students of the technical majors at Universities an emphasis should be placed on the applicable nature of the mathematical terms introduced, such as derived, integral, differential equation, order, etc. with the purpose of mastering essential knowledge and skills associated with their future engineering occupation. The need to solve various production problems entails various calculations where the application of dimensionless quantities. However, in a number of areas there is a need to use physical quantities with indication and their units' measuring This could be measuring the strain on a beam, calculating the thermal duty cycle of a transistor, determining the movement resistance of an object in liquid, etc. [8]. The units of measure provide quantity and quality evaluation of the calculation. Each science deals with units of measure rendering the results of its application. Those can be data about a process at its various stages of development. This information can display how a process evolves, what steps are necessary to be taken for its enhancement towards the desired end purpose. In a number of cases the mathematical model of processes or phenomena is demonstrated through complex systems of differential or integral differential equations. This demands determining of a numeric solution using and developing appropriate algorithms and methods, for which it is necessary to apply higher-level algorithmic languages. When using computer applications, however, we only deal with the numerical values of variables and not with their corresponding units. When giving a mental solution to a physical problem we operate entirely with physical quantities. Therefore, with languages it is vital to keep in mind the rule that all physical quantities ought to be in one system of units. They have to be without factors such as miles, mega, etc. [3,10]. The next step in utilizing computer technology when solving physical-mathematical, engineering-technical as well as study problems is represented by computer algebra system (CAS) like Maple, Mathematica, etc. [4]. One of the most common CAS is Maple which is used with solving scientific-technical, engineering and study problems [4,5]. The product represents a powerful computer system, who gives opportunities for efficient solutions of Algebraic and Geometrical problems, tasks of Mathematical Analysis, Probability Theory and Statistics, numerical calculations, etc. The system allows for analytical and numerical solving of equations and systems, drawing graphs, optimization, mathematical modeling, transformations, statistical data processing, symbolic mathematics, etc. It also allows for determining of the numerical values of quantities when solving specific problems and their dimensions. All this facilitates the reference to physical dimension formulae. Its advantage is that by only a couple of lines of commands one unit of measure or quantity can be converted into another, which is quite handy for mathematicians, engineers, economists, etc. These calculations are carried out with the help of the Units package for calculations of physical quantities.

2. Quantities, units and systems [1,2,8]

2.1. Quantities and units

A physical quantity is either a quantity within physics that can be measured, as mass, volume, etc. or the result of a measurement. *Physical quantities* are divided into categories. *Quantities of the same category* are those that can be compared. e.g. a category with quantities like length, distance, diameter, height, etc. *Unit* or *quantity for comparison* is a constant quantity that allows comparison of quantities within one category. Any other quantity of

the category can be displayed as a function of this unit by multiplying it by a number (the numerical value of the quantity, represented by this unit). e.g. tension of an electric circuit U=0,05.10^3 V=0,05kV.

2.2. System of quantities

Quantities of different categories are those that connect by equations manifesting the physical laws. In order to define systems of quantities and to introduce the term *physical dimension* (was introduced by Fourier, 1822), certain quantities have to be regarded as independent, i.e. they are considered base quantities. In 1960 at the 11th General Conference in Measures and Weights a set of base quantities of the *International System of Units* (SI) was accepted, each field of study having a need only of a few of those quantities: Mechanics: length, mass and time; Electricity and magnetism: length, mass, time and electrical current.

2.3. System of units

Units in a system are selected arbitrary, however, it is more convenient if the base and derived units are in accordance with the chosen system of quantities. Such a system of units is called coherent (SI system). The coherent unit for all dimensionless quantities is the unit one, indicated with 1.

3. Systems of Units built in Maple [6,7,8,9,11]

The following systems of units are built in Maple: *Atomic, CGS, EMU, ESU, FPS, MKS, MTS, SI.*

3.1. Atomic

Atomic units form a system of units convenient for atomic physics, electromagnetism and quantum electrodynamics, particularly for describing the properties of electrons. They have been chosen such that the fundamental electron properties are all equal to one atomic unit. The numerical values of the following six physical constants are all unity by definition: t*wo properties of the electron, its mass and charge* - the electron mass m_e (9.1093897e-31 kg) and elementary charge e (1.60217733e-19 C); *two properties of the hydrogen atom, its Bohr radius and electric potential energy in the ground state* - Bohr radius a_0 (5.291 772 108(18)×10^{-11} m) and Hartree energy E_h (4.359 744 17(75)×10^{-18} J); *two constants* - angular momentum - Planck's constant $h/2\pi$ (1.054 571 68(18).10^{-34} J s) and electrostatic force constant - Coulomb's constant 1/(4πε$_0$) (8.9875516×10^9 C^{-2} N m^2). These six quantities are not independent; to normalize all six quantities to 1, it suffices to normalize any four of them to 1. Derived Atomic Units are time, velocity, force, current, temperature, pressure.

3.2. The Centimeter-Gram-Second (CGS)

The system goes back to a proposal made in 1832 by the German mathematician Carl Gauss. The mechanical units are the same in all CGS systems, but there are several variants of electric additions. Length, mass and time, however are not sufficient to define electric and magnetic quantities; a fourth dimension must be included. The system has four varieties: electrostatic, electromagnetic, Gaussian and Heaviside-Lorentz system. The different CGS systems arose from differing choices of the additional dimension. Like SI it has same base units, but they have other decimal prefix. Derived CGS are the units dyne, erg, poise, stokes, gauss, oersted and maxwell.

3.3. The Electromagnetic System of Units (EMU)

The electromagnetic system of units (EMU) has the centimeter, gram, second and biot as its base units, where the biot is energy-equivalent to the unit square root dyne ((cm)^(1/2)*g^(1/2)/s). For naming consistency, the biot is called the abampere.

3.4. The Electrostatic System of Units (ESU)

The electrostatic system of units (ESU) has the centimeter, gram, second and franklin as its base units, where the franklin is energy-equivalent to the unit square root dyne centimeter (cm^(3/2)*g^(1/2)/s). For naming consistency, the franklin is called the abcoulomb.

3.5. The Foot-Pound-Second (FPS)

The FPS (the British, imperial or often called in USA, the inch-pound) system of units has the foot, pound and second as its base units. Unlike modern systems of units, composite dimensions are not necessarily represented by a product of powers of the base units.

3.6. The Meter-Kilogram-Second (MKS)

The MKS system of units has the meter, kilogram and second as its base units. Although the MKS system does not include units of electricity or magnetism, the SI system, which is also based on the meter, kilogram and second, does.

3.7. The Meter-Tonne-Second (MTS)

The MTS system of units has the meter, tonne and second as its base units.

3.8. International system SI [4]

The International System of Units SI consists of a set of units together with a set of prefixes. The system is based on: seven nominally dimensionally independent base units: kilogram, meter, second, mole, ampere, kelvin and cande; two dimensionless units - radian and steradian; prefix (kilo, nano, etc.) - a name or associated symbol that precedes a unit of measure (or its symbol) to form a decimal multiple or submultiple. They are used to reduce the quantity of zeroes in numerical equivalencies; derived units with special names - hertz, newton, joule, watt, pascal, etc.; compound units derived from SI units - square meter, cubic metre, radian per second, newton second, etc.; Non-SI units accepted for use with SI - minute, hour, degree of arc, minute of arc, second of arc, litre, tonne, electronvolt, astronomical unit, atomic mass unit. In addition to the SI units there are also a set of non-SI units accepted for use with SI.

4. Maple tools for the conversion of data [9]

The conversion of data in Maple is provided for by its Units package. It has a graphic customer interface for the transformation of units in separate environments for the completion of calculations. The commands for dimensions and units are in the dialogue window Unit Converter and are described in the package *Unit Converter Support Package*. Each command in the package is accessible in two *forms*: short and long. The long form of command is necessary when the short one is not defined by the *with* command, **with(PackageName, command)** or when there is a command of the same name in the Maple package PackageName in use.

4.1. Work environments

Maple package offers 3 work environments: *Default* – it does not accept any use of units. However, there are conversion routines that convert units. It consists of the following commands: **convert[units], convert[temperature], convert[conversion_table], convert[dimensions], convert[system]**; *Standard* – some of the options are modified to support entering of units as expressions. Typing in **with(Units[Standard])** command displays options for entering of units while the use of short forms from the Units package for dimensions, units and systems of units is not supported. ***Unit(unit_name)** command is used to enter units as expressions. The result appears in square brackets. The different environment allows for quantities to be indicated in common symbols, used as names of the units, where *m* refers to 'meter' and *s* to 'seconds'; N*atural* – the list of commands for the calculation of units is the same, with the difference of options. Here the natural numerical system for the designation of signs **(*unit_name)** is used whereas units are entered as expressions.

4.2. The Convert command

In Maple the *convert* command can be applied directly for single transformations without the **with(Units)** command. Determinant for the transformation is a variable without sign. The *conversion factor* can be determined with using an unassigned variable in the convert command, e. g. commands for conversion from 5 feet to meters and the conversion formula from feet to meters are:

>convert (5.0, units, ft, m); 1.524 >convert(x,units,ft,m); $381/1250\,x$

Some important conversions:

- *temperature conversions* – the units conversion changes. To convert absolute temperatures from one scale to another must use the temperature option to convert ().

>convert (15, units, degC, degF); 27 >convert (0, temperature, degC, degF); 32

- *angle conversions* – the trigonometric functions in Maple expect angles in radians. In the Standard environment can simply enter the angle in any units and Maple automatically performs the conversion.

> with(Units[Standard]): $\alpha := 45 * Unit(\deg)$; $\alpha := 45[arc\deg]$

> $\cos(\alpha)$; $\sqrt{2}/2$ >evalf(%); 0.7071067810

4.3. Commands in the Units package

The package offers 20 different commands. The **with(Units)** command allows work with physical units where a list of options is presented. Commands could be categorized in the following *groups*:

- **commands for adding or changing a unit, dimension, system of units (beginning with Add):**
  - *AddBaseUnit* – add a base unit and associated base dimension.

>AddBaseUnit(unit, context=unit_context, dimension=dimension_name, opts);

- *AddDimension* – add a base unit and associated base dimension.

>AddBaseUnit(unit, context=unit_context, dimension=dimension_name, opts);

- *AddSystem* – add or modify a system of units. > AddSystem(system, opts, units);
- *AddUnit* - Units[AddSystem] - add or modify a system of units. > AddSystem(system, opts, units);

- **commands for restoring a quantity, information, list of dimensions, units, systems of units *(beginning with Get):***
  - *GetDimension* – return dimension as a product of powers of base dimensions. >GetDimension(dim);
  - GetDimensions – list all dimensions. >GetDimensions(opts);
  - *GetSystem* – list units in a system of units. >GetSystem(system)
  - *GetSystems* – list all systems of units. > GetSystems();
  - *GetUnit* – get unit information. > GetUnit(unit, opt1, opt2, ...);
  - *GetUnit*s – list all unit names. >GetUnits(opts);
- **commands for testing (beginning with Has):**
  - *HasDimension* – test whether a dimension exists. > HasDimension(dim);
  - *HasSystem* – test whether a system of units exists. > HasSystem(system);
  - *HasUnit* – test whether a unit exists. > HasUnit(unit, opts);
- **commands for changing a dimension, system of units (beginning with Remove):**
  - *RemoveDimension* – remove a dimension. > RemoveDimension(dim);
  - *RemoveSystem* – remove a system of units. >RemoveSystem(system)
- **commands for setting a context, system of units (beginning with Use):**
  - *UseContexts* – set default context(s). >UseContexts(ctx1, ctx2, ...);
  - *UseSystem* – set the default system of units. >UseSystem(system, opts);
- **commands for displaying a set context, systems of units (beginning with Using):**
  - *UsingContexts* – list the default unit contexts. > UsingContexts();
  - *UsingSystem* – return the default system of units. > UsingSystem();
- **commands for deriving output:**
  - *Unit* – return argument as a unit in standard form. > Unit(expr);

4.4. Conversion between measuring systems

Maple automatically converts the solution from the given systems and units.

>with(Units[Standard]); Dist:=5*Unit(ft)+2.5*Unit(inches); $Dist := 1.587500000\ [m]$

It is easier to solve the above problem in the standard US system (FPS: foot-pound-second), using the ***convert*** command: >Dist:=convert(Dist,system,FPS); $Dist := 5.208333333\ [m]$

4.5. Prefixes in the units of measure

In order to write a set of units in a short form and to avoid lengthy or short names, the System of Units SI and the International Electrical-Technical Commission have approved a list of prefixes that can be used together with the base units. For each set, prefixes can be added to the name of the unit and their symbol can be added to the symbol of the base unit. Prefixes cannot be added to the symbol and the prefix of the symbol cannot be added to the symbol of the unit. Prefixes should be used together with the unit. It cannot be expressed as numerical value. e.g. *k* cannot be represented as 1000. Prefixes cannot be combined to form complex prefixes. e.g. *nanometer* cannot be written out as *millimicrometer*. The prefixes of the units of measure in Maple are given in Table 1. They can only be added to those inbuilt units of measure that allow for that. For instance, if in Maple we operate with meters (m), decimeters (dc), centimeters (cm), millimeters (mm), etc., then after using the *convert* command:

>with(Units): convert([m,dm,cm,mm],conversion_table,output=grid);

The conversion table is given in Figure 1.

5. Some examples from the mathematical analysis [12]

5.1. Determining velocity and acceleration of an object through a derivative

Find out the acceleration ***a*** of a free-falling object, if the dependency of the distance ***s*** on the time ***t*** :

$$s = \frac{1}{2}.g.t^2 + v_0.t + s_0 \qquad (1)$$

where – $g = 9{,}8\ m/s^2$ - the acceleration of gravity; $s_0 = s\big|_{t=0}$ - value of ***s*** if ***t=0***; $v_0 = v\big|_{t=0}$ - value of ***v*** if ***t=0***.

Table 1

10^n	Prefix	Symbol	10^{-n}	Prefix	Symbol
10^24	yotta	Y	10^(-1)	deci	d
10^21	zetta	Z	10^(-2)	centi	c
10^18	exa	E	10^(-3)	milli	m
10^15	peta	P	10^(-6)	micro	mu,u,mc
10^12	tera	T	10^(-9)	nano	n
10^9	giga	G	10^(-12)	pico	p
10^6	mega	M	10^(-15)	femto	f
10^3	kilo	k	10^(-18)	atto	a
10^2	hecto	h	10^(-21)	zepto	z
10^1	deka	da,dk	10^(-24)	yocto	y

Figure 1

UnitName	Symbol	To: m	dm	cm	mm
meters	m	1	10	100	1000
decimeters	dm	$\frac{1}{10}$	1	10	100
centimeter	cm	$\frac{1}{100}$	$\frac{1}{10}$	1	10
milimeters	mm	$\frac{1}{1000}$	$\frac{1}{100}$	$\frac{1}{10}$	1

Solution: 1. The values for of the three known parameters - acceleration of gravity ***g,*** distance ***s0*** and velocity ***v0*** are entered in Maple in their respective units meter per second, meter and meter per second, as Maple output reflects the unit:

> with(Units[Standard]): g:=9.8*Unit(m/s^2); $g := 9.8\left[m/s^2\right]$ > s0*Unit(m); $s0[m]$ > v0*Unit(m/s); $v0[m/s]$

2. Determine the dependence of the distance of the time using formula (1) – enter meter per second and second for the initial velocity ***v0*** and time ***t***:

>distance:=0.5*g*(t*Unit(s))^2+v0*Unit(m/s)*t*Unit(s)+s0*Unit(m); $v := 4.90t^2 + v0t + s0[m]$

3. By using the *diff* command twice is received the velocity and acceleration of the object. To differentiate with respect to a variable having a unit – second in this case – use the syntax *diff(function,variable*Unit(unit))*.

> velocity:=diff(distance,t*Unit(s)); $v := 9{,}80t + v0\ [m/s]$

> acceleration:=diff(velocity,t*Unit(s)); $a := 9{,}80\ [m/s^2]$

5.2. Calculating of power with the help of a defined integral.

The contraction ***S*** of a spring is proportional to the applied power ***F***. Find out the work of the power ***F*** when the contraction of the spring is by 5 cm, if to contract it by 1 cm a power 10H is needed.

Solution: As set in the condition, the power and move are bound by the following dependency

$$F = k.S \qquad (2)$$

The measure units of quantities are as follows: ***S*** in meters, ***F*** in newtons. The work of the power is defined by the formula:

$$A = \int_a^b F(s).ds \qquad (3)$$

1. Enter the following quantities and their units meter and newton: ***S*** = 0.01m, ***F*** = 10N:

> with(Units[Standard]): F:=10*Unit(N); $F0 := 10[N]$ > S:=0.01*Unit(m); $s0 := 0.01[m]$

2. Calculate the value of ***k*** using the formula (2): > k:=F/S; $k := 1000\left[kg/s^2\right]$

3. Determine the power - formula (2): > F:=k*S; $F := 1000.s^2\left[kg/s^2\right]$

3. Define the work of the power ***A*** by using the ***int*** command– formula (3)

> A:=int(F,s=a..b); $A := (500.b^2 - 500.a^2)\left[kg/s^2\right]$

4. Enter the units of the limits ***a*** and ***b*** of the defined integral

> Values:=[a=0*Unit(m),b=0.05*Unit(m)]; $Values := [a = 0, b = 0.05[m]]$

5. Compute the work of the force using the command **eval -** > eval(A,Values); $1.2500[J]$

In the Standard Units environment, the **int** function integrates an expression with respect to a name that can have a unit. The result is the integral of the expression, with respect to the variable of integration, with a unit, the integrand unit multiplied by the variable of integration unit.

5.3. Calculating the velocity of radium's decay and its period of half-decay with the help of a differential equation

The velocity of decay of radium is in direct ratio to its amount at each given time. Find out: A. the law of change of the radium's mass ***m*** depending on the time ***t***, if when ***t=0*** radium's mass is m_0 ; B. the period of half-decay.

Solution: A. The velocity of decay of radium is

$$dm/dt = -k.m \tag{4}$$

where – *k* is a coefficient of direct ratio (κ>0). Equation (4) is a separable differential equation. The sign on the right is a minus, as with passing of time the radium's mass gets reduced. After separating the variables and integrating the two sides of the equation, its general solution is:

$$m = C.e^{-k.t} \tag{5}$$

When using the given initial condition in the problem $m(0)=m_0$, the partial solution is:

$$m = m_0.e^{-k.t} \tag{6}$$

B. For the time t_0 the radium's mass is decayed by $\alpha\%$ from its original mass. Therefore, coefficient ***k*** can be defined by the correlation:

$$(1 - \alpha/100).m_0 = m_0.e^{-k.t_0} \tag{7}$$

where $k = -1/t_0 \,.\ln(1 - \alpha/100)$

Thus it is deduced for the radium that ***k***=*0.000436* (the unit for time is year). The period of half-decay of radium, i.e. the interval of time for which half of its initial mass decays is defined by (6) for the set value of ***k*** and replacing of m_0 with $m_0/2$. There are other problems in physics and chemistry similar to this type of equation (4). The solution with Maple is:

A. DE's solution:

1. Enter the differential equation (4) and by the *dsolve* command its general solution

> with(Units[Standard]): equ:=diff(m(t),t)=-k*m(t); $edu := dm(t)/dt = -k.m(t)$

2. The partial solution of (4) is reached by entering the initial condition:

> IC := m(0)=m0; $IC := m(0) = m0$ > mass := dsolve({equ,IC},m(t)); $mass := m(t) = m0.e^{(-kt)}$

3. To incorporate units into the partial solution specify *k, m0* and *t* in the list:

>Values:=[k=0.000436*Unit(1/yr),m0=m0*Unit(kg),t=t*Unit(yr)];

$Values := [k = 0.00436 * \mathrm{Unit}[1/yr], \mathrm{m0} = \mathrm{m0} * \mathrm{Unit}[\mathrm{kg}], \mathrm{t} = \mathrm{t} * \mathrm{Unit}[\mathrm{yr}]]$

4. Compute the mass *m* as a function of *t* alone by evaluating in on those parameters using the eval command:

>eval(mass,Values); $m\left(t\left[yr\right]\right) = m\,0\,[kg\,].e^{(-0.000436\ \ [1/yr\,]t\,[yr\,])}$

B. Defining the period of half-decay of radium

1. Replace m_0 with *m0/2* and *t* with *T* in (6): > equ1:=subs(m(t)=m0/2,mass); $\mathrm{equ1} := \mathrm{m0}/2 = \mathrm{m0e}^{(-\mathrm{k\,t})}$

2. Solve the equation about the period *T:* >T:=solve(%,T); $T = \ln(2)/k$

3. Enter the units and value of *k*: >Values: = [k=0.000436 * Unit (1/yr)]; $Values := k = [0.000436 * Unit[1/yr]]$

4. Compute the period T using the eval command, evaluate the result and convert the hours into years:

>T:=eval(T,Values); $T = 2293.577982.\ln(2)[yr]$ >T:=evalf(%); $T = 1589.787112[yr]$

6. Conclusion

One of the most important issues students should dwell on when solving applied problems are whether the required quantity is physical or non-physical and if the unit of the quantity in question is known or not, etc. Any computation in a specific problem should commence only after all quantities are converted into the right units according to SI, if no other system of units is referred to explicitly. After solving a specific problem they should do a check through the physical dimensions of the output quantities. If all is correct, then this is a guarantee of a right solution. Solving applied problems enhances students' engineering thought, i.e. their ability to observe links between Maths and Physics, on the one side, and various technical applications of these sciences, on the other, also to envisage possibilities for applying this knowledge to practice and to realize scientific ideas on a practical level.

Bibliography

[1] "A Dictionary of Units of Measurement" http://www.unc.edu/~rowlett/units/index.html
[2] "Index to Units & Systems of Units" http://www.sizes.com/units/index.htm
[3] Engineering and scientific calculations http://www.megabook.ru/pc/encyclop.asp?topic=pc_542&rubr=pc_542
[4] Kovacheva Ts. "Mathematical packages for teaching and research in Internet applications and information support", "Information theories@Application", v.11,4,2004, 387-393.
[5] "Maple Application Center", "Waterloo Maple Software"www.maplesoft.com
[6] "New packets of the system Maple 7" http://ais.khstu.ru/Maple7/Glava%2016/Index40.htm
[7] "Products and Solution" www.maplesoft.com
[8] "Reference book for Units" http://www.bgnews.bg/media.html?media=47549806
[9] "The Units Package in Maple" http://www.adeptscience.co.uk/download/dlddsp/9304/0/All/A4+Maple+Units+Poster.html
[10] Units in Mathcad & Maple http://twt.mpei.ac.ru/ochkov/work2_eng.htm
[11] "SI Units, Conversion, Measurement skill" http://www.wacek.co.za/

Author's Information

d-r Tsvetanka Kovacheva *– Lecturer at Department Mathematics of Technical University, Bulgaria, 9010 Varna, 1 Studentska str., e-mail: Tsveta_Kovacheva@tu-varna.acad.bg*

ABOUT ONTOLOGY APPLICATION TO THE DESCRIPTION OF SYLLABUS

Evgeny Eremin

Abstract*: Publication describes the experience in application of ontology technique to structuring of educational materials. Several topics of physics were formalized by means of* ***Protégé*** *software tool. Some principal problems in building of knowledge structure were found, so the discussion may interest not only ontology users, but also the developers of ontology tools.*

Keywords*: ontology, program, education, course, Protégé, knowledge structure, objects, inheritance, classes.*

ACM Classification Keywords*: K.3.1 Computer Uses in Education – Computer-assisted instruction; E.1 Data Structures – Trees; E.2 Data Storage Representations – Object representation; I.2.4 Knowledge Representation Formalisms and Methods – Frames and scripts; I.2.6 Learning – Knowledge acquisition.*

Introduction

At present time **ontologies** – formal descriptions of terms and relations between them in some knowledge domain – are increasingly using for structuring of the comprehensive expertise, accumulated by mankind, and its transformation into computer representation. This method of structure storage already has many functioning complete applications in various areas. Perspective theoretic studies, aimed on support of the correct semantic search in electronic documents (including data selection by net agents) and automatic building of ontologies from

found information, are also of great importance. Numerous examples of ontologies and their practical applications were more than once described in literature [1–4].

