

TEM JOURNAL

TECHNOLOGY EDUCATION MANAGEMENT INFORMATICS

129 - 210

EDITORIAL BOARD

Editor-in-chief:

Prof. Dr. Camil Sukic

Lector:

Irma Halilovic

Members:

Prof. Dr. Keiichi Kaneko

(Tokyo University, Japan)

Prof. Dr. Klaus Tochtermann

(Graz University of Technology, Austria)

Prof. Dr. Dilip Patel

(South Bank University, London, UK)

Prof. Dr. Dzafer Kudumovic

(University of Tuzla, Bosnia and Herzegovina)

Prof. Dr. Bekim Fetaji

(South East European University, Macedonia)

Prof. Dr. Shushma Patel

(South Bank University, London, UK)

Dr. Gordana Velikic

(University of Rochester, USA)

Prof. Dr. Dusan Malbaski

(University of Novi Sad, Serbia)

Prof. Dr. Borislav Odadzic

(University of Novi Sad, Serbia)

Prof. Dr. Kosta Voskrsenski

(University of Novi Sad, Serbia)

Prof. Dr. Norzaidi Haji Mohd Daud

(University Teknologi MARA, Malaysia)

Prof. Dr. Özcan Asilkan

(Akdeniz University, Turkey)

Prof. Dr. Solza Sopova Grceva

(FON University, Macedonia)

Table of Contents:

Enhancing E-Mail Marketing by Semantic Addressing -----	131
<i>Tanja Rasovic, Danijela Milosevic, Zeljko Zoric, Marjan Milosevic</i>	
A survey on academic teachers' perceptions about ICT in education -----	136
<i>Solza Sopova Grceva</i>	
Formalization of the General Hoare Logic Laws -----	145
<i>Aleksandar Kupusinac, Dusan Malbaski</i>	
Blended Learning of DSP Trough the Integration of On-Site and Remote Experiments -----	151
<i>Radojka Krneta, Djordje Damnjanovic, Marjan Milosevic, Danijela Milosevic, Milija Topalovic</i>	
Using Genetic Algorithm For Solving Time Tabling Multidimensional Issues and its Performance Testing -----	161
<i>Majlinda Fetaji, Bekim Fetaji, Mirlinda Ebibi</i>	
Design of Algorithms for Improvement of Delphi's Controls DBGrid and DBNavigator -----	167
<i>Fadil Novalic, Bekim Fetaji, Mensura Kudumovic</i>	
The Application of Modern ICT in Increase of the Road Traffic Safety Level in Terms of Applicability of the Interdependence of Global Positioning System (Assisted GPS) and Dedicated Geographic Information System (GIS) -----	174
<i>Mersad Mujevic, Camil Sukic, Dzafer Kudumovic</i>	
Devising and Analyzing Expert Based Learning Methodology ----	180
<i>Mirlinda Ebibi</i>	
Two Idea Implementation of Real-Time Systems -----	188
<i>Piotr Konczak, Wojciech Zabierowski</i>	
E-Bibliotherapy System : Book Contents for Improving Quality of Youth's Life -----	192
<i>Wilawan Phornphatcharaphong</i>	
Lean Startup in Croatia -Does the Croatian Startup Scene Develop Effective Enterprises?-----	200
<i>Maja Lalic, Marina Klacmer Calopa, Jelena Horvat</i>	

Published by: UIKTEN - Association for Information Communication Technology Education and Science.

Address of the Editorial Board: Hilma Rozajca 15. 36300 Novi Pazar, Serbia. Phone: +381 63616084

Contact Information : e-mail : temjournal@gmail.com, Web Address: www.temjournal.com, www.tem-journal.com .

Printed by: Grafikolor, Kraljevo, Serbia.

Volume 1 / Number 3 / 2012.

ISSN: 2217-8309 (Print).

ISSN: 2217-8333 (Online).

Indexed in: Index Copernicus.
Research Bib.
getCITED.
Google Scholar.

Enhancing E-Mail Marketing by Semantic Addressing

Tanja Rasovic¹, Danijela Milosevic², Zeljko Zoric¹, Marjan Milosevic²

¹Employment Agency of Montenegro, Podgorica, Montenegro

²Technical faculty Čačak, University of Kragujevac, Sv. Save 65, Čačak, Serbia

Abstract – This paper presents architecture of the software system for semantic e-mail addressing. It explores the possibilities for creating and updating the knowledge base system about employers and job vacancies, which is created based on domain ontologies. It also describes in details the process of publishing database on the Semantic Web and plans for further updating and improving the existing knowledge base system. Due to specific kind of work, and necessity of automating communication with employers, the presented system is applied in the Employment Agency of Montenegro.

Keywords – Semantic Web, Semantic e-mail addressing, mailing lists, RDF, FOAF

1. Introduction

Nowadays, the Internet represents a valuable marketing tool. As it grows, the number of opportunities for company promotion on the Internet arises, as well as the possibility to tailor it to different individual needs.

As described in Dave Chaffey book [1], the best Internet Marketing techniques in practice are search engine marketing (SEM), banner ads on specific websites, email marketing, mobile advertising, affiliate marketing, and marketing through social media.

Email marketing appliance has a prominent place, because it is confirmed in practice for its successfulness and ease of use. According to a survey of Internet marketing development trends, which was initiated by the Strong Mail [2], a leading provider of online marketing solutions in the field of e-mail marketing and social media, most companies plan to increase the budget intended for e-mail social media marketing in 2012. year. The main tendency is to increase the budget intended for e-mail services, social media and web site optimization. Moreover, according to the same research, activities on development and updating of personalized and targeted mailing lists will grow together with databases integration for enabling "the supply of

highly professional e-mail content to interested recipients."

Ryan and Allis have pointed out the ten recommendations of good practice for companies wanting to promote their products and services by using e-mail marketing in [3]. E-mail marketing can be used for sales management, providing customer service and building customer relationships and trust. In order to achieve the best possible results and reach the target audience, it is necessary to build segmented e-mail list, so that each entry received only emails that interest him. Here comes the challenge of creating good and trustful emailing list where each offer should meet its needs and expectations. The new web technology such as Semantic web enables this process and significantly enhance the effectiveness of the email marketing.

In order to promote business and cooperation of the Employment Agency of Montenegro (EAM) and potential employers, a semantic based model and software application are developed to conduct e-mail marketing techniques. Due to the specificity of the particular job and various activities and interests of employers, the semantic addressing of e-mail messages is applied. Employers are allowed to be alone or check the mailing list and choose which category to belong and from which information will be given by the EAM.

2. Semantic e-mail addressing

Semantic e-mail addressing denotes that particular e-mail messages are sent to mailing list recipients that are recognized to be interested in receiving such information. Essentially, semantic e-mail addresses are logical descriptions of recipients rather than static lists of strings. Therefore, they allow sending (with the same description) e-mails to highly dynamic groups of people and at the same time ensuring, that the "right" people (at this specific moment in time)

are addressed. Such semantic e-mails addresses are stable, whereas the group might change very frequently.

Such approach will enable the members of the mailing list an easy administration of their applications to various mailing lists. This way, addressing stands for the breaking of the complex applications to simple factors, a better understanding of the set of requirements, according to the rules defined by the ontology. In this way the knowledge we have about a particular element has been disassembled for the purpose of data reuse [4].

An interesting example of semantic e-mail addressing is described in [5]. The system sends e-mails to all participants of the seminar, in which they respond to potentially attend the evening and their individual choice from the dinner popup menu. Their responses are collected at the server side, shaped by the answers of the participants, and report is provided on dinner preparation details. Model also provides other features, such as a response to the time required for preparation of selected foods, optimal procedures, and so on.

The appliance of semantic email addressing has many advantages. Software system for e-mail marketing in the Employment Agency of Montenegro recognized the benefits of semantic addressing and applied it in the everyday company business.

Since the Employment Agency of Montenegro tags its employers by different attributes eg. organization, number of employees, organizational structure and interests about the cooperation with the Employment Agency, the proposed software application is the ideal solution to automate communication in the direction Employment Agency - employers. The conceptual model is described in detail in [6].

In the past, communication via e-mail messages in the Employment Agency of Montenegro was carried through the mail client software by creating separate interest groups of employers depending on the EAM needs. This way, the same employer could join two or more groups, depending on his interests. Such communication took place in one direction, e.g. EAM sent e-mails according to the organization of its mailing lists, but not upon the real employer's requests. This method of communication proved to be complicated for EAM employees and also inefficient for employers since they did not receive mails on demand but rather emails according to the

personal judgment of EAM personal responsible for this task. Since the user always expect to obtain clear information relating to his right profile and his interests, he would consider such emails as spam messages. All those issues indicate that communication campaign of EAM should be much improved.

3. Semantic email addressing software system ASEA

The programming team of Employment Agency of Montenegro has developed ASEA software application for our own e-mail marketing purposes to solve the previously stated problems. ASEA is a based on Active Server Pages (ASP) with on-line database creation tool for MS SQL Server 2000/2005, Skins using Cascading Style sheets. ASEA has many powerful and easy setup tools and options, making it simple to create Newsletters, E-mail Marketing Campaigns, Templates, RSS News Feeds, and lots more.

ASEA is designed for the Windows hosting environment, and use the Windows IIS web server with ASP enabled. Database is SQL Server 2000. TCP/IP connections to the SQL Server must be enabled. One of the following e-mail components needs to be installed on the web server in order ASEA to send e-mails: *CDOSYS*, *CDONTS*, *W3 Jmail*, *Persist AspEmail*, *SeverObjectsAspMail*. SMTP server that ships with MS IIS also needs to be installed.

Some of the main ASEA features are the following:

- Sending unlimited number of e-Newsletters and e-mails;
- Unlimited number of subscribers and categories;
- RSS News Feeds; Personalized Newsletters;
- E-mail marketing;
- Subscriber import tools - import lists from CSV/Text files and databases;
- Rich Text Editor - WYSIWYG e-Newsletter and Template Writing Editor
- E-mail activation of new subscriber account (optional);
- Personalized e-Newsletters with member name, e-mail, company name, address, etc.;
- Web-based Subscriber Management Centre for changing members settings and subscriptions;
- Opt-in e-mail confirmation (optional);
- Create, save, edit and delete, unlimited number of e-Newsletter Templates;

- Image and file uploads supported
- Online web frontend for viewing News Bulletins and Newsletters (optional)
- Change the look and feel by creating new skins, or select from a number of built in Skins;
- E-Newsletter Statistics; Admin Control Panel;

The Subscriber Management Centre has the following characteristics:

- Category Subscription Management to change which categories the user is subscribed to;
- Subscribe to unlimited number of Newsletter Categories;
- Update Name, E-mail Address, Password, Company Name, Address, etc.;
- HTML or Plain Text e-Newsletter option (only if admin has allowed plain text e-Newsletters);
- Resend activation confirmation e-mail, if subscriber has not confirmed their opt-in subscription; Remove account option.

4. ASEA system for semantic email addressing

ASEA system consists of interconnected modules, with the central ASEA application. The architecture of this system includes several components as shown in Figure 1. It provides sending semantically addressed e-mail messages, and also, it defines ontology for publishing certain information on the Semantic Web. The main role of the system architecture is to organize the storage, accessing and manipulating of the knowledge in the employment domain, so such presented knowledge can communicate with other systems and easy to reuse.

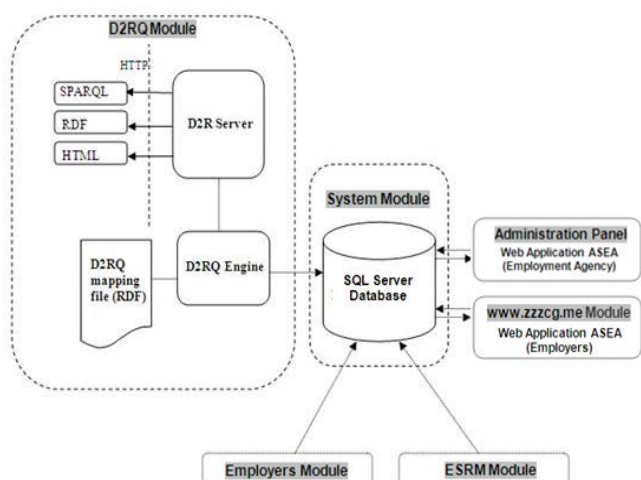


Figure 1. ASEA system architecture

ASEA architecture contains six modules:

- Module employers - Application for generating and maintaining data on employers.
- Module www.zzzcg.me - Website of the Employment Agency.
- System module - a module to update the database ASEA.
- The administration panel - to generate user profiles, maintaining customer data, and send a semantically addressed e-mail messages.
- Module ESRM (records of vacancies) - the application for generating and maintaining data on job vacancies.
- D2RQ module - a module for the publication of selected data on the Semantic Web.

Mapping relational databases is essentially a presentation of these databases for machine-readable data processing. RDF/XML is an XML syntax for RDF data. Today, there are many programs for database direct mapping, depending on the type of the database, compatibility and the need for certain capabilities of the program that performs the mapping. The process of mapping relational databases in the ASEA was conducted using D2RQ platform, components from which it consists. D2RQ platform enables treating non-RDF Databases as virtual RDF graphs. D2RQ is a declarative language to describe mappings between relational database schema and OWL/RDFS ontologies. The D2RQ Platform uses these mapping to enables applications to access a RDF-view on a non-RDF database through the Jena and Sesame APIs, as well as over the Web via the SPARQL Protocol and as Linked Data. The D2RQ Platform consists of:

- the D2RQ Mapping Language, a declarative mapping language for describing the relation between an ontology and an relational data model.
- the D2RQ Engine, a plug-in for the Jena and Sesame Semantic Web toolkits, which uses the mappings to rewrite Jena and Sesame API calls to SQL queries against the database and passes query results up to the higher layers of the frameworks.
- D2R Server, an HTTP server that can be used to provide a Linked Data view, a HTML view for debugging and a SPARQL Protocol endpoint over the database.

The D2RQ Engine is implemented as a Jena graph, the basic information representation object within the Jena framework. A D2RQ graph wraps a local relational databases into a virtual, read-only RDF

graph. It rewrites Jena or Sesame API calls, find() and SPARQL queries to application-data-model specific SQL queries. The result sets of these SQL queries are transformed into RDF triples or SPARQL result sets that are passed up to the higher layers of the framework. The D2RQ Sesame interface wraps the D2RQ Jena graph implementation behind a Sesame RDF source interface. It provides a read-only Sesame repository interface for querying and reasoning with RDF and RDF Schema.

D2R Server is a tool for publishing relational databases on the Semantic Web. It enables RDF and HTML browsers to navigate the content of the database, and allows applications to query the database using the SPARQL query language. D2R Server builds on the D2RQ Engine [7].

The reasons for the mapping certain data from the database of the ASEA in this system was that to use a D2R server it is enough to have installed Java 1.4 or newer, then the ease of mapping SQL database, and compatibility with other databases, as SQL database is not only in the company, detailed instructions on the use of this program, and many forums dedicated to the topic about D2RQ platform

The process of obtaining an appropriate RDF file is the following [7]:

- Download and extract the archive into a suitable location.
- Download a JDBC driver from your database vendor. Place the driver's JAR file into D2R Server's /lib directory. A list of JDBC drivers from different vendors is maintained by Sun. Also take note of the driver class name (e.g. org.postgresql.Driver for PostgreSQL or oracle.jdbc.driver.OracleDriver for Oracle) and JDBC URL pattern (e.g. jdbc:mysql://servername/database for MySQL) from the driver's documentation. Drivers for MySQL and PostgreSQL are already included with D2R Server.
- Generate a mapping file for your database schema. Change into the D2R Server directory and run: `generate-mapping -o mapping.n3 -d driver.class.name -u dbuser -p dbpasswordjdbc:url...` (mapping.n3 is the name for the new mapping file)
- Start the server: `d2r-server mapping.n3`

D2R Server uses the D2RQ Mapping Language to map the content of a relational database to RDF. A D2RQ mapping specifies how resources are identified and which properties are used to describe

the resources. The generate-mapping script automatically generates a D2RQ mapping from the table structure of a database. The tool generates a new RDF vocabulary for each database, using table names as class names and column names as property names. The mapping file can be edited with any text editor. D2R Server will automatically detect changes to the mapping file and reload appropriately when you hit the browser's refresh button.

Besides, mapping of the certain data of employers and vacancies that they have announced is the first step towards using Semantic Web application in the IT system of the Employment Agency of Montenegro. As there are several private agencies for employment mediation in Montenegro besides Employment Agency of Montenegro, with appropriate published documents in RDF file about employers and job vacancies advertised by all agencies, it is possible to make a semantic search engine which will support searching of this data. Relief in the formation of this browser is that the employer ontology and occupations are clearly defined and thus greatly facilitated search of certain data.

To begin this initiative in the RDF employer file are published only those data that are also available through the website of the Central Registry of the Commercial Court: Name, Address, PostCode, Municipalities, ActivityCode, Activity, DateEstablishment, E-mail. Since the vacancies are advertised three times a week, the service will start in the same terms and it will publish newly created RDF file on the Internet. In this way data about employers and advertised vacancies from Employment Agency of Montenegro database become part of the global knowledge base, ready for reuse as a part of the Semantic Web.

ASEA bases its operation on a predefined mailing list because the group to whom e-mails are sent is already known and registered in the local database. These are employers registered in Montenegro, which still do not have a FOAF [8],[9] file published on the Internet. So, their first appearance on the Semantic Web will be by mapping database of the ASEA.

ASEA is open in the sense that it can be easily upgraded with option to send an e-mail to certain persons who have announced their FOAF file on the Internet. The further development of ASEA would be adding the ability to send a semantic addressed e-

mail using the FOAF mailing lists, which provides an opportunity to send e-mail to anyone on the Web by not knowing his e-mail address, and whose attributes defined in the FOAF file suit selected attributes of the sender. FOAF is a document in which a person keeps some personal information such as name, e-mail address, homepage and friends. This file links to other FOAF file and so the network expands. The new upgraded procedure would be: read the FOAF data, imports into a repository, and by selecting create the mailing list, which would be imported into the database server.

5. Conclusion

The recognized problems of organizing and tailoring emails to the target potential clients in the Employment Agency of Montenegro are solved by developing ASEA software application based on semantic web technology.

The main advantage of this automation process of communication with employers is to save time, ease and effectiveness in informing employers of different interests, send personalized messages to selected clients, all aimed at accelerating the process of recruitment of persons from the register of unemployment. Within this program there is a statistic for monitoring the status and interests of the employers on the mailing list, which for the Employment Agency presents the direction in which to develop and improve their services. Because of the possibility that the e-mail is sent only to registered persons with known attributes, the possibility of spamming is practically reduced to a minimum. Semantic e-mail addressing is especially important in business communication, as in this case the recipient does not need to think whether he received spam or not. The results of ASEA appliance will be monitoring over the time, and concrete enhances will be published later.

The further development of the application will be in towards improving the search for FOAF files application to upgrade application so it could send messages addressed to someone who has published his FOAF file on the Web. Since this is the first application applied in Montenegro dealing with semantic e-mail addressing, it is expected that this method of sending personalized messages will

popularize ASEA, as well as the process of publishing information on the Internet in the form of Semantic Web.