Ontologies essentially facilitate the mutual understanding between people jointly using information. Furthermore knowledge representation in a form of ontology not only makes possible its automatic processing, but permits people to formulate their experience in some domain in the clearest and the most demonstrative way.

The last fact is very interesting from educational point of view. Learning, being a process of purposeful knowledge transfer, belongs to the fields of human activities where ontologies are natural (see [3] for examples). In particular, creating of the effective automated learning systems strongly depends from the success in structuring of knowledge and its representation in the forms available to computer.

This paper describes an attempt to apply ontology for structuring of some topics from the educational course. Usually most examples of such ontologies are developed for programming languages (see publications [5, 6] for example), where all the results look clear and elegant because these languages are artificial design and so well-structured. Publication [5] even raises a question about the harmony of the built ontology. But other knowledge domains are not so clean, as it results form [7, 8] where the analyses of ontologies developed for various educational disciplines are described.

Several chapters from physics were considered in this paper for structuring of educational materials (to simplify the study, they were taken from the textbook for the last classes of secondary school). Although the choice of the topics was made according to the author's preferences, it has some reasons: physics is the thing for ontology application. From discussing point of view this discipline is very interesting because it mirrors objective complexity and interdependence of the natural phenomena; besides, the way, in which physic knowledge is structured, determines learning strategy in many respects [9, 10]. In consequence of the importance of physical basics conceptual systematization, paper [10] offers a special course in teachers training, aimed «not to teach more physics but to organise what have already been learnt».

Package **Protégé** v. 3.1.1 (Protégé-2005) was used for creating and keeping educational ontologies. Software choice was determined by the renown of this package and also by the existence of accessible detailed descriptions [4, 11–13].

Statement of the problem

The problem under consideration naturally arises from everyday pedagogical activities. Every teaching course always has a syllabus – some list of topics and subjects to learn (in Russia syllabus is an official document, although it's not dogma). When it is written for a course taught for a long time and supported by the set of time-proved textbooks of various authors (let's mention physics and geometry as examples), it's not difficult to realize such scheme. Furthermore, practical experience shows that existent changes in this case are not too often and usually not essential. Situation with rapidly developing computer disciplines is quite different: syllabuses are changing at every turn, so textbooks are often incomplete and can't timely catch all movements in science; the experience of teaching for nascent topics does not exist. As a result, the questions that were added to syllabus during regular renewal are unfamiliar to teachers and sometimes they can't neatly imagine where to find the material for these chapters of the course. In such cases teachers strongly lack for several phrases explaining the topic, together with reference list closely connected with this concrete question. So they naturally wish to get additional information on any syllabus item, in other words, using pedagogical terminology, every item must provide brief explanation of its subject.

Possible computer solution of the problem lies in building of educational course's ontology, which contains comments and references at every point. As an additional advantage of ontology approach (in comparison with the «paper» solution), we visualize interrelations between subjects of our course, that is very useful for organization of well-timed repetition and planning of exposition order.

As it was mentioned above, this work deals with ontologies for the course of physics. The stable Russian schoolbook [14] was used as a resource for building ontology. We'll not consider questions, connected with plural possibilities of material exposition here. Using the terms from publications about ontologies [6, 8], we plan to create the ontology of the educational course but not of the correspondent knowledge domain, at that in the simplified version – using the only textbook.

Principles of ontology building

Considering some ambiguity of existing terminology about ontology's components, let us name the main terms that will be used in the discussion: in fact it is the denomination system, on which Protégé software is based.

Ontology is built from classes, slots and instances. **Classes** describes individual concepts of the knowledge domain, and their **instances** are examples of concrete objects realization. **Slots** describe properties and attributes; they can be obtained both to classes and instances as well. For example we can name terms *concept* or *law* as typical classes of educational material. Representative slot of the *concept* class is *definition*, and the *law* class may contain specific slot *mathematical expression*. Instances of *concept* are *electric current* and *electric charge*; the *law* class specifically realizes as *Ohm Law* and *Joule-Lentz law*, or maybe texts about these objects.

It is worthy of note that only definite interrelations between mentioned above categories are admissible in Protégé software [12].

As a rule, new class may be reproduced from parent class. Concrete instance also descends from correspondent class (some classes, called **abstract**, deny this possibility), but it must be terminal node of any ontology, i.e. instance principally can't have inheritors. Protégé also supports **multiply inheritance**, when some class has several parents and inherits all their slots.

Slots are determined independently from any class or instance (this allows using the same slot in different branches of hierarchy). There are two types of slots in Protégé: **own slots** and **template slots**. First are attached to their class or instance and capable to store an individual value. Second type belongs to class only, and all such slots are inherited. Template slots in a class are unable to have value in substance, until will be passed on to concrete instance; here they become the own slots and hence get property to be filled with value. Slots may be added to the class only, and instances get slots inheriting them from the class.

Each class is associated rigidly with interface **form**, by means of which user fills required slot values. Form's view is easy to edit, so it may be composed in any usable for input look.

Later, describing difficulties in building of our ontology for educational material from physics, we'll need these data about ontology's components interrelations.

Ontology realization and its difficulties

Even preliminary analysis of the knowledge domain for our problem displays, that three kinds of classes as minimum are necessary:

- type of educational material (*description* or *law* as an example); it determines what data components are stored for every variety of syllabus questions;
- fundamental concepts from the whole physics course which are used in all of its parts (physical magnitude, unit, system of units etc.);
- categories, comprised in the concrete part of physics (electricity and magnetism were selected for the trial ontology).

Existence of several closely interrelated class levels in itself generates significant difficulties. Essential interdependence between fundamental physical concepts make situation much more complicated, because such complex relations not always keep within hierarchical structure. Let us consider an example from fundamental categories of physics. Some *system of units* is used for measuring a *physical magnitude*. This *system of units* consists from an aggregate of definite *units*, and every *system of units* contains its own set of *units*. Some *units* may be included into different *systems of units*. Withal many *physical magnitudes* can be measured by several *units*, and selected *unit* in its turn depends from *systems of units*. At last the process of measurement itself lies in the comparison of measuring *physical magnitude* with some reference *physical magnitude* which is defined as a *unit*. We must emphasize, that we can't go without enumerate above concepts, because every physical magnitude must be measured in some units.

We must agree with the authors of publication [7], who accentuate that classification of educational content in the form of hierarchical structure is one of the main difficulties. The reason is apparently principled and lies in the nature of a learning material. As it was noted in [3, 15], five types of relations between terms exist: «part–whole», e.g. bumper and a car; «collocation», e.g. words in the sentence; «paradigmatic relations», e.g. Sun and Solar system; synonyms and antonyms. G. Booch in his fundamental book [16] adduce somewhat different list of basic relations between classes: class/subclass («is–a») – rose is a flower; whole/part («part of») – petal is a part of

rose; semantic relations, associations (rose and candles both can be used for table decoration). It is evident that in spite of some difference in classifications, the semantic relations in both are the worst for univocal tree formalism versus all the rest.

The analysis of the physics categories' tree also demonstrates that hierarchy of concepts not always determines the order of their learning. For example the topic Ohm law for the part of the circuit use to be learnt before the similar law for the whole circuit, although from hierarchical position the first one is a descendant from the second.

If we remember about the existing of two opposite ways in cognition – induction and deduction, then some limitation of univocal tree ontologies (at least as applied to educational process) become more distinct.

Another principled difficulty in building educational ontology springs out from «heterogeneity» of all real learning materials. In the same textbook chapter we often find closely a definition of some physical magnitude, some laws in which it is involved, and also the description of these laws' application to human activity. As a result it is not easy to build unified ontology for all various fragments of knowledge.

Let us consider one more example. Fig. 1 shows a small fragment of developing ontology for the topic «Electric current».

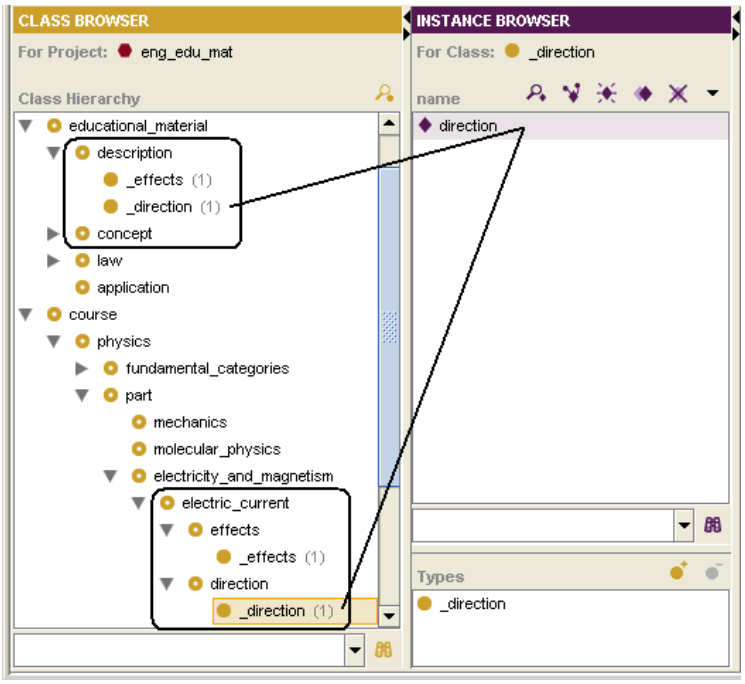

Fig. 1

In the top part of this ontology we see the class *educational_material*; its subclasses (*description*, *concept*, *law* and others) correspond to the pieces of the learning texts that form any concrete physical topic. Every type of the material has definite set of slots, which is inherited according to the basic ontology's principles. For example the specific slot for *concept* is *definition* (slots are not shown on fig.1).

Now let's advert to the class *electric_current*, located in the bottom part of the figure. In substance it is *concept*, so we ought to add the slots for this kind of educational material, using multiply inheritance. But at the same time two next subclasses – *effects* and *direction* – serve as *descriptions*, hence they do not need slot like *definition* from the superclass, which is the descendent of *concept*. Nevertheless, subclasses can not refuse from inheriting slots. Thus we see the main reason of this contradiction: class must have instrumentation not only for the extension of its own structure, but for its restriction as well [16].

The possible solution, which stays within Protégé knowledge model, is to add necessary slots from subclasses of *educational_material* on the very last stage, i.e. just before creating concrete instance of a class. As a result, we may create accessorial class (*_direction* for *direction* superclass on fig. 1), which doesn't take part in the common hierarchy, and add the second parent superclass *description* to it. In fine, *_direction* (peculiar «mixer» for the required slots) gets its own set of slots, specific for this material, without any influence on inheritance process because of absence of the descendant classes. But this mixed class allows producing an instance of educational material with all necessary properties.

Described above accessorial classes are marked on the hierarchical scheme on fig. 1 by different graphic symbol – fully fill circle: this sign is used in Protégé for **concrete** classes, which are allowed to have instances. Alternative classes that produce only classes are called **abstract** and marked by the circle with white center. From the point of view of the described model such difference is clear, because instances are created only from classes with preliminary prepared total set of slots.

Such method of the multiply inheritance was suggested in Flavors language (citing from [16]): small classes, unappropriated for producing instances, were mixed to other classes, providing them more complex structure.

Such method is called **creating admixture** (mixin). Subclasses, produced from *educational_material* class, play a role of admixture in our ontology.

In fact Protégé allows to manage without accessorial classes like *_direction* in the above example, mixing slots directly in the instance (see the bottom of the instance browser on fig. 1). This solution, quite suitable for practice, seems us slightly inconsecutive from the positions of the conventional building of full class hierarchy.

Seeing principled character of these difficulties with restrictions of class inheritance, we may think about improvement of the ontology keeping systems themselves. Several ways of the improvement may be offered.

First of all, from theoretical point of view it looks winning to introduce a role for slots similar it is done for abstract and concrete classes. Considering that Protégé already has two types of slots (template slot and own slot), it is easy to generalize formally inheritance model and define new type, called, say, private slot. As it is clear from the following table, this new type of slot, in contrast to the own one, will pass to the instances of the class, but will not be inherited by its subclasses.

Slot type	Class inheritance	Instance inheritance
private?	**–**	**+**
own	**+**	**–**
template	**+**	**+**

Maybe such generalization will conflict with Protégé knowledge model. As a variant, the mentioned above way of temporary mixing of another class without including its slots into inheriting template may be suggested.

It is worth to mention about prevalent in OOP **hidden** (private) properties, which are inherited, but «not visible» in the subclasses-descendants. Something similar may be done for slots, but great amount of hidden unused slots will make tables of slots boundless.

At last some variant template for slots may be offered for realization – an analog for variant record in Pascal, where an actual set of fields depends from the value of tag field (from *educational material* in our case).

Realization of links inside material

Very important advantage of educational material in electronic form is the possibility to see related topics while reviewing it. Protégé package provides a simple but usable mechanism for realization of such references – the possibility of slot to have an instance as its value. Consequently, slot of such type, placed on form with the material, becomes the reference to another material: remember that in the terms of our ontology concrete fragments of educational texts are instances, so it is a question of links between instances of different classes. Using such slots on material's form, we can review linked instance by means of mouse double click. The obtained realization is very close to hyperlink, which, being clicked, opens connected resource in a new browser window.

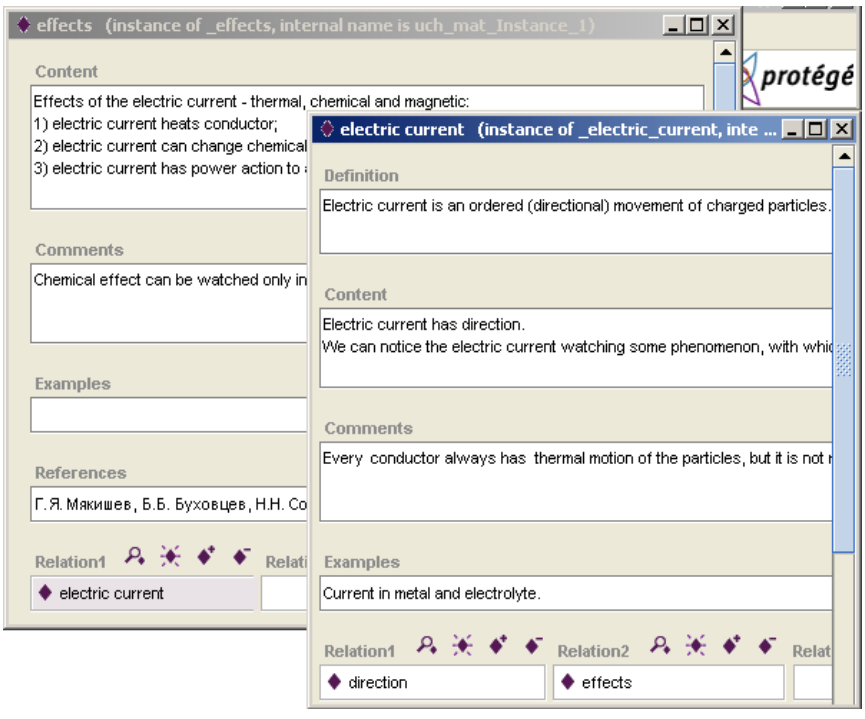

Fig. 2

Fig. 2 demonstrates a form with question «Effects of the electric current». In the top window related fragment «Electric current» was opened; reference slot of the same name (see field *Relation1* in the bottom form) was the source of call.

Forms on fig. 2 also represent a possible way how explanation of the syllabus items' contents can look. Let us note the special importance of the form field called *References* – it can be found in the left bottom part of fig. 2 and contains the reference to Russian textbook [14].

Future work

At present time the common basis of the ontology is built and class hierarchy for several topics of physics course are created. Some additional theoretic interest may be found in continuing of work, aimed on realization of ontology for several different parts of physics, because their interrelations may arise some new specific problems.

Similar work for other disciplines should be done in perspective with the purpose of comparison the result ontologies. The hypotheses exist that such results may help to choose some objective elements for estimation of the complexity of learning materials, and also for the description of courses' organization and internal structure.

Bibliography

[1] A. Gómez-Pérez, M. Fernández-López, O. Corcho. Ontological Engineering with Examples from the Areas of Knowledge Management, e-Commerce and the Semantic Web. – Springer-Verlag, London, 2004.

[2] A. Maedche. Ontology Learning for Semantic Web. – Kluwer Academic Publishers, Boston, 2002.

[3] J. Milam. Ontologies in High Education. In: Knowledge Management and Higher Education: A Critical Analysis. Ed. Metcalfe A.S., Idea Group Publishing, Hershey, PA, 2005. – P. 34–62.

[4] N.F. Noy, D.L. McGuinnnes. Ontology Development 101: A Guide to Creating Your First Ontology. Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-0880, 2001. [Electronic resource] / Accessible at: http://protege.stanford.edu/publications/ontology_development/ontology101.html

[5] S. Sosnovsky, T. Gavrilova. Development of Educational Ontology for C-programming // Information Theories & Applications. – 2005. – 13 (4). – P. 303–308.

[6] K. Olsevicova. Topic Maps e-Learning Portal Development // The Electronic Journal of e-Learning. – 2006. – 4 (1). – P. 59–66; available online at www.ejel.org

[7] D. Dicheva, C. Dichev. Authoring Educational Topic Maps: Can We Make It Easier? // Proceedings of ICALT. – 2005. – P. 216–219.

[8] D. Dicheva, C. Dichev. Confronting Some Ontology-building Problems in Educational Topic Map Authoring // Proceedings of the Workshop on Applications of Semantic Web in E-Learning (SW-EL@AH'06), in conjunction with AH. – 2006. – P. 55–64.

[9] N.W. Brickhouse. Teachers' beliefs about the nature of science and their relationship to classroom practice // Journal of Teacher Education. – 1990. – 41 (3). – P. 53–62.

[10] I.T. Koponen, T. Mäntylä., J. Lavonen. Challenges of Web-based Education in Physic Teachers' Training // Proceedings of ICTE. – 2002. – P. 291–295.

[11] The Protégé Project [Electronic resource] / Accessible at: http://protege.stanford.edu

[12] N.F. Noy, R.W. Fergerson, M.A. Musen. The Knowledge Model of Protégé-2000: Combining Interoperability and Flexibility // Proceedings of EKAW 2000, Lecture Notes in Artificial Intelligence, no. 1937. – Springer-Verlag, Berlin. – P. 17–32.

[13] N.F. Noy, M. Sintek, S. Decker, M. Crubézy, R.W. Fergerson, M.A. Musen. Creating Semantic Web Contents with Protégé-2000 // IEEE Intelligent Systems. – 2001. – 16 (2). – P. 60–71.

[14] G.Ya. Myakishev, B.B. Buchovcev, N.N. Sotskiy. Physics: Textbook for the 10 form of secondary school. – Prosveshenie, Moscow, 2002 (in Russian).

[15] A. Papadopoullos. Meaningful Search: Why PET Scanners are not about Cats & Dogs. – Convera, Carlsbad, CA, 2003.

[16] G. Booch. Object-Oriented Analysis and Design with Applications. Addison-Wesley Publishing Company, 1993.

Author's Information

Evgeny Eremin *– Perm State Pedagogical University; Russia, 614990, Perm, Sibirskaya str., 24; e-mail: eremin@pspu.ac.ru*

INNOVATION EDUCATIONAL PROGRAMME "MARINE ENGINEER"

Larisa Zainutdinova, Anatoly Korablin, Roman Lidgi Goryayev

Annotation: *The urgency of the problem of realizing the principles of open education for training engineers of marine specialities is shown. The innovation educational programme "Marine engineer" has been offered by the Marine technologies, power engineering and transport institute of Astrakhan State technical university [ASTU]. The structure of the Innovation educational center "Marine engineer" has been developed.*

Keywords*: open education, innovation programme, marine engineer, electronic training aids*

ACM Classification Keywords: *K.3.1 Computer Uses in Education.*

Introduction

After the USSR's break up the port-city Astrakhan situated not far from the border became the main Russia's sea gate at the Caspian sea. The conditions of Russia's participating in the Sea power community have changed, the geopolitical significance of the southern regions and sea ports in goods trans-shipment, especially oil has increased. New oil and gas companies came into the city. Opening up gaseous condensate field and the Caspian sea shelf change the Caspian region into one of the biggest centres of gas, oil and oil-products production, processing and transportation. ASTU achieved the status of a prestigious educational institution both in the country and abroad. It is considered to be one of the best educational institutions on fishing, marine and technical directions in the Russian Federation. Lately the university teaching staff have been developing fundamentally new trends connected with the rebirth of the native fishing production, navy and inland water transport, the perfection of their exploitation and increase of navigation safety, etc. On basis of these investigations the works connected with creating fundamentally new curriculum both for high schools and institutions of higher education appeared taking into account the fast evolutional process which will radically change the functional duties of senior and technical staff of enterprises and organizations in the nearest future.

Training specialists for fleets and enterprises connected with them in ASTU is conducted in accordance with the National educational standards, coordinated with the demands of the International convention about training and certificating sailors and keeping watch 78/95 (TCSKW 78/95) of the International marine organization (IMO). The university is a progressive institute of higher education realizing the intentional specialists training on the given direction.

In their graduation thesis students solve real problems of fishing, transport and port activity: the application of new technique and technology for opening up a new freight flow, developing traffic centers , creating ecologically clean fishing technologies, the questions of technical exploitation and so on.

Opening the international transport passage "North-South" in the Caspian basin will allow the Astrakhan region to get a strong impulse of developing which will broaden and improve such strategic communications as navigable, transport and railway ones. Moreover the Russian fleet ship staff has a great need for raising the level of their skills and receiving extra professional education.

The attraction of the university for investors and students is determined by a wide spectrum of activities:

- teaching activity;
- operational-technological and service activity;
- organizational and management activity;
- project-designing activity;
- production-technological activity;
- scientific-research activity.

A high level and a wide spectrum of the given services allow the university to remain the main strategic direction centre in the Astrakhan region, satisfying employers and partners' needs.

It is no secret that lately the demand for marine technical education has grown in foreign states which send their representatives to our university for a probation period and studying which points to the prestigiousness of ASTU education.

Foreign students come to our university not only to study but on excursions, to scientific conferences and friendly meetings as the university is famous for its social and cultural traditions. The International friendship club where national holidays are celebrated and the days of national culture are held is functioning. Astrakhan is a multinational city, where a tolerant attitude to the representatives of different nationalities has historically been formed.

Taking into account a great society's need in the system of the open i.e. continuous, flexible, distributed education the Marine technologies, power engineering and transport institute attached to Astrakhan State technical university has worked out the innovation educational programme "Marine engineer" for the further perspective development step.

Innovation Educational Programme "MARINE ENGINEER

The purpose of the innovation educational programme "MARINE ENGINEER" is: to increase the quality of education, to expand the spectrum of educational services (including the remote learning) and as a result to improve the situation on the labour market on the marine direction in the Russian Federation and first of all in the Southern Federal District. In prospect the exit to the international educational field is expected.

For realizing the programme the Innovative-educational centre "MARINE ENGINEER" was created. The centre structure is shown in figure 1.

Chief-coordinator of the Innovative-educational centre "MARINE ENGINEER" is director of the Marine technologies, power engineering and transport institute of Astrakhan State technical university.

Monitoring and analysis department provides collecting the information about educational services consumers, labour market demands, forms flexible work curriculum corresponding with National Educational Standard demands and individual trainee's requirements. Monitoring and analysis department plays a vital part in realizing Innovative-educational programme.

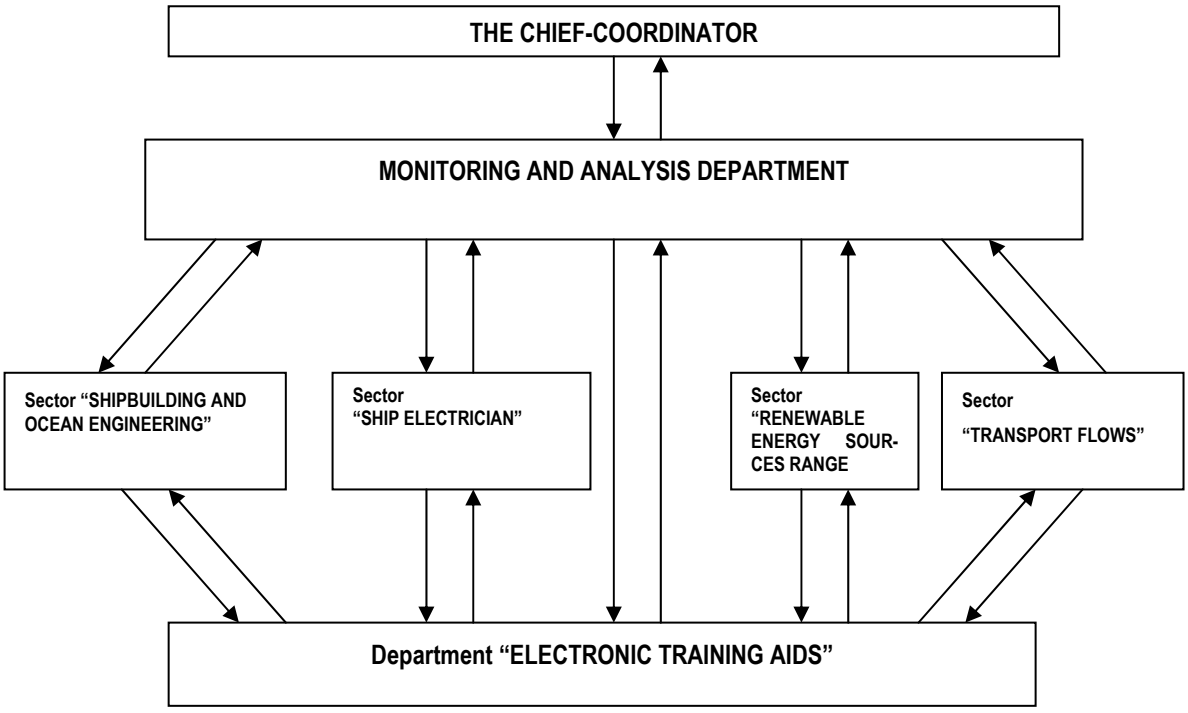

Fig.1. the Innovative-educational centre "MARINE ENGINEER" structure

Sector "SHIPBUILDING AND OCEAN ENGINEERING".

The following enterprises take part in the work of this department: "Shipbuilding and power marine technique complexes" chair, collectives of the adjacent chairs of the Marine technologies, power engineering and transport institute; Ltd company "Marine shipbuilding plant named after K. Marx", "Astrakhan shipbuilder", "Astramarin", "Shipbuilding plant named after Lenin", "Caspribkholodflot", "Physics institute DNC RAN" and others. The purposes of the sector in the educational activity and on the labour market is to increase the quality of training students and graduates who already have the industrial and scientific activity experience, on basis of which the growth of a great demand for specialists on the direction "Shipbuilding and ocean engineering" on the labour market in the Southern Federal District and over the Russian Federation by 25-30% on the whole and as a result of it the increase of entrants by 35-40% with the students screening reduction by 50-70% is expected.

Sector "SHIP ELECTRICIAN".

The sector functionates on basis of the chair "Electrical equipment and ship automation" which has close scientific connections with the Russian State oil and gas university named after I.M. Gubkin (Moscow), Moscow power Institute, Ufa State oil technical university. The chair has modern equipment and software of the company "SHNEIDER – ELECTRIC" – the biggest developer and supplier of the automation of energy objects and energy saving transmission engineering to the Russian market.

The biggest oil and gas industry enterprises functionate on the territory of the Astrakhan region. All of them are characterized by a high level of per capita power consumption and automation of industrial plants and technological complexes and are equipped by the most up-to-date electrical equipment, automation means and systems, the service of which requires highly qualified staff.

The prospects of the sector's "Ship electrician" work are connected with the growing necessity in electricians engineers, caused by the development of the shipbuilding and ship repairing complex in the region, a rapid growth of marine traffic across the transport passage "North-South" via the port "Olya". The demand for the specialists in the field of operational and after-sales service of electrical equipment and ship automation, electrical power audit and energy saving technologies is increased.

Sector "RENEWABLE ENERGY SOURCES RANGE"

The sector's work is provided by the collective of the "Heating engineering" chair which has a high scientific potential and close scientific connection with the Academy of Sciences of Russia.

Renewable energy sources range (RES) is created on the territory of ASTU and on the territory of the vegetable-growing and melon-growing Scientific-research institute, Kamyzyak town. Teaching-commercial demonstrational range of renewable energy sources and installations on their basis will allow:

- To propagandize the possibilities of using renewable energy sources in the region.
- To use RES in the heat- and power supply of the objects near the Range in Kamyzyak town (vegetable-growing and melon-growing Scientific-research institute) and in Astrakhan (ASTU) for the elimination of energy shortage and the particular tariffs reduction.
- To provide the possibility of conducting scientific research on the optimization of the operating mode of the solar, wind and heat plump plants in the region's conditions.
- To work out the modernization activities for increasing the efficiency of the RES power plants.
- To provide the holding of the seminars and training activities for the region's power engineering specialists.
- To intensify the practical training of the students of heat-and-power engineering and electric power specialities on using RES in the regional power engineering.

Sector "TRANSPORT FLOWS"

The sector functionates on the basis of the chairs "Organization and safety of traffic" and "Water transport exploitation". The subjects of the sector are:

- the effective use of the material, financial and people resources;
- providing the safety of traffic in different conditions;
- working out the effective schemes of organizing the transport means movement;
- the analysis of the production-economic activity of the region's transport enterprises;
- modeling processes of functioning the transport-technological systems and regions transport flaws;
- forecasting the development of the regional transport systems;

- developing the generalized variants of solving the region's transport problem;
- working out the measures on improving control systems on transport.

Department "ELECTRONIC TRAINING AIDS"

The department "Electronic training aids" provides the development and application of electronic training aids within the limits of the innovation educational programme "MARINE ENGINEER".

The work of this department is based on the progress of the scientific school of doctor of pedagogical science, professor Zainutdinova L.H. The main direction of the scientific research is the methodology of creating and applying electronic training aids in the field of technical disciplines. The postgraduate course on speciality 13.00.02 – The theory and principles of education and training (technical disciplines, higher education level) is opened. The specialists on developing electronic training aids are trained there. We take part in the Complex programme of the Russian Academy of Sciences "Information and communication technologies in the continual education system". There are scientific connections with the leading national institutes of higher education, among which one can find: Moscow power institute, Moscow institute of mines, Moscow steel and alloy institute, Ufa aviation technical institute and many other institutes of higher education.

Scientific connections with the following foreign educational and training institutions: the Higher technical school Konstants city (Germany), FOI Institute of Information Theories and Applications (Bulgaria), Mount Wachusett Community College have been established.

The experience of organizing a number of international scientific-methodic conferences devoted to the application of information technologies to electrotechnical education has been accumulated. The conferences were held in 1992, 1993, 1995, 1998, 2000, 2003, 2006.

The created electronic training aids are developed taking into account pedagogical, psychological and ergonomic requirements. A sufficiently high level of the developments is verified by the stamps of the Scientific guidance board on the discipline "Electrical engineering and electronics" of the Education Ministry of the Russian Federation.

Structural ties

Both feedforward and feedback ties between the separate structural subdivisions in the Innovation educational centre "MARINE ENGINEER" structure shown in figure 1 are represented. On solving innovation tasks in conditions of the influence of many factors it is impossible to do without feedback. The feedback allows to fulfill the interactive process of the structural subdivisions for the purpose of making the optimal educational programme for the certain groups of students.

Conclusion

The Innovation educational programme "Marine engineer" providing the possibility of realizing the open education principles has been offered. The Innovation educational centre "MARINE ENGINEER" structure has been worked out.

Working out new training aids (mainly electronic) for the most suitable perception and learning the teaching material, the possibilities of the remote education in the virtual sphere; the application of educational technologies, providing the combination of theoretical and practical engineering training in conditions of modern productions; the formation of skills and abilities by means of off-centre approaches to organize independent students' work - all this is supposed to contribute to increasing the quality of training different categories of trainees.

The realization of the Innovation educational programme "Marine engineer" will give an opportunity of the systematic change from the extensive principle of training specialists toward the intensive, modern and perspective principle which is based on the development of the intellectual constituent in all the education system and the combination of the new training methods with the industrial, planning-designed and scientific research work.

The realization of the Innovation educational programme "Marine engineer" will assist in solving the problem of the continual, flexible, distributed education.

Authors' Information

Zaynutdinova Larisa Hasanovna *- Astrakhan State technical university, chief of the Eelectrical engineering chair, the doctor of pedagogical science, professor; Russia, 414025, Astrakhan, Tatischev street, 16; E-mail: lzain@mail.ru*

Korablin Anatoly Viktorovich *- Astrakhan State technical university, director of the Marine technologies power and transport Institute, candidate of technical science, the associate professor; Russia, 414025, Astrakhan, Tatischev street, 16; E-mail: imtet@astu.org*

Lidgi Goryayev Roman Anatolievich *- Astrakhan State technical university, director's substitute of the Marine technologies power and transport Institute, candidate of technical science, Russia, 414025, Astrakhan, Tatischev street, 16; E-mail: Lidgi-Goryaev@rambler.ru.*

THE METHODS OF CONDUCTING STUDIES WITH THE APPLICATION OF COMBINED DIDACTIC INTERACTIVE PROGRAMME SYSTEMS

Maxim Polskiy

Abstract: *The methods of the application of the Combined didactic interactive programme system on electrical engineering disciplines has been worked out and the possibility of its application for providing a complex of different kinds of studies: lectures, tutorials, laboratory studies and also for organizing students' independent work has been verified. The given methods provide the organization of the reproductive (recognition and reproduction) and productive heuristic educational-cognitive students' activity in conditions of gradualness and completeness of education with the closed directed automatic control.*

Keywords: *lecture, tutorial, independent students' work, combined didactic interactive programme system, reproductive and productive educational-cognitive activity.*

ACM Classification Keywords*: K.3.1 Computer Uses in Education, J.2 Physical Sciences and Engineering.*

Introduction

The problem of the rational use of information technologies in the educational process is the most important in pedagogics nowadays. The complex use of such means for methodical provision of different kinds of studies in the widest aspect is proved by I.V. Roberts' [Роберт, 1994], studies, and for the field of general technical disciplines – by the works of S.V. Panyukova [Панюкова, 1998] and L.H. Zainutdinova [Зайнутдинова, 1999].

The Combined didactic interactive programme system (CDIPS) being used for conducting lectures, tutorials, laboratory studies and students' independent work (SIW) is developed at the Electrical engineering chair of Astrakhan State technical university. CDIPS provides the closed directed automatic control both for the reproductive and productive heuristic educational-cognitive students' activity.

Let us examine the methods of the application of this system on electrical engineering disciplines for organizing and conducting different kinds of activities

Lectures

According to the traditional training technology in an institution of higher education lectures are considered to be the main and the most important kind of studies and lecturing is committed to the most erudite and experienced teachers. The lecture contains a great volume of a new teaching material given to students. However a teacher with such kind of studies "uses the unfastened control in the scattered information process" [Беспалько, 2002, с. 181]. As a result of it the lecture can not pretend to providing a high-quality learning of the educational-cognitive activity by students.

Meanwhile according to V.P. Bespalko this form of training is suitable for creating the initial orientation in the studied discipline. Learning the educational-cognitive activity in such cases is corresponding to the first level (recognition). Therefore, a traditional lecture must be used by teachers at the initial stages of training.

Nowadays many institutes of higher education have specially equipped lecture halls, giving the opportunity of modern computer support of this kind of studies. In the works [Казаков и др., 1995; Задорожный, 1997; Зайнутдинова, 1999] the experience of organizing lectures in the room equipped with a multimedia-projector is viewed. The activation of students' attention at the expense of showing colourful, visual and moving pictures on the screen is stressed.

Astrakhan State technical university (ASTU) has also special lecture-halls equipped with multimedia projectors, where lectures are held. Many teachers prepare interactive presentations more often designed with the help of PowerPoint application. Created within the limits of the present research the CDIPS on electrical engineering disciplines are applied by us at the lectures in the lecture-halls equipped with multimedia projectors.

Conducting lectures with the help of the CDIPS intensifies the role of the didactic education visualness principle. At the same time besides the illustrative function, computer graphics, guaranteeing the recognizability of the represented objects we also took into consideration its cognitive functions, enabling to use one of the most important cognitive mechanisms of man's thought – the ability to think by means of complicated spatial images. This approach has a vital importance for electrical engineering disciplines as we speak about expounding abstract teaching material of a high complexity level.

Our experience shows the following advantages of CDIPS during lecturing:

-the extension of teaching information capacity;

-the enlargement of using visual means;

-the possibility of the virtual laboratory experiments demonstration.

Let us emphasize again that the lecture does not guarantee students a high level of learning educational-cognitive activity. In connection with this we view these studies as a means of initial orientation organization during learning one or another topic of the disciplines of electrical engineering cycle. Within the limits of lectures CDIPS is used by us at the initial stages of training.

Tutorials

During tutorials there is a considerable increasing of activity of educational-cognitive students' activity. Let us examine the methods of conducting tutorials with the use of CDIPS shown in figure 1.

Tutorials are conducted in the university display rooms. At the same time it is necessary for every student to work at a computer individually. As a rule it is reached at the expense of conducting studies in subgroups (12-15 people).

Let us examine the methods of conducting tutorials by the example of the CDIPS "Quadripoles". The contents include the following topics:

1. The quadripole definition.
2. The quadripole equations.
3. The experimental definition of A-parametres.
4. Quadripole equivalent schemes.
5. Quadripole combinations.
6. Quadripole transfer function.

After triggering CDIPS "Quadripoles" the title-page on which one can see two buttons "topic choice" and "the information about the programme" appears on the screen. After pressing the button "topic choice" a student gets an opportunity to pass on to one or another topic of the studied section "Quadripoles".

According to the offered methods of conducting a lesson (fig.1) a teacher offers the students to review the theoretical material studied at the lecture, e.g. the topic "The quadripole equations". For several minutes the students briefly look through the contents of this topic (the main notions, methods and formulae, needed for task solving).

Having reviewed the necessary theoretical material, the students pass on to fulfilling a practical task, corresponding to the first level of learning the educational-cognitive activity (recognition). **The first level questions and tasks are the simplest. They can be regarded as an addition to reviewing theoretical**

material. The main purpose of the first level tasks is the recognition of the teaching material previously studied at the lecture by the students.

Every student is given an individual task consisting of 6 questions selected at random. Every question has several variants of answer, among which the only one is true. The interactive training dialogue script assumes an unambiguous reaction to every student's answer: the confirmation of the right action or giving out a tip in case of an error. However to get the lowest passing score (mark≥4) for the admission to the second level tasks is possible only if you answer all the questions properly mainly from the first effort and without any tips.

Let us remind that according to [Беспалько, 2002] the estimation of learning educational-cognitive activity must be realized with the help of learning coefficient Cl, evaluated by the ratio of the number of the essential operations properly done by the students "p" (the actions being done by the doer and leading to the achievement of activity purpose) to the total number of the essential operations "m" in the task: Cl =p/m. Here the condition of the completeness of training at one or another level conforms with the value Cl≥0,7. Within the limits of CDIPS the mark is given out according to five ball scale. It is connected with the fact that most students understand this very approach. Here the 4 ball mark conforms with the value of learning coefficient Cl ≈0,7. After the completion of doing the task the student is given a mark taking into account the total number of questions, the number of the right answers and the number of efforts to answer the same question. If the student gets a mark less than 4 balls (Cl≤0,7), then the teacher recommends him to review the theoretical material again and then to do this task once more time. In case when the mark is 4 balls and higher (Cl≥0,7), then the student passes on to doing the second complexity level practical task.

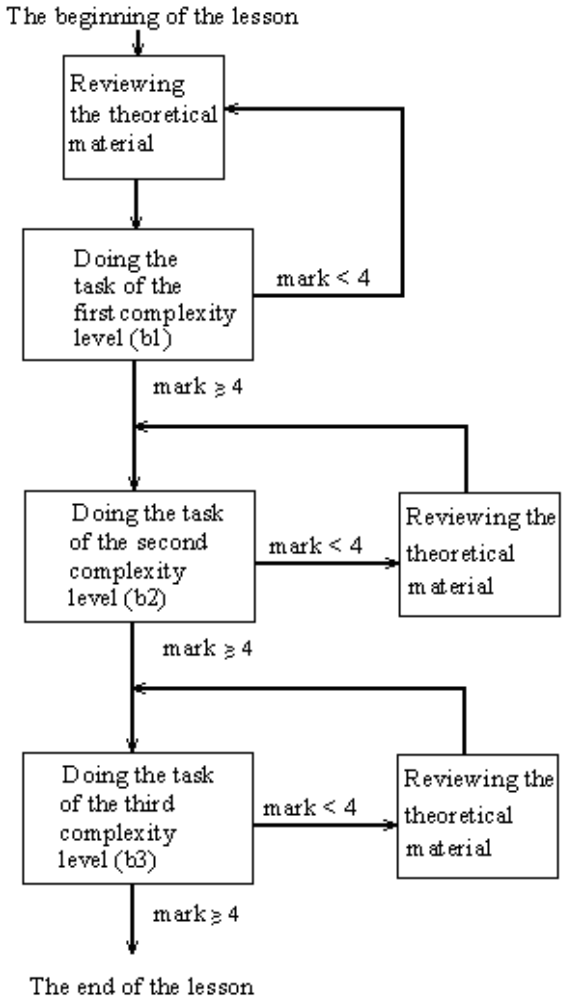

Figure. The methods of conducting a tutorial with the use of the combined didactic interactive programme system on electrical engineering disciplines

The form of the practical tasks organization viewed above and namely the choice of one of the answer variants yields in its pedagogical effectiveness to the traditional form of the teaching tasks organization in the course of electrical engineering disciplines. So, e.g. in the well-known electrical engineering tasks collections [Бессонов, 2000] or [Шебес, Каблукова, 1990] we find a great number of tasks worked out at a high methodical level, the solution of which assumes using these or those laws, methods or techniques and is accompanied by a considerable range of calculations. Most of these tasks from the work's [Беспалько, 2002], point of view can be divided into two groups:

- standard tasks, the conditions of which allow direct application of the learnt algorithms, rules or formulae for their solving;
- non-standard tasks, requiring from the student to use the earlier learnt knowledge in non-standard situations. Here the student transforms the initial conditions of the task in order to bring them to standard solution methods. Such an educational-cognitive activity is called heuristic.

At the tutorials within the limits of the CDIPS standard and non-standard tasks are provided by us. At that standard tasks are referred to the second complexity level in view of their corresponding to the second level of learning the educational-positive activity (algorithmic activity). According to the methods of conducting a tutorial (fig.1) the student may begin doing standard tasks after getting the lowest passing score at the first level.

The programme gives out every student an individual task (e.g., “Quadripole equivalent schemes”). The variance of the second level tasks is provided by the casual choice of electrical circuits and their parameters.

While the student is doing the second level complexity task **the interactive educational dialogue is accompanied by the functional inspection of all the student’s actions.** CDIPS controls every step of training and efficiently forms the specific corrective teaching effects (declarative feedback).

For securing his object the student follows the strictly established algorithm designed in the programme. Any opportunity of choosing any other way of solution is excluded. Thus thanks to the strictly established limits of the educational-cognitive activity the student learns the main algorithms and ways of solving standard tasks of electrical engineering disciplines.

After finishing the calculated task of the second complexity level with the mark less than 4 balls the student should review the theoretical material again and then do the task of this level one more time. In case of successful finishing this task (the mark is 4 balls and higher) the student may pass on to solving non-standard tasks.

Non-standard tasks are referred to the third level complexity tasks as they correspond to the third level of learning the educational-cognitive activity (heuristic activity).

The practical tasks of the heuristic level are provided in the CDIPS “Quadripoles” for the topic “Quadripole transfer function”. Here the student is given an opportunity of the independent choice of the electric circuit scheme for studying and optional specifying its parameters. The student may also choose the way of solving convenient for him. CDIPS doesn’t restrict the freedom of actions. The interactive training dialogue is accompanied by the more enlarged stage-by-stage control over the student’s actions.

The student inputs the intermediate results got by him during the task fulfillment into the special fields of the CDIPS where they are checked up. On basis of the intermediate results input by the student (if these results go into the admissible intervals) the graph of the frequency characteristics of the studied electrical circuit is being made in an automatic regime on the screen. In case of making errors one can see the departure of the received results from the reference valuations in the graph and correct his activity. Thus the student is given an opportunity to make conclusions about the appropriateness of the solving process individually by means of visualizing the discrepancy of the results input by him and reference valuations on the screen. In a certain sense the programme shows the student “in the implicit form” his possible mistakes **(visual-suggestive feedback).**

At the final stage the sample graph appears on the screen, the programme evaluates the departure of the results input by the student from the sample and gives him a final mark.

After the successful fulfilment of the third complexity level task by the students (the mark is 4 balls and higher) the training process within the limits of this topic can be found complete. Otherwise (the mark is less than 4 balls) the student is recommended to review the theoretical material once again and then to do the tasks of this level one more time.

Thus it is shown that the methods of conducting a tutorial (the scheme of which is shown in fig.1) with the use of the CDIPS on electrical engineering disciplines is worked out taking into account the conditions of graduality and completeness of training. The graduality means that no level of learning can be missed in course of training. In the process of task solving the student gradually pass from simple tasks to more difficult ones. The completeness means that at every level of learning educational-cognitive activity the mark must be not less than 4 balls.

It must be noted that the teacher’s role in organizing tutorials with the use of the CDIPS on electrical engineering disciplines is:

- to explain the volume and the contents of the studied topic, to pay attention to the notes, definitions, formulae and methods from the theory which can be useful in the process of task solving at the beginning of the lesson;
- to control the fulfilment of the conditions of gradualness and completeness of training during the lesson. The educational-cognitive students’ activity at the tutorial must take place according to the methods shown in fig.1;
- to give professional advise on the questions connected with the rules of the work with the programme during the lesson. The student’s attention must be concentrated mainly on the studied topic.

On the whole the teacher’s activity with using the CDIPS during the tutorials on electrical engineering disciplines becomes considerably easier. He does not have to form individual training tasks as they are automatically generated by the CDIPS. The teacher does not have to check up the students’ solutions. However the quality of checking made by the CDIPS appears to be much higher. No teacher can physically provide such degree of inspection, especially the check-up of numeric values.

Thus, the application of the CDIPS at tutorials provides:

- the opportunity of reviewing the theoretical material;
- giving out individual variants of the training tasks which are characterized by a high variance to the students during the lesson;
- students' fulfillment of practical tasks corresponding to the first, second and third levels of learning the educational-cognitive activity during the lesson in conditions of gradualness and completeness of training with the closed directed automatic control;
- the evaluation of the results of doing the training task;
- easing the teacher's role in controlling the training process;
- the colourfulness and visualness of presenting the teaching information on the screen.

Laboratory studies

The physical experiment is an essential part of the training process in teaching electrical engineering disciplines. When using a traditional technology of conducting laboratory studies the tasks are fulfilled on various laboratory stands and experimental installations, adjusted to the certain, narrow enough ranges of changing the controlled values.