Acknowledgements

Research presented in this paper is supported by Serbian Ministry of Education, Science and Technological Development through national project Infrastructure for electronically assisted learning, III-47003

References

- [1]. Dave Chaffey, Fiona Ellis-Chadwick, Kevin Johnston, Richard Mayer, *Internet Marketing – Strategy, Implementation and Practice*, England, Pearson Education Limited, Third edition, 2006.
- [2]. Kevi Chang, *StrongMail Marketing Trends Survey Reveals Positive Economic Outlook for 2011*, Eastwick Communications for StrongMail Systems, 650-480-4080.
http://www.strongmail.com/company/news-and-events/press_120910.php
- [3]. Ryan P. M. Allis, *Best practices for E-mail Marketers*, Copyright Broadwick Corp. 2005.
- [4]. Philipe Rödlach, *Enabling Semantic E-mail Addressing*, bachelor Thesis, University of Innsbruck, Semantic Technology Institute, Emmat 370r, A-6105 Leutasch, Matrikelnr, Innsbruck, June 30, 2008.
- [5]. Luke McDowell, Oren Etzioni, Alon Halevy, *Semantic Email: Theory and Applications*, Department of Computer Science & Engineering, University of Washington, Box 325350, Seattle, WA 98195-2350, USA, 2004.
- [6]. Tanja Rašović, Željko Zorić, *Idejno rješenje Aplikacije za semantičko adresiranje e-poruka u Zavodu za zapošljavanje Crne Gore*, XVI naučno – stručni skup INFORMACIONE TEHNOLOGIJE – sadašnjost i budućnost, Žabljak, od 22. do 26. februara 2011, Zbornik radova skupa, str. 79. , 2011.
- [7]. The D2RQ Platform v0.7 - Treating Non-RDF Relational Databases as Virtual RDF Graphs, [Online] Available:
<http://www4.wiwi.fu-berlin.de/bizer/d2rq/spec/>
- [8]. FOAF project, [Online] Available:
<http://www.foaf-project.org/projects>
- [9]. Friend of a friend (FOAF) search engine, [Online] Available: <http://www.foaf-search.net/>

Corresponding author: Tanja Rasovic
Institution: Employment Agency of Montenegro
E-mail: tanja.rasovic@zzcg.me

A survey on academic teachers' perceptions about ICT in education

Solza Sopova Grceva¹

¹ Faculty for ICT, FON University, Bul. Vojvodina bb, Skopje, R. Macedonia

Abstract – In this paper we present the analysis, conclusions derived from a universities/faculties survey, concerning the use and perception of ICT in education. It has been conducted during the third year of implementation of the EU project “Integrating E-Learning across Teachers Curriculum”. Our objectives were to understand the attitude the current faculty members have towards educational technology, and to determine how it is affecting their teaching practices. Our belief is that this information will be useful for the universities/faculties to build up their future policies.

More specifically, we evaluated the following issues:

- Faculty perceptions and priorities with respect to educational technology
- Faculty experiences with and problems using educational technologies
- Faculty preferences regarding technology support and education

Keywords – Teachers survey, ICT in education, ICT perceptions

1. Introduction

Within our project we have been working with the teachers and students at the Teacher Training faculties in the broader terms. Those are: four Pedagogical faculties that are educating teachers for pre-school and primary schools; a Faculty for natural sciences and mathematics educating subject teachers for secondary schools; and a Teacher training faculty that educates language teachers for secondary schools. All institutions are from R. Macedonia (MK). Our EU project partners were University of Groningen, The Netherlands, Catholic University of Leuven, Belgium and University of Edinburgh, UK. The broader goal of the project was to involve the teachers at teachers' training faculties in MK into the technology enhanced teaching, to reconstruct curriculums respecting our EU partners' practices and following the basic hypothesis that only critical adoption of appropriate technologies within the

curriculum can make the good teaching more efficient and better.

The target group in this survey was the teachers at the teachers' training faculties in R. Macedonia. Through the project the teachers were exposed to many different technologies, software tools and new hardware. Some of them were very excited, some were just trying to support by technologies the traditional teaching methods, and some were very successful in being creative in their teaching with technologies.

Little research has been done to investigate the impact of digital technology on the working environments of those who teach student teachers, at universities in MK [1]. This survey is our contribution toward that goal.

2. Methodology

The survey contained 10 closed and 3 open-ended questions. The approach in this process involves a systematic item writing, revision process and implementation method. We used methodologies of similar surveys by prominent EU and USA universities [2], [3] [4] and [8].

Most of the data are presented as percentage. In some questions we use mean of means of the answer to appropriate questions. This statistics represents the average rating given by all survey respondents to all possible answers to that question. We use a scale from 1 to 4, where 4 is “Large degree”, 3 is “Moderate degree”, 2 is “Small degree” and 1 is “Not at all”. We also display the highest and the lowest ranked answers to each question as determined by the mean score. The number of items in the highest/lowest sets was determined by natural breaks in the data, e.g., three answers that are noticeably above or below the mean of means for that question. If there were no natural breaks, we have tried to provide as much data as possible. Finally, we provide

information about the distribution of responses where appropriate. The range of mean scores for a question indicates how tightly or loosely clustered respondents' ratings of items in the question were. For instance, a wide range indicates that some of the listed factors attracted them much more to the use of educational technology than the others.

2.1 Survey sample

A total of 78 teachers of different ranks participated in the survey. The overall response rate was 82%. From the Teacher training faculties, partners in the project participated 58 and the rest are from other faculties: Faculty of Economics, Faculty of Languages and Faculty of Informatics. The last groups, although not directly involved in the project, volunteered in this survey since during the project period many teachers of these faculties participated in our workshops and other training events. It is interesting that, since we started to use course management software Moodle as a part of the project activities for the Teacher Training faculties, the whole University became attracted to the idea. Our target was initially to put on this platform the list of 14 courses from the Teacher Training faculties, but at this moment 77 courses from different disciplines are using online facilities. The survey results presented here may represent the views and experiences of the other group of teachers (not from the Teacher Training faculties) somewhat less well since their number in our target group is smaller. The division of teachers by ranks was: Full professors 17, Associate professors 48 and Teaching assistants 13.

2.2 Survey and analysis – highlights

In this section, we present and analyze responses to selected survey questions.

Question 1: “Of the following options, what are the three items to which you think it most important for your University/Faculty to allocate resources?”

Scale is “Most important”, “Next most important” and “Third most important” (Figure 1).

The desire for faculty technology support is evident. Nearly 60% of the respondents cited it as one of the top three items. Then, respondents also cited faculty technology development assistance, but it was noticeably ranked lower (below 40%). What is

interesting they have lowest ranked the support for the students (below 30%).

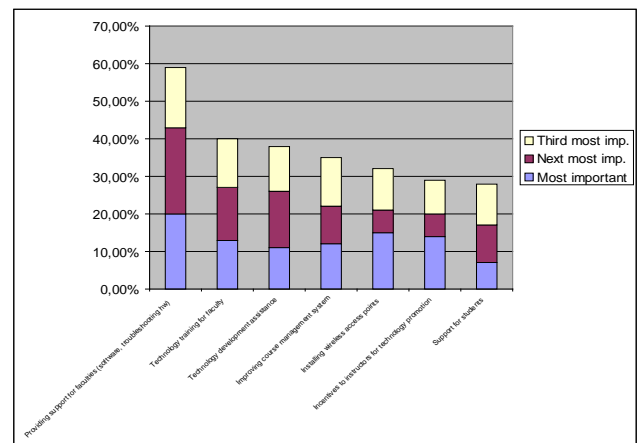


Figure 1. Results from question 1.

Question 2: “Imagine a classroom that is technologically ideal for your teaching. Which of the following would that classroom contain?” (Figures 2 and 3).

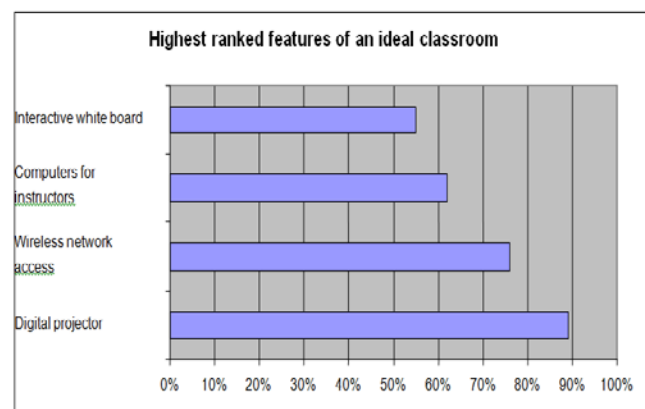


Figure 2. Results from question 2.

Respondents inclined toward wanting their ideal classroom to contain technologies for their own, but not for their students' use, and they choose technologies that can be used primarily to deliver information. But, on the other hand, the interactive white boards, a completely new technology introduced within the project, that encourages interactive way of teaching and learning, became a very attractive and useful technology almost instantaneously. Most of the teachers developed some lectures which were really imaginative. Although the respondents could choose all the listed technologies, they showed little interest in technology for students, nor in videotaping their classes. Several respondents indicated that they

wanted computers and Internet access for students, but controllable by professors.

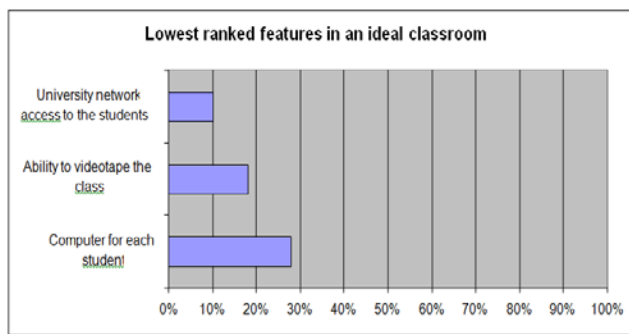


Figure 3. Results from question 2.

Question 3: “What are the factors that attract you to the use of the educational technology in your teaching?” (Figures 4 and 5).

The results indicate strong overall attraction to use technologies into teaching. Among other, it is conceivable that respondents choose student-instructor communication option because they want to use technology to initiate a dialogue about course material. But the heavy emphasis on information delivery makes it more likely that the communication has to do with easy making materials available to students, and to stick to the traditional way of teaching by presentation. Although Moodle as a learning platform was put into place right at the beginning of the 3-years project, the options for discussions and collaborative work were hardly used, either by the teachers or by the students.

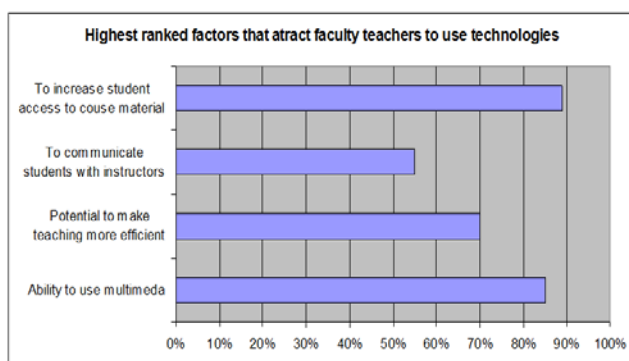


Figure 4. Results from question 3.

It is also worth noting that the high ranking given to “Ability to use multimedia” parallels our findings that this is the strongest teachers’ interest.

“Students demands for technology” is among the lowest ranked options. This indicates that the

teachers are not motivated by a real demand of the students, which is very discouraging because in reality the students are driving force for changes and use of technologies.

“Ability to use games and simulations” is lowest ranked for two reasons: Many responders think that games are not suitable for educational purposes, and for the simulations they lack specific skills and resources.

What is also striking is the wide range in the ratings given to items, indicating substantial differences to which the items attract responders to the use of technology.

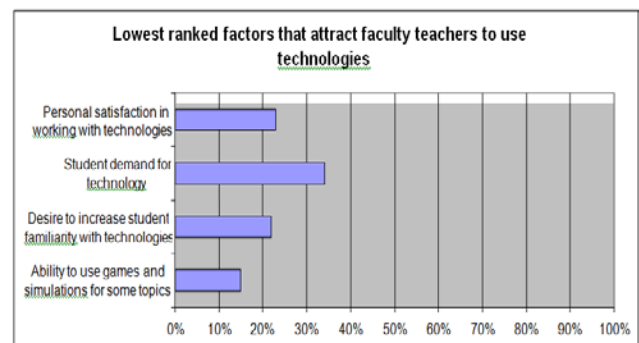


Figure 5. Results from question 3.

Question 4: “How effective or ineffective do you think educational technology is for implementing each of the following teaching techniques?” (Figures 6 and 7).

There is an evident difference in the ranks between the highest and the lowest ranked technology supported teaching techniques. Again we see a significant emphasis on delivering information, also on students being active themselves by presenting their work. Teaching techniques that involve student-student discussions, collaborative work through peer reviews and group assignments are near the bottom, even though these techniques are well established as effective technology-enhanced learning practices in the literature.

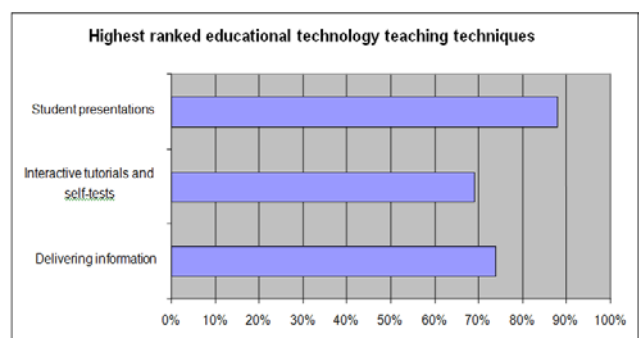


Figure 6. Results from question 4.

During our project workshops and working sessions we also put a lot of effort to encourage these types of activities, but both the teachers and the students didn't find it very useful. We isolated one factor that is certainly behind this attitude. That is the time constraints they have in fulfilling the goals of a certain teaching unit, or task. This disparity simply reflects faculty members' perception that delivering information with technology is simple and reliable, while interaction is, relatively speaking, more complex and time consuming.

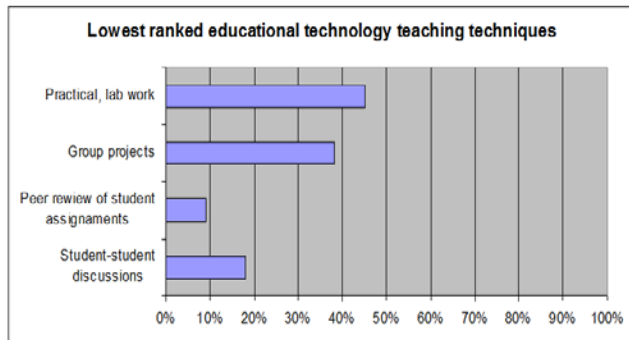


Figure 7. Results from question 4.

Also, a frustration that the students are generally more advanced, specifically in some technologies that involve communication and multimedia usage, is a factor of frustration among the more or less inexperienced teachers. They feel somehow exposed in front of the students, and that their authority is in question. We have seen such examples during the project time, when the students tried to teach the teachers how to use the more complicated multimedia options. Instantly and spontaneously the teachers tried to diminish the value of such a technology, and to reject it for some time.

Question 5: "Educational technology can be used either face-to-face in the classroom or in the laboratory (e.g. Power Point presentations), or online. What is your experience in using educational technology to enhance teaching?" (Figure 8).

It is good to see that only 8% of the respondents reported that they used neither digital nor online technology in their teaching. This indicates that, possibly as a result of our 3 years work on this project, the vast majority of teachers used technologies in some way to enhance their teaching.

On the basis of our experience it is reasonable to suppose that most of the 58% that declared using digital technologies are mostly Power Point users.

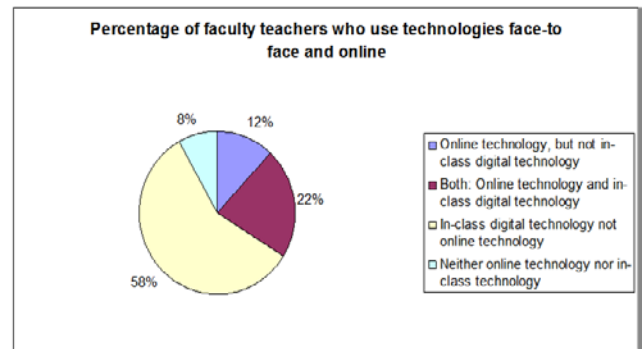


Figure 8. Results from question 5.

The penetration of a Learning Management System like Moodle, which we introduced in the project as a platform for online courses, made a whole difference from some previous surveys [5]. Now we have almost 20% of teachers using the online teaching, although with an emphasis on delivering information.

Question 6: "How much of a barrier has each of the following factors been to your use of digital technologies in conjunction with your teaching?" (Figures 9 and 10).

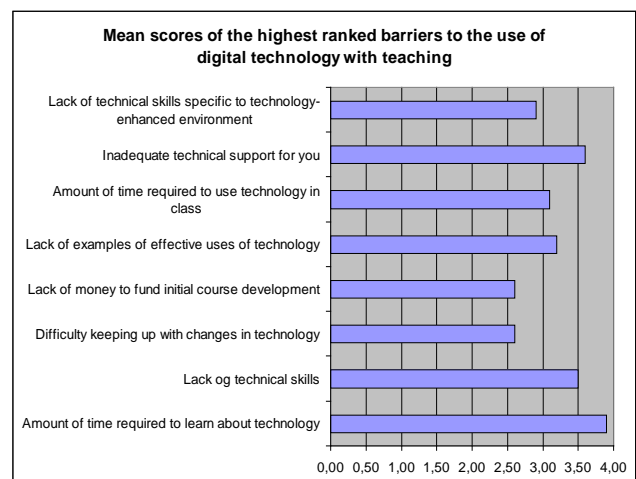


Figure 9. Results from question 6.

When these responses are compared to the answers in Question 3 where they were asked about the factors that attracted them to technology, and when mean of the means of those two are compared, it appears overall that respondents are much more attracted to use the technology than held back from it by barriers. In spite of some evident resistance, this fact is encouraging.

As can be seen, lack of time to learn about technologies is a dominant theme, also the amount of time required to use technology in the class. Many respondents described in detail their lack of time for training. Moreover, they emphasized the lack of time

to develop their own technology supported teaching material.

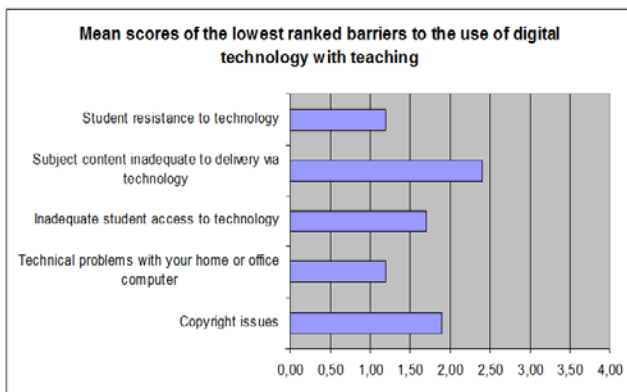


Figure 10. Results from question 6.

The need for technical support is also very highly ranked barrier factor, a result consistent with the desire for faculty technical support. Many respondents emphasized existence of well-trained staff as their back-up.

Teachers' insufficient mastering in technology supported teaching is among the highest barriers. Further, the high ranking given to the "Lack of models/examples of effective uses of technology" is consistent with their need to see what and how the other faculty members are doing with technology.

This demand for positive examples is also expressed in one of the following questions, when it comes to the specific technologies topics. But, what we also covered with questions not presented in this article is using complementary sources like manuals, documents, help functions, books for obtaining knowledge about the subject matters. The results were highly disappointing, but predictable. Only 12% of all the teachers involved in the project were low to moderate users of such complementary sources. The vast majority strongly relied on on-line help and most frequently asked for a face-to-face instruction.

It is not surprising at all to see Copyright issues among the lowest ranked barriers, since the law that treats these issues in MK is poorly enforced. That might also mean that faculty members tend to focus exclusively on educational purpose when considering whether their use of copyrighted material is a legal and an ethical issue.

Students' resistance to technology was also low in the ranking, which is interesting in light of how low-ranked student demand was in teachers answers in Question 3. One possible answer is that students neither demand, nor resist technology; another is that faculty members are simply not motivated by students' desires. In any case, pressure from students in either direction was not apparent in these survey results, where the teachers were the target group.

Question 7: "When you are developing course materials, how often do you use each of the following software tools?" (Figures 11 and 12).

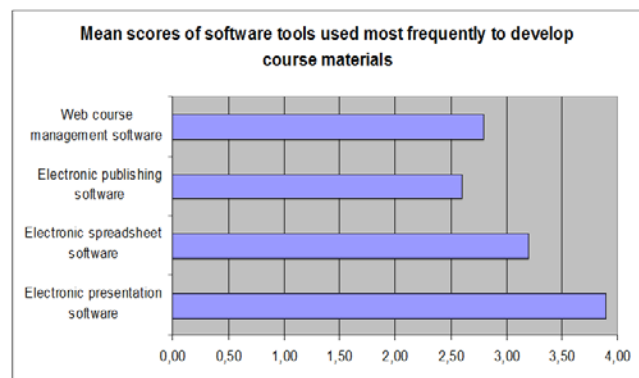


Figure 11. Results from question 7.

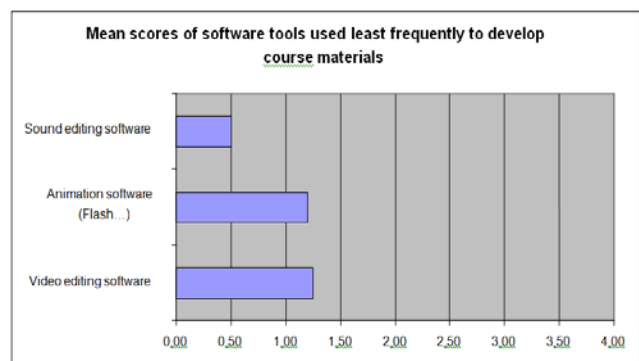


Figure 12. Results from question 7.

Power Point is far most used tool. Video, sound and animation software are used much less frequently. Many of them have never used any of those tools. Overall, there is a clear division between the tools the respondents used reasonably often and those used by only several. It is not that they don't want or need to use them, but they are simply too complex to the most of them, for which they need an assistance. This strong division also tells us that there is a strong division into heavy users of certain tools, and complete nonusers. It is encouraging to see that Course management software, which was only introduced within our project, has a factor of over 2.5.

Question 8: “How helpful have you found each of the following ways of acquiring skills about educational technology?” (Figures 13 and 14).

The ranking shows that the respondents found many of the ways of learning listed here, at least somewhat helpful. Three out of four top-ranked options involved being face-to-face, and practically every method of learning about technology that puts a faculty member in the presence of another more skilled person was highly ranked. Online classes are not favorable way of learning. This topic is highly confusing. How could the teachers encourage the students to take on-line classes, if they are not enthusiastic when asked to follow, or prepare such lectures?

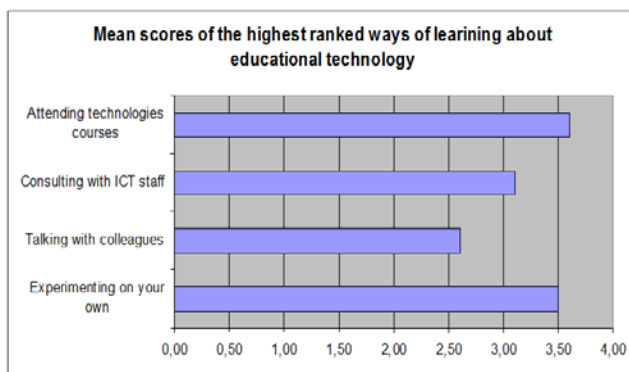


Figure 13. Results from question 8.

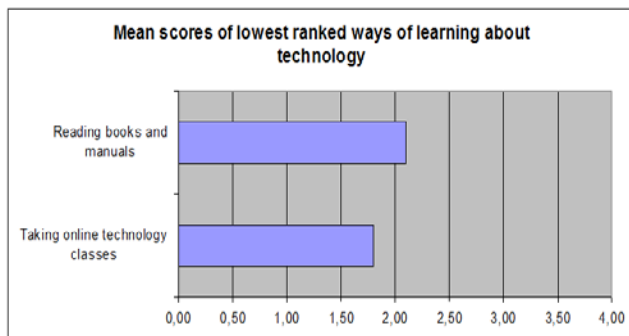


Figure 14. Results from question 8.

Question 9: “Suppose you had a time slot in which you can learn about educational technology. Which of the following topics is most interesting to you?” (Figures 15 and 16).

On a first glance, the prominent interest in information design is consistent with the perception of the educational technology primarily as a way of delivering information. On the other hand, their obvious concern with the pedagogy of teaching that also scores high could be somehow interpreted

differently. They are aware that educational technology provides them with excellent tools and possibilities to support other ways of teaching, like interaction with students, problem based teaching, individual and collaborative work, etc. They just lack time and lack skills to implement such teaching techniques.

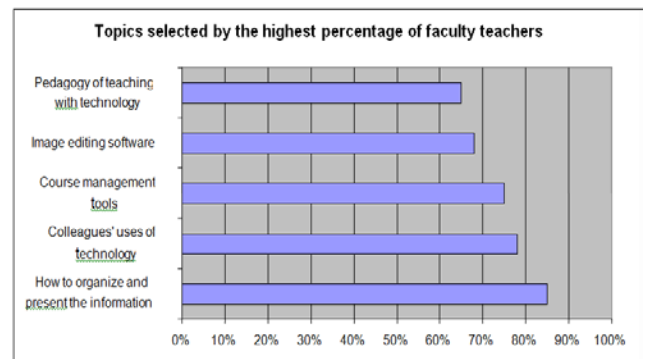


Figure 15. Results from question 9.

Another interesting feature of responses is the dominance of non-technical topics among top-rated answers. Respondents appeared to be interested in learning about design, usability, and pedagogy to a greater extent than learning about the changing bits and peaces of technology. This is very satisfying result for the project results, since we were insisting on these priorities for modern teaching. Further, this evidence suggests that faculty interest in their colleagues' uses of technology stems from desire to understand how to use educational technology well. All of this may point to a tendency among faculty members to focus on the educational rather than on the technical aspects of digital technology.

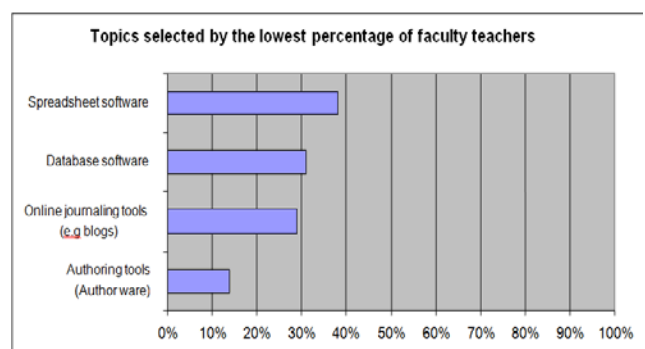


Figure 16. Results from question 9.

Question 10: “What are disciplines where technology supported learning is most efficient and applicable: Social sciences, Art/Music, Exact sciences, Languages?” (Figure 17).

The results are reflecting almost exactly our project experience, working with teachers that teach courses in the above categories. We were very satisfied with the response particularly in teachers teaching languages and arts. It kept surprising us all the time the lack of imagination of the teachers in sciences (math, physics, biology, chemistry...) to use enormous repositories with readymade objects, even if most of them are language independent, explaining via animations some very abstract phenomena, etc.

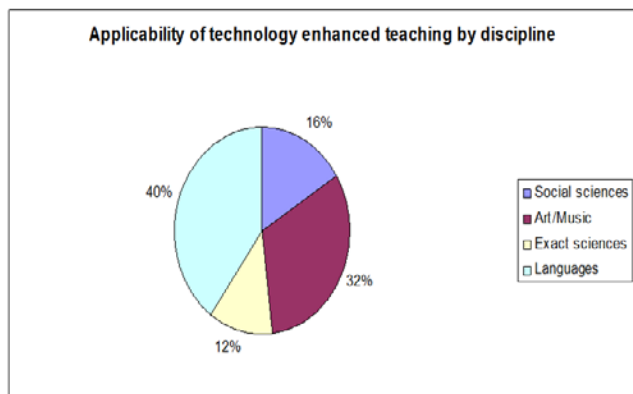


Figure 17. Results from question 10.

On the other hand, the teachers in arts and music were most creative and really felt that their teaching is made more efficient, attractive and rich with technologies.

Question 11: “What are the most interesting developments in educational technology that you are aware of (either now, or coming in the future)?”

Here are the different technologies ordered in decreasing priority, given by the respondents: Wikis, Blogs, Adobe suit, Virtual reality, Student response systems.

Analysis

Interestingly “Student response systems” was the single most common answer to this question, although this was not a popular answer to the question that asked respondents to imagine an ideal classroom. All these answers leads us to a conclusion, when we analyze the previous questions and answers, that the listed technologies above have a recognized value and potential for the future, but not what they actually use right now to enhance the teaching.

Question 12: “What are the most effective ways of using technology in your discipline?”

Analysis

Responses to this question varied widely and fit no easily to a certain pattern. One theme had to do with the use of non-text media, like animations, video and graphics. From one of the previous question answers, one can see that these technologies were poorly ranked in their usage. Conclusion might go into the direction that the majority of the teachers would be very keen to use them, only they lack skills and it seems to them as a complex problem. Group and individual student projects were also mentioned by many respondents.

Question 13: “Do you have any further comments regarding educational technology at your university/faculty?”

Analysis

In responses to this question, many faculty members emphasized the need for support, provided by well trained staff members. General worries about the lack of standardization were mentioned as well, specifically concerns about cross-platform compatibility; different and changing course management systems; lack of centrally supported services and applications; lack of material in Macedonian language on the Web; variations in classroom technology; compatibility with the technology solutions in MK schools; lack of institutional strategy.

3. Results

We can summarize the following moderate encouraging picture from the results presented above:

- Teachers have moderate to strongly positive attitudes toward educational technologies
- They reported a relatively moderate rate of problems related to their use of educational technologies
- Strongly desired to learn more about educational technologies

- Believed that digital technology is educationally effective in a variety of contexts

Technology as information delivery tool

Faculty teachers appear to see educational technology primarily as a means for the efficient delivery of information. Respondents, unfortunately, consistently rated uses of technology that support collaboration, interaction, engagement, or games and simulations below uses that support information delivery, increased access to and effective information design of course materials, etc.

Time factor

Lack of time is an extremely important issue for faculty teachers. The “amount of time required to learn about technology” was among the highest barriers the respondents cited to their use of technology. Also the “amount of time required to use technology in class” was among the highest ranked. In their open discussions they describe in detail their shortage of time to learn, compared to time spent on administration, lectures, consultations with students and research. Most interesting is that most of them expressed preferences for services that involve others doing things for them (Web site setup and hosting, developing materials, etc.)

Importance of examples/models

Survey respondents indicated that one of the biggest barriers that affect their use of educational technologies is the lack of models and examples of effective use. Talking with colleagues followed only experimenting on one’s own as respondents preferred way of learning. Finally, vast majority reported that they want to learn more about how their colleagues use educational technology.

Training and technical support

Lack of technology support was one of the most important barriers respondents cited to their use of technology. Providing this support is their highest priority. They all emphasized the need for facilities accessible after the working hours and the need for well trained staff members.

Pressure from students

Faculty members are not motivated to use or not use educational technology by student demand or

resistance. We often think that student demand motivates faculty teachers to integrate technology into the teaching, which showed not to be exactly the case. The converse is expressed somewhat less frequently, namely that educators are sometimes reluctant to use certain technologies because of students’ resistance. It is interesting to note that neither of these ideas is supported by the data from this survey. Student demand for technology, in teachers prospective was very low on the list that attracts respondents to use of technology, and student resistance to technology likewise was very low on the list of barriers.

Technology users and non-users

Faculty members who do not use educational technologies are more concerned about their lack of skills, knowledge, and access to models, and have more doubts about its effectiveness.

For the purpose of this analysis, technology users were defined as respondents who reported having taught at least one course involving online educational technology uses more advanced technology into teaching. It was the vast majority of respondents (76%).

4. Conclusion

Considering very carefully the findings from this survey, as well as the outcomes from the other research made within the project, a sound strategy was built up and successfully implemented through the following working packages:

- Revision, reconstruction and innovation of undergraduate and postgraduate curriculum at Tecaheer Training Faculties in MK. Courses (non-ICT) were reconstructed, upgraded and new developed to integrate E-Learning into the teaching process, respecting the subject matter content and providing student-centered program
- E-Learning Expertise Centre (<http://elc.ugd.edu.mk>) was established that is: E-Learning Resource centre for all the Faculties of Pedagogy in our country with full technical support; Support of the teaching process; Support of the practical work of the staff and the students; Regional

E-Learning Help Centre for the schools in the region; Training Centre.

- Necessary E-Learning supporting teaching tools were developed (instructional and authoring software).
- A general model for E-Learning integration into the teaching process was developed, also applicable for other educational settings.
- System for Quality control and monitoring was developed and introduced.

The findings of the survey paved our way towards higher motivation from the teachers and the students, their critical adoption of technologies and changing their attitude towards the learning/teaching process in general.

References

- [1]. Grceva, S., Zdravev, Z., "Monitoring the teacher's attitude in adopting the new information technologies", Proceedings of the Second International Balkan Congress: Searching excellence in education, Edirne, Turkey, 2004.
- [2]. "Faculty Technology Survey 2007", <http://www.oit.umn.edu/prod>, University of Minnesota, US, 2007.
- [3]. <http://web.ccsu.edu/itc/2007surveyresults/p5classroomtechnology.pdf>
- [4]. Daniel A. Wagner, Bob Day, Tina James, Robert B. Kozma, Jonathan Miller, Tim Unwin, "Monitoring and Evaluation of ICT in Education Projects", Handbook, November 2005.
- [5]. Grceva, S., "Evaluation of technology supported courses", Document published by Tempus JEP 40020-2005, 2009.
- [6]. Roblyer. MD, "Integrating Educational Technology into Teaching, Starting out on the Internet: A Learning Journey for Teachers", Prentice Hall, 2003.
- [7]. Solza Grceva, Software Process Self-Assessment Methodology, Tem Journal, ISSN 2217-8309, e-ISSN 2217-8333, pp 65-72, Vol. 1, No. 2, 2012.
- [8]. Hutchison, A., Reinking, D., "Teachers' Perceptions of Integrating Information and Communication Technologies Into Literacy Instruction: A National Survey in the United States", Reading Research Quarterly, 2011.

Corresponding author: Solza Sopova Grceva .
Institution: Faculty for ICT ,FON University, Bul.
Vojvodina bb, Skopje, R.Macedonia.
E-mail: solza.grceva@fon.edu.mk

Formalization of the General Hoare Logic Laws

Aleksandar Kupusinac¹, Dusan Malbaski¹

¹Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

Abstract – This paper presents a new approach to formalizing the general rules of the Hoare logic. Our way is based on formulas of the first-order predicate logic defined over the abstract state space of a virtual machine, i.e. so-called *S*-formulas. *S*-formulas are general tool for analyzing program semantics inasmuch as Hoare triples of total and partial correctness are not more than two *S*-formulas. The general rules of Hoare logic, such as the laws of consequence, conjunction, disjunction and negation can be derived using axioms and theorems of first-order predicate logic. Every proof is based on deriving the validity of some *S*-formula, so the procedure may be automated using automatic theorem provers. In this paper we will use Coq.

Keywords – Program verification, program correctness, Hoare logic, first-order predicate logic, Coq.

1. Introduction

Hoare logic incorporates the formulas of total and partial correctness, the assignment axiom and numerous rules [1]. The formulas of total and partial correctness are customarily denoted respectively by $\{P\}S\{Q\}$ and $P\{S\}Q$ and their meaning is given in a descriptive form. Instead of this, this paper introduces strict mathematical notation for both formulas treating them as two special *S*-formulas [2]. Formulas of the first-order predicate logic defined on the abstract state space we call briefly *S*-formulas [3].

We will show that the general rules of Hoare logic are theorems that can be derived using solely the axioms and theorems of predicate logic. It follows that Hoare logic is a special case of first-order predicate logic. Connecting Hoare's ideas with predicate logic is of significant importance [2, 4]. In such connection Hoare logic is an appropriate mechanism for describing program syntax, while in its background predicate logic stays with its powerful mathematical proving tools.

Accordingly, proving program correctness, as well as building new theorems conforms to the validity proofs of appropriate *S*-formulas. Based on that, we may conclude that for proving program correctness and new theorems we need rather uncomplicated mathematical tools such as axioms, theorems and

proving procedures of first-order predicate logic. Moreover, the above-mentioned proofs can be automated by using theorem provers. We will demonstrate those possibilities using the prover Coq [5].

The Coq system is designed to develop mathematical proofs, and especially to write formal specifications, programs and to verify that programs are correct with respect to their specification. It provides a specification language named GALLINA. Terms of GALLINA can represent programs as well as properties of these programs and proofs of these properties. Clearly, GALLINA allows to develop mathematical theories (built from axioms, hypotheses, parameters, lemmas, theorems and definitions of constants, functions, predicates and sets) and to prove specifications of programs [6].

2. *S*-formulas

In this paper we use the following concepts and notation:

- The set of abstract states A ,
- State variables (*S*-variables) x, y, z, \dots ,
- State constants (*S*-constants) s_1, s_2, s_3, \dots ,
- Unary *S*-formulas or *S*-predicates P, Q, B, \dots ,
- Binary *S*-formulas or *S*-relations S_1, S_2, S_3, \dots ,
- Program variables a, b, c, \dots ,
- Program constants c_1, c_2, c_3, \dots .

Let $\{a_1, a_2, \dots, a_n\}$ be a set of program variables, which take values from sets D_1, D_2, \dots, D_n respectively. Interpretation of the set A with respect to the set $\{a_1, a_2, \dots, a_n\}$ is a bijection that maps any *S*-constant from A to the appropriate vector of program constants from D_1, D_2, \dots, D_n (usually called state vector). *S*-relation $S(x,y)$ contains ordered pairs (x,y) , where $x \in A$ is the initial state and $y \in A$ is the final state. Interpreted *S*-relation on the set A is called syntactic unit on program variables $\{a_1, a_2, \dots, a_n\}$. A syntactic unit may be written in many different ways (program code is one of them), and it can refer to a statement, block, subprogram or

program. This means that we observe two domains: the abstract state domain with S -constants, S -variables, S -predicates and S -relations and the interpretation domain with vectors of program constants, program variables, predicates and syntactic units. To simplify, S -constant is interpreted as a vector of program constants from the set D_1, D_2, \dots, D_n , S -predicate is interpreted as a Boolean expression, and S -relation as a syntactic unit with program variables $\{a_1, a_2, \dots, a_n\}$. Interpretation is denoted by “.”. For example, $x: a > 0 \wedge b = 5$ means that S -variable x represents all states in which program variables a and b satisfy $a > 0$ and $b = 5$.