The use of software and computers as "virtual laboratories" considerably extends the experiment abilities in comparison with the physical simulation and also sets free from considerable explicit costs for producing special models.

Nowadays lessons in many institutes of higher education are conducted with the use of electronic computers and special program packages such as Microcap, System View, Electronics Workbench and others.

The Electronics Workbench system is the most popular programme for modelling electrical circuits. It favourably differs from all the others by the simplicity of programming, the availability of usual measuring instruments models and a wide set of elements. Such a "virtual laboratory" allows realizing a natural sequence of making an experiment.

The electrical engineering chair of ASTU has a considerable experience in conducting laboratory studies and also term papers with the use of EWB on electrical engineering disciplines. The special methodical textbooks for conducting laboratory studies and term papers with the use of EWB on the discipline "Circuit theory principles" are published. The lack of feedback and accordingly the impossibility to realize the closed directed automatic control over the educational-cognitive students' activity should be referred to the disadvantages of the "virtual laboratory" on basis of Electronics Workbench.

The CDIPS offered in this research allows realizing feedback when making a virtual experiment and provides control.

The experience of conducting laboratory works within the limits of the CDIPS with using a virtual laboratory Electronics Workbench 5.12 allows emphasizing the following advantages in comparison with the traditional methods:

- providing the automatic closed directed control over the educational-cognitive students' activity:
- decreasing time spent by the students on doing all the tasks of laboratory work, which allows to pass a test in this work within one lesson;
- the opportunity for every pupil to conduct laboratory works individually, which assists in better understanding of the studied questions;
- easing the teacher's activity on managing the learning process during a laboratory lesson.

Inspite of the advantages enumerated above it should be noted that computer simulation can not in full measure change real physical experiments. Because of this very reason we combine the studies in real laboratories with attracting the "virtual laboratory" on basis of Electronics Workbench in approximately equal ratio.

Independent work

The new national educational standards on electrical engineering disciplines are characterized by decreasing the number of the office hours and increasing the requirements to students. This contradiction is compensated by giving considerable range of hours to the student's independent work (SIW). Because of this one of the main teacher's tasks is an effective organization of students' selftraining.

The electrical engineering chair of ASTU has a considerable experience of applying the didactic interactive programme systems in organizing students' selftraining. For the last 15 years the training-apparatus programmes, electronic and test systems have been applied in organizing SIW.

Since 2004 the CDPIS have been applied in organizing students' selftraining at the electrical engineering chair of ASTU. This means most of all meets the tasks of SIW: provides the familiarization with the theoretical material, practical tasks (of the first, second and third levels of learning the educational-cognitive activity), the functional and stage-by-stage inspection of the student's actions.

The main advantage of the CDIPS during the student's independent work with it is the organization of the interactive training dialogue. Doing some actions, solving some tasks a student gets the teaching system's reaction which evaluates the quality of his actions and gives out the corrective influences in case of making errors. In other words the CDIPS takes upon itself a part of teacher's management functions.

It must be noted that a student has no time limits and may work with the programme with the individual speed convenient for him. Moreover the choice of one or another complexity level can be made by the students independently. Such approach allows the student to make the self-appraisal of his knowledge level.

For organizing SIW with the use of the CDIPS the hours in the time-table of interchair use display rooms are reserved. Moreover many students do their independent work at home. From our point of view the use of the CDIPS within the open education is a perspective direction.

Conclusion

The Combined didactic interactive programme system worked out by the author is applied at the electrical engineering chair of Astrakhan State technical university for providing a complex of different kinds of studies: lectures, tutorials, laboratory studies and also for organizing students' independent work. The methods of applying CDIPS, providing the organization of the reproductive (recognition and reproduction) and productive heuristic educational-cognitive students' activity in conditions of gradualness and completeness of education with the closed directed automatic control.

Bibliography

[Беспалько, 2002] Беспалько В.П. Образование и обучение с участием компьютеров (педагогика третьего тысячелетия). – М.: Изд-во Московского психолого-социального института; Воронеж: Изд-во НПО МОДЭК, 2002. – 352 с.

[Бессонов, 1996] Бессонов Л.А. Теоретические основы электротехники. Электрические цепи: Учеб. для электротехн., энерг., приборостроит. спец. вузов – 9-е изд., перераб. и доп. – М.: Высш. шк., 1996. – 638 с.

[Зайнутдинова, 1999] Зайнутдинова Л.Х. Создание и применение электронных учебников (на примере общетехнических дисциплин): Моногр. – Астрахань: Изд-во «ЦНТЭП», 1999. – 364 с.

[Задорожный, 1997] Задорожный А.М. Развитие мультимедиа-центра Новосибирского государственного университета // Материалы Междунар. науч.-метод. конф. «Новые информационные технологии в университетском образовании». – Новосибирск: НИИ МИОО НГУ, 1997. – С. 33–35.

[Казаков и др., 1995] Казаков В.Г., Дорошкин А.А., Задорожный А.М., Князев Б.А. Лекционная мультимедиа-аудитория // Информатика и образование. – 1995. – № 4. – С. 105–110.

[Панюкова, 1998] Панюкова С.В. Информационные и коммуникационные технологии в личностно-ориентированном обучении. – М.: Изд-во ИОСО РАО, 1998. – 225 с.

[Роберт, 1994] Роберт И.В. Современные информационные технологии в образовании: дидактические проблемы; перспективы использования. – М.: Школа–Пресс, 1994. – 205 с.

[Талызина, 1984] Талызина Н.Ф. Управление процессом усвоения знаний. – М.: МГУ, 1984. – 344 с.

[Шебес, Каблукова, 1990] Шебес М.Р., Каблукова М.В. Задачник по теории электрических цепей. – М.: Высш. шк., 1990. – 544 с.

Authors' Information

Polskiy Maxim Aleksandrovich *– Astrakhan State technical university, the senior teacher of the electrical engineering chair, candidate of pedagogical science; Russia, 414025, Astrakhan, Tatischeva Street, 16; e mail: mpol@inbox.ru*

FUZZY MODEL OF THE AUTOMATED SYSTEM OF MODULE KNOWLEDGE CONTROL

Elena Prisyazhnyuk

Annotation: *The author analyzes some peculiarities of information perception and the problems of tests evaluation. A fuzzy model of tests evaluation as means of increasing the effectiveness of knowledge control is suggested.*

Keywords: *fuzzy sets, test*

Introduction

Changes in the sphere of education as a result of the integration of Ukraine in the Bologna process require full and comprehensive modernization of education on the basis of information teaching technologies. Practicing credit-module system of the learning process organization makes important working out effective means of students' knowledge control. The research analysis of this problem shows the tendency of enlarging tests usage as the instrument of the studied material quality evaluation. The main advantage of computer tests is the opportunity to ask all the students within the assignment in equal conditions and according to the equal grades scale. It increases the objectivity of knowledge control in comparison with the traditional methods.

Usage of computer technologies considerably decreases time of conducting control of knowledge quality in the academic discipline; teacher's engagement is decreased; the degree of objectiveness of knowledge evaluation is decreased; working with the testing program is a good training for studied material reviewing; on the basis of the testing results the teacher can analyze the learning process according to the definite topic and make the correction of the tempo, accents and methods of teaching.

On the other hand the traditional tests application is supposed to choose the answers (and their evaluation correspondingly) on the basis of two-positional logic. It is supposed to use them adequately only in terms of strictly formally asked questions. It leads to absolutely simple questions formulations which "lie on the surface". At the same time knowledge appropriation includes not only (and not so much) memorizing a priori veritable facts but the capability to understanding general phenomena, tendencies [Мелецинек А., 1998]. To control this knowledge "indirect" questions are more effective. Such questions formulation (and, correspondingly, the answer variants) is supposed to have less formal semantics [Нариньяни, 1994]. From the other side such questions cause the problems of simple answers evaluation. Application of verbal scales for the evaluation {false, not quite right, almost right, true} and mechanism of fuzzy logics seems more proved.

Fuzzy model of the automated system of module students knowledge control in the discipline "Informatics" for pedagogical major "Mathematics and informatics" is described.

Some questions of the effectiveness of testing conducting

The effectiveness of testing conducting depends first of all on such factors as:

- individual perception and, accordingly, tests understandings;
- objective analysis of the data base and completing results analysis according to the methods used.

The peculiarities of perception are studied in particular by informational psychology: the models of conscious processing of information by a person are described and analyzed. Technical characteristics of perception, schemes of information processing by a person are used. Let's discuss some perception characteristics which should be taken into account while formulating tests questions.

The first advantage of knowledge control conducted in written form is: power of man's perceptional optical channel is one step higher than of acoustical. According to the research given in [Мелецинек А., 1998] the power of optical channel is about 107 byte/sec, the power of acoustical 106 byte/sec. So the information perception in a visible form (written form, in a type of a picture) promotes perception speed and, consequently, its comprehension.

The second advantage deals with the psycho-physiological characteristics of people who take tests. As we eliminate the teacher's direct participation in testing we eliminate the opportunity of "psychological pressure",

teacher's preconceived attitude. On the other hand, some students will feel more comfortable in the situation of module control without a teacher. Let's see the example: if they experience inner disturbance which increases while communicating with a real examiner; in case of a permanent conflict with a teacher, etc.

The choice of the tests questions length should be done taking into account the capability of their processing by a tested person. It is connected with the power of the apperception process (transmission of semantic irritation into short-term memory), in other words, with «comprehension of information». In [Мелецинек А., 1998] they give the apperception speed about 16 bite/sec and time of information awareness in short-term memory approximately 10 seconds. It means that the formulation of the question must not be too long. Simple calculations show – not more than 160 bites (it is, approximately, a sentence with 14-16 words).

Selecting tests questions it is necessary to take into account their motivation and natural forgetting processes. It means delivering from the excessive details of the material. As information is memorized much better when it possesses more sense and is structuralized [Мелецинек А., 1998], it is necessary to clear up not separate facts and fundamental details but typical structures of the material in maximum logical semantic interconnections. The situational test questions are more appropriate in these situations, i.e. a problem situation is set and you are suggested to choose the optimum way out strategy.

The question of motivation in teaching and, in particular, in testing is pretty problematic and deals with the personal interest and success expectation. Among the situational motivational factors the probability of success and attractive value of the task are especially important. In [Мелецинек А., 1998] such approach is suggested according to which motivation of result can be the highest with the average level of the task difficulty, i.e., when probability of success achieves 50%. Motivation of result stimulates especially effectively in such task and problem setting when it is possible both to solve and not to solve them. In testing it is necessary to choose the questions of average level of complication coming from the evaluation of students' knowledge level.

The effectiveness of students' perception in testing depends also on their maximum concentration at this time. It depends indirectly on the physiological state of a person at this moment: ability to work, fatigability, etc. Person's fatiguability is subjected to changes during a day. In [Мелецинек А., 1998] they give the scheme of changes of organism physiological readiness (in percents) to activity during 24 hours. «Tops» of physiological activity during a working day are on the time interval from 8 to 12 hours. A substantial «decline» of working activity during a day (except of natural «falling out» from 21 to 23 hours and at a night-time) is from 14 to 16 hours. Taking into account these factors control means, testing in particular, should be organized if possible, in the period of concentrated attention. It is a period when the concentration of the students is maximal.

Fuzzy model of results evaluation

The other important element of the effective testing is an objective analysis of the data base. In the basis of it there is the certain model of results evaluation. The traditional system of evaluation within the framework of two-positional logic suggests a choice on every question of the only right answer from the offered list. As a result of accumulation points on every correct answer they make identification of the points amount with the appropriate range and summarizing the total for testing. The procedure is easily formalized and programmed.

But the basic question of the similar testing is a problem of questions (tasks, situations) selection with the only right answer. What type of students' knowledge is presented as a result of such testing? How is it possible to formulate the questions of «average level of difficulty» in such conditions?

Application of fuzzy model of testing results evaluation allows to put questions and situations more flexibly. It motivates students not to reproduce separately memorized facts but to be able to solve the problem. They demonstrate not only "declarative" knowledge, knowledge "on the surface" but the understanding of the situation, its processes and structure.

Let X^i be a set of the answers to i-question presented in the test, i є {1…n}, x^i - variant of the answer to i-question, $x^i \in X^i$. A^i - fuzzy set of «correct answers» to the first question. The list of answers on every question is analyzed on its belonging to the fuzzy set A^i and is accordingly evaluated by the function of belonging

$$\mu_{A^i}(x^i) \quad , \quad \mu_{A^i}(x^i) \in [0,1] \quad , \quad x^i \in X^i \quad . \tag{1}$$

During testing not the points but functions of belonging are accumulated and general fuzzy grade A of "the correct answers" on the set of answers X appears as distinct combination of fuzzy sets A^i with such kind of the function of belonging:

$$\mu_A(x) = \sum_{i=1}^{n} \mu_{A^i}(x^i) \quad . \tag{2}$$

Additionally evaluating questions it is possible to take into account their importance coefficients that reflect their contribution degree into general grade. Thus they can differentiate the questions levels of «complexity». Then (2) will be presented as:

$$\mu_A(x) = \sum_{i=1}^{n} \lambda^i \mu_{A^i}(x^i) \quad , \quad \lambda^i > 0 \quad , \quad \sum_{i=1}^{n} \lambda^i = 1 \quad , \tag{3}$$

where λ^i - coefficient of importance of the first test question.

After giving fuzzy grade on formulas (2), (3) the traditional procedure of comparison of general grade with an appropriate range and putting a general grade for testing takes place.

Thus, fuzzy model of evaluation (1) - (3) includes not only the traditional procedure of ranges agreement in which the integrated testing evaluation with a general grade in testing in 5 or 7 points scale ECTS is suggested, but the set of expert procedures for determination (1) on every test question.

For integration of expert evaluation one of procedures discussed in work [Voloshin, 2003] determining a group evaluation as «fuzzy function of belonging» can be applied:

$$\mu^{*(\min)}{}_{A^i}(x^i) = \sum_{j=1}^{m} \alpha_j \, \mu^{(\min)}{}_{A^i}(x^i_j)/m \quad , \quad \mu^{*(\max)}{}_{A^i}(x^i) = \sum_{j=1}^{m} \alpha_j \, \mu^{(\max)}{}_{A^i}(x^i_j)/m \quad , \tag{4}$$

where m is a number of participants of examination, a_j is a coefficient of j-expert's competence.

After defining the fuzzy function of belonging as a resulting interval $[\mu^{*(\min)}{}_A(x_i), \mu^{*(\max)}{}_A(x_i)]$ on each variant of the question a set (4) is presented to a person who makes decisions (to the teacher who conducts testing) for a final choice (scalarization of fuzzy function of belonging into discrete).

After conducting expert procedures (1) - (4) the procedure of testing conducting and evaluating can be programmed in the appropriate automated system of module knowledge control.

Architecture of the system of module knowledge control

Architecturally the system of module knowledge control consists of a few interrelated subsystems (SS).

SS of adjusting system work is intended for:

- system preparations for the concrete group of participants (creation of the folder and the file which identify a participant);
- Adjusting to participants' network or autonomous work.

SS of data introduction provides:

- installation and saving information about the participants of module control;
- the user's choice of the answer variant to the test questions in the dialogical mode;
- returning to the previous dialogical box with the opportunity of answer's editing.

SS of verification and analysis is intended for:

- formalization of the procedure of putting grades that allows to promote the process objectivity of module control conducting.

Service SS includes:

- making report on results of testing verification and presenting it to the student;
- presenting information about the criteria of work evaluation to the student.

Conclusions

Fuzzy model of the system of module knowledge control allows to conduct testing taking into account some factors described in engineering pedagogics [Мелецинек And., 1998], as factors which make the process of knowledge control more effective. Fuzzy grades application gives an opportunity to use "indirect" situational questions in the tests. It allows evaluating students' knowledge level more precisely and more objectively.

Bibliography

[Мелецинек А., 1998] Мелецинек А. Инженерная педагогика. – М.: МАДИ, 1998. – 185 с.

[Нариньяни, 1994] Нариньяни А.С. Неточность как Не-фактор. Попытка доформального анализа. – Москва-Новосибирск, 1994 г. Препринт РосНИИ ИИ, № 2. – 34 с.

[Voloshin, 2003] Voloshin O.F., Gnatienko G.N., Drobot E.V. Fuzzy membership function in a fuzzy decision making problem // International Journal Information theories & applications. – Vol. 10, № 3, 2003. – P. 243-247.

Authors' Information

Elena Prisyazhnyuk - *Kirovohrad pedagogical university named after V.Vinnichenko, PhD, associate professor; Kirovohrad, Ukraine, e-mail: elena_drobot@ukr.net*

PECULIARITIES OF THE ELECTRONIC EDUCATIONAL AND METHODOLOGICAL COMPLEX UNDER THE POINT-RATING TECHNOLOGY

Olga Lyubova, Natalia Luybova

Abstract*: At present in the sphere of electronic learning in the light of solving tasks put by the Bologna Declaration an important place is being taken by electronic educational and methodological complexes (EMC).The authors have put forward new components of EMC necessary for the organization of educational process and for the determination of labour intensity according to modules and students' activity type. They also suggested a technology of defining the rating of the grade in the credit-module system.*

Keywords*: electronic educational and methodological complex, electrical engineering and electronics, point-rating technology and credit-module system*

Introduction

Electronic teaching today is an essential component in the organization of the study process. There are known electronic textbooks and multimedia author's courses [Zainutdinova, 1999], network courses on particular disciplines [Lyubova, 2004], virtual laboratories and electronic tests, electronic educational and methodological complexes (EMC), which start to be especially interesting after Russia's joining the Bologna process.

Main part

Tasks, set by the Bologna declaration, oriented on the unified educational space and creation of possibilities for flexible educational paths require new principles of the study process organization, its global computerization, starting from the formation of individual study plans. The key moment in the unified educational environment is the modularity of a curriculum and point-rating technology (PRT) of knowledge assessment comparable in different educational environments.

Elaboration of PRT principles at the example of generally professional discipline "Electrical engineering and electronics", as well as alterations connected with the introduction of this technology into a study process, have become the main task of the authors.

The basis of study process organization on curriculum disciplines is EMC, the components of which must be as follows:

- Working program;
- Course of lectures;
- Laboratory- based practical classes;
- Autonomous work;
- Tests for self-check;
- Literature;
- Glossary.

In the point-rating technology all EMC components must be oriented on modules of different types and levels. For the generally professional discipline it means the main and supportive module types of the basic and advanced level.

The basis of a new EMC must be represented by a module program which embodies the system of knowledge rating determination. With this end in view there is suggested a correspondence table of labour intensity in mastering the discipline main modules (in hours) and of points amount based on 100 points rating system (table1).

Table 1

Correspondence of labour intensity, credits and points amount based on modules and activity types.

№	Module name	Labour intensity, hours/credit units/points	Activity types, hours/points		
			Lectures	LPC	AW (training, CGW, CP,etc)
1	Basic concepts. Course structure. Analysis and calculation of electric circuits	36 1,0 22	8 4	11 5,5	8 CGW – 15 12,5
2	Three-phase circuits. Basic connections «Y» and «Δ»	36 1,0 8	6 3	10 5,0	8
3	Analysis and calculation of magnetic circuits. Transformers.	36 1,0 24	6 3	12 6,0	8 CP – 30 15
4	Kinds of electrical machines, their operating parameters and performance figures	36 1,0 9	8 4	10 5,0	8
5	Bases of electronics	26 0,72 7	6 3	8 4	8
	Total	170 / 4,72 70	34 17	51 25,5	40 45 27,5

Table 2

Correspondence of rating points to letter and number grades

Points	Letter Grades		Number grade
	USA	EU	Russia
96–100 91–95	A A–	A (exceptional)	5
88–90 84–87 81–83	B+ B B–	B (very good) C (good)	4
78–80 **74–77** 71–73	C+ C C–		
68–70 64–67 61–63	D+ D D–	D (satisfactorily) E (fair)	3
0–60	F	F	2; 1

According to the specialists' recommendations 30 points out of 100 points should be referred to a complex test or examination (in the traditional system), in that case students' current activity types will be assessed as 70 points. At the same time, it is recommended to assess the availability of lectures and their attendance as well as other

types of students' activities as 1 point for 2 hours. Attention should be paid to the correspondence of point-rating technology to other systems of assessing students' activity results (table 2).

In the context of the credit-module system "Labour intensity" column in table 1 is of interest – in terms of its correspondence to credit units or credits on the whole for a discipline according to a curriculum and singled out modules. One credit unit is assumed to be equal to 36 academic hours: 1 credit = credit unit = 36 hours.

Conclusion

Complex test as a new component of EMC requires further elaboration to comply with the level of achieving different competences.

Bibliography

[Zainutdinova, 1999] Zainutdinova L.Kh. Elaboration and application of electronic textbooks. – Astrakhan': Printing House «CNTEP», 1999. – 363 pp.

[Lyubova, 2004] Lyubova O.A., Konovalova E.A. E-learning system WebCT // Application of new technologies in education: Selected papers of the XVth International conference – Troitsk, 2004. – pp. 103–105.

Authors' Information

Lyubova Olga Alexandrovna *– Arkhangelsk state technical university, deputy director of Information Technology Institute, candidate of technical science, associate professor; 17, Severnaya Dvina Emb., Arkhangelsk, 163002, Russia: vlubov@atknet.ru, iit@agtu.ru.*

Lyubova Nataliya Viktorovna *– European consulting centre, IT-administrator; 11-45, Sovetskaya street, Arkhangelsk, 163020, Russia; e-mail: Natalia.Lyubova@fc.folkuniversity.ru*

THE EXPERIENCE SOFTWARE-BASED DESIGN OF VIRTUAL MEDICAL INTRASCOPY SYSTEMS FOR SIMULATION STUDY

Oleg Avrunin, Liliya Aver'yanova, Valery Golovenko, Olga Sklyar

Abstract*: The questions of software-based design of "virtual" technical systems are considered as facility of imitation experiment for educational purposes. These virtual systems are usable for analysis of medical intrascopy systems functioning. The virtual educational technical systems allow guarantee the goodness technical training of bioengineers.*

Keywords*: medical intrascopy systems, virtual technical systems, imitation experiment.*

ACM Classification Keywords*: K.3.2 Computer and Information Science Education — e-Learning Systems*

Introduction

Medical intrascopy systems are up-to-day technical systems, which allow get information about internal structure of human body. Principles of organization and functioning of this equipment are the barest necessity for biomedical engineers. These systems based at high technology of physics, electronics, applied mathematics and computer science. Moreover, these systems are unique, expensive and require radiation safety therefore engineer's training requires tentative explanation of principal modes of operation at simple virtual analogs. As virtual analog e-learning means can be used, because kernel of any intrascopy system is computer. The main difference between e-learning means and real technical system is availability of detector. E-learning means have the virtual detector of certain type. The type of virtual detector is determined by physical phenomena (ultrasound, x-ray etc). On conditions that virtual detector is adequate, then virtual intrascopy system' rest parts are similar to real system. The degree of virtual intrascopy system' adequacy depends on selection of presentation medium and software environment.

Objective

The aim is working up block diagrams of virtual intrascopy systems and their computer-based realization as trial learning software.

Materials and methods

The simulation of bio-object structure allowed creation the object phantom. Also the virtual emissive source built up. The virtual source simulates the main physical properties and technical characteristics of some real emissive sources. The simulation of phantom and virtual source interaction was used for creation virtual detector. The synthesis of block diagrams was realized for different e-learning virtual intrascopy systems. E-learning virtual intrascopy systems created as computer systems. The software environment Borland Delphi 6 and API OpenGL used for creation of special-purpose software. This software is created as simplified analogue of application programs which realize adjustment, data processing and visualization at real intrascopy systems.

Design projects and main results

The virtual intrascopy systems are software, which allow have relative structure of the technical system and investigate the process in this system. These virtual systems allow imitation experiments. Such experiments are used for learning: sequence of operations, instrument settings, parameters of malfunction. There was analyzed, that next consecution of actions was common for all virtual intrascopy systems:

- forming of source;
- source - bio-object interaction;
- detection the result of interaction;
- images' reconstruction and visualization.