The symbol \leftrightarrow means “abbreviation”. If α is a token and F is an S -formula then $\alpha \leftrightarrow F$ means “ α is an abbreviation for F ”. If F_1 and F_2 are two S -formulas with the same form, we say that F_1 is syntactically identical to F_2 , and write $F_1 = F_2$. If F_1 and F_2 have the same meaning but not the same form, they are semantically equivalent, denoted by $F_1 \equiv F_2$. When writing S -formulas we will obey the usual priority conventions, where the order of priority is: negation \neg , conjunction \wedge , disjunction \vee , implication \Rightarrow , equivalence \Leftrightarrow . The priority can be changed by using brackets $()$ and $[]$.

We use strict mathematical notation for $\{P\}S\{Q\}$ and $P\{S\}Q$ formulas:

- Total correctness formula (**TCF**)

$$\{P\}S\{Q\} \leftrightarrow \forall x[P(x) \Rightarrow (\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z)))] ,$$

- Partial correctness formula (**PCF**)

$$P\{S\}Q \leftrightarrow \forall x[(P(x) \wedge \exists yS(x,y)) \Rightarrow \forall z(S(x,z) \Rightarrow Q(z))] .$$

Hoare’s total correctness formula, denoted by $\{P\}S\{Q\}$, is defined by the statement “if the syntax unit S starts in a state satisfying the predicate P , then it terminates in a state satisfying the predicate Q ” [1]. The connection between this sentence and the formula (**TCF**) is apparent: if for every state x the S -predicate P holds, then the S -formula $\forall x \exists y S(x,y) \wedge \forall z (S(x,z) \Rightarrow Q(z))$ is true. The state x is then called the initial state. The formula $\forall x \exists y S(x,y)$ means that for every initial state x there exists a state y such that $S(x,y)$. The state y is then called the final state. The meaning of the S -formula $\forall x \forall z (S(x,z) \Rightarrow Q(z))$ is the following: if for every initial state x and every state z it is true that $S(x,z)$, then in the state z the S -predicate Q is true.

Hoare’s partial correctness formula, denoted by $P\{S\}Q$, is defined by the statement “if the syntax unit S starts in a state satisfying the predicate P and if it terminates then the final state satisfies the predicate Q ” [1, 7]. In terms of our consideration, we assert: if for some state x the predicate P holds and if there exists a final state y such that $S(x,y)$, then the formula $\forall x \forall z (S(x,z) \Rightarrow Q(z))$ is true.

We will briefly cite some well-known theorems of predicate logic that will be needed for further proofs in this paper (the symbols F, G, H and K stand for S -formulas):

- (T₁) $\forall x \forall y F \Leftrightarrow \forall y \forall x F$,
- (T₂) $\exists x \exists y F \Rightarrow \exists y \exists x F$,
- (T₃) $\forall x F \Leftrightarrow F$,
- (T₄) $\forall x (F \wedge G) \Leftrightarrow \forall x F \wedge \forall x G$,
- (T₅) $\forall x F \vee \forall x G \Rightarrow \forall x (F \vee G)$,
- (T₆) $\neg \forall x F \Leftrightarrow \exists x \neg F$,
- (T₇) $\forall x F \Leftrightarrow \forall x (F \Leftrightarrow \tau)$,
- (T₈) $\forall x (\tau \Rightarrow F) \Leftrightarrow \forall x F$,
- (T₉) $\forall x \neg F \Leftrightarrow \forall x (F \Leftrightarrow \phi)$,
- (T₁₀) $\forall x (F \Leftrightarrow F \wedge F)$,
- (T₁₁) $\forall x (F \Leftrightarrow F \vee F)$,
- (T₁₂) $\forall x (\neg F \vee \neg G) \Leftrightarrow \forall x \neg (F \wedge G)$,
- (T₁₃) $\forall x (\neg F \wedge \neg G) \Leftrightarrow \forall x \neg (F \vee G)$,
- (T₁₄) $\forall x (F \Rightarrow G) \Rightarrow (\forall x F \Rightarrow \forall x G)$,
- (T₁₅) $\forall x (F \Rightarrow G) \Leftrightarrow \forall x (\neg F \vee G)$,
- (T₁₆) $\forall x [(F \Rightarrow H) \wedge (H \Rightarrow G)] \Rightarrow \forall x (F \Rightarrow G)$,
- (T₁₇) $\forall x [(F \Rightarrow G) \wedge (H \Rightarrow K)] \Rightarrow \forall x [(F \vee H) \Rightarrow (G \vee K)]$,
- (T₁₈) $\forall x [(F \Rightarrow G) \wedge (H \Rightarrow K)] \Rightarrow \forall x [(F \wedge H) \Rightarrow (G \wedge K)]$,
- (T₁₉) $\forall x [(F \Rightarrow G) \wedge (F \Rightarrow H)] \Leftrightarrow \forall x (F \Rightarrow G \wedge H)$,
- (T₂₀) $\forall x [(F \Rightarrow G) \vee (F \Rightarrow H)] \Leftrightarrow \forall x (F \Rightarrow G \vee H)$,
- (T₂₁) $\forall x [(F \Rightarrow H) \wedge (G \Rightarrow H)] \Leftrightarrow \forall x (F \vee G \Rightarrow H)$,
- (T₂₂) $\forall x [(F \Rightarrow G) \vee (H \Rightarrow K)] \Rightarrow \forall x [(F \wedge H) \Rightarrow (G \vee K)]$,

where

$$\begin{aligned} \forall x \tau(x) &\equiv \top, \\ \forall x \phi(x) &\equiv \perp. \end{aligned}$$

Program correctness or a new theorem are proven by proving the validity of an appropriate S -formula. This needs a modest mathematical apparatus e.g. the axioms, theorems and proof procedures of the first-order predicate logic. Firstly, we prove a useful theorem which provides an alternative form of the total correctness formula (**TCF**).

Theorem 1. $\{P\}S\{Q\} \Leftrightarrow \forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z [P(x) \wedge S(x,z) \Rightarrow Q(z)]$.

Proof. Since:

$$\{P\}S\{Q\} \Leftrightarrow \forall x[P(x) \Rightarrow (\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z)))]$$

, by the Theorem (T₁₉), the right side becomes:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[P(x) \Rightarrow (S(x,z) \Rightarrow Q(z))]$$

and by the Theorem (T₁₅), it becomes:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[P(x) \Rightarrow (\neg S(x,z) \vee Q(z))] \\ \equiv \forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[\neg P(x) \vee (\neg S(x,z) \vee Q(z))].$$

After that, by the Theorem (T₁₂), we obtain:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[\neg(P(x) \wedge S(x,z)) \vee Q(z)]$$

and finally, by the Theorem (T₁₉), it becomes:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)].$$

Q.E.D.

3. General Laws of the Hoare Logic

In this section we will consider the general laws of Hoare logic such as the laws of consequence, disjunction, conjunction and negation [1]. While the Hoare logic treats these laws as rules, we will treat them as theorems. Some of them will be proven using Coq automatic prover.

3.1 Laws of Consequence

Theorem 2. $\forall x(P(x) \Rightarrow R(x)) \wedge \{R\}S\{Q\} \Rightarrow \{P\}S\{Q\}$.

Proof. Since:

$$\{R\}S\{Q\} \Leftrightarrow \forall x[R(x) \Rightarrow (\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z)))]$$

the left side of the implication can be written as:

$$\forall x(P(x) \Rightarrow R(x)) \wedge \forall x[R(x) \Rightarrow (\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z)))]$$

and by the Theorem (T₁₆), we obtain:

$$\forall x[P(x) \Rightarrow (\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z)))]$$

i.e.

$$\{P\}S\{Q\}.$$

Q.E.D.

Theorem 3. $\{P\}S\{R\} \wedge \forall z(R(z) \Rightarrow Q(z)) \Rightarrow \{P\}S\{Q\}$.

Proof. By the Theorem 1, the left side of the implication can be written as:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[P(x) \wedge S(x,z) \Rightarrow R(z)] \wedge \forall z(R(z) \Rightarrow Q(z))$$

and by the Theorem (T₁₆), we obtain:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)],$$

i.e.

$$\{P\}S\{Q\}.$$

Q.E.D.

Theorem 4. $\forall x(U(x) \Rightarrow P(x)) \wedge \forall z(Q(z) \Rightarrow V(z)) \wedge \{P\}S\{Q\} \Rightarrow \{U\}S\{V\}$.

Proof. By the Theorem 2, the left side of the implication can be written as:

$$\forall z(Q(z) \Rightarrow V(z)) \wedge \{U\}S\{Q\}$$

and by the Theorem 3, we obtain:

$$\{U\}S\{V\}.$$

Q.E.D.

Finally, using by the Theorem (T₃), from Theorems 2, 3 and 4 we can obtain the well-known Hoare's rules of consequence [1]:

$$\frac{(P \Rightarrow R), \{R\}S\{Q\}}{\{P\}S\{Q\}},$$

$$\frac{\{P\}S\{R\}, (R \Rightarrow Q)}{\{P\}S\{Q\}},$$

$$\frac{(U \Rightarrow P), (Q \Rightarrow V), \{P\}S\{Q\}}{\{U\}S\{V\}}.$$

The Theorems 2, 3 and 4 also can be proven using automatic prover Coq:

```
Variable A: Set.
Variables P Q R: A->Prop.
Variable S: A->A->Prop.
Theorem t2 : ((forall x:A, (P x->R x)) /\
(forall x:A, (R x ->((exists y:A, S x y)/\
(forall z:A, (S x z ->Q z )))))) ->
(forall x, (P x ->((exists y, Sxy)/\
(forall z, (S x z ->Q z ))))))).
firstorder.
```

```
Variable A: Set.
Variables P Q R: A->Prop.
Variable S: A->A->Prop.
Theorem t3 : ((forall x:A, (P x ->((exists
y:A, S x y)/\
(forall z:A, (S x z ->Q z )))))) /\
(forall z:A, (Q z ->R z))) -> (forall x,
(P x ->((exists y, S x y)/\
(forall z, (S x z ->R z ))))))).
firstorder.
```

```
Variable A: Set.
Variables P Q U V: A->Prop.
Variable S: A->A->Prop.
Theorem t4 : ((forall x:A, (U x->P x)) /\
(forall x:A, (P x ->((exists y:A, S x y)/\
(forall z:A, (S x z ->Q z )))))) /\
(forall z:A, (Q z ->V z))) -> (forall x, (U x ->((exists
y, S x y)/\
(forall z, (S x z ->V z ))))))).
firstorder.
```

3.2 Laws of Conjunction

Theorem 5. $\{P\}S\{Q\} \wedge \{R\}S\{W\} \Rightarrow \{P \vee R\}S\{Q \vee W\}$.

Proof. By the Theorem 1, the left side of the implication can be written as:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)] \wedge \forall x[R(x) \Rightarrow \exists yS(x,y)] \wedge \forall x\forall z[R(x) \wedge S(x,z) \Rightarrow W(z)].$$

By the Theorem (T₁₇), we obtain:

$$\begin{aligned} & \forall x[(P(x) \vee R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[(P(x) \wedge S(x,z)) \vee \\ & (R(x) \wedge S(x,z)) \Rightarrow (Q(z) \vee W(z))] \\ & \equiv \forall x[(P(x) \vee R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[((P(x) \vee R(x)) \\ & \wedge (S(x,z) \vee S(x,z))) \Rightarrow (Q(z) \vee W(z))] \\ & \equiv \forall x[(P(x) \vee R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[(P(x) \vee \\ & R(x)) \wedge S(x,z) \Rightarrow (Q(z) \vee W(z))], \\ & \text{i.e.} \\ & \{P \vee R\}S\{Q \vee W\}. \end{aligned}$$

Q.E.D.

Theorem 6. $\{P\}S\{Q\} \wedge \{R\}S\{W\} \Rightarrow \{P \wedge R\}S\{Q \wedge W\}$.

Proof. By the Theorem 1, the left side of the implication can be written as:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)] \wedge \forall x[R(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[R(x) \wedge S(x,z) \Rightarrow W(z)].$$

By the Theorem (T₁₈), we obtain:

$$\begin{aligned} & \forall x[(P(x) \wedge R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[(P(x) \wedge S(x,z)) \wedge \\ & (R(x) \wedge S(x,z)) \Rightarrow (Q(z) \wedge W(z))] \\ & \equiv \forall x[(P(x) \wedge R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[(P(x) \wedge R(x)) \wedge \\ & S(x,z) \Rightarrow (Q(z) \wedge W(z))], \\ & \text{i.e.} \\ & \{P \wedge R\}S\{Q \wedge W\}. \end{aligned}$$

Q.E.D.

The Theorems 5 and 6 can be proven using Coq:

```
Variable A: Set.
Variables P R Q W: A->Prop.
Variable S: A->A->Prop.
Theorem t5 : ((forall x:A, (P x -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> Q z ))))) /\ (forall x:A, (R x -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> W z )))))) -> (forall x:A, ((P x /\ R x) -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> (Q z /\ W z ))))))).
firstorder.
```

```
Variable A: Set.
Variables P Q R W: A->Prop.
Variable S: A->A->Prop.
Theorem t6 : ((forall x:A, (P x -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> Q z ))))) /\ (forall x:A, (R x -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> W z )))))) -> (forall x:A, ((P x /\ R x) -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> (Q z /\ W z ))))))).
firstorder.
```

3.3 Law of Resolution

Corollary 1. $\{P\}S\{Q\} \wedge \{\neg P\}S\{W\} \Rightarrow \{\tau\}S\{Q \vee W\}$.

Proof. If we substitute R with $\neg P$ in the Theorem 5 we obtain:

$$\begin{aligned} & \{P\}S\{Q\} \wedge \{\neg P\}S\{W\} \Rightarrow \{P \vee \neg P\}S\{Q \vee W\}, \\ & \equiv \{P\}S\{Q\} \wedge \{\neg P\}S\{W\} \Rightarrow \{\tau\}S\{Q \vee W\}. \end{aligned}$$

Q.E.D.

3.4 Law of Disjunction

Theorem 7. $\{P\}S\{Q\} \vee \{R\}S\{W\} \Rightarrow \{P \wedge R\}S\{Q \vee W\}$.

Proof. By the Theorem 1, the left side of the implication can be written as:

$$\begin{aligned} & (\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)]) \\ & \vee (\forall x[R(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[R(x) \wedge S(x,z) \Rightarrow W(z)]) \\ & \equiv (\forall x[P(x) \Rightarrow \exists yS(x,y)] \vee \forall x[R(x) \Rightarrow \exists yS(x,y)]) \wedge (\forall x \forall z \\ & [P(x) \wedge S(x,z) \Rightarrow Q(z)] \vee \forall x \forall z[R(x) \wedge S(x,z) \Rightarrow W(z)]). \end{aligned}$$

By the Theorem (T₂₂), we obtain:

$$\begin{aligned} & \forall x[(P(x) \wedge R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[(P(x) \wedge S(x,z)) \wedge \\ & (R(x) \wedge S(x,z)) \Rightarrow (Q(z) \vee W(z))] \\ & \equiv \forall x[(P(x) \wedge R(x)) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[(P(x) \wedge R(x)) \wedge \\ & S(x,z) \Rightarrow (Q(z) \vee W(z))], \\ & \text{i.e.} \\ & \{P \wedge R\}S\{Q \vee W\}. \end{aligned}$$

Q.E.D.

The proof of Theorem 7 in Coq is following:

```
Variable A: Set.
Variables P Q R W: A->Prop.
Variable S: A->A->Prop.
Theorem t7 : ((forall x:A, (P x -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> Q z ))))) /\ (forall x:A, (R x -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> W z )))))) -> (forall x:A, ((P x /\ R x) -> ((exists y:A, S x y) /\ (forall z:A, (S x z -> (Q z /\ W z ))))))).
firstorder.
```

3.5 Laws of Conjunction and Disjunction

Theorem 8. $\{P \vee R\}S\{Q\} \Leftrightarrow \{P\}S\{Q\} \wedge \{R\}S\{Q\}$.

Proof. The left side of the equivalence can be written as:

$$\forall x[(P(x) \vee R(x)) \Rightarrow \exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z))]$$

and by the Theorem (T₂₁), we obtain:

$$\forall x[(P(x) \Rightarrow \exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z))) \wedge (R(x) \Rightarrow \exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z)))],$$

i.e.

$$\{P\}S\{Q\} \wedge \{R\}S\{Q\}.$$

Q.E.D.

Theorem 9. $\{P\}S\{Q \wedge R\} \Leftrightarrow \{P\}S\{Q\} \wedge \{P\}S\{R\}$.

Proof. By the Theorem 1, the left side of the equivalence can be written as:

$$\forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow Q(z) \wedge R(z)]$$

and by the Theorem (T₁₈), we obtain:

$$\begin{aligned} & \forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)] \wedge \\ & \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow R(z)] \\ & \equiv \forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow Q(z)] \\ & \wedge \forall x[P(x) \Rightarrow \exists yS(x,y)] \wedge \forall x \forall z[P(x) \wedge S(x,z) \Rightarrow R(z)], \end{aligned}$$

i.e.

$$\{P\}S\{Q\} \wedge \{P\}S\{R\}.$$

Q.E.D.

Theorem 10. $\{P \vee U\}S\{Q \wedge W\} \Leftrightarrow \{P\}S\{Q\} \wedge \{U\}S\{W\} \wedge \{P\}S\{W\} \wedge \{U\}S\{Q\}.$

Proof. By the Theorem 8, from the left side of the equivalence we obtain:

$$\{P \vee U\}S\{Q \wedge W\} \Leftrightarrow \{P\}S\{Q \wedge W\} \wedge \{U\}S\{Q \wedge W\}$$

and by the Theorem 9, we obtain:

$$\{P\}S\{Q \wedge W\} \wedge \{U\}S\{Q \wedge W\} \Leftrightarrow \{P\}S\{Q\} \wedge \{U\}S\{W\} \wedge \{P\}S\{W\} \wedge \{U\}S\{Q\}.$$

Q.E.D.

Theorem 11. $\{P\}S\{Q\} \vee \{P\}S\{W\} \Rightarrow \{P\}S\{Q \vee W\}.$

Proof. If we substitute R with P in the Theorem 7 we obtain:

$$\{P\}S\{Q\} \vee \{P\}S\{W\} \Rightarrow \{P \wedge P\}S\{Q \vee W\}$$

and by the Theorem (T₁₀), we obtain:

$$\{P\}S\{Q\} \vee \{P\}S\{W\} \Rightarrow \{P\}S\{Q \vee W\}.$$

Q.E.D.

3.6 General Law of the Excluded Miracle

Theorem 12. $\{P\}S\{\varphi\} \Leftrightarrow (P \Leftrightarrow \varphi)$, i.e. $\{P\}S\{\varphi\} \Leftrightarrow \neg P.$

Proof. The left side of the equivalence can be written as:

$$\forall x[P(x) \Rightarrow (\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow \varphi(z)))].$$

Since the S -formula $\forall x\forall z(S(x,z) \Rightarrow \varphi(z))$ is valid if

$\forall x\forall z\neg S(x,z)$ is valid, we obtain:

$$\forall x[P(x) \Rightarrow (\exists yS(x,y) \wedge \forall z\neg S(x,z))]$$

$$\equiv \forall x[P(x) \Rightarrow \varphi(x)]$$

and by the Theorem (T₉), we obtain:

$$\forall x\neg P(x)$$

i.e.

$$\neg P.$$

Q.E.D.

3.7 Laws of Negation

Theorem 13. $\{P\}S\{Q\} \wedge \{R\}S\{\neg Q\} \Rightarrow \neg(P \wedge R).$

Proof. If we substitute W with $\neg Q$ in the Theorem 6, we obtain:

$$\{P\}S\{Q\} \wedge \{R\}S\{\neg Q\} \Rightarrow \{P \wedge R\}S\{Q \wedge \neg Q\}$$

$$\equiv \{P\}S\{Q\} \wedge \{R\}S\{\neg Q\} \Rightarrow \{P \wedge R\}S\{\varphi\}$$

and by the Theorem 12, we obtain:

$$\{P\}S\{Q\} \wedge \{R\}S\{\neg Q\} \Rightarrow \neg(P \wedge R).$$

Q.E.D.

Theorem 14. $\{P\}S\{Q\} \wedge \{P\}S\{\neg Q\} \Leftrightarrow \forall x\neg P(x).$

Proof. If we substitute R with $\neg Q$ in the Theorem 9, we obtain:

$$\{P\}S\{Q\} \wedge \{P\}S\{\neg Q\} \Leftrightarrow \{P\}S\{Q \wedge \neg Q\}$$

$$\equiv \{P\}S\{Q\} \wedge \{P\}S\{\neg Q\} \Leftrightarrow \{P\}S\{\varphi\}$$

and by the Theorem 12, we obtain:

$$\{P\}S\{Q\} \wedge \{P\}S\{\neg Q\} \Leftrightarrow \neg P,$$

i.e.

$$\{P\}S\{Q\} \wedge \{P\}S\{\neg Q\} \Leftrightarrow \forall x\neg P(x).$$

Q.E.D.

Theorem 15. $[\{P\}S\{\neg Q\} \Rightarrow \neg\{P\}S\{Q\}] \Leftrightarrow \exists xP(x).$

Proof. By the Theorem (T₁₅), the left side of the equivalence become:

$$\neg\{P\}S\{\neg Q\} \vee \neg\{P\}S\{Q\}$$

and subsequently, by the Theorem (T₁₂), we obtain:

$$\neg[\{P\}S\{\neg Q\} \wedge \{P\}S\{Q\}].$$

Then, by the Theorem 14, we obtain:

$$\neg[\forall x\neg P(x)]$$

and after that, by the Theorem (T₆), we obtain:

$$\exists xP(x).$$

Q.E.D.

Theorem 16. $\{P\}S\{Q\} \wedge \neg\{P\}S\{Q\} \Leftrightarrow \forall x\exists yS(x,y) \wedge \forall x\forall z(S(x,z) \Rightarrow Q(z)).$

Proof. If we substitute R with $\neg P$ in the Theorem 8, we obtain:

$$\{P \vee \neg P\}S\{Q\}$$

$$\equiv \{\tau\}S\{Q\}.$$

Since:

$$\{\tau\}S\{Q\} \Leftrightarrow \forall x[\tau(x) \Rightarrow \exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z))],$$

by the Theorem (T₈), we obtain:

$$\forall x[\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z))].$$

Q.E.D.

Theorem 17. $\exists x\exists zS(x,z) \wedge \neg Q(z) \Rightarrow [\neg\{P\}S\{Q\} \Rightarrow \neg\{P\}S\{Q\}].$

Proof. By the Theorem (T₁₅), the right side of the implication can be written as:

$$\neg\{\neg P\}S\{Q\} \vee \neg\{P\}S\{Q\}$$

and by the Theorem (T₁₂), we obtain:

$$\neg[\{\neg P\}S\{Q\} \wedge \{P\}S\{Q\}].$$

Then, by the Theorem 16, we obtain:

$$\neg\forall x[\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z))]$$

$$\equiv \exists x\neg[\exists yS(x,y) \wedge \forall z(S(x,z) \Rightarrow Q(z))].$$

By the Theorem (T₁₃), we obtain:

$$\exists x[\neg\exists yS(x,y) \vee \neg\forall z(S(x,z) \Rightarrow Q(z))]$$

$$\equiv \exists x[\forall y\neg S(x,y) \vee \exists z\neg(S(x,z) \Rightarrow Q(z))]$$

and by the Theorem (T₁₅), we obtain:

$$\exists x[\forall y\neg S(x,y) \vee \exists z\neg(S(x,z) \wedge \neg Q(z))].$$

After that, by the Theorem (T₁₂), we obtain:

$$\exists x[\forall y\neg S(x,y) \vee \exists z(S(x,z) \wedge \neg Q(z))]$$

$$\equiv \exists x\forall y\neg S(x,y) \vee \exists x\exists z(S(x,z) \wedge \neg Q(z))$$

and finally, by the Theorem (T₁₁), we obtain:

$\exists x \exists z (S(x, z) \wedge \neg Q(z)) \Rightarrow \exists x \exists z (S(x, z) \wedge \neg Q(z)) \vee \exists x \forall y \neg S(x, y)$.

Q.E.D.

The proofs of Theorems 12, 13 and 14 in Coq are following:

```
Variable A: Set.
Variables P : A->Prop.
Variable S: A->A->Prop.
Definition phi (x:A) := False.
Theorem t12 : (forall x:A, (P x -> ((exists
y:A, S x y)/\ (forall z:A, (S x z->phi z))))
<-> (P x<->phi x)).
firstorder.
```

```
Variable A: Set.
Variables P Q R: A->Prop.
Variable S: A->A->Prop.
Theorem t13 : ((forall x:A, (P x ->
((exists y:A, S x y)/\ (forall z:A, (S x z->Q z)))) /\ (forall x:A, (R x -> ((exists
y:A, S x y)/\ (forall z:A, (S x z->(\neg Q z)))))) -> (forall x:A, (\neg(P x /\ R x))).
firstorder.
```

```
Variable A: Set.
Variables P Q: A->Prop.
Variable S: A->A->Prop.
Theorem t14 : ((forall x:A, (P x ->
((exists y:A, S x y)/\ (forall z:A, (S x z->Q z)))) /\ (forall x:A, (P x -> ((exists
y:A, S x y)/\ (forall z:A, (S x z->(\neg Q z)))))) <-> (forall x:A, (\neg(P x))).
firstorder.
```

Corollary 2. $\{P\}S\{Q\} \wedge \{P\}S\{\neg Q\} \Leftrightarrow (P \Leftrightarrow \varphi)$.

Proof. From the Theorem 14 we obtain:

$\forall x \neg P(x)$,
i.e. $P \Leftrightarrow \varphi$.

Q.E.D.

Corollary 3. $\{P\}S\{\neg Q\} \Rightarrow \neg\{P\}S\{Q\} \Leftrightarrow \neg(P \Leftrightarrow \varphi)$.

Proof. From Theorem 15 we obtain:

$\exists x P(x)$
 $\equiv \neg(\forall x \neg P(x))$,
i.e. $\neg(P \Leftrightarrow \varphi)$.

Q.E.D.

4. Conclusion

In this paper, we have proposed a new method for formalizing the general Hoare logic rules. The approach is based on axioms and theorems of first-order predicate logic. It uses so-called *S*-formulas, which are defined on the abstract state space of a virtual machine. Proving program correctness and/or establishing new theorems conform to proving the

validity of the appropriate *S*-formula, and for that, we need only the first-order predicate logic. The mathematical mechanism developed apart from being general, brings together Hoare's ideas and first-order predicate logic. It also enables automatic proofs of program correctness and/or new theorems. In addition, we have provided strictly formal proofs for the general laws of Hoare logic and some of them are proven using Coq automatic prover.

Our future research will be aimed towards investigating formalization of the special Hoare rules (*while*, *if-then-else* etc.) and more complex properties and relationships that exist between preconditions, postconditions and syntax units. The second line of work will be development of algorithms for automated program correctness proofs.

Acknowledgements

This work was partially supported by the Ministry of Science and Education of the Republic of Serbia within the projects: ON 174026 and III 044006.

References

- [1]. Gordon, M. J. C. : *Programming Language Theory and its Implementation*. Prentice Hall International (UK) Ltd., Hertfordshire, UK, 1988.
- [2]. Kupusinac, A. : Analysis of Characteristics of Dynamic Postconditions in Hoare Triples. Ph.D. thesis, (*in Serbian*), Faculty of Technical Sciences, Novi Sad, Serbia, 2010.
- [3]. Kupusinac, A. and Malbaški, D. : Analysis of Loop Semantics using *S*-formulas. TEM Journal: Vol. 1, No. 2, pp. 72-77, 2012.
- [4]. Hoare, C. A. R. and Jifeng, H. : *Unifying Theories of Programming*. Prentice-Hall, London, 1998.
- [5]. Bertot, Y. and Castéran, P. : Interactive Theorem Proving and Program Development, Coq'Art: the Calculus of Inductive Constructions. Texts in Theoretical Computer Science. An EATCS Series, Vol. 25, Springer-Verlag, Berlin, Heidelberg, 2004.
- [6]. The Coq Development Team: The Coq Proof Assistant Reference Manual Version 8.2-bugfix. INRIA, Orsay, France, 2009.
- [7]. Hoare, C. A. R. and Lauer, P. E. : Consistent and Complementary Formal Theories of the Semantics of Programming Languages. Acta Informatica, 3, 135–153, 1974.

Corresponding author: Aleksandar Kupusinac

Institution: University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia

E-mail: sasak@uns.ac.rs

Blended Learning of DSP Through the Integration of On-Site and Remote Experiments

Radojka Krneta¹, Djordje Damnjanovic¹, Marjan Milosevic¹, Danijela Milosevic¹,
Milija Topalovic²

¹ Technical Faculty Čačak, University of Kragujevac, Svetog Save st. 65, Čačak, Serbia

² High School Ivanjica Arilje, Vojvode Misica st. 42, Arilje, Serbia

Abstract - The aim of this paper is to describe blended learning of an engineering master course in DSP through the integration of on-site and remote lab experiments. This integration of lab experiments is suggested as one of successful solution for “visualization” of DSP theory. The student survey concerning to preferred type of lab exercises is carried out and results discussed.

Key words - DSP course, on-site experiments, remote experiments, blended learning mode

1. Introduction

As a rule, learning basic theoretical concepts of signal and system analysis and synthesis is difficult for the students of engineering. This difficulty is a result of the gap between understanding mathematical formalisms of these concepts and student’s abilities to connect these theoretical concepts with practical engineering applications. In the aim of solving this problem many “recipes” suggested for “visualization” of digital signal processing (DSP) theory.

There are many research papers dealing with on-site and remote engineering laboratory experiments. The most of these experiments designed by using LabVIEW and MATLAB/SIMULINK® environments. Some of them consider on-site and remote experiments from the engineering aspect primarily, whereas the other ones deal also with the educational aspect of this method of engineering education.

The five similar scenarios of building a remote web-based laboratory for development and running of DSP experiments are described in the papers [1], [2], [3], [4] and [5]. Laboratory hardware and software consist of microcontroller, digital signal processor (DSP), field-programmable gate array

(FPGA), LabVIEW Virtual Instruments (VI) and client application by which the end user (students) facilitates access to remote experiment resources. Students at remote terminals can perform remotely experiments using real hardware equipments and tools. An in-house developed embedded hardware and a software control system based on MATLAB/Simulink and LabVIEW is used in the DSP remote laboratory at the University of Maribor [5]. This remote laboratory enables the users to easily interact with a set of experiments through a friendly LabVIEW user interface. In addition, this remote laboratory includes a booking system, which enables remote users to book experiments in advance.

Some another papers that we analyzed [6], [7] and [8], deal with remote control applications.

The developed platform for remote real-time control of Internet-connected system [6] is based on an industry-standard DSP board supported by MATLAB/SIMULINK®. The control algorithms for the physical devices can be programmed by two different ways: (1) locally from SIMULINK® and (2) either locally or remotely from an M-code program which is installed from the MATLAB® workspace.

The framework for the WebLab laboratory exercise [7] has been designed using LabVIEW by creating flexible and scalable measurement and control applications that will enable a remote user to perform the required laboratory exercises and control the laboratory equipment.

Web based remote microcontroller laboratory is presented in the [8] as a possibility for making microcontroller experiments independent from the time and place. Several application modules, selected from real life applications, are designed to improve

the skill of the students. The system prompts students for user ID and password. The one who enters to the system will be the moderator of the experiment and 10 minutes duration will be assigned for experiment and the other users can only observe the experiment and discuss with others by using the chat tool.

The special issue of the International Journal of Online Engineering includes some works of The International Conference Exp.at'11[9] devoted to online experimentation, had as scope to contribute to the world capabilities in online experimentation and in particular in remote and virtual labs, fostering the collaborative work in emergent technologies Conference. The papers [10] – [14] have drawn our particular attention.

The approach suggested in [15], based on integrating on-site and distance learning environments, is similar to our approach of DSP laboratory. According to this approach, the students will combine, during the DSP lab, on-site lab sessions and remote-controlled experimentation. Such integration of on-site learning with remote-access experimentation offers a powerful tool, especially for students with learning disabilities or for students who are employed. Presented The Integrated Learning Methodology (ILM) offers an answer to the disadvantages of the on-site and web-based (virtual or remote-access) learning methods when used separately, by integrating their advantages. The laboratory administrator creates accounts and defines time quotas for each experiment. All users, including instructors, gain access to the system via Experiment Management System (EMS) that allows inputting User ID and Password in order to obtain an authentication and clearance to start the session. After clearance is granted and the student has requested particular experiment, he is obliged to submit preliminary questionnaire of the experiment, which is intended for checking that the student has sufficient knowledge for the experiment. The preliminary report is checked by the responsible instructor and, if it is successful, the student is allowed to allocate a time quota for the experiment. After performing the experiment the student submits the final report and gets score and remarks for the experiment.

As we intended to create blended learning mode of our advanced DSP course on the basis of mixture of

on-site and remote exercises and web-based teaching materials, the study of the papers [16] and [17] helped us a lot. In the paper [16] authors have described the usage of the remote laboratory in an e-learning scenario based on common learning platforms such as Moodle. The laboratory architecture is organized in three layers: the resources, the server and the user interface. The resources are the real electronic devices and software packages used to run the lab activities. The lab server is the software module that interacts with these resources and manages the incoming requests from end-users. The DSP lab is structured as a software development environment where users can develop and build C applications, and monitor their execution on the remote development board. Students are able to access the laboratory through a web interface. A proper scheduling module automatically manages concurrent accesses to the same device. The laboratory can be used in two different ways: the user can create a new project and write source code from scratch or load an existing project from a repository. Remote laboratory sessions are integrated in The Aulaweb portal course management system of the University of Genoa and it is based on the Moodle platform. Remote laboratory sessions are introduced by guidelines that explain lab activities.

In the paper [17] authors have presented the new web-learning system, which combines two educational resources, the virtual and remote laboratories (VRLs) and the synchronous collaborative learning practice. The main objective of developed system is to offer a shared VRL that can be controlled in real-time by different members of a virtual class (students and teacher) and to be able to share the same experiments. The collaborative e-learning system that authors have been developed allows a group of students to share experiences at the same time they practice using VRLs. This system also permits teachers to track, supervise, and help students in their experimental exercises in a synchronous way. The VRLs are based in Java applets developed in Easy Java Simulations (EJS). During the teacher tutorial time, students connect to the teacher and ask questions through Skype. The shared VRL is composed of an applet for each class member. Authors are currently working on applying their collaborative synchronous system to remote network laboratories.

Some other authors deal with the pedagogical aspect of DSP learning [18], [19], [20] and [21].

One approach where remote experiments are treated as learning objects, which are stored in a repository, developed and presented in [18]. Advantages of virtual experiment regarding several pedagogical features, such as identification and profiling, discussion forums, testing, report preparation and delivery, user statistics and feedback, have been underlined in this paper.

The educational experience consists of the helping for technology students, who generally learn by Active Experimentation, develop, to some extent, the abilities of Abstract Conceptualization, through innovative teaching technique and enhance their interest in a multidisciplinary curriculum, described in the paper [19].

For the purpose of “visualization” of filtering concepts, LabVIEW filter palette has been used for the virtual experiment of band pass digital filter design and active band pass filter [20]. These virtual experiments also have been realized on hardware developing platform NI-ELVIS II+. Theoretical characteristics of active band pass filter validated by measurements on realized hardware model. Pedagogical issues concerning meeting different learning styles through integration of those virtual and hands-on laboratory experiments in DSP laboratory are elaborated in the [20].

The traditional approach of teaching engineering concepts that comes as the combination of classroom teaching and homework exercises lacks the student's intuition for applying same concepts to different new problems. The integration of virtual and hands-on laboratory experience in addition on theoretical DSP concepts creates the perfect match for improving student practical skills. On the basis of mixture of on-site and remote exercises and web-based teaching materials, blended delivery mode of advanced DSP course at Master study program in Electrical and Computer Engineering, is enabled.

We use on-site MATLAB/SIMULINK® and LabVIEW virtual interactive DSP experiments and hardware DSP laboratory experiments on the NI-ELVIS II + development platform as well as remote DSP experiments on the NI CompactRIO platform in our DSP lab for “visualization” of some course topics

in Advanced Digital Signal Processing as a part of our ongoing efforts in DSP laboratory development.

Individual differences in cognitive learning styles e.g. student's mode of thinking, perceiving, remembering, or problem solving are quite obvious when teaching science or engineering. This indicates that multiple approaches are needed to achieve the best for students. Using student survey we have discovered that we can meet different learning style of our engineering students through integration of on-site and remote DSP experiments.

2. Blended DSP course supported by On-site and Remote experiments

Course in Advanced Digital Signal Processing is the obligatory course of Master Study in Remote Control Curriculum and Master Study in Computer Engineering Curriculum at Technical Faculty Cacak, University of Kragujevac. The main course objectives are to gain:

- The knowledge of advanced signal processing techniques such as random signals filtering, spectral estimation and prediction and adaptive filtering, and to use it in the present-day control systems and engineering applications.
- The use a combination of theory and software and hardware implementations in solving practical signal processing problems.

After completion of this course, each student is expected to be able to:

- Describe and analyze discrete time stationary stochastic signals, in terms of their autocorrelation sequence and spectral density, and to determine how these properties are affected by linear filtering
- Know how to perform sampling and reconstruction and describe how these operations affect both deterministic and stochastic signals, in the time and frequency domain
- Estimate the spectral density of a signal, based on a limited number of noise samples, especially:
 - implement and use non-parametric methods for spectral estimation.

- implement and use parametric methods for spectral estimation.
 - estimate parameters in the models, using MMSE and least squares methods.
 - use the models with the estimated parameters in applications such as spectral estimation and prediction.
- Know how to perform adaptive filtering.
 - Use a combination of theory, hardware and software implementations to solve practical signal processing problems.
 - Think critically, ask questions, and apply problem-solving techniques.

Considering that some of our master students are from the cities dislocated from Technical Faculty place and some of them are employed, we use blended delivery mode for teaching and learning on this course. The course comprises theoretical lectures, placed on the Moodle LMS system, lab and computer sessions. Beside lectures, additional teaching materials, like different tutorials and virtual experiments hosted on the laboratory Moodle system and delivered through the web.

On-site lab exercises with appropriate computational examples and short theoretical test before the lab exercise are organized on the weekends for each of main tree topics of course: Spectral analysis of stochastic signals, optimal filtering and Adaptive filtering.

We use MATLAB software package and The National Instruments (NI) hardware with NI LabVIEW software in our DSP laboratory for creating virtual and hardware experiments.