In compliance with foregoing there were created: virtual ultrasound system, virtual X-ray computer tomography (CT), virtual radioisotope system.

The virtual ultrasound system. This system is destined for imitation of functioning of ultrasound scanner at A- and B- modes. The block diagram of this system is shown at fig.1.

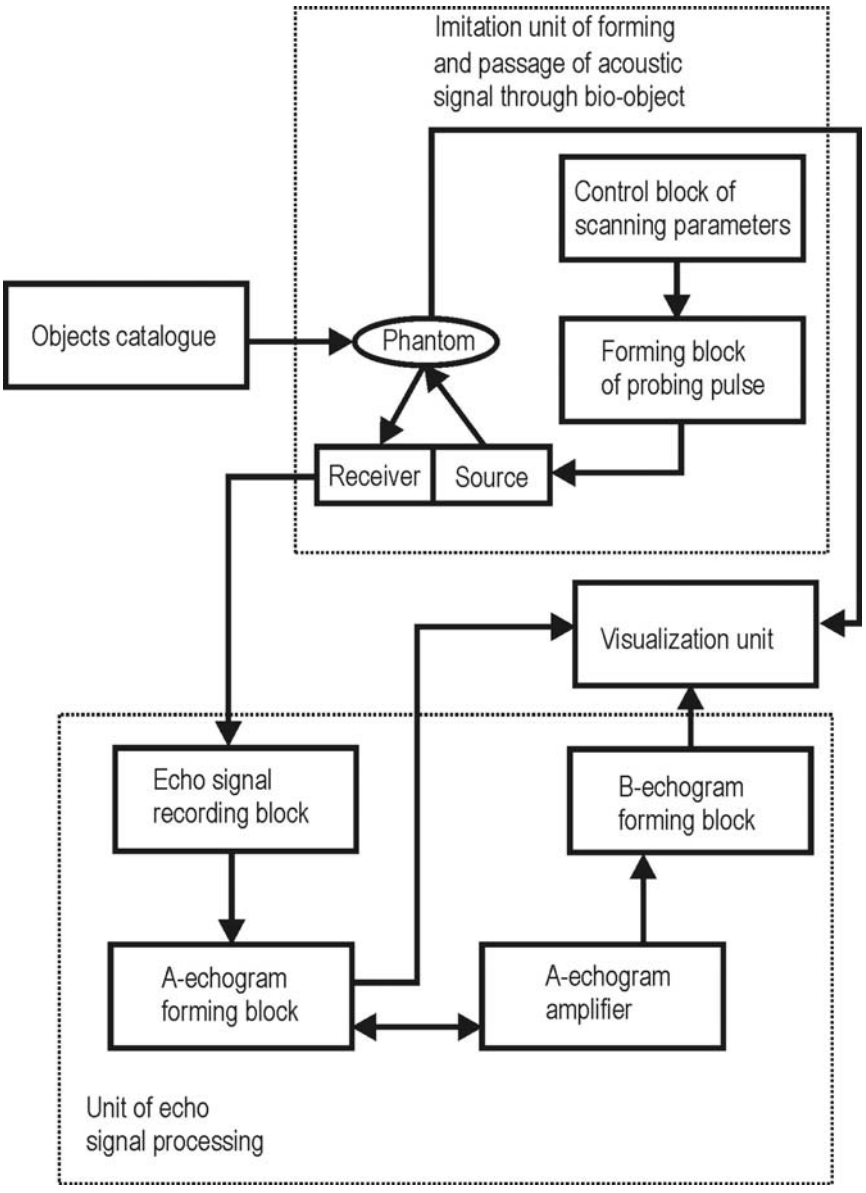

Fig. 1 The block diagram of virtual US-scanner

Objects catalogue. There are the graphic files of phantom slices. The phantom simulates heterogeneous object, where tissues of object have different acoustic impedance. One presented by gray scale.

Imitation unit of forming and passage of acoustic signal through bio-object. As the virtual source and receiver the linear 1D acoustic grid is used. The dimension of grid element is variable. This unit allows imitate process of acoustic radiation, passage and reflection of one with following detection of reflected acoustic ray. The forming part of this unit allows operate by probing pulse interval and periodicity.

Unit of echo signal processing. There are following parts of this unit: echo signal recording block, A-echogram forming block, A-echogram amplifier, B-echogram forming block.

Visualization unit. This unit allows visualize A- and B-echograms as at real US-scanner. Moreover virtual US-scanner allows show imitated real-time process (fig. 2).

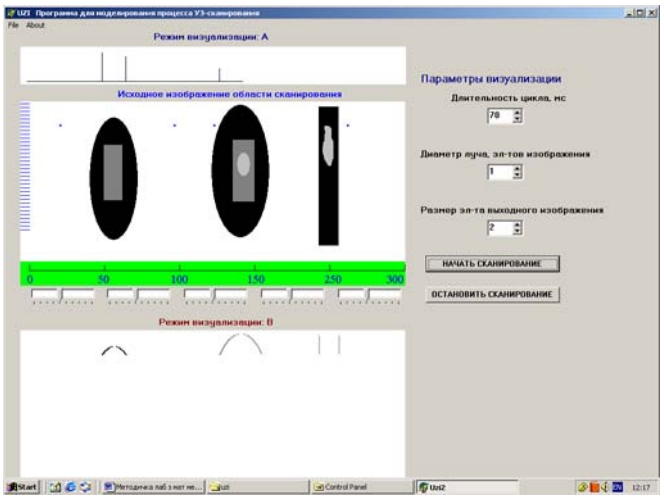

Fig. 2 The visualization of adjustment, scanning and image construction by virtual US-scanner

The virtual CT. This system is destined for imitation of functioning CT of different generations (fig.3).

The software of virtual CT is imitated getting of ray sums' array for one section (slice) of the phantom and reconstruction of section' image by method of reciprocal projection. The block diagram of the virtual CT system is shown at fig. 4.

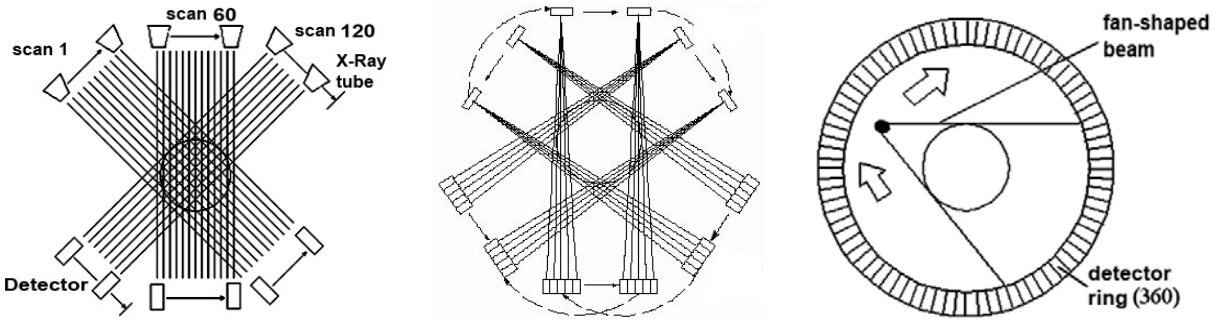

Fig.3 Tomographic scanner variants according to CT generation

Objects catalogue. There are the graphic files of phantom slices. The phantom simulates heterogeneous object with different density of tissues. One presented by gray scale as at X-ray image.

Imitation unit of forming and passage of X-ray through bio-object. The forming X-ray block is used as the virtual X-ray source. The kinds of X-ray source (single or fan beam) and detector (single or detector matrix) are selected in accordance with CT generations (block of selection of scanning system' model). The control block of scanning parameters allows adjust the scanning step and range (angle of system' rotation, step of X-ray tube-sensor system displacement). The forming block of operative co-ordinates area allows imitate reference of coordinates space to the object.

Unit of X-ray signal processing. There are following parts of this unit: the forming block of radiation sum, the forming block of array of radiation sum values, image reconstruction block (the back projection method), image post-processing block (low-frequency filtering and threshold processing).

Visualization unit. This unit allows visualize X-ray passage through the object and result of image reconstruction and post-processing (fig.5).

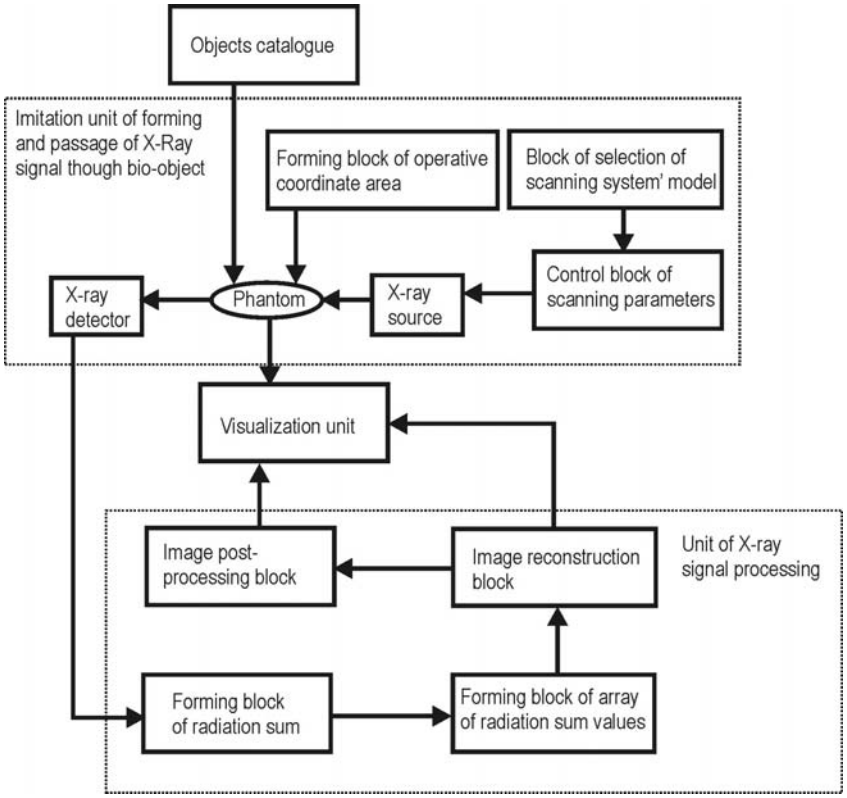

Fig. 4 The block diagram of virtual CT

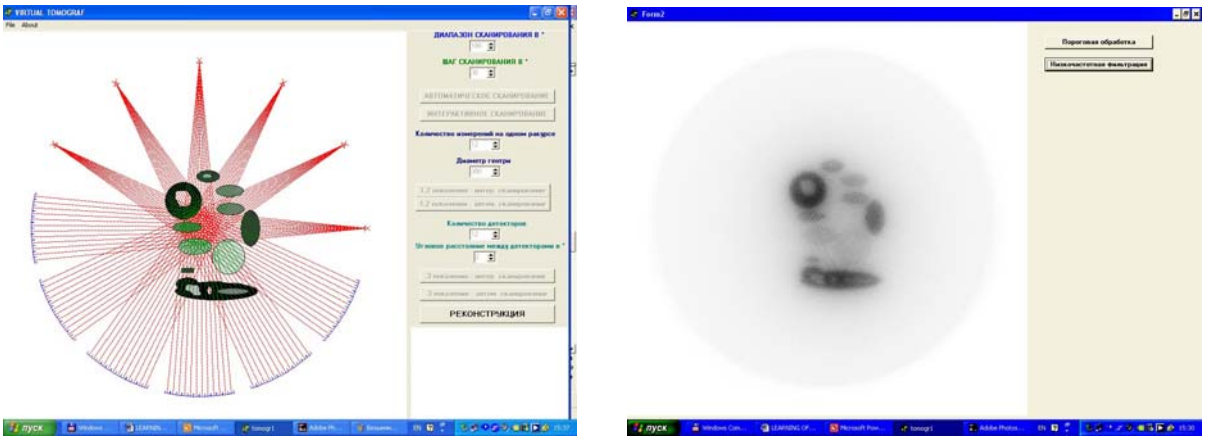

Fig.5 The visualization of adjustment, scanning and image reconstruction by virtual CT

The virtual radioisotope intrascopy system. This system is destined for imitation of data processing at the radioisotope intrascopy system (fig. 6). As distinct from others intrascopy systems this system is lack imitating units of virtual source and detector. There are two units only: the unit of γ-image processing and visualization unit.

Objects catalogue. There are folders with array of graphic files of phantoms and real γ-images, for each examination are p successive frames (at this program $p = 16$).

Unit of γ-image processing. There are following parts of this unit: forming block of two γ-image arrays from initial array, blocks of histogram analyses these arrays, constructing blocks of graph of residual isotope quantity for each half of γ-image and difference graph.

Visualization unit. This unit allows visualize: initial array of γ-image frames, two graphs of residual isotope quantity for right and left image parts and difference graph (fig.7).

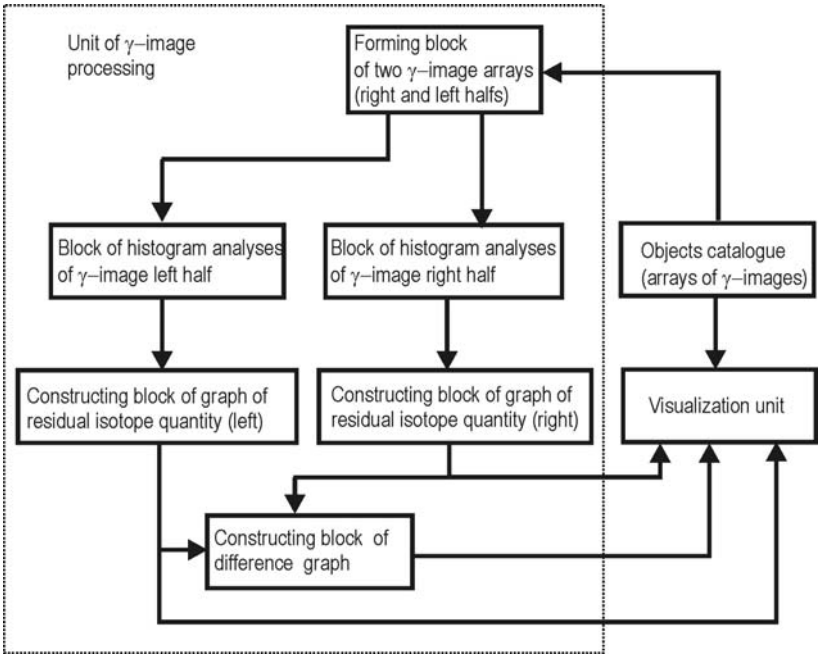

Fig. 6 The block diagram of the virtual radioisotope intrascopy system

Conclusion

Created virtual intrascopy systems allow carry out imitation experiments. Use of e-leaning means is effective method for training of bio-engineers and physicians. These systems may be additional leaning means at study of any high-end technology apparatus. The perspective of this work is design software for creating virtual operation room with several intrascopy systems and modern surgical tools models for surgical planning. This technology is very actually, for example, for neurosurgery planning. This special software will allow surgeon to simulate operation process and choose small-invasive surgical access.

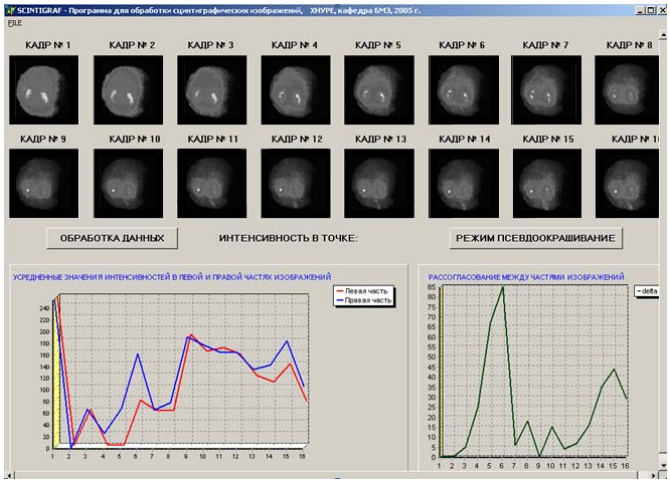

Fig.7 The visualization of kidney γ-image arrays and graphs of residual isotope quantity by virtual radioisotope intrascopy system

Authors' Information

Oleg Avrunin *— PhD, assistant professor, e-mail: gavrun@list.ru*
Liliya Aver'yanova *— PhD, senior lecturer, e-mail: liandr@ukrpost.ua*
Valery Golovenko *— assistant professor, e-mail: golovenkovalera@mail.ru*
Olga Sklyar *— researcher, e-mail: olga.sklyar@googlemail.com*
BME Department, Kharkov National University of Radioelectronics, Lenin ave, 14, Kharkiv, 61166, Ukraine.

INFOSTATION-BASED ADAPTABLE PROVISION OF M-LEARNING SERVICES: MAIN SCENARIOS

Ivan Ganchev, Stanimir Stojanov, Máirtín O'Droma, Damien Meere

***Abstract**: This paper presents an adaptable InfoStation-based multi-agent system facilitating the mobile eLearning (mLearning) service provision within a University Campus. A horizontal view of the network architecture is presented. Main communications scenarios are considered by describing the detailed interaction of the system entities involved in the mLearning service provision. The mTest service is explored as a practical example. System implementation approaches are also considered.*

***Keywords**: InfoStations, intelligent agents, multi-agent system, CC/PP, UAProf.*

***ACM Classification Keywords**: K.3.2 Computer and Information Science Education, H.3.4 Systems and Software.*

I. Introduction

The InfoStation-based system described in this paper is established and operates across a University Campus area mainly for the purposes of the mobile eLearning (mLearning) process. It provides "many-time, many-where" wireless services accessible via mobile devices (cellular phones, laptops, personal digital assistants–PDAs) through geographically intermittent high-speed connections. In this paper, we focus on the main communication scenarios of service provision and show how the different components of the network architecture collaborate to facilitate one particular service, namely the mLecture service. We emphasize the service's ability to adapt to the changing environment/context including the change of the mobile device and/or the change of the access network/InfoStation.

The rest of the paper is organized as follows. Section II presents briefly the InfoStation-based network architecture. Section III illustrates the mTest service provision outlining sample interactions between system entities following the four main communications scenarios. Section IV outlines some implementation issues, and finally Section V concludes the paper.

II. InfoStation-based Network Architecture

The following InfoStation-based network architecture provides access to mLearning services, for users equipped with mobile wireless devices, via a set of InfoStations deployed in key points around a University Campus (Ganchev, Stojanov et al. 2004; Ganchev, Stojanov et al. 2006; Ganchev, Stojanov et al. 2006). The InfoStation paradigm is an extension of the wireless Internet as outlined in (Adaçal and Bener 2006), where mobile clients interact directly with Web service providers (i.e. InfoStations). The 3-tier network architecture consists of the following basic building entities as depicted in Figure 1: user mobile devices, InfoStations and an InfoStation Center.

The users request mLearning services (from their mobile devices) from the nearest InfoStation via available Bluetooth (IEEE 802.15 WPAN), WiFi (IEEE 802.11 WLAN), or WiMAX (IEEE 802.16) connection. The InfoStation-based system is organized in such a way that if the InfoStation cannot fully satisfy the user request, the request is forwarded to the InfoStation Center, which decides on the most appropriate, quickest and cheapest way of delivering the service to each user according to his/her current individual location and mobile device's capabilities (specified in the user profile). The InfoStation maintains an up-to-date repository of all profiles and eContent. The InfoStations themselves maintain cached copies of all recently used user profiles and user service profiles, as well as a local repository of cached eContent.

In the following section we describe the provision of one particular service, the mTest service, in more detail.

III. mTest Service

The multi-agent approach to the structuring of the system is adopted as most suitable. In order to facilitate flexible and adaptable service provision, the intelligent agents, residing within each of the three tiers of the system

architecture, must interact so as to satisfy in the 'best' possible way any user requests they might encounter. The mTest service provides a means for educators to evaluate the student's acquired knowledge. It therefore allows the educator to sense whether the students are grasping the material being presented, and judge the best pace with which to cover topics. The mTest service also allows the educator to shape the learning experience of the students, ensuring their focus is drawn to the most relevant material. From a student's perspective, it can also provide valuable feedback concerning their progress, which can be the source of great motivation for the student to work hard, or indeed work harder. The provision of a multimedia mTest service can aid users in maintaining a high level of concentration and actually become more engaged in the material, and as such provide an optimal learning environment.

However for this service to be successful, synchronization of the off-line eLearning process with the on-line mLearning process is imperative. Synchronization is especially important in an InfoStation scenario due to this paradigm's geographically intermittent connection (mobile users come in and out of range/contact with the InfoStations), as demonstrated later in this section. However the Personal Assistant, installed on the user mobile device, allows the user to continue to utilize the mTest while at the same time maintaining the user service profile. Thus the student may complete the test while outside the contact range of any InfoStation, with the user service profile reflecting the student's progression. Once the intelligent agent (Personal Assistant) comes within range of another InfoStation (*'Change of InfoStation'* scenario), this InfoStation will authenticate, authorize, and account the user. The Personal Assistant analyses the user *mTest* service profile, and sends the updates to the InfoStation (delivery of the completed mTest for grading purposes). The InfoStation forwards this updated user service profile to the InfoStation Center in order for the student's assessment to be graded and the *mTest* service profile to be updated. The control information included in this profile update allows the educator to monitor the students test scores and their progress through the assignments (i.e. time spent for each question + total time). Once this grading is complete, the InfoStation Center sends the assessment results back to the InfoStation, which then forwards the results to the Personal Assistant and the student, so that s/he can review them and gain valuable feedback about his/her own performance. The student is then free to continue onto other test, assessments or assignments, or chose another service.

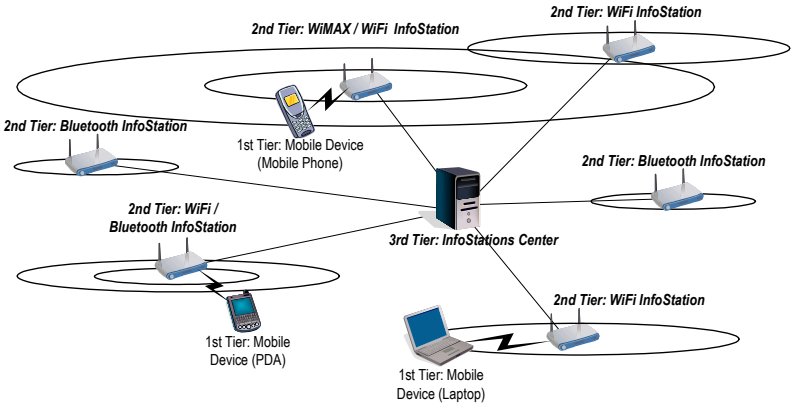

Figure 1. The 3-tier InfoStation-based network architecture

However, before an mTest can be successfully delivered, the mTest content must be adapted and customized according to the capabilities of the current user device, current access network constraints and the user preferences. For instance, the user mobile device may be limited in its capabilities to play video content in which case video components will be sent in a format that best suits the device, or they may be simply omitted. Indeed the entire mTest service could be offered as a text-based assessment. The user may also choose to access a fully featured multimedia version of the mTest service later, when using a device with greater capabilities (e.g. a laptop). This service adaptation is used to address the shortcomings of some low-end mobile devices while still delivering the services.

Indeed a change of device is only one of a number of scenarios that could take place during the service provision. Due to user mobility (e.g. moving between geographically intermittent InfoStation cells) and device mobility (e.g. switching between devices) the following four main communications scenarios are possible:

- No change;
- Change of user mobile device;
- Change of InfoStation;
- Change of user mobile device and InfoStation.