MATLAB software package has become standardized and inevitable simulation tool for “visualization” of DSP theory. Many MATLAB based DSP “visual experiments” are constituent parts of lectures and practical exercises at the courses of system and signal theory and digital signal processing for a long time.

Like MathWorksInc., National Instruments also offers nowadays plenty of opportunities for incorporating NI hardware and NI LabVIEW software in a classroom and remote laboratory for teaching and learning DSP. Integration NI hardware

and LabVIEW software is almost seamless.

For the reason of achievement the better results and to meet different learning styles we provide our students to exercise on remote DSP experiments via the web in addition to on-site lab sessions.

We foster the class and web discussions via forum to enhance collaborative work during student’s work on on-site and remote laboratory exercises and solving their homework. In this way the simulation of real work engineering environment is done.

This approach of combining of on-site, virtual and remote experiments compensates the disadvantages of one type of experiments with the advantages of other one [15].

2.1 On-site DSP hardware experiments

Modeling and simulation in virtual laboratory environment based on MATLAB and LabVIEW software cannot completely prepare students of Electrical Engineering for work with hardware equipment because they will have to experiment a lot within their future engineering practice during the designing, testing and running of practical engineering applications. The aim of hardware laboratory experiments in education of engineers through “physical contact with hardware” means better understanding of acquired theoretical knowledge in order to apply it more successfully in future engineering practice. It is especially important for the courses with complex mathematical background such as Advanced Digital Signal Processing.

Regarding “physical contact with hardware” we integrated several hardware experiments into the realization of course in Advanced Digital Signal Processing.

One of the on-site hardware DSP experiments in our DSP laboratory, created in the aim of better understanding of theory of course topic in adaptive filtering, illustrates implementation of LMS (Least Mean Square) algorithm on NI cRIO 9074 FPGA hardware platform. NI 9205 as an input module and NI 9263 as an output module are also used as additional hardware components.

The used hardware platform is an advanced embedded control and data acquisition system

designed for applications that require high performance and reliability. NI CompactRIO is powered by National Instruments LabVIEW FPGA and LabVIEW Real-Time technologies, giving engineers the ability to design, program, and customize the CompactRIO embedded system with easy-to-use graphical programming tools. This chassis contains the Spartan-III FPGA chip with 2M gates that offers ultimate processing power and the ability to design custom hardware using LabVIEW FPGA software. This is an embedded real-time controller module featuring an industrial 400MHz Free scale MPC5200 real-time processor for deterministic and reliable real-time applications. The chassis containing the FPGA has 8 slots to connect external hardware modules, used for signal acquisition. The real-time controller contains a 10/100BaseT/TX Ethernet port to communicate with the PC or with other systems. The LabVIEW suite is used to implement the hardware architectures for signal processing. [22]

Another used hardware is a NI 9205 input module. The NI 9205 is a C Series module, for use with NI CompactDAQ and CompactRIO chassis. The NI 9205 features 32 single-ended or 16 differential analog inputs, 16-bit resolution, and a maximum sampling rate of 250 kS/s [23].

The NI 9263 is a 4-channel, 100 kS/s simultaneously updating analog output module for any NI CompactDAQ or CompactRIO chassis [24].

Adaptive filtering is one of the inevitable topics in advanced DSP courses. LMS algorithms are a class of adaptive filter method used to mimic a desired filter by finding the filter coefficients that relate to producing the least mean squares of the error signal (difference between the desired and the actual signal). It is a stochastic gradient descent method in that the filter is only adapted based on the error at the current iteration [25].

The laboratory environment for hardware experiment concerning LMS adaptive algorithm “visualization” is shown in the Fig. 1.

The experiment regarding noise cancellation carried out in the NI LabVIEW FPGA programming environment by using adaptive LMS algorithm.

The hardware experiment described above carried out by using of sine wave input signals which was

compromised by noise. The input signals were set as follows: a sine wave with 0.4V amplitude and 30Hz frequency and the noise signal with 100Hz frequency. The input noisy signal in comparison with the smooth one is shown in the Fig. 2.



Figure 1. The laboratory environment for LMS adaptive algorithm hardware experiment

A system is said to be adaptive when it tries to adjust its parameters with the aim of meeting some well-defined goal or target that depends upon the state of the system and its surroundings. So the system adjusts itself so as to respond to some phenomenon that is taking place in its surroundings. In this case we can said that “surroundings” is noise (first graph in the Fig. 2) and when the process of adaption is done, smooth sine wave signal will be appear on the output of adaptive system (second graph in the Fig. 2).

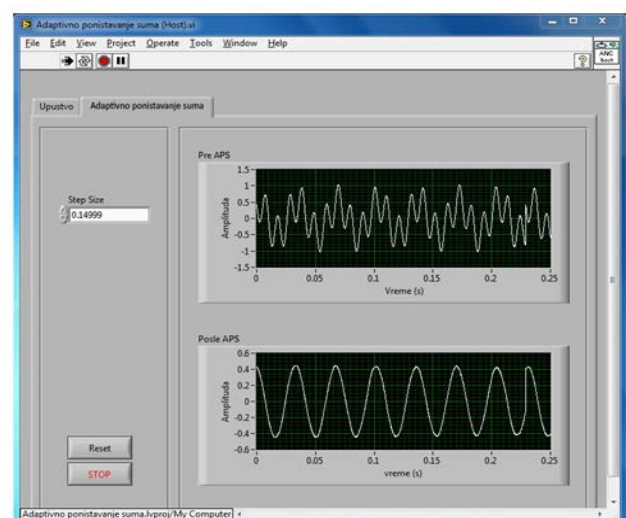


Figure 2. The input noisy signal in comparison with the smooth one 1) signal + noise 2) filtered signal

This is one of good examples for learning how adaptive LMS algorithm can be used in practice that is how the theoretical DSP concepts learned in the classroom are ultimately implemented in a real time embedded DSP system.

Similar implementation of the LMS adaptive algorithm on the NI cRIO-9104 FPGA chassis by using of 20 bit fixed-point arithmetic, have presented in the paper [26]. The design is evaluated in terms of SNR, filter length and FPGA resources. The tracking performance of the LMS derivatives in adaptive noise cancellation for a speech signal corrupted by white noise analyzed in the [27] by using the same NI cRIO-9012 module.

2.2 On-site MATLAB/SIMULINK® DSP experiments

MATLAB software package has become standardized and inevitable way of “visualization” of DSP theory for a long time. Many MATLAB based DSP “visual experiments” are constituent parts of lectures and practical exercises at the courses of system and signal theory and digital signal processing.

Ready-made MATLAB solutions known as “toolboxes”, provide large range of options in combination with Simulink. DSP System Toolbox and Simulink provide algorithms and tools for the design and simulation of digital signal processing. These MATLAB capabilities is of great importance for education of future engineers, because all theoretical concepts can be “seen” by using of MATLAB simulation that faithfully illustrates the processes in a practical environment.

We can design digital filters by MATLAB using either the Digital Filter Design block or the Filter Realization Wizard. These blocks are capable of calculating filter coefficients for various filter structures. In this section, design of LMS adaptive algorithm by using of the Digital Filter Design block is described. We used the conversion of white noise to low frequency noise to simulate white noise effect.

In order to learn how adaptive LMS algorithm can be used in practice, we have simulated a practical application [28]:

Suppose a pilot is speaking into a microphone within the cockpit of an airplane.

The noise of the wind passing over the fuselage is also reaching the microphone. A sensor is measuring the noise of the wind on the outside of the plane. We want to estimate the wind noise inside the cockpit and subtract it from the input to the microphone so that only the pilot's voice is transmitted. Fuselage converts white noise, derived from wind, into low-frequency noise. This noise contains certain frequencies that have to be filtered. Low-frequency noise is transmitted to a microphone with a pilot's voice. The system, which converts white noise to low-frequency noise, have been created in Simulink by using Digital Filter Design block.

Adaptive filters track the dynamic nature of a system and allow us to eliminate time-varying noise signal. The DSP System Toolbox libraries contain blocks that implement least-mean-square (LMS), Block LMS, Fast Block LMS, and recursive least squares (RLS) adaptive filter algorithms [28]. We have design an LMS adaptive filter to remove the low frequency noise from the signal.

In the aircraft scenario, the adaptive filter removes the low frequency noise heard inside the cockpit, so the pilot's voice is the only input to the microphone. The Simulink model for removing noise from the microphone signal is shown in the Fig. 3.

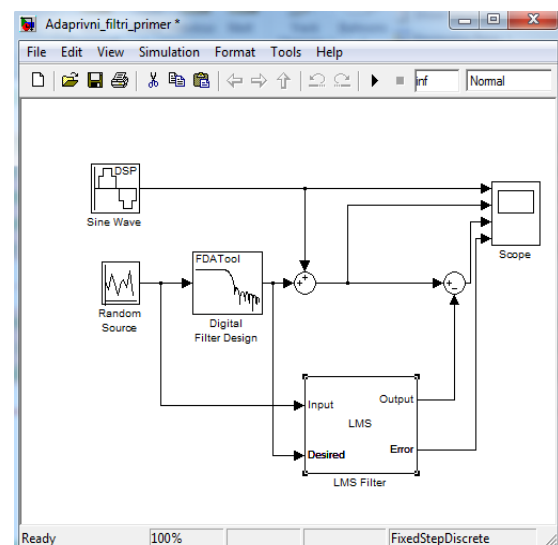


Figure 3. The model of adaptive noise cancellation

The results of the adaptive noise cancellation are shown in the Fig. 4.

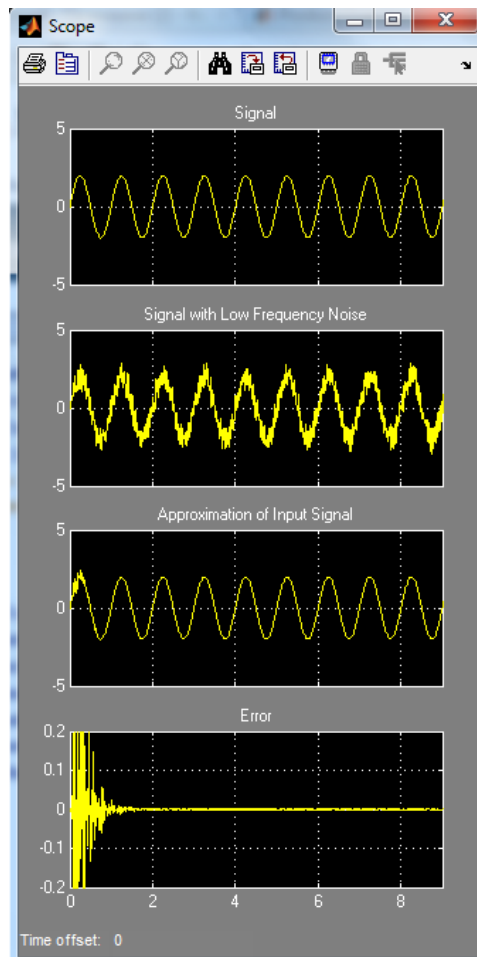


Figure 4. The results of the adaptive noise cancellation

First graph in Fig 4 represents the signal which simulates the voice of the pilot. This signal has to be translated through a microphone to the certain receiver. Second graph indicates that the first signal is compromised by low frequency noise. This signal has to be filtered by adaptive LMS algorithm. The result of process of adaptive noise cancellation is shown on third graph. This signal is the microphone signal from which the noise has removed during adaptation process. The fourth graph represents the signal of adaptation error.

It can be seen that the adaptation error decays to zero quickly.

2.3 Remote DSP Experiments

Web-based remote experimentation enables remote users to develop skills, which deal with real systems and instrumentation with the added advantage of providing broader access to expensive specialized equipment at any time and from any location [1]. When students interact remotely with the laboratory

plants they have the opportunity to verify what happens when they modify and manipulate the experiment. Besides, the student can run the same experiment, more than once.

The combined use of FPGA/PC connected test hardware and appropriate software may open a way to develop a remote multi-user time-sharing system for hardware experiments, where students at remote terminals can perform actual experiments using real hardware equipments and tools remotely from home or students residence.

The remote laboratory, accessible from anywhere through the Internet connection, has been built according to the general methodology to control instruments through Internet [1]. Basic structure of the laboratory is shown in Fig. 5

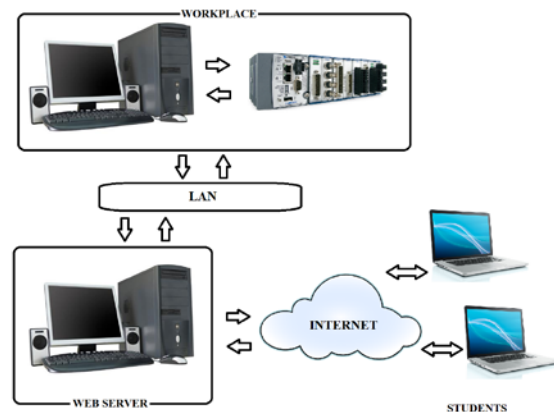


Figure 5. Basic structure of remote laboratory

The workspace in the Fig. 5 in case of our DSP laboratory supports standard iterative FPGA design and testing flow and provides hardware platform for the experiment of noise cancellation that carried out in the National Instrument LabVIEW FPGA programming environment. This experiment (described in 2.1) we realized previously as on-site hardware experiment (Fig. 1).

Lab View has its internal web-server, supporting web-publishing of the created models and algorithms. This option allows us to remotely control cRIO platform and LMS adaptive algorithm implemented on the platform.

In order to allow students to run the algorithm remotely, we configured the network in the following way: the computer running Labview and the cRIO platform are connected to the same LAN network, using Wi-Fi router, which is further, connected to the

Internet and got a public IP address. The Labview's web-server is listening on port 8000, and this port is forwarded on the router, thus the remote user might get to the PC in the LAN and use the web-page generated.

By using Web publishing tool option we assign the URL address for our application. Actually, this is the router's public IP, and using this address the remote user access the hardware or software which is connected to the PC running Labview. The result of remote hardware experiment on the remote user side is shown in the Fig. 6. It is evident that this result is the same as the one carried out as on-site hardware experiment (described in 2.1).

There is a drawback to this remote-experiment scenario: only one user may access to the remote experiment at the same time. Therefore, the usage should be well planned and scheduled.

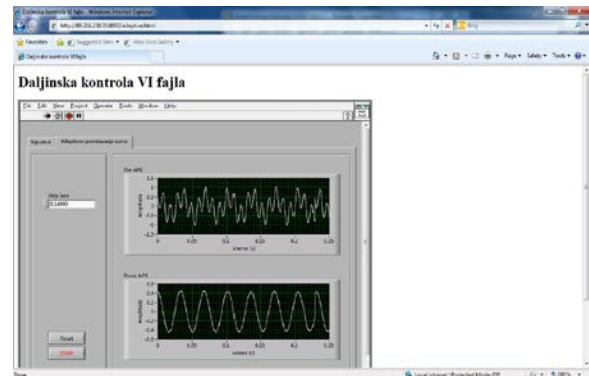


Figure 6. The result of remote hardware experiment on the remote user side

In better understanding of theory concepts in Advanced Digital Signal Processing the most helpful are: (rate with numbers from 1-4, 1 not helpful at all, 2 of very little help, 3- helpful, 4- very helpful)	1. Matlab simulations			
	2. Simulink simulations			
	3. LabView simulations			
	4. Hardware experiments			
For efficient gaining of skills and practical knowledge in Advanced Digital Signal Processing the most helpful are: (rate with numbers from 1-4, 1 not helpful at all, 2 of very little help, 3- helpful, 4- very helpful)	5. Matlab simulations			
	6. Simulink simulations			
	7. LabView simulations			
	8. Hardware experiments			
The most useful scenario, considering place and methods (check one experiment type for every item)				
	Matlab experiment	Simulink experiment	Labview experiment	Hardware experiment
9. In the lab it is most useful to learn individually with				
10. At home, doing remote experiment individually using				
11. In lab, with teacher’s assistance				
12. At home, doing remote experiment with teacher’s online help				
13. In lab, working in group				

Table 1. The questionnaire items

3. Student survey

In order to investigate what is the preferred form of lab exercises among our engineering students, an online survey was constructed. It consisted out of thirteen items, presented in a concise form, using Moodle's Questionnaire module. The group of 22 students was involved in the research. Items used are given in Table 1.

A four-item Likert scale was used for first eight items. For items 9-13 every choice was assigned a number from 1 (Matlab) to 4 (Hardware experiment).

Survey results shown that for theory concepts students prefer LabView, since more than 90% rated this lab exercise as very helpful or helpful. MatLab and Simulink got similar results, while hardware experiments shown as helpfull in about 70% of cases.

For practical knowledge students also mostly preferred LabView, again over 90% „helpfull“ rates.

In third items category, for item 9, hardware experiment was most preferred with about 50% votes. Item 10 showed that about 50% of students prefer Matlab, a bit less was with item 11. At item 12, equal preference was shown for Matlab and LabView, about 40% for each. At item 13 almost 50% of students preferred hardware experiment, followed by Matlab (25%), LabView and SimuLink.

4. Conclusion

It is obvious that is significant number of authors deal with remote and virtual lab exercises in recent years. That is from the reasons of the importance and potential of remote and virtual labs for the enhancement of the learning process in engineering education in the classroom or in an e-learning and blended learning environment. This is should be considered in context of overcoming the gap between understanding mathematical formalisms in engineering courses and practical application deployment.

We have created blended learning environment by integrating virtual and hands-on laboratory practices together with on theoretical DSP concepts to enhance the teaching process for engineering students at the master study course in Advanced Digital Signal Processing at Technical Faculty Cacak, University of Kragujevac.

The extensive survey was conducted to test what the preferred form of lab exercises by combining the questionnaire items on usability on understanding of theory concepts and practical skills and knowledge on course in Advanced Digital Signal Processing. As expected, the obtained results showed that for the most of our students preferred hardware and LabVIEW experiments which obviously indicated that these two kinds of experiments are the most suitable for engineering students as them distinguished by practical learning and useful activities for them are skills practicing [21].

We are going develop our DSP laboratory towards the usage of the remote experiments in an e-learning scenario based on common learning platforms such as Moodle. The authentication of the remote users and the scheduling of the remote experiments have to be solved in such a way that experiments can be controlled in real-time by students and teacher in the virtual class allowing them to share the same experiments like in a traditional classroom. Teachers and students will be enabled to share practical experiences in an collaborative e-learning synchronous environment.