Within each of these scenarios, the initial interactions between the entities remain the same. We utilize the "Composite Capabilities / Preference Profile" (CC/PP) as the uniform format for the implementation of the user profiles. The Master Profile repository in the InfoStation Center contains descriptions of all registered user devices, i.e. their capabilities and technical characteristics. During the initial AAA procedure, the user's Personal Assistant sends as parameters the make and the model of the user device. An agent working on the InfoStation (or the InfoStation Center) reads the corresponding device's description from the repository and according to this, selects the 'best' format of the mTest content, which is then forwarded to the user. However a problem arises when a user uses a non-registered device as s/he might receive the lecture content in unsuitable format. Thus the users need first to register any new mobile device they want to use within the system. In this case, during the initial AAA procedure the Personal Assistant sends a full description of the user device's capabilities towards the InfoStation Center. The manager agent on the InfoStation registers the user in its local Virtual Address Book and updates user/service profiles, before forwarding the user request onto the InfoStation Center. A Profile Agent within the InfoStation Center (updates and) analyses the user profile stored in its Master Profile Repository.

The Service Agent, in collaboration with the Profile Agent, creates a list of services applicable to the user and makes a service offer to the Personal Assistant, which displays this to the user. If the user chooses the mTest service, s/he then specifies the desired mTest content. The InfoStation checks if it has the most up-to-date version of the desired MTest (in the format that best suits the user) in its local repository of cached eContent. If so, it forwards the mTest content onto the user. On the other hand if the InfoStation does not have the requisite content in the required format or most up-to-date version of the content, it will forward on the user request to the InfoStation Center. The InfoStation Center, having already received the make and the model parameters, retrieves the device description from its central CC/PP repository, and adapts the selected mTest content to the format which best suits the user device's capabilities, access constraints and user preferences. This adapted mTest is then forwarded onto the user. The Charging & Billing Module (within the Business Support Domain of the InfoStation Center) also monitors which formats are utilized to access the content, as each format may have minor differences in costs associated with it.

'No Change' Scenario

Figure 2 illustrates the straightforward provision of the mTest service within the system. If the InfoStation can fulfil the user service request (i.e. the required mTest content's format that best suits the current user context is available at the InfoStation), the content is forwarded onto the user.

However if the InfoStation is unable to meet the demands of the user, the request is forwarded

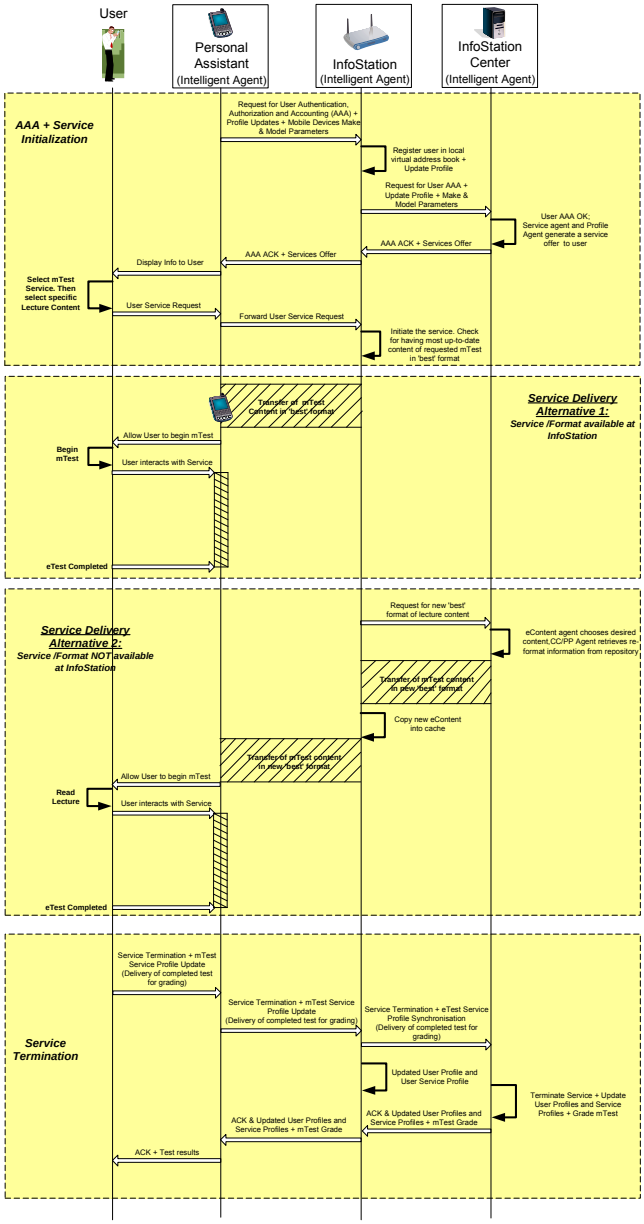

Figure 2. Sample interaction between entities involved in *mTest* service provision in the *'No Change'* scenario

onto the InfoStation Center. Here the eContent manager chooses the required/best format of the content (from the repository) and in conjunction with the CC/PP agent reformats the content and transfers the adapted eContent onto the user's Personal Assistant. The InfoStation will store a copy of this re-formatted eContent in its cache, in case if another user requests the same mTest. Once the service is terminated, the user profile and the user service profile are updated within the InfoStation and InfoStation Centre so as to reflect the progression of that particular user through the mTests.

'Change of Device' Scenario

Due to the inherent mobility of this system, it is entirely possible that during mLearning service provision, the user may shift to another mobile device (e.g. switch to a device with greater capabilities). By switching to a device with greater capabilities, the user may experience a much richer service environment and utilize a wider range of resources. Figure 3 depicts the case where the user switches from a PDA to a laptop, whilst utilizing the mTest service.

In this case, the users Personal Assistant sends a notification of device change to the InfoStation, detailing the make and model parameters of the new device. Then the InfoStation checks its cache for the required/best format to suit the capabilities of the new user device. If the new format is available, the InfoStation immediately forwards this formatted content onto the user's Personal Assistant.

If however, the InfoStation does not have the new required/best format of the lecture, it requests this from the InfoStation Center, which will retrieve it from its eContent repository.

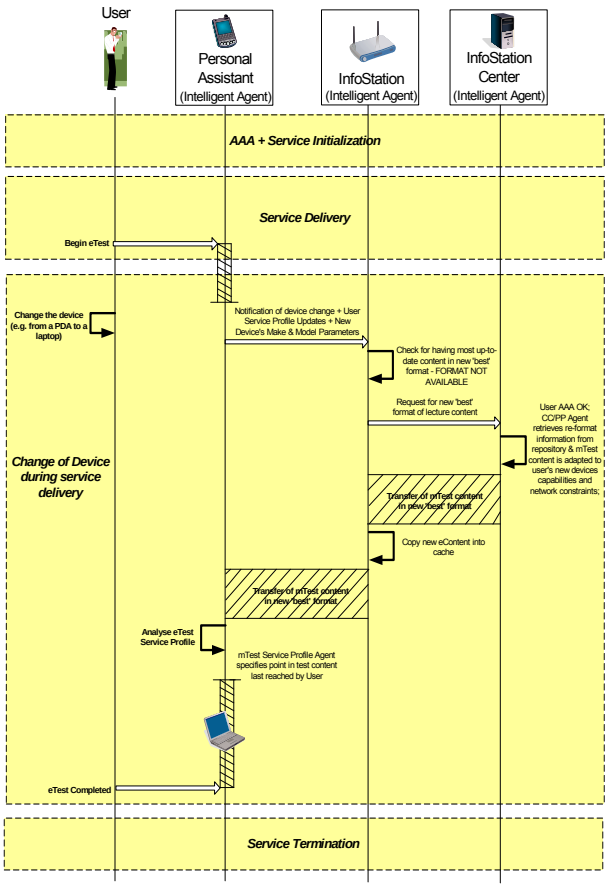

Figure 3. Sample interaction between entities involved in *mTest* service provision in the *'Change of Device'* scenario

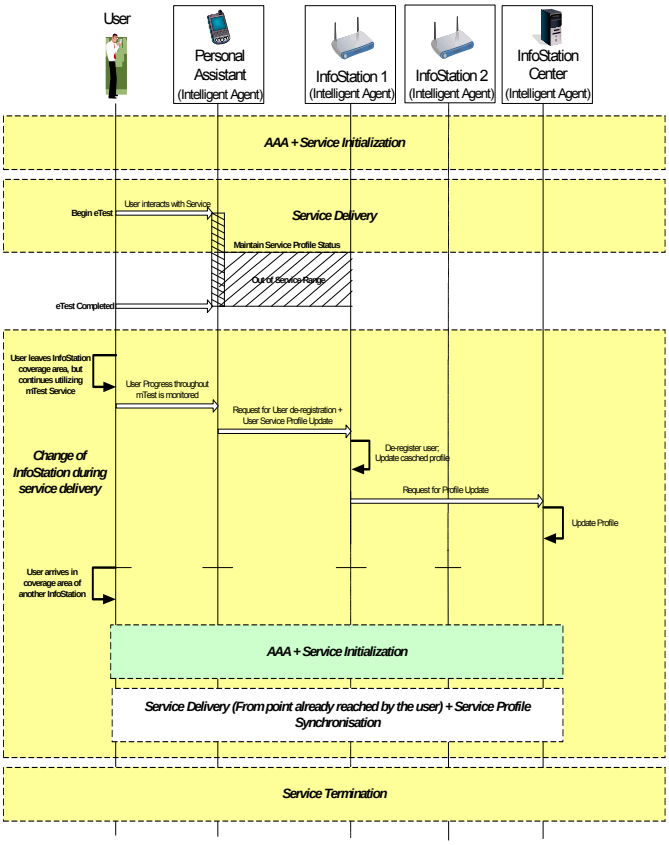

Figure 4. Sample interaction between entities involved in *mTest* service provision in the *'Change of InfoStation'* scenario

'Change of InfoStation' Scenario

Within the InfoStation paradigm, the connection between the InfoStations themselves and the user mobile devices is by definition geographically intermittent. With a number of InfoStations positioned around the campus,

the users may pass through a number of InfoStation cells during the service session. This transition between InfoStation cells must be completely transparent to the user, ensuring the user has apparent un-interrupted access to the service.

The following Figure 4 illustrates the entity interactions involved in the transition between InfoStations. As the user mobile device moves from the coverage area of an InfoStation, the Personal Assistant requests user de-registration from the local Virtual Address Book of the InfoStation. The Personal Assistant also requests one last user service profile update before leaving the coverage area of the current InfoStation. The InfoStation de-registers the user, updates the cached profile, and forwards the profile update to the InfoStation Center to make necessary changes in the Master Profile Repository.

Meanwhile the user continues to progress through the mTest content. The Personal Assistant monitors this progression. When the user arrives within the coverage area of another InfoStation, the AAA and the service re-initialization procedure takes place first. After updating the user service profile, the newly requested sections of the mTest (if any) will be delivered to the user according to the tests completed while out of range of the InfoStations.

'Change of Device & InfoStation' Scenario

We have outlined the separate instances where the user may switch his/her access device or pass between a number of InfoStation cells during a service session. However a situation may arise where the user may change the device simultaneously with the change of the InfoStation. The following Figure 5 illustrates the entity interactions, which occur in this scenario.

Both procedures for device change and InfoStation change (as described in the previous two subsections) could be considered as automatic procedures, independent of each other. Hence each of these may be executed and completed at any point inside the other procedure without a hindrance to it. The two alternatives are shown in Figure 5.

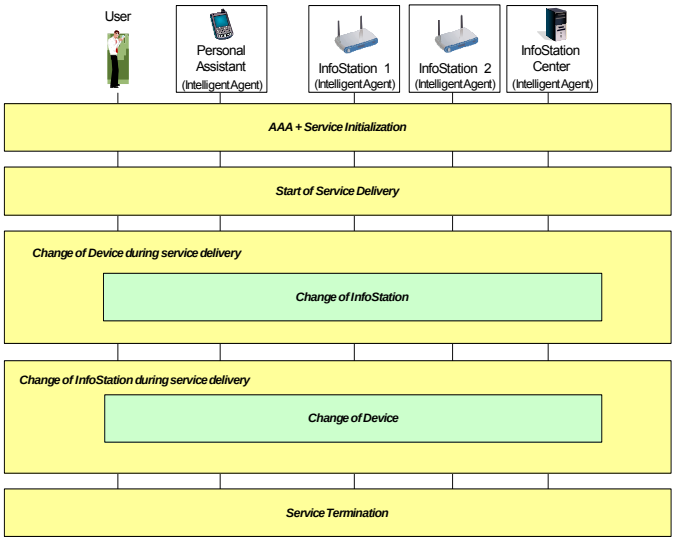

Figure 5. Sample interaction between entities involved in *mTest* service provision in the *'Change of Device & InfoStation'* scenario

IV. Implementation

For the implementation of the User Profile and User Service Profile, which are integral to the facilitation of fully adaptable services, we have opted to use the uniform format "Composite Capabilities/ Preference Profile" (CC/PP) (Kiss 2006). This format is platform-independent and is based on the Resource Description Framework (RDF) (Manola and Miller 2004) and is recommended by the World Wide Web Consortium (W3C). A CC/PP profile is basically a description of device capabilities as well as specific user preferences that can be utilized to guide the adaptation of service content delivered to that device. This adapted and personalized mLearning allows us to offer multimedia content and activities adapted to learners' specific needs and influenced by their specific preferences and context. So when a specific user / mobile device submits a request to use a certain service, the source of that service (i.e. the InfoStation or the InfoStation Centre) customizes and tailors the service content to meet the user preferences and the capabilities of his/her current mobile device. In essence, content is adapted to 'best' suit the individual user and the specific device at that particular time. As we have illustrated in the previous section, the user may change devices a number of times during a service session. So through the customization and tailoring of the services (and their content), these services can be offered to users, independent of the type of mobile devices. This is an essential factor in this type of network, as user devices and preferences will be as varied as the users themselves. A CC/PP profile contains a number of attributes and associated values, which

are used by the InfoStations to determine the most appropriate ('best') format of the resource to be delivered to the user's Personal Assistant.

The User Agent Profile (UAProf) (OMA 2006) specification is a concrete implementation of the CC/PP developed by the Open Mobile Alliance (OMA). This specification builds upon WAP 2.0 (WAP, 2007) and facilitates the flow of capability and preference information between the Personal Assistant, the InfoStation and the InfoStation Center. This specification defines this capability and preference information through a structured set of components and attributes. Components are grouping mechanisms for attributes, therefore in essence, a CC/PP or UAProf profile is organised as a structured set of attributes and value pairs.

The following are the most useful components defined within the UAProf specification. However we could add our own additional components and attributes to better convey capability and preference information within our system:

- *Hardware Platform*: contains attributes that describe the hardware characteristics of the current user device, e.g. device type, model number, input and output methods, screen size, color capabilities, image capabilities, device CPU etc.
- *Software Platform:* contains attributes relating to the operating environment of the device, e.g. operating system name-vendor-version, JVM version, audio & video codecs, Java enabled etc.
- *Network Characteristics:* attributes relating to the network capabilities of the terminal, e.g. bearer characteristics – latency, reliability etc.
- *Application Preferences:* attributes relating to the browser application on the device, e.g. browser name-version, content types accepted by browser, markup languages, scripting languages supported etc.
- *WAP Characteristics:* attributes relating to the WAP capabilities of the terminal, e.g. WAP version, WML script libraries, supported WAP applications.

The different entities within the system can use this capability and preference information to ensure that the user receives service/content that is tailored for the environment in which it will be accessed. However, it is possible to even further customize the service to suit the preferences of the user. This is achieved through the extension of the CC/PP vocabulary. A CC/PP vocabulary defines the format or structure of the profile information, which is exchanged between a Personal Assistant and the InfoStation. While CC/PP and UAProf already define a number of components and attributes to describe the many different capabilities of the user device, we define a number of attributes relating to the user himself/herself, which could be used to further customize and enhance the service for that individual user. The user preference components can specify anything from the user's name, the languages s/he speaks, user's age, location, and the format in which the user would prefer to receive information. Another important attribute within the user profile is to specify the role or job title of the user, i.e. whether the individual is a lecturer or a student etc. Specific groups may be allowed access to different resources related to the service.

Figure 6. Screenshots of *mTest* service execution on devices with varying capabilities.

On figure 6 are two sample screen shots of how this service will appear on mobile devices of varying capabilities. The screen shot on the left represents a device with the capabilities to show complex graphical information. In this case the question posed within the mTest requires the student make an observation, and answer a question regarding the image shown. As this device is capable of supporting multimedia, it may also facilitate an audio element to the mTest.

The device on the right illustrates how a device with more limited capabilities may allow the student to complete the mTest without any multimedia elements. That particular device's profile will specify its capability to only handle text information during its communications with the InfoStations, and as such the InfoStation will provide only the requisite text information.

V. Conclusion

The implementation of the adaptable InfoStation-based mLearning Service Provision within a University Campus has been outlined in this paper. The underlying network architecture has been detailed. The mTest service, which provides a means to evaluate the students acquired knowledge and provide valuable feedback to students concerning their progress, has been described. The entity interactions involved in facilitating this service during the four main communications scenarios have been detailed. The process of adapting and customizing the mTest content according to the capabilities of the current user device, current access network constraints and the user preferences has also been outlined.

The utilization of the Composite Capabilities/ Preference Profile" (CC/PP) format for the implementation of the User/Service Profiles, which are integral to the adaptation of the services, has been outlined. The benefits of using this format have also been considered.

Acknowledgments

Dr. Ivan Ganchev, Dr. Máirtín O'Droma, and Damien Meere wish to acknowledge the financial support of the Ireland's HEA Strategic Initiatives Funding Program 'Technology in Education' for the development of the system.

Dr. Ivan Ganchev and Dr. Stanimir Stojanov wish to acknowledge the support of the Bulgarian Ministry of Education and Science for Research Project "Consumer-Oriented Model and architecture for Mobile E-learning seRviCEs (COMMERCE)" Ref. No. BY-MИ-101/2005.

Bibliography

Adaçal, M. and A. Bener (2006). "Mobile Web Services: A New Agent-Based Framework." IEEE Internet Computing Vol. 10(no. 3): pp. 58-65.

Ganchev, I., S. Stojanov, et al. (2006). An InfoStation-Based Multi-Agent System for the Provision of Intelligent Mobile Services in a University Campus Area. IEEE-IS'06, London.

Ganchev, I., S. Stojanov, et al. (2006). An InfoStation-Based University Campus System for the Provision of mLearning Services. IEEE-ICALT '06, Kerkrade, The Netherlands.

Ganchev, I., S. Stojanov, et al. (2004). Enhancement of DeLC for the Provision of Intelligent Mobile Services. 2nd International IEEE Conference on Intelligent Systems (IS'2004), Varna, Bulgaria.

Kiss, C. (2006). Composite Capability/Preference Profiles (CC/PP): Structure and Vocabularies 2.0. C. Kiss, W3C.

Manola, F. and E. Miller (2004). RDF Primer (W3C Recommendation). B. McBride, W3C.

OMA Open Mobile Alliance (OMA) - http://www.openmobilealliance.org/.

OMA (2006). User Agent Profile version 2.0. OMA specification; available at http://www.openmobilealliance.org/release_program/docs/UAProf/V2_0-20060206-A/OMA-TS-UAProf-V2_0-20060206-A.pdf, Open Mobile Alliance.

W3C World Wide Web Consortium (W3C) - http://www.w3.org/.

WAP, (2007). WAP 2.0 - http://www.wapforum.org/what/technical.htm.

Authors' Information

Dr. Ivan Ganchev *– Dip. Eng. (honours), PhD, IEEE (M.), IEEE ComSoc (M.); Lecturer and Deputy Director of the Telecommunications Research Centre, University of Limerick, Ireland. He has served on the TPC of many international conferences including IEEE VTC2007Spring, IEEE Globecom2006, IEEE ISWCS 2006 & 2007. Ivan.Ganchev@ul.ie.*

Dr. Stanimir Stojanov *– Dip. Eng. (Humboldt, Berlin), PhD (Humboldt, Berlin); Associated Professor, Chief of eCommerce Laboratory, and Head of Department of Computer Systems, Faculty of Mathematics and Informatics, University of Plovdiv, Plovdiv, Bulgaria.* S.Stojanov@isy-dc.com

Dr. Máirtín S. O'Droma *– B.E., PhD, C.Eng., FIEE, IEEE (SM); Senior Lecturer and Director of the Telecommunications Research Centre, University of Limerick, Ireland. He has served on the TPC of many international conferences including IEEE VTC2007Spring, IEEE ISWCS 2006 & 2007.* Mairtin.ODroma@ul.ie

Damien Meere *– Researcher in the Telecommunications Research Centre in the University of Limerick, Ireland. He is currently pursuing his MEng degree leading to transfer to PhD.* Damien.Meere@ul.ie

TECHNOLOGY OF SATELLITE AND MOBILE COMMUNICATION IN MODERN DISTANCE EDUCATION

Viktor Bondarenko

Abstract*: This paper describes the use of technology of satellite and mobile communication for quality improving of modern distance education.*

Keywords*: satellite communication, mobile telephones, training, education.*

ACM Classification Keywords*: H.4.3. Communications Applications*

Introduction

The intensive development of communication systems opens new perspective opportunities for the remote training. The satellite and mobile communication systems are most interesting directions of communication systems, which can be effectively used in the field of the remote training.

The satellite Internet is a unique means of access to the educational Internet-resources in places, where are inconvenient the connection to the Internet through switched telephone channels, dedicated channel or using ADSL-technologies. The satellite channel provides the same fast and reliable data transfer, as well as a dedicated channel.

Such satellite channel enables to receive large volume of the educational information including multimedia manuals, average volume of which is measured in hundreds Megabyte. Because of high-speed access in the Internet, it is possible to see, to listen lectures, and to conduct training in real time mode if the teacher is working with the WEB-camera.

The satellite TV, which is realized on that equipment as the satellite Internet, allows stable and qualitatively to see the educational television programs. Such TV not depends on a territorial location of the television centers and ground transponders.

The means of mobile communication allow to use GPRS (General Packet Radio Service) and EDGE (Enhanced Data for Global Evolution) technology of the data batch transfer [Bondarenko, 2006], due to them it is possible the communication and information exchange between students and teachers practically from any place not only country, but also all continent.

Taking into account above-stated, the specified communication facilities present large interest for the formation of a new technology, which can improve of education quality thanks to more effective contact of students with teachers.

This technology is applied to all forms of training, but in particular, to correspondence and remote forms, because such students have not stable contact with teachers, because, as usually, they are located on large distances from an educational institution. However, the stable contacts of students with the teachers determine quality of received education.

The article is devoted to this problem, where is presented the technology of training. This technology is based on the use of satellite and mobile communication systems. The described technology is implemented at the Bank Faculty of the Kiev National Economic University.

General principles of the satellite and mobile communication use in educational process

The technology of the use of the asymmetric satellite Internet in educational process is shown in Fig.1. A student install the complete set of equipment for the satellite communication (the satellite dish, the converter, the DVB-card), with which student can receive all entering data from the Internet, for example, access to educational sites, files, E-mail, consultation in the on-line mode. The student's query for receiving of necessary information is sent on the server with the help of another Internet-channel. Usually such Internet channel is the mobile telephone, which works on GPRS-technology if the access to cheaper means of the data transfer is absent. Alternatively, it is possible to use the Internet-channel based on the dial-up modem use, if the student can use stationary telephone communication channels. The satellite antenna and stationary or mobile telephone can work in pair, not creating any difficulties, as volume of the outgoing information is usually small (dialogue in forums, ICQ, E-mail).

The satellite «NSS-6» resource is used for organization of satellite communication channels.

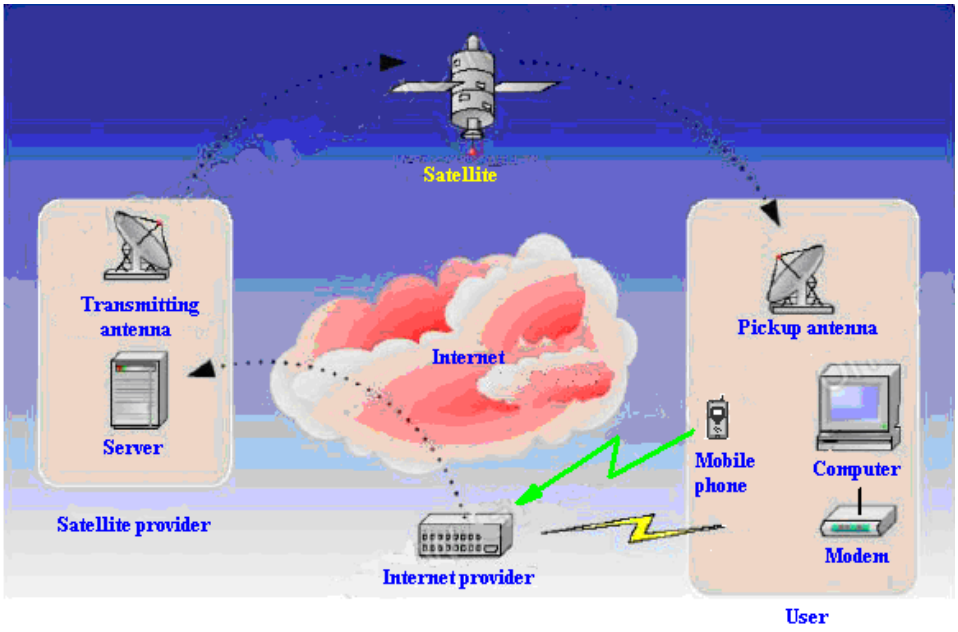

Fig.1. Technology of the use of the asymmetric satellite Internet in educational process.

It is possible to describe information flows in the system as follows: the user (teacher, student) has a complete set of the equipment for reception of signals from the geostationary satellite and some ground connection with the Internet. When the student asks about any information in the Internet, his query is directed to the Internet provider or mobile communication operator. The information, which was asked by student, is sent to him not directly and at first, it goes to the satellite provider. The satellite provider directs this information on the satellite, and already satellite relays this information to the user. The user receives the information with the help of the satellite antenna and the DVB-card inserted in PCI slot of the computer. The satellite access to the Internet uses the DVB-standards and technologies, which are used for modern digital TV. This explains an opportunity of using of the same equipment for satellite access in the Internet and for the viewing of the digital satellite television programs and listening of qualitative digital broadcasting, which also can be used in the educational purposes.

The basic means of educational process technology

The basic means of the educational process support are educational portals, in which are included such means of training: multimedia courses, simulators, tests. Let us consider briefly each element of the specified set.

Educational portals. The most important components of educational process are educational portals. For example, the educational portal *educator.narod.ru* for support of the Computer Science training. One of such portals *victorbondarenko.euro.ru*, which supports the student's preparation on the discipline «Bases of the

Electrical Engineers and Electronics», is shown in Fig. 2. It is possible to receive from this portal lectures, multimedia courses, simulators, tests, tasks for self-preparation, tasks for laboratory works performance, examples, tests for self-checking knowledge, instructions, materials for the review and discussions.

It is possible to communicate with the teacher, using the guest book of the portal. The E-mail is used for active communication of students with the teacher. The student can write to the teacher the letter using the address *victorbondarenko@euro.ru*. He can receive the answer with an explanation of problems, which have arisen during the task performance. After receiving the task, the student prepares for realization of laboratory works, carries out them on the laboratory stands and further he forms results. In case of necessity, the student can write materials for the common review and discussions.

The developed materials the student places on Web-server, sending them with the help of the FTP-protocol. Communicating with the Web-server, the teacher carries out consideration and analysis of the students works, forms the database of tasks processing results, which were executed by the students, carries out correction of a didactical material, which is on the server, carries out the tests construction and updating.

During check of the tasks, the teacher uses the database for preservation of the tasks check results. This database automatically calculates a total estimation of the student with the help of the formula, which is given by the teacher.

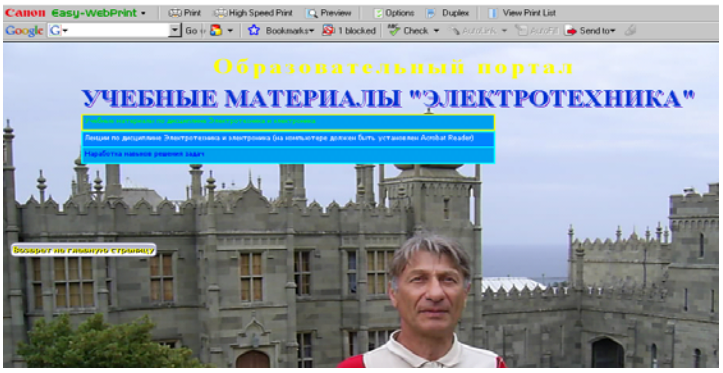

Fig. 2. A general view of the educational portal victorbondarenko.euro.ru

Multimedia courses. The modern means of computer engineering allow considerably to raise a level of efficiency of the manuals, because the author can include in the manuals besides the text and figures a sound, animation, functioning program systems, the algorithms of the work with the manuals can be inserted too.

Due to such means, the information perception by students essentially improves, because of that training is more effective.

Some manuals were created on the base of methodology, which was offered in [Bondarenko, 2005-1]. The first of such manuals was developed the multimedia course on the discipline «Computer Science».

This course occupies 135 Mbytes of a disk space and includes the loading module, which is loaded automatically after the disk mount. The course allows with the help of the convenient menu to select two themes of the multimedia course - « Web-pages Designing» (duration is 60 minutes) and « Work with system Excel » (duration is 120 minutes). The dense format MP3 was used for preservation of a sound. Further the menu has the item «The Test Word-Excel» for a call of the test for check of the Windows, Word, Excel knowledge, and then the menu item «Simulator Excel», which load the simulator for receiving of skills of the mathematical tasks decision in the system Excel.

The test tasks are called from the menu item «Test tasks». These tasks are intended for the independent decision. Besides, the menu has item «About the project», which contains the short information on system installation, and the author's information.

The multimedia course has such structure on each of two themes. The theme is divided on fragments. The student has an opportunity to pass a fragment, which he already has learned. If the fragment is not learned after the first study, the student has an opportunity to repeat it so much time, how many is necessary. Each fragment includes the theoretical information, which is accompanied by an illustrative material and sound explanation. Then, the student has an opportunity to execute practical tasks. For this purpose, the necessary system (Internet Explorer or Excel) is automatically loaded and the example of the tasks solution is shown on subjects of a fragment. Further, it is offered to the student to execute the similar task independently.

There is an opportunity to repeat each theme from a beginning after passage of all fragments of a theme. If it is not need, it is possible to performance of laboratory work. It is carried out one laboratory work on the theme "Web-pages designing" and two laboratory works on the theme "Work with system Excel". The course contains examples of laboratory works, and examples of the reports designed to them. Besides, some tens tasks are given on each laboratory work, so that each student of group would receive the individual task.

Simulators. Simulators are next important technological elements, which are used in training [Bondarenko, 2005-2]. Let us consider in more detail work of the concrete simulator, which is used during study of the Computer Science course. The simulator is intended for a receiving such skills in system Excel: the calculation of mathematical expressions, the work with matrixes, the forecasting, the solution of the linear algebraic equations systems, the solution of the nonlinear equations and the solution of optimization problems.

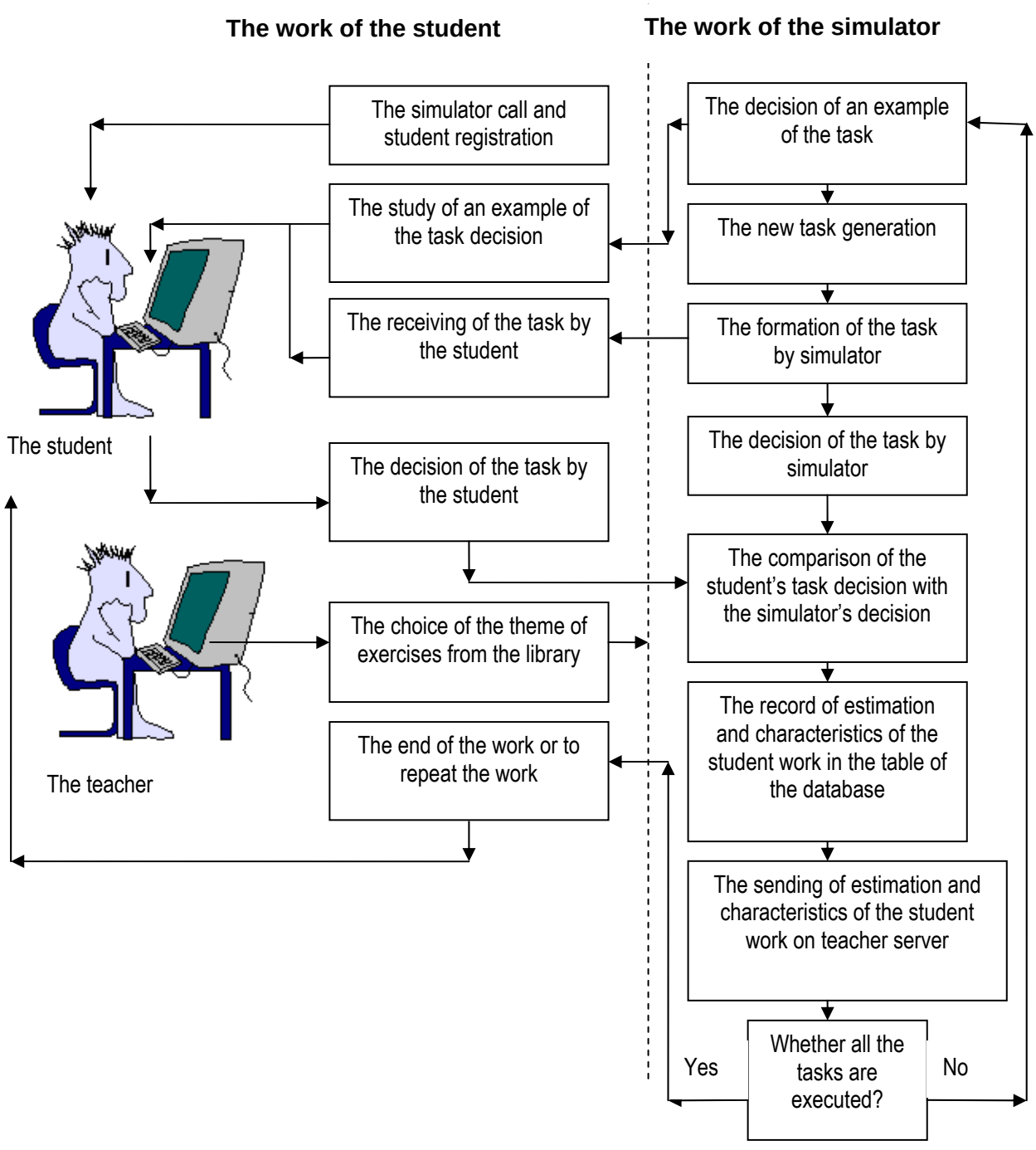

Fig. 3. The structure of the simulator functioning.

After the simulator call, the student should be registered. He begins the work with the simulator by pressing the button «Beginning of training». The structure of the work with the simulator is shown in Fig. 3.

The student consistently carries out such actions during his work with the simulator (see Fig. 4.):

1. First it is necessary to analyze examples of the task correct solution, which are executed by simulator (to press the button 1).
2. Further, the student receives the task with the data, which are random generated by the simulator (to press the button 2).
3. The student solves independently the task (solution should be brought in area «Results»).
4. It is necessary to confirm the termination of the task performance by pressing the button 3.

The simulator solves the same task simultaneously with a student and further it compares the correct task solution to the student's task solution. After such comparison, the simulator puts mark to the student for the executed exercise in the table of the database, which is constructed in environment of the system Access.

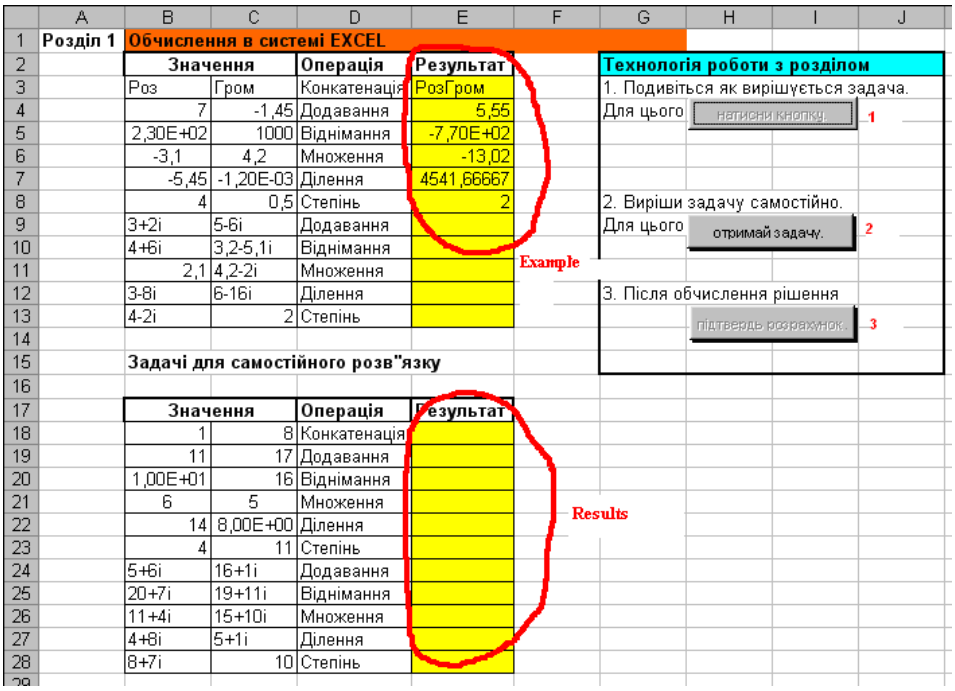

Fig. 4. The simulator window for receiving skills of mathematical expressions calculation in the system Excel.

The table of the database contains the name of the student, number of his group, title of exercise, the date of its performance, time of a beginning and termination of exercise performance, time which student spends for exercise performance, mark for the executed exercise.

The student activity information is kept in the database Access as the table 1.

Table 1. The information of the student's activity in educational process.

Name	Group	Exercise	Date	Beginning	End	Time of performance of exercise	Mark
Bondarenko	6108/2	Calculation	02-08-2004	20:26:23	20:26:24	1	0
Ivanov	6108/2	Forecast	02-08-2004	20:26:29	20:26:30	1	1

The teacher can analyze activity of each student in different planes with the help of typical queries, which are generated in language SQL. He can determine weak places in the educational material learning, most expedient

tactics of educational process conducting both in group as a whole and for the separate students. Such analysis is carried out with the help of the analysis system.

The work with the simulator is one of the constituents of student's preparation on the Computer Science course.

The tests. The next components of educational process are the automated tests, which are constructed with the help of test-constructed system [Bondarenko, 2004]. For example, Excel and Visual Basic test. The test includes questions about the systems Windows-2000/XP, Word, Excel and Visual Basic. It consists of 87 questions. Time of testing is 20 minutes. Figures are widely used in the test. These figures show panels and menu of systems Windows-2000/XP, Word, Excel.

The Fig. 5 shows the general view of other test, which is used during study of the discipline «Bases of the Electrical Engineers and Electronics». The test consists of four tasks. The time of testing is 20 minutes. In case of necessity of calculations performance, the student can made such calculations with the help of the system Excel, temporarily entering in the Excel from the test is possible to do with the help of the button «Excel» pressing.

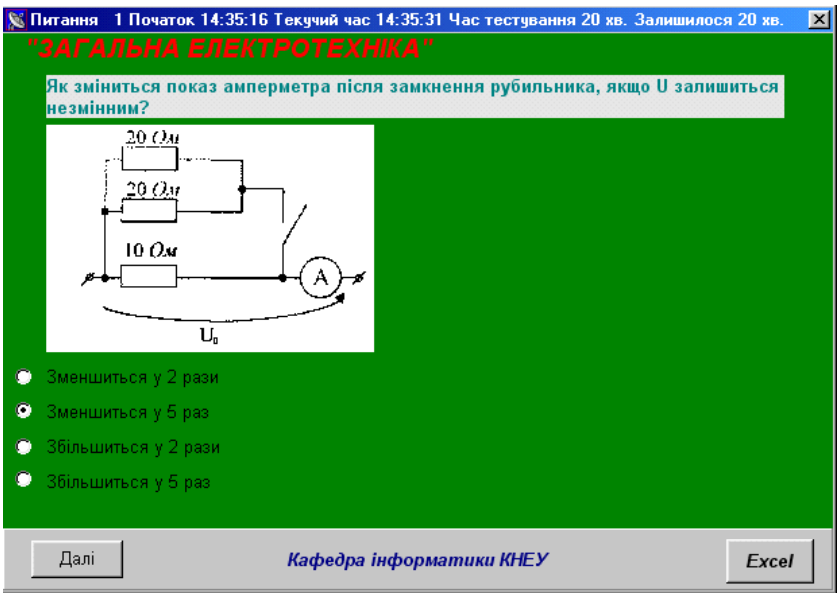

Fig. 5. A general view of the test on the course «Bases of the Electrical Engineers and Electronics».

After the termination of the test, the student automatically receives a mark and quantity of questions, on which he has answered correctly. Questions, on which the student had no time to answer during time allocated for the test, are considered as such, on which are given the wrong answers. The protocol of the answers of the student is fixed in a file and the teacher can see it in future during the analysis of educational process.

Technology of educational process

The technology of educational process is shown in Fig. 6. We will present the use of the satellite and mobile communication technology in educational process using the considered above opportunities.

The teacher prepares and places an educational material, necessary for study (task, abstracts of lectures, multimedia courses, simulators, tests) on Web-portals *educator.narod.ru* and *victorbondarenko.euro.ru* for the using in the Internet. Simultaneously same information with changes focused on the mobile telephone using is brought on Wap-portal (*www.tagtag.com/educator*).

The preparation of an educational material is carried out with the help of the various specialized editors (Fig. 6).

The student reads out the necessary information from Wap-portal on the mobile telephone or from Web-portal through satellite communication on the computer, carries out the task and results are sent with the help of e-mail to the teacher, using for sending the mobile telephone or the Internet from the stationary computer.

If communication of the student with the teacher is direct, the teacher has an opportunity to write in the student mobile telephone the abstracts of lectures, tests, tasks and other information from the computer connected to the mobile telephone with the help of the cable. In such form the educational material is very convenient for daily work and it can be used as useful intellectual amusement if this material would be realized as the game project, which is interesting to the student.

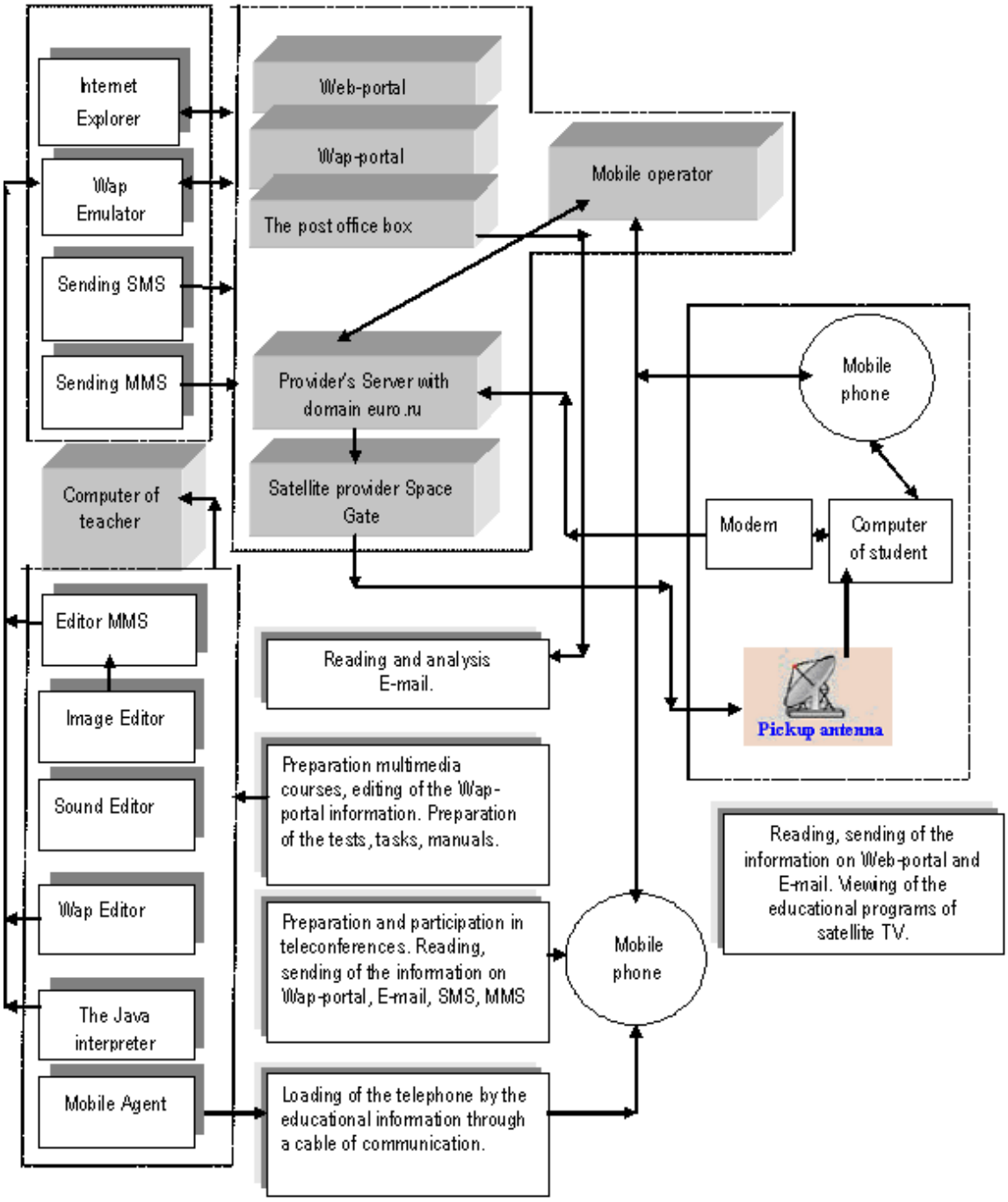

Fig. 6. The technology of the satellite and mobile communication in educational process.

Sound files with an explanation of a difficult educational material by the teacher can be loaded on the mobile telephone of the student from Wap-portal or from the computer connected to the mobile telephone with the help of the cable.

In case of a necessary consultation, the student can use such opportunities of the mobile telephone: voice communication, E-mail, and short messages SMS. The teacher frequently uses the SMS-message also for the purpose to make in group the announcements, appointments, and so forth. MMS-message can be used for receiving of fragments of multimedia courses.

The conferencing can be used for a difficult material discussion and «brain attacks» realization.

It is planned in the future the using of the satellite TV for the educational programs and lectures reception.

Conclusion

The described above technology of remote organization of educational process is successfully developed at the Bank Faculty of the Kiev National Economic University. The implementation of this technology is carried out in parts and in the future it is planned inclusion of the educational programs of the satellite TV. This technology is used for preparation of the specialists of the various forms of training. However, it is observed greatest efficiency of the technology in the student's preparation process of the correspondence form of training, because such students have not stable possibilities of direct communication with the teacher and this technology makes such communication more active.