References

- [1] X. Yue, E. M. Drakakis, J. Harkin, M. J. Callaghan, T. M. McGinnity, L. P. Maguire, Modular Hardware Design for Distant-Internet Embedded Systems Engineering Laboratory, *Computer Applications in Engineering Education*, Vol. 17, Issue 4, December 2009, pp. 389-397.
- [2] C. H. Chen, H. C. Lin, A Distance e-Learning Platform for Signal Analysis and Measurement Using FFT, *Computer Applications in Engineering Education*, Vol. 19, Issue 1, March 2011, pp. 71-80.
- [3] R.C. Maher, Crossing the bridge: taking audio DSP from the textbook to the DSP design engineer's bench, *Proc. IEEE Signal Processing Society 4th Signal Processing Education Workshop*, Jackson Lake, WY, September, 2006
- [4] M. Drutarovský, J. Šaliga, I. Hroncová, Hardware infrastructure of remote laboratory for experimental testing of FPGA based complex reconfigurable systems, *Acta Electrotechnica et Informatica*, Vol. 9, No. 1, 2009, pp. 44-50.
- [5] D. Hercog, *Hands-on Teleoperation*, Faculty of Electrical Engineering and Computer Science, University of Maribor, February 2007. http://www.ro.feri.uni-mb.si/predmeti/int_reg/Predavanja/Lab_exercises/taret%20-%20hands%20on%20teleoperation.pdf (Accessed in April 2012)
- [6] O. Peñaloza-Mejía, L. A. Márquez-Martínez, J. Alvarez-Gallegos, and H. J. Estrada-García, DSP-based real-time platform for remote control of internet-

- connected systems, *Computer Applications in Engineering Education* doi: 10.1002/cae.20462 2010.
- [7] M. Stefanovic, V. Cvijetkovic, M. Matijevic, V. Simic, A LabVIEW-Based Remote Laboratory Experiments for Control Engineering Education, *Computer Applications in Engineering Education*, Vol. 19, Issue 3, September 2011, pp. 538-549.
- [8] H. Çimen, Đ. Yabanova, M. Nartkaya, and S. M. Çinar, Web Based Remote Access Microcontroller Laboratory, World Academy of Science, *Engineering and Technology* 44, 2008, pp. 192-195.
- [9] International Journal of Online Engineering (iJOE), Vol 8 (2012), Special Issue: exp.at'11 Conference, <http://www.online-journals.org/index.php/i-joe/issue/view/140>
- [10] F. Said, Benachenhou Abdelhalim, Neveux Guillaume, Barataud Denis, Design of a Flexible Hardware Interface for Multiple Remote Electronic practical Experiments of Virtual Laboratory, *International Journal of Online Engineering (iJOE)*, Volume 8, Special Issue 2: "exp.at'11 Conference" (2012)
- [11] N. Crabeel, B. C. Neves, B. Malheiro, RemoteLabs Platform, *International Journal of Online Engineering (iJOE)*, Volume 8, Special Issue 2: "exp.at'11 Conference" (2012)
- [12] M. T. Valdez, C. M. Ferreira, F. P. M. Barbosa, Software Packages to Support Electrical Engineering Virtual Lab, *International Journal of Online Engineering (iJOE)*, Volume 8, Special Issue 2: "exp.at'11 Conference" (2012)
- [13] V. Sousa, P. Ferreira, M. Gericota, Hey Fellows, We Shrunk the Server, *International Journal of Online Engineering (iJOE)*, Volume 8, Special Issue 2: "exp.at'11 Conference" (2012)
- [14] A. Cardoso, M. Vieira, P. Gil, A Remote and Virtual Lab with Experiments for Secondary Education, Engineering and Lifelong Learning Courses, *International Journal of Online Engineering (iJOE)*, Volume 8, Special Issue 2: "exp.at'11 Conference" (2012)
- [15] Z. Dvir, Web-Based Remote Digital Signal Processing (DSP) Laboratory Using The Integrated Learning Methodology (ILM), *Information Technology: Research and Education*, 2006. ITRE '06, E-ISBN: 1-4244-0859-8, Tel-Aviv, July 2007, pp. 211-216.
- [16] P. Buschiazzo, D. Leoncini, R. Zunino and A.M. Scapolla, A Web-Based Laboratory for Digital Signal Processing, *International Journal of Online Engineering (iJOE)*, Vol. 6, 2010, pp. 6-11.
- [17] C. A. Jara, F. A. Candelas, F. Torres, S. Dormido, F. Esquembre, Synchronous collaboration of virtual and remote laboratories, *Computer Applications in Engineering Education*, Vol. 20, Issue 1, March 2012, pp. 124-136.
- [18] A. Bagnasco, P. Buschiazzo, D. Ponta, A. M. Scapolla, A learning resources centre for simulation and remote experimentation in electronics, *PETRA 2008*, Athens, Greece, Article no. 63.
- [19] S. Jahanian, J. M. Matthews, Multidisciplinary Project: A Tool for Learning the Subject, *Journal of Engineering Education*, April 1999, pp. 153-158.
- [20] R. Krneta, Đ. Damnjanović, Danijela Milošević, Integration of virtual and hands-on-laboratory experience in learning of filtering concepts, *SCIENTIFIC BULLETIN of "Politehnica" University of Timisoara, Romania, Transactions on AUTOMATIC CONTROL and COMPUTER SCIENCE*, Vol. 56 (70), No. 3, September 2011, pp. 121-126.
- [21] D. Milošević, M. Brković, D. Bjekic, Designing lesson content in adaptive learning environments, *International Journal of Emerging Technologies in Learning (iJET)*, Volume 1, No 2, 2006.
- [22] National Instruments cRIO 9074, Available at: <http://www.ni.com/pdf/manuals/374639e.pdf>
- [23] National Instruments NI 9205, Available at: <http://sine.ni.com/nips/cds/view/p/lang/en/nid/208800>
- [24] National Instruments NI 9263, Available at: <http://sine.ni.com/nips/cds/view/p/lang/en/nid/208806>
- [25] D. G. Manolakis, V. K. Ingle, S. M. Kogon, *Statistical and adaptive signal processing*, ISBN 13: 978-1-580053-610-3
- [26] E. Szopos, H. Hedesiu, LabVIEW FPGA based noise cancelling using the LMS adaptive algorithm, *ACTA TECHNICA NAPOCENSIS Electronics and Telecommunications*, Vol. 50, No. 4, 2009, pp. 5-8
- [27] E. Szopos, H. Hedesiu, V. Popescu, L. Festila, Comparison of LMS algorithm derivatives using LabVIEW, *ACTA TECHNICA NAPOCENSIS Electronics and Telecommunications*, Vol. 50, No. 4, 2009, pp. 43-46
- [28] Adaptive filter in Simulink, Available at: <http://www.mathworks.com/help/toolbox/dsp/gs/f7-6281.html>

Acknowledgement

Research presented in this paper is supported by Serbian Ministry of Education, Science and Technological Development through national project Infrastructure for electronically assisted learning, III-47003

Corresponding author: Radojka Krneta

Institution: University of Kragujevac, Technical Faculty
Cacak

E-mail: rkrneta@gmail.com

Using Genetic Algorithm For Solving Time Tabling Multidimensional Issues and its Performance Testing

Majlinda Fetaji¹, Bekim Fetaji¹, Mirlinda Ebibi¹

¹South East European University, Contemporary Sciences and Technologies, Ilindenska bb, 1200 Tetovo, Macedonia

Abstract. The focus of this research is analysing the possibility of applying genetic algorithm concept into time tabling or otherwise known as scheduling. In order to test the concept a desktop software solution is created and tested its performance. The contribution of the research study is the proposed approach with the use of genetic algorithms when developing time tabling software solution. Findings regarding the allocation of resources over time to perform a collection of tasks, while taking all constraints into account have been stated and recommendations are provided.

Keywords. Genetic Algorithm, Time Tabling, Scheduling, Testing.

1. Introduction

The focus of this research study is the investigation into multidimensional specifics of time tabling and scheduling and finding the most appropriate algorithm for a software solution.

In order to test our concept a software solution has been developed. Insights and recommendations have been proposed.

The creation of a teaching schedule is a complex problem that is part of NP-hard problems. As it is known the time required for solving this type of problems increases exponentially with the problem size. In order to generate this type of schedules we must choose the right optimization techniques that produce optimal solutions in an acceptable time depending on size. The most efficient methods for resolving this type of problems are genetic algorithms.

Teaching schedule is a highly complex problem which is part of the field of scheduling. Scheduling is defined as “allocation of resources over time to perform a collection of tasks, while taking all constraints into account, so that input demands are met in a timely and cost-effective manner” [1].

There are a lot of categories of scheduling inside school institutions, such as teaching, exam and student scheduling.

Timetabling is a multi-dimensional assignment problem, in which students and teachers (or faculty members) are assigned to courses, course sections or classes and events (individual meetings between students and teachers) are assigned to classrooms and time slots. [2]

Traditionally, timetables have been constructed by hand and then modified as appropriate each year (a process known as local repair). This is a laborious process and it would be desirable to automate it in some way.

The usage of many dimensions increases the time needed for creating the schedule, so in order to minimize scheduling conflicts it's better to use genetic algorithms. During this study are listed other reasons why to choose this algorithms for solving this type of problems. The constraints can be divided into two groups: hard constraints and soft constraints. The schedule has to satisfy all hard constraints in order to be feasible and it should satisfy as much as possible soft constraints in order to be good quality.

2. Review of Timetabling and Scheduling

The term scheduling is used a lot and in different computing areas. Firstly it was used in operating systems. According to Pinedo “Scheduling is a decision-making process that is used on a regular basis in many manufacturing and services industries. It deals with the allocation of resources to tasks over given time periods and its goal is to optimize one or more objectives.” [3] For different real-life domains may be different resources (runways at an airport, crews at a construction site, processing units in a computing environment, etc), different tasks (operations in a production process, take-offs and landings at an airport, stages in a construction project, executions of computer programs, etc) and different objectives (the minimization of the completion time of the last task, the minimization of

the number of tasks completed after their respective due dates, etc). One of these domains that require scheduling is the education sector (i.e. courses timetabling and exam timetabling). These kinds of problems are a continuous challenge for Artificial Intelligence and Operational Research as this kind of problems are very difficult to solve for the reasons stated below:

- Scheduling and timetabling problems are NP-hard, and that they cannot be solved in polynomial time using a deterministic algorithm.
- Complexity of scheduling task is totally dependent on the number of instances and constraints. But in case of limited resources and strict time and cost restrictions, it is very hard to formulate schedules.

Scheduling, as a decision-making process, plays an important role in most manufacturing and production systems as well as in most information processing environments. It is also important in transportation and distribution settings and in other types of service industries. [3]

3. Review and Analyses of Genetic Algorithms

“Genetic algorithms are a type of iterative mathematical modeling technique used to find the optimal combinatorial state given a set of parameters of interest. Usage of the term “genetic” refers to the mechanism of the algorithm where, through the process of iteration, individual models “evolve” over time and compete with each other in a Darwinian fashion where the fittest model emerges as the solution, similar to how chromosomes evolve to create speciation.” [4]

In a genetic algorithm, a population of strings (called chromosomes or the genotype of the genome), which encode candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem, evolves toward better solutions. Traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible. The evolution usually starts from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness), and modified (recombined and possibly randomly mutated) to form a new population. The

new population is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached. [5]

Genetic Algorithms (GAs) was invented by John Holland and developed this idea in his book “Adaptation in natural and artificial systems” in the year 1975.

Holland proposed GA as a heuristic method based on “Survival of the fittest”. GA was discovered as a useful tool for search and optimization problems. [6].

The real challenge in implementing genetic algorithm is usually to implement the fitness function, which contains all the knowledge of the problem to be solved. “The fitness of an individual in a genetic algorithm is the value of an objective function for its phenotype. For calculating fitness, the chromosome has to be first decoded and the objective function has to be evaluated. The fitness not only indicates how good the solution is, but also corresponds to how close the chromosome is to the optimal one.” [6]

In case of multi-objective or Pareto optimization there is not any one number to describe the quality but several different qualities. The user is supposed to choose the proper quality combination that best fit to his/her purposes. Synonyms of fitness function include: cost function, score, and ranking.

4. Problem Definition

Creating a schedule (timetable) for a university means finding the right combination between a group of events (courses to be taught in a time period) and a group of resources (teachers, rooms, classes) by fulfilling the group of constraints given.

In this section, we give a description of the scheduling problem addressed in this study. This scheduling problem arises in a university in Tetovo. Faculty of CST - Contemporary Sciences and Technologies is a large faculty in terms of the number of teachers and the number of students and that’s why we will focus on this faculty.

In order to graduate from this faculty, each student has to complete a number of courses, where some courses are elective and some others

obligatory. Here, a course refers to a subject taught one or more times within a week, and each course has a certain number of credits.

There are two types of teachers: full time and part time teachers. For this faculty, some courses could be taught jointly by part time and full time teachers. The part time teachers' requirements, such as the course can only be taught during certain time periods have to be satisfied. For the full time teachers, they are further divided into groups such as administrative positions (Vice Dean, Dean, etc) and other full time teachers who do not hold any key administrative position.

In this study, we focus on courses which can be taught by either full time teachers only, or taught jointly by full time and part time teachers. The teacher assignment problem involves assigning and scheduling the teachers to the courses by taking some factors, such as the teacher's abilities and number of courses offered, into consideration.

The objective of the software solution is the creation of a weekly teaching schedule for different categories of teachers in the university mentioned before. Scheduling problems are considered as multi objective optimization problems. If the number of the events and resources used in a university is not very large the schedules can be created manually, but if the number of students and courses increases and the university has lack of rooms the problem becomes very difficult to be solved manually. A schedule created manually will be difficult to modify. In order to simplify the schedule creation process for large universities we have chosen to solve it with genetic algorithms as one of the best techniques for this kind of optimization problems.

There are various types of constraints that mostly vary from the type of problem that will be scheduled. Timetable problems are subject to many constraints that are usually divided into two categories: "hard" and "soft". Hard constraints are rigidly enforced and have to be satisfied in order the timetable (schedule) to be feasible. Soft constraints are those that are desirable but not absolutely essential, because usually it is impossible to satisfy all of them. [10]. A schedule is not useful if it does not satisfy hard constraints, and it is not optimal if it does not satisfy soft constraints. Below are given some of examples of hard and soft constraints taken in consideration during this work.

HARD CONSTRAINTS
The room is big enough for all the attending students and satisfies all the features required by the event
No resource (teacher, student or classroom) is assigned to different events at the same time
There cannot be more than 2 classes for a subject on one day
For each time period there should be sufficient resources (e.g. rooms and lecturers) available for all the events that have been scheduled for that time period
Room capacities not exceeded
Maximum number of time periods per day should not exceed particular value
Each lecture is held in a classroom belonging to specific set of valid rooms for lecture
Each classroom has its own availability schedule
Each lecture is assigned to a teacher that belongs to specific set of teachers that can deliver lecture
SOFT CONSTRAINTS
A particular class may need to be scheduled in a particular time period
A student has a class in the last time slot of a day.
A student has more than two classes in a row
Each teacher has its own availability schedule ensuring he submits plan with desirable time periods that suits him best
Classrooms should not be booked which are much larger than the size of the class
Every staff should get at least one first hour
Classes should be scheduled within preferred hours
Every teacher has minimum and maximum limit of weekly work-hours.
Most students do not wish to have empty periods in their timetable

Table 1. Hard and soft constraints for the teaching schedule

The teaching schedule is formulated as follows:
Problem = {T, C, E, R, CC, W}, where T = {T1, T2,...} is a set of teachers, C = {C1,C2,...} is a set of courses, E = {E1,E2,...} is a set of timeslots with a day of week and a time period, where the day of week is Monday to Friday and the time period is 1 to 5. R = {R1, R2, ...} is the set of classrooms and CC= {CC1, CC2,...} is a set of constraints, W= {W1,W2,...} is a set of weights for each constraint.

5. Development and Implementation

Partitioning the application into logical modules is the first step of the overall problem. The architecture chosen for developing this software is a multi-tier architecture, exactly three-tier architecture, which are:

- Data Access Tier (TSADDataAcces)
- Business Logic Tier (TSABusiness)
- User Interface Tier (TSAUserInterface)

The working logic and relationship between these layers is explained below.

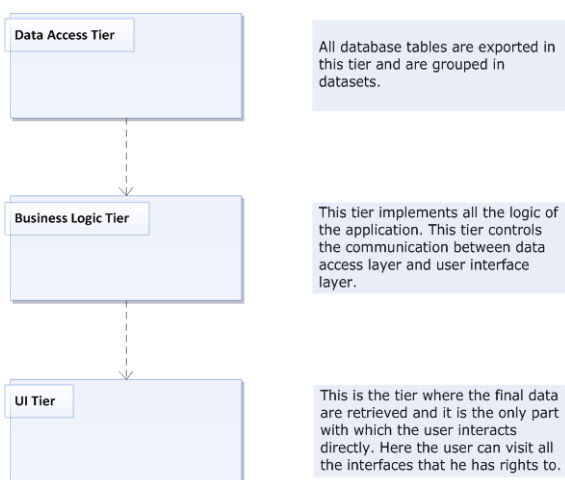


Figure 1. Software Architecture

Inside Data Access Layer are created three different datasets. This division is done by taking in consideration the group of functionalities that we have decided to implement in this application.

- Student Dataset
- Teacher DataSet
- TSA DataSet

The datasets have been grouped almost with the same logic as entity relationships. Each dataset contains data tables, table adapter (save the main queries used in the program) and the relations between data tables. The relations are the same as in ER diagrams explained above. All the queries listed on data table adapters are used in Business Layer Tier.

For each table in the database is created an object in the business layer. DomainEntity is one of the basic classes of this layer and this class is not written by me.

Does not exist any reference where to find this class because it is not in the internet or in any book. All the other classes inherit from this basic class.

For all the classes used the structure is the same:

- Is declared one data table, one row and one table adapter variable.
- Are declared two constructors that have different parameters.
- For each field in the corresponding table a specific class is created a property that is of the same type as the field in the database table.
- 3 override methods (Load, Save, Delete) are used. This method override the exact methods of DomainEntity class.
- For each query in the table adapter that corresponds the specific class is created a method.

The user interface layer has these main modules:

1. Teachers Module - the user can make the basic actions with teacher's data (Add/Modify/Delete data). A teacher can be deleted if does not exist any event connected with him/her.

The screenshot shows a Windows application window titled 'Teachers'. It contains a table with columns 'TeacherCode', 'TeacherTitle', and 'TeacherName'. The table lists five teachers. To the right of the table are buttons for 'New', 'Edit', and 'Delete'. Further right is a form for entering teacher details, including fields for 'Teacher Name', 'Code', 'Institute', 'Position', 'Type', 'Gender', 'Mail', 'Title', 'Status', and 'Color'. A 'Save' button is at the bottom right.

TeacherCode	TeacherTitle	TeacherName
04	PhD	Agna Dika
03	MSc	Malinda Felag
02	MSc	Marka Apoclova
01	PhD	Enkan Felag
05	PhD	Abdulla Zernabifu

Figure 2. Teachers Module

The screenshot shows a Windows application window titled 'Courses'. It contains a table with columns 'CourseCode', 'CourseName', and 'NoCredits'. The table lists six courses. To the right of the table are buttons for 'New', 'Edit', and 'Delete'. Further right is a form for entering course details, including fields for 'Course Name', 'Course Code', 'Classroom Type', 'Language', 'Type', 'No of credits', 'Study Group', and 'Color'. A 'Save' button is at the bottom right.

CourseCode	CourseName	NoCredits
08	Network operating	21
05	Network program...	23
01	Microcontroller an...	23
03	Introduction to the...	35
02	Object Oriented Pr...	20
04	Algorithms and Dat...	21
07	Introduction to Info...	23
06	Database Technol...	21

Figure 3. Course Module

2. Courses Module - the user can make the basic actions with courses data (Add/Modify/Delete data). A course can be deleted if does not exist any event connected with it.

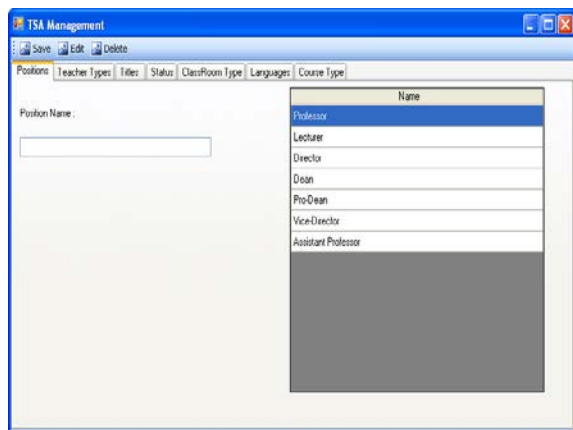


Figure 4. Management Module

After having finished all the necessary adjustments on teaching tasks Generate Schedule Module is the final module that the user must access to finish the whole process.