Bibliography

[Bondarenko, 2006] Victor Bondarenko Mobile Communication Technology as a Tool of Educational Process. Proceedings of International Conference "Modern (e-) Learning" July 1-5, 2006, Varna (Bulgaria). FOI-Commerce, Sofia, 2006, pp.229-232.

[Bondarenko, 2005-1] В.Є.Бондаренко Методологія побудови мультимедійних підручників. Удосконалення змісту та форм організації навчального процесу відповідно до міжнародних стандартів. Т2, Збірн. Матер.Науково-методичної конференції 2-4 лютого 2005 р., К.:, КНЕУ, 2005, с. 56-58.

[Bondarenko, 2004] В.Є. Бондаренко Інструментальний комплекс для формування адаптивних систем контролю знань. "Методичні та практичні аспекти застосування та розвитку системи контролю знань в університеті "Збірник матеріалів науково-методичної конференції. К.: КНЕУ, 2004, с. 173-176.

[Bondarenko, 2005-2] В.Є. Бондаренко Дистанційний тренажерний комплекс для навчання роботі з системою EXCEL і тестування отриманих навичок. Образование и виртуальность. Вып. 9.Харьков, 2005, с. 60-64.

Author's Information

Viktor Bondarenko *– Kiev National Economic University; Pobeda ave., 54, Kiev-047, Ukraine, 03047; e-mail: victorbondarenko@rambler.ru*

IMPLEMENTATION OF DISTANT LEARNING PORTALS BASED ON CASE-TECHNOLOGY METAS

Ludmila Lyadova, Alexey Urezalov, Andrey Khlyzov

Abstract*: The paper describes an approach to the development of software aimed at the creation of distant learning portals integrated with education support and educational institution management systems. The software being developed is based on CASE-technology METAS which is used for the creation of adaptive distributed information systems. This technology allows to dynamically adjust the portal's structure and portal's functionality enhancements.*

Keywords*: portal, learning portal, distant learning, testing, information system, CASE-technology.*

ACM Classification Keywords*: D.2 Software Engineering: D.2.2 Design Tools and Techniques – Computer-aided software engineering (CASE); H.3 Information Storage and Retrieval: H.3.5 Online Information Services – Web-based services; K.3 Computers and Education: K.3.1 Computer Uses in Education – Distance learning.*

Introduction

Because of a widespread occurrence of the Internet during the late decade its users became able to quickly and easily access the desired information. It is well known that demand determines supply. That's why with the growth of users' needs there appeared many internet resources. It also applies to educational resources. Many educational portals were created lately. They include, for example, the Federal Portal «Russian Education» (www.edu.ru) and the Russian Educational Portal (www.educentral.ru). Besides there are educational institutions' portals which are certainly playing now an important role in the educational system. It means that they provide not only the delivery of important on-line information for students and teachers of these institutions, but also abilities

for outside users to be registered at the portal and to perform operations with its resources. It should be particularly meant that many universities provide opportunities for distant learning. This paper presents technology which allows to simplify and automate the creation of such portals.

Portal, the Concept and Functions

In order to increase the efficiency of educational institutions it is necessary to implement a certain technological solution for integrating information in the educational field and creating an adaptable environment which would provide opportunities for remote workplaces. These workplaces are intended to allow employees, teachers and students not only to get access to the information resources, but also to perform typical operations concerned with their day-to-day activity. Such solutions are usually implemented in Web-portals which provide unified access to both public and nonpublic organizations' resources through the Internet.

A portal provides *1) an integration of applications and data and users access to them through the unified interface in accordance with the rules prescribed for them; 2) a workplace personalization; 3) publishing, distributing and presentation of information; 4) data categorization, exhaustive and relevant information search; 5) business-processes' management and collective work; 6) feedback and development*.

One of the main functions of a portal which distinguishes it from a "traditional" Web-site is an integration of data, being received from different sources, and applications, automating typical operations performed by users through the Web-interface. Another non-trivial task is a feedback support which is the key to the portal's development and its adaptation to user needs and changing conditions. Solving these tasks implies implementing appropriate mechanisms which would provide, in particular, data restructuring and user interface adjustment, functionality enhancements and the possibility for integration with external systems. This paper describes the technology suggested by authors for the development of portals satisfying mentioned requirements.

Standards and Technologies

CASE-technology METAS

The software described in this paper is based on CASE-technology METAS which provides information systems (IS) developers with means for data restructuring, user interface generation and adjustment, attaching components created by third-party developers, reporting, business-processes and security management [1].

Systems created with METAS are based on interpretation of multilevel metadata which describe the data domain model (this includes data allocated at the database of IS, their structure and operations concerned with their processing). The logical level of the data model allows users to manipulate data in terms of data domain entities. The logical level is reflected on the physical level which defines data presentation in terms of database (DB) tables of the system. Restructuring components provide the ability to dynamically change data model of IS DB. User interface (the main window of application and the object explorer in the form of a tree designed to navigate through data domain objects in accordance with existing relations between them, data input-edit forms) is generated automatically from the defined data model. Moreover, there is a capability to adjust interface to user needs. Users of the system can work with IS database (DB) through both Windows- and Web-interface. Reporting components offer a capability to create and execute database queries and develop document templates generated by the system. One can also place documents obtained from different sources in different formats to the DB. The functionality of IS can be enhanced also by means of attaching in the process of running the system new components (for example controls or business-operations) which can be designed by third-party developers and by means of business-processes management.

IMS Q&TI

Knowledge control is one of the most important components of every system used to support educational process. Testing is a traditional approach to control the knowledge of students. As a result of the wide and long-term application of tests there are many materials today which can be and must be reused or transferred from one system to another. That's why we need to standardize the way to represent and store tests for maintaining resources interoperability and their compatibility with different testing systems.

The most popular test standard today is IMS Q&TI [2, 3]. This standard is accepted by all major testing system vendors. Almost all testing systems use this specification to exchange the test material and some of them use it to store tests. In Russia this standard is accepted as the main standard for test storing. The main features of it are

the separation of material's description and representation, the support for test hierarchies, hints, different ways for processing answers, an enhanced set of test settings and a lot of question types.

The Architecture of Information Systems Based on Technology METAS

The technology METAS is aimed at the creation of distributed information systems which integrate geographically remote subsystems (or domains). These subsystems can interact in different modes by using the BizTalk Server technology. Every domain is represented by application which has client-server architecture and works with a local database. Remote users can get access to IS resources through a Web-interface. A general architecture of a subsystem and a pattern of user access to IS resources through a Web-interface are shown on Fig. 1.

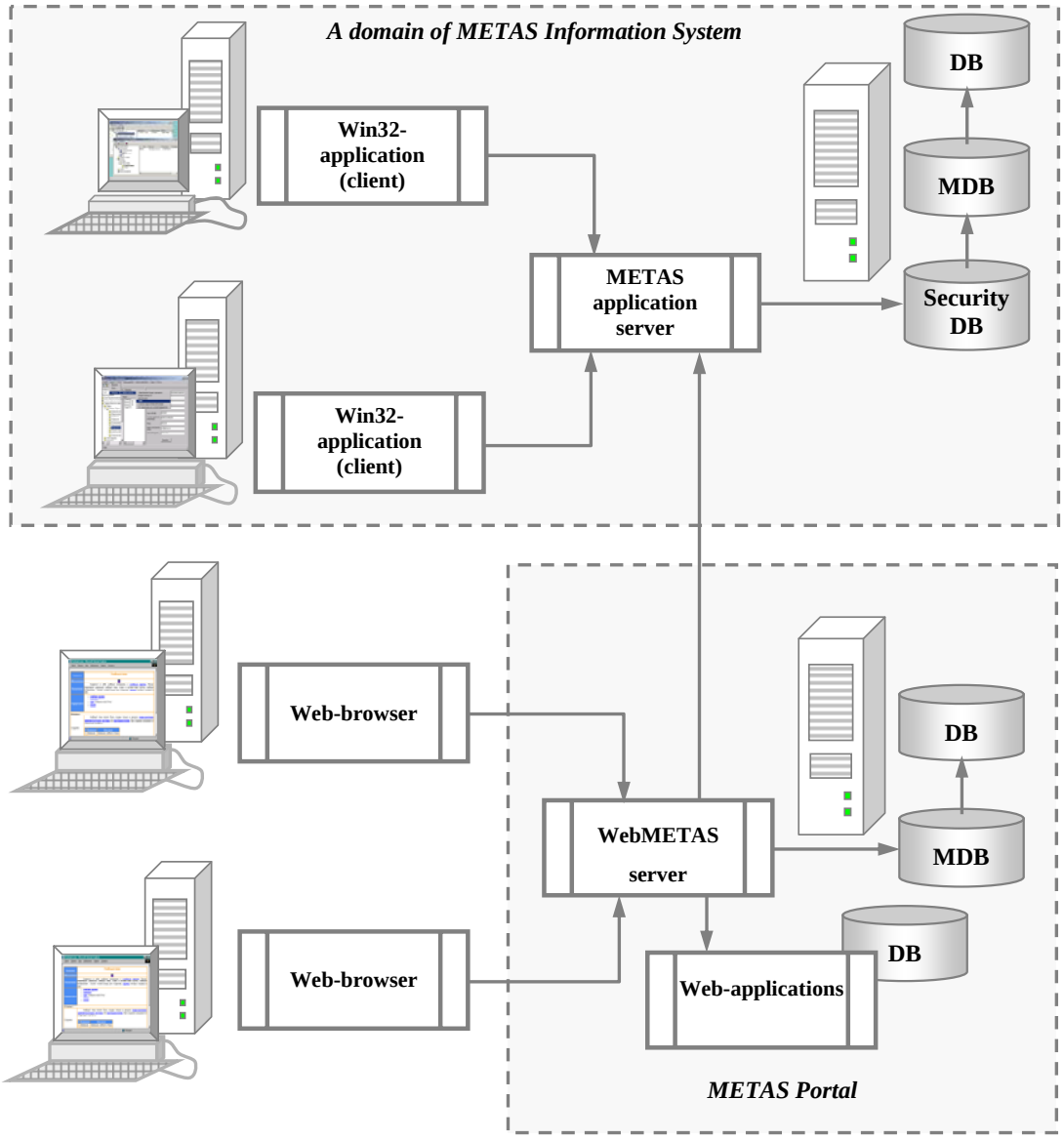

Figure 1. A general architecture of interaction between METAS components

The technology METAS enables to create applications which allow local users to work with them through Windows-interface and remote users through Web-interface. User interface is generated automatically from information stored in metadata database (MDB) of the information system. One of the METAS features is the ability to connect to different database management systems (DBMS) for which ODBC drivers are provided. The database access is carried out through the ADO.NET technology. An application specially developed in compliance with the BizTalk Server technology requirements allows to organize interaction and data transfer between subsystems (or domains) in different modes and using different protocols. In the process of subsystems'

integration the METAS technology allows not only to transfer DB data but also to replicate all changes made to MDB. This provides the possibility to distribute changes in data structure, user interface settings and functionality enhancements. These capabilities are implemented in the replication component of CASE-system METAS.

The designed architecture allows to integrate stand-alone running applications which have different purposes and to combine models developed for different data domains. These features serve as the framework for creating integrated information systems for educational institutions consolidating applications designed for the management of these institutions and learning process [4].

EduMETAS, a Tool for Automating the Process of Creating Distant Learning Portals

A portal usually includes a forum, news, document publishing, links, search, authentication and other modules. Multilevel data model enables users to equally design and generate all these modules in METAS-system. On a logical level the data domain is described as a set of entities which represent data domain objects, their attributes and relations between objects. All operations are performed exactly with objects of this level. So, the logical level allows abstracting from the structures and peculiarities of data storage in relational database tables. A presentation level is used for describing the interface of a user which works with a system implemented on a METAS-technology basis.

The software reviewed in this paper operates via interaction with the logical level of the METAS data model. The administrator of a portal can design the structure of it and its modules by means of restructuring components which are developed as a Windows-application. This structure is used as a framework for generating the portal. To solve this task we developed a component responsible for Web-presentation of information through objects' data input-edit forms. We also implemented components which secure the portal's data, allow to create and maintain portal user accounts, user groups and their permissions for accessing and modifying portal resources.

By using METAS's universal adjustment components we were able to create Web-application providing flexible means for dynamic restructuring of the portal and extending its functionality [5, 6]. This allows the portal to be adjusted to satisfy the changing conditions and user needs during its operation (without having to recompile it).

The portal's information resources are described in terms of data domain objects. Every object is associated with some type. An object type is specified by its attribute set, Web-presentation and user permissions for accessing objects of that type.

A user can create, modify or delete objects in compliance with his/her permissions. Permissions can be set both for individual users and user groups.

A user can navigate resources of the portal through the site map in the form of portal objects' tree view the structure of which is determined by metadata. Every site's section has a corresponding object in the tree view. When a user selects tree's node (or some section of the portal) a Web edit form or document is displayed. Editing information about the objects implies modifying its attributes. Every attribute is shown on the Web edit form through some control. For each attribute the layout and the behavior of the corresponding control is set. Manipulation with object's attributes is executed in a common way. On the other side one can extend the portal's functionality through enriching the set of available attribute types and corresponding controls for manipulating them. That's one of the ways for providing the necessary flexibility. For example, it becomes possible to work with data which have sophisticated organization (files of different types, hierarchical classifiers, etc.). For increasing efficiency of user's work a web form can contain controls associated with referenced objects' attributes or lookups on parent and child objects.

Extending the functionality of a portal is possible not only by introducing new types of controls. It can also be made by supporting business-operations. Business-operation is a non-typical operation performed on objects (operations for creating, modifying and deleting objects are not considered as business-operations) which is specific for a particular application and its data domain. Such operations can be implemented by third-party developers and attached to portal during its operation.

So, a developer of a portal is provided with all means for designing its structure and content and performing necessary operation on it.

It was mentioned that a subsystem for knowledge remote control and user testing is a mandatory part of distant learning portals. This subsystem is implemented by attaching the application which implements business-operations on objects which represent tests and users of the portal (experts, students and administrators which will be described further in this paper).

Now we will focus on the testing subsystem of the distant learning portal EduMETAS.

Testing Subsystem's Architecture

The testing subsystem must work with at least three user categories:

1. "Expert" – a user who creates tests for controlling student's knowledge of the data domain through test building components. Expert should be a person with teaching and practical experience in the data domain of the test being created (a teacher).

2. "Student" – a user (usually a student) who examines his knowledge in a particular data domain. Initial requirements for a student include minimal skills of working with a computer through Windows- or Web-interface.

3. "Administrator" – a person who maintains and sets up all parts of the distant testing subsystem and is responsible for its operability (a developer).

For every user category appropriate permissions are defined. Obviously an "expert" should be able to create tests, modify and delete them, to set assessment criteria, to view and analyze test results. A "student" should not have access to operations of modifying and viewing the test. He (she) must be able only to pass the test by choosing the test's type and the particular test and view the results. "Administrator" should have access to all data and their database descriptions for maintaining the system in the operable condition.

Besides, users from different categories should have access to different functions: a "student" needs only to view test's question in a reasonable view and to select or enter answers; an "expert" needs a tool to create tests and set up the appearance of their questions, to build database queries to put out the results of the testing; an "administrator" should have tools for controlling users' work with the system.

According to IMS Q&TI standard a test has a hierarchical structure. Every test consists of sections, every section contains questions and questions include information depending on the question's type. A test can contain the following question types: "choice", "multiple choice", "string response" (when a user should enter the text), ""numeric response" (when a user should enter some number), "match objects" (when objects from several lists have to be grouped together) , "fill-in-blank" (when a user should fill numbers or text in blanks in the question's text). In addition to standard question types implemented in the system new question and task types can be created via restructuring and business-operation attaching tools.

The testing component is implemented as a system-independent module [7] which performs test's running and results' check. This module has several functions such as preparing the data for testing, running the test, results' check, user interface and interface with the testing subsystem to which it is connected.

The test executing system includes several modules. Its architecture is shown on Fig. 2.

The test executing system consists of five main modules: system dispatcher, user dispatcher, generator, test player and analyzer. It uses local database and that provides the possibility to integrate with various testing systems which support IMS Q&TI standard. The interaction is performed on a basis of

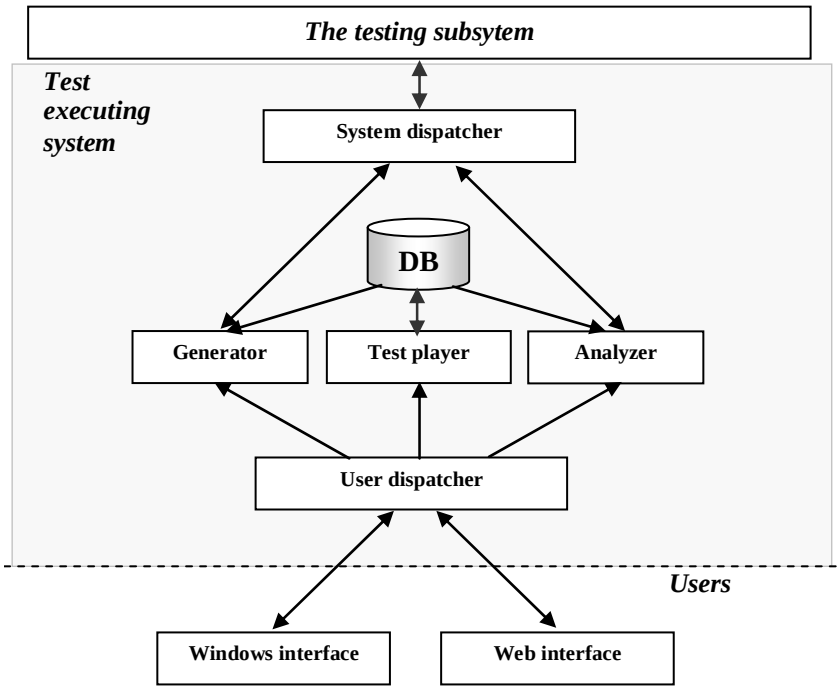

Figure 2. A general architecture of the test executing system

XML.

Now we'll take a closer look at every of this modules.

The main purpose of *the user dispatcher* is to redirect user requests to other modules. A user interacts through Web- or Windows-interface exactly with this module by sending requests. These requests should be processed by different system's modules. That's why when the user dispatcher receives a request for accessing data or executing some operation it analyzes the request and redirects it to the appropriate system's module which implements the requested function. The dispatcher maintains the user's session and when it receives the response from this module it sends the result of the operation to the user.

The system dispatcher is developed to redirect requests from the testing system into which the test player is integrates to other modules. Depending on request's parameters it redirects the request to the generator or the analyzer. When it receives request's result from the test executing system the system dispatcher returns it as a response to the testing system. When the test's result is requested the system dispatcher redirects it to the analyzer. If the data are passed for storing to the DB (in XML format), the request is redirected to the generator.

The main functions of *the generator* are to make a list of users in the database, to make a list and descriptions of tests, to set an order of questions for testing a particular user. Requests for these functions are received by the generator from the user or the system dispatcher. A command from the system dispatcher should have an XML-string as a parameter whish must contain a list of all users who can pass tests, a list of all tests with questions in the IMS Q&TI 1.01 standard and the mapping of users and tests (which tests are accessible for each particular user). If there is no such mapping, it is considered that all tests are available for all users.

Commands from the user dispatcher can contain following sets of parameters:

- no parameters (in that case the response contains a list of users from the users table of the database);
- user ID (in that case the response contains a list of tests available for the user with the specified ID)
- user ID and test ID (in that case it is considered that the user chose a test to pass and a sequence of question is generated for that user depending on the type of constructing a list of questions for the selected test).

The main purpose of the test player is to store to the database the user's answer to the question and to return a new question. Parameters of the request to this module must include the user ID and the question ID. One more parameter is optional. This is the user's answer to the question (in XML format). If the third parameter is missing it is considered that this is a request for a new question. In that case the text of the question is retrieved from the questions table and the description of the user is retrieved from the users table. This description is used to perform some verifications such as the time of passing the test (whether the user exceeded the time limit for the test), the sequence of user responses for the question (whether the user can answer the questions in an arbitrary order), etc. If all verifications are successful the text of the new question (in XML format) is returned as the answer to the dispatcher's request. Otherwise the cause of rejecting the request is returned. If the third parameter is specified (so it is the request for storing the user's answer) then the user's description is extracted from the users table to performs such verifications as the possibility to answer the question again (i.e. correct the previously submitted answer), etc. If all verifications are successful then the value passed as the third parameter is stored in the database. The returned result contains an empty XML document if the request is completely accomplished or an XML describing the cause of rejecting the request if storing the answer failed.

The analyzer has two main functions. They are an examination of the test results and an output of these results. The request for the examination of the results is sent by the user's dispatcher. Request parameters must include the user ID which is used to select answers and check-up the results for the chosen test. Results for each question are stored in the database table. The result of fulfilling the request are the number of correct answers and/or the list of "question number - result of question's checking-up" pairs.

At present Microsoft Access or Microsoft SQL Server (or just Express Edition) can be used as the database for testing subsystem. The results can be stored in Microsoft Office documents.

Conclusion

The paper presents an approach to developing educational portals by means of CASE-technology METAS which is used to create dynamically adjustable distributed information systems and by means of testing components developed by ANO "Institute of computing" and Perm State University's Computer Science Department's employees. These components can be used to create portals which implement all functionality necessary for

different user categories. It is possible thanks to system's dynamic adaptation and functionality extension capabilities. The technology allows working with different relational database management systems and integrating heterogeneous information systems. Besides users can both work using Windows applications or gain access to the portal's resources through the Web interface of the system.

Bibliography

[1] Лядова Л.Н., Рыжков С.А. CASE-технология METAS // Математика программных систем: Межвуз. сб. науч. тр. / Перм. ун-т. Пермь, 2003. С. 4-19.

[2] IMS (IMS Global Learning Consortium) – American Project [Web Resource]: http://www.imsproject.org.

[3] IMS Q&TI Specification [Web Resource]: http://www.imsproject.org/question.

[4] Лядова Л.Н. Архитектура информационной системы «Образование Пермской области» // Математика программных систем: Межвуз. сб. науч. тр. / Перм. ун-т. Пермь, 2002. С. 25-35.

[5] Рыжкова Е.А., Хлызов А.В. Реализация удаленного доступа к ресурсам информационной системы «Образование Пермской области» // Информатика в школе: Тезисы докладов X юбилейной областной научно-методической конференции 9-10 января 2006 г. «Рождественские чтения» / Перм. ун-т. Пермь, 2006. С.86-88.

[6] Хлызов А.В. Разработка средств создания порталов с использованием многоуровневых метаданных // Технологии Microsoft в теории и практике программирования: Тез. докл. конференции-конкурса / Нижегородский ун-т. Нижний Новгород, 2006. С.310-313.

[7] Урезалов А.В. Разработка средств тестового контроля на основе CASE-технологии METAS // Технологии Microsoft в теории и практике программирования: Тез. докл. Конференции-конкурса / Нижегородский ун-т. Нижний Новгород, 2006. С.303-306.

Authors' Information

Ludmila Lyadova *– Head of Department, Computer Science Department, Perm State University, Bukirev St., 15, Perm, 614990, Russia; e-mail: cs-psu@mail.ru.*

Alexey Urezalov *– University Undergraduate, Computer Science Department, Perm State University, Bukirev St., 15, Perm, 614990, Russia; e-mail: uralkama@mail.ru.*

Andrey Khlyzov *– University Undergraduate, Computer Science Department, Perm State University, Bukirev St., 15, Perm, 614990, Russia; e-mail: andrew_khlyzov@mail.ru.*

TABLES OF CONTENTS OF IJ ITK – VOLUME 2

Volume 2, Number 1

Volume 2, Number 2

Volume 2, Number 3

Volume 2, Number 4

Volume 2, Number 5

AUTHORS' INDEX

TABLE OF CONTENTS OF VOLUME 2, NUMBER 5