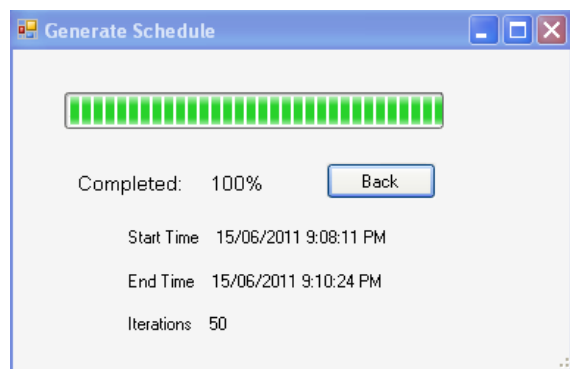


Figure 5. Generate Schedule after module entries

6. Testing Results

There are a lot of testing realized and most importantly the Incremental integration testing, using bottom up approach for testing i.e. continuous testing of an application as new functionality is added; Application functionality and modules should be independent enough to test separately. Done by programmers or by testers as described in [4].

This testing is done during the software development. The test is done in the following order, Dataset testing, class testing and modules testing.

Inside Datasets is implemented the database logic. All the database connections, data result set retrieval operations, connection pooling, checking the data is performed in these classes. Dataset testing is illustrated below. Here is testing if the database accepts TeacherCode longer than 2 characters, as the MaxLength property of the Teacher Dataset requires.

The test shows that the software outputs an error if TeacherCode is not correct.

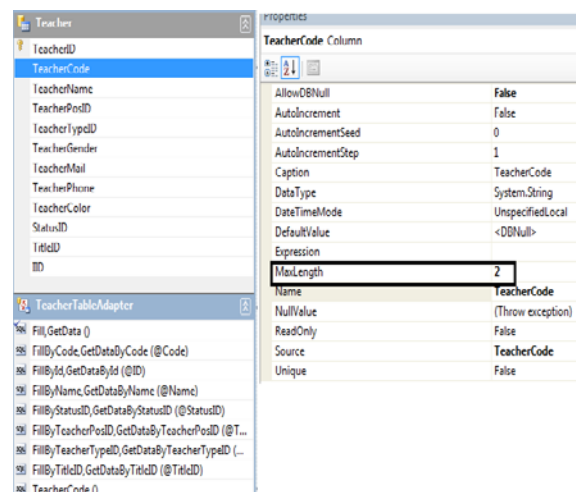


Figure 6. Dataset restrictions

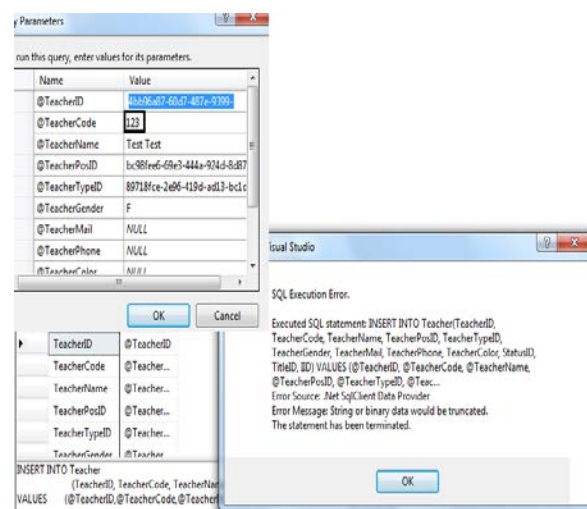


Figure 7. Execution Testing

The modules testing stage depends on the business logic tier. Because if the logic of the business is implemented right, also the information will retrieve without errors. Each action in User Interface Tier is related to a method of business objects, that is related with DataAccess Tier (Figure 23).

Stress testing – System is stressed beyond its specifications to check how and when it fails. Performed under heavy load like putting large number beyond storage capacity, complex database queries, continuous input to system or database load. [21]

Stress testing is done in order to test the software performance. These tests show that if the user

increases the data in the EduTask tables it requires much more time for the final result to be shown.

Usability testing – User-friendliness check. Application flow is tested, Can new user understand the application easily. [21]

This type of testing is done in parallel with modules testing. Is tested if it's easy for the user to understand how is data entry done in this application, and how can they see the software output. Each step has its own messages, in both cases of output, correct or incorrect one.

7. Conclusion

The research study contributes with genetic algorithms approach in developing time tabling automated solutions that according to the testing results and user feedback has been shown effective.

This study attempted to resolve some of the definitional and methodological difficulties encountered by previous researchers. It involved review and comparative analyses of algorithms most suited for solving the problem with time tabling and scheduling.

The difficulties for achieving a best performing algorithm have made it almost impossible to have an advanced graphical user interface.

- This work has been very useful, because inside it we can find a very good combination between software engineering and artificial intelligence.

- Inside this software is implemented a model that allows one course to be taught by different teachers, and to be in different languages.

- The final scheduling interface is created in C# especially for this project.

The model used inside this work has been tested for real data obtained from a university and some data created randomly. The software shows that for the real data the proposed model creates faster

timetable results than those timetables that can be created manually. But the model needs still some other improvements in the fitness function in order to have better results.

The project did meet the main objective to analyze and develop a teaching scheduling application. The student scheduling part isn't implemented in this solution, but this application has the basics (database logic) for satisfying this request that is planed as future work.

References

- [1] Fetaji M. Fetaji, B. (2008). "Usability testing and evaluation of a mobile software solution: A case study" – IEEE conference, ITI, Dubrovnik, Croatia, 23-26 June 2008, pp (501 - 506).
- [2] Hossam Faris, Alaa Sheta, Ahmed Tobal. A parallel genetic algorithm for solving timetabling problem. ICGST-AIML Journal, ISSN: 1687-4846, Volume 8, Issue II, September 2008.
- [3] Lovrekovic, Z, Lovrekovic, T., (2012). "Software Application for Managing Multidisciplinary and Interdisciplinary Projects as a Part of Educational Process", Journal TEM, Technology Education Management Informatics, ISSN: 2217-8309, Volume 1, Number 1, 2012, Association for Information and Communication Technology Education and Sciences, Serbia.
- [4] Rita Gaidukeviciene, Eugenijus Kurilovas. Comparative Study of Profiled School Scheduling Programs in Lithuania. Informatics in Education, 2005, Vol. 4, No. 1, 19–42
- [5] Sadaf Naseem Jat, Shengxiang Yang. A Guided Search Genetic Algorithm for the University Course Time tabling Problem. Multidisciplinary International Conference on Scheduling : Theory and Applications (MISTA 2009).

Corresponding author: *Majlinda Fetaji*

Institution: *South East European University, Macedonia.*

E-mail: *m.fetaji@seeu.edu.mk*

Design of Algorithms for Improvement of Delphi's Controls DBGrid and DBNavigator

Fadil Novalic¹, Bekim Fetaji², Mensura Kudumovic³

¹Department for Computer Sciences, University of Novi Pazar, Serbia

²Contemporary Sciences and Technologies, South East European University, Tetovo, Macedonia

³Faculty of Medicine, University of Sarajevo, Sarajevo, Bosnia and Herzegovina

Abstract: This paper is occupied with the improvement of three main functions of the preview of information from database in a table form: storage of changes or new entry in the table, delete of records from the table and sorting of information by clicking on the heading of column in the table information review.

These improvements were obtained by occurrence coding connected to DBGrid. The accomplishment of these functions is regulated by the way that users of Windows applications accepted it as usual in that businesses, so the regulations of these applications which are programmed in Delphi improved its quality. Very important attribute of this paper is that the coding of algorithms have been done for using its procedures without a change, what creates the modularity of the source code.

Keywords: Delphi DBGrid, Delphi DBNavigator, Design Algorithms, Improving Algorithms, Sorting Algorithm

1. Introduction

Algorithm is defined as an accurate computer procedure which requires some values, or group of values, as an entrance and accords any value or group of values as an exit [1].

The implementation of algorithms is very expanding. Algorithm is written on the basis of mathematic structure which mostly corresponds to the received problem, and sometimes the existing algorithms are analyzed or repaired for the received problem, which is to be solved by a computer tool. [2].

In order to solve one problem, many variously correct algorithms can be designed. Such algorithms are called equivalent algorithms and for the same entrance dimension give similar exits [2].

The algorithms which are the subject of this work, have been developed because of requirements of some of the basic application functions which show the data from the database, but developed in

Delphi, in order to be modulated for the users' practice. During the development of some information systems and practical tutoring with students, we came to the conclusion that we should improve three basic functions of showing data from database in the table form:

1. storing of changes or new entry in the table
2. deleting of records from the table and
3. sorting of data by pressing the heading of column in the table information review.

These improvements were achieved along with event coding referring to DBGrid: storing of information is done by pressing the key Enter on the keyboard : procedure DBGridKeyPress), delete by click on the key Delete (procedure DBGridKeyUp), and sorting by pressing the mouse on the heading column in the table review (procedure DBGridTitleClick). The process of deleting and sorting information is done by pressing the keyboard instead of pressing with mouse on the buttons that are on Delphi's control of DBNavigator which was made for the process. The modularity of the source code was achieved in the way that Delphi's control names weren't used in this paper, but to proceed them with calling in the argument attributes of the procedure where the code is written. It enables those who want to use these improvements for their Delphi's project to copy the code into the procedure without any changes, and even if he gives other names to controls or set (Unit) Data Set controls for connecting with the base. These procedures were written for ADO DataSet controls.

The simple example of data review was elaborated in this paper. The algorithms were represented descriptively. The way of algorithm progress and source code written for these algorithms has started from elaborating the main command, then

it is completed with the condition analyzing that should be accomplished in order to avoid errors in the course of program activation.

2. Related Works

There are many works related to the algorithms implementation in different fields, what shows its riveness. For example, Dynamical Visualization Process [4], computer graphic[5] etc. Many scientific works are occupied with the problems of data sorting in the shape of the table which displays Delphi's control DBGrid, as Web portal.[8], [9]. The paper *Improving Delphi TDBGrid* [6] represents some of the functions for improving DBGrid, which makes it more user friendly. There are next improvements: the change of a background color according to the cell type, the integration of textual data searching, arrange of columns, an automathic arrange of column's wideness, the scroll by the wheel on the mouse, word wrapping cell, sound effects and integration like the menu for separate records in the base.

The paper [7] describes the internal realization mechanism of DBGrid control, and introduces how to realize displaying of serial number of record, sorting of column title and saving and restoring of column width and column sequence.

It is explained how to sort DBGrid with the help of THeaderControl component on the Web page . This code is written for Form's OnCreate event.

At the Delphi's portal <http://delphi.about.com>, many useful procedures can be found, and in the article [9] some are explained for shape change of mouse when it is above the article column and for the data sorting in DBGrid by pressing the heading of the column. The procedure for sorting contains the source code which enables the change of font style in the heading of the column where the data were sorted.

The source code for arranging the data in DBGrid, from the web portal example and from the book of Delphi [3], depends on the names of Delphi's controls that are involved in the procedures. It what differs these procedures from mentioned examples is the attribute of the modularity and simplicity for understanding, what manages its wide implementation.

We didn't find the procedures with the property of modularity of source code, which manages the storage and delete of data by pressing the key of keyboard.

3. The Description of Delphi's Application for Data Displaying from the Database in Dbgrid

Delphi's control of DBGrid realizes the displaying of data from the particular tables in the database in a table shape. For the need of this paper or research was taken simple example involving students. In the picture 1. is shown Delphi's application with displayed data in DBGrid. The data are sorted in hierarchy in the database.

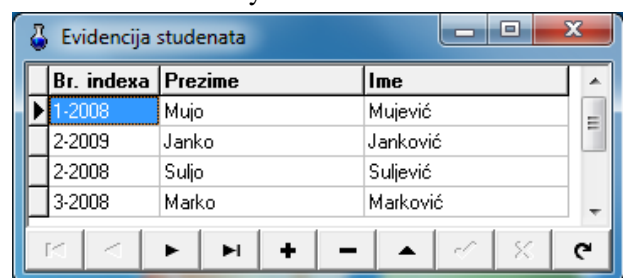


Figure 1. Window of Delphi's application with DBGrid and DBNavigator

To display the data from the base in DBGrid, the link between a component and data has to be appointed. This link is a chain of few components. The first chain is **ADOConnection** control, which serves as a connector to the database. The next chain is a control **ADOtable**. This control is connected to ADOConnection, and its attribute is **TableName** which assesses the connection between the table in the database. ADOtable is a control ,whose attributes would be used in the described procedures in this research. ADOtable is joined as a property of DataSet as next control in the chain of **DataSource**. This control is attached to DBGridu via its property **DataSource**. After mentioned connections , the property **Active** is necessary for ADOtable to be set at **True** and the data will be seen in DBGrid.

At the bottom of the window is controlDBNavigator. Through its property DataSource connected with it and the buttons on it are used to operate with the data from connected table. The control DBGrid and DBNavigator are connected to the same DataSource and so their interacting is realized, that is the possibility to operate with the same data.

4. An Algorithm for Storing Data via DBGrid Pressing the Key ENTER

When the data is shown in Delphi's applications from the database in the control DBGrid, then it can be simply changed with selecting the cells and retyping the new contents. Also the new data entry can be realized by getting into a new line before last in the records in DBGrid. In that way, the new way of data entry is realized. The storing of new changes or new entry can be realized in two ways: some new record should be selected in DBGrid or to click the button of DBNavigator, which is expected for storing changes in the database. This button is named in the picture 2. as Save.



Figure 2. DBNavigator

In this research, the algorithm was designed to realize the task of storing the data changes from the database with one press on the key Enter on the keyboard.

In Delphi, when the connection to database is realized via ADO components for sorting the changes in the database is realized with the method Post in ADODataset control. This method should be used by pressing the key ENTER. Algorithm for storing the data can be described through one step:

Algorithm 1: Storing the changes by pressing the key ENTER

- Step 1: Was Enter pressed?
- **Yes:** Save the changes

The source code for this algorithm should be written in the procedure, which is connected to OnKeyPress from DBGrid control:

```
procedure TForm.DBGridKeyPress(Sender:
TObject; var Key: Char);
begin
  if Key = #13 then
    TDBGrid(Sender).DataSource.DataSet.Post;
end;
```

To succeed the modularity of the source code of this procedure, to DataSet control from where the method should be realized through the argument property of procedure **Sender**. When this argument is

set as the argument of the type **TDBGrid**, we will get DBGrid from which is realized OnKeyPress. Calling its property **DataSource**, then the property DataSet from DataSource control, we come to DataSetcontrol. Instead of name DataSetcontrol, in the source code we will use the term **TDBGrid(Sender).DataSource.DataSet**. This term will be used in every procedure elaborated in this research. After the completeness of this change data or the new data entry will be sorted. The absence of this algorithm is the display of error in realization, if the key ENTER is pressed in situation when the new data change or data entry is not done, e.g. when DataSet control isn't in Edit or in Insert mode. In the picture 3. Is shown DialogBox with the message about the error: "Dataset not in edit or insert mode".

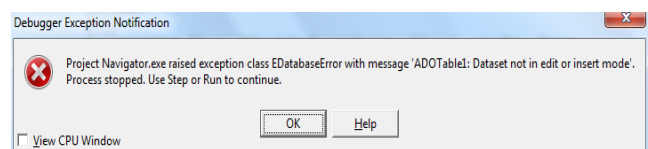


Figure 3. The message about an error occurred during the realization of Post method when the changes were not made

To eliminate the possibility of this error appearance, one more question in an algorithm should be added about the state of DataSet control:

Algorithm 2: The sorting of the changes by pressing the key ENTER and analyzing the status of DataSet control

- Step 1: Was ENTER pressed?
- **Yes:**
 - Is it in DataSet or Edit or Insert modue
 - **Yes:** Save the changes.

The source code should be displayed now:

```
procedure TForm.DBGridKeyPress(Sender: TObject;
var Key: Char);
begin
  if Key = #13 then
    if TDBGrid(Sender).DataSource.DataSet.State
      in [dsEdit, dsInsert] then
      TDBGrid(Sender).DataSource.DataSet.Post;
end;
```

4.1. An Algorithm for Cancelling the Changes or New Data Entry via DBGrid by Pressing the Key ESC

To cancel the sorting or the new data entry, it is needed to click DBNavigator button CANCEL. (Picture2.). This procedure should be realized

pressing the key ESC in the keyboard, because it's the regular custom of the user of Windows applications to cancel some important procedure.

What key ESC realizes without additional programming when OnKeyPress is in DBGrid, to cancel the change of an item field in the record which was currently selected. However, the changes within other item fields of that record which have been already realized, will be done moving in other record. It's needed to use the method CANCEL above DataSet control, when it's wanted to cancel the changes in the record. An algorithm for this procedure is similar to algorithm of storing the changes pressing the key ENTER. The first is in ASCII value for pressing the key, because we now examine if the key ESC is pressed, whose value is 27. The second difference is in the method, instead of Post, we now use the method Cancel.

Algorithm 3: *The cancel of the changes pressing the key ESC*

- Step 1: has the key ESC been pressed?
 - **Yes:** Cancel the changes.
-

To realize the method Cancel, it's not needed for Data Set control to be in Edit or Insert mode. The source code for this algorithm is also written in procedure DBGridKeyPress:

```
procedure TForm.DBGridKeyPress(Sender: TObject;
var Key: Char);
begin
  if Key = #27 then
    TDBGrid(Sender).DataSource.DataSet.Cancel;
end;
```

Because the source code for both algorithms (2 i 3) is written in the same procedure, we will show the complete procedure:

```
procedure TForm.DBGridKeyPress(Sender: TObject;
var Key: Char);
begin
  if Key = #13 then
    if TDBGrid(Sender).DataSource.DataSet.State
      in [dsEdit, dsInsert] then
      TDBGrid(Sender).DataSource.DataSet.Post;
  if Key = #27 then
    TDBGrid(Sender).DataSource.DataSet.Cancel;
end;
```

The source code of this procedure will operate in every Delphi's project without any changes in the procedures OnKeyPress at DBGrid.

4.2. The Comparison of the Two Equivalent Algorithms for Storing the Changes or Entries in the Database

An algorithm which responds to the whole procedure DBGridKeyPress is the following:

Algorithm 4: *Storing or cancelling the changes pressing the key ENTER or ESC on keyboard*

- Step 1: Was the key ENTER pressed?
 - **Yes:**
 - Is DataSet in Edit or Insert mode?
 - **Yes:** Save the changes.
 - Step 2: Is ESC pressed?
 - **Yes:** Cancelling the changes.
-

The equivalent algorithm 4 can be written in the next:

Algorithm 5: *Storing or cancelling the changes pressing the key ENTER or ESC in the keyboard*

- Step 1: Is DataSet in Edit or in Insert mode ?
 - **Yes:**
 - Is DataSet in Edit or in Insert mode?
 - **Yes:** Save the changes.
 - Step 2: Is ESC pressed?
 - Yes:** Cancelling the changes
-

The next results are achieved, by testing the algorithms (4 i 5) :

- Step 2 is the same with both algorithms.
- In the first step, two conditions were examined: is the key ENTER pressed and status of DataSet control.

In algorithm 4, the first question is if the key ENTER was pressed, then the status of DataSet control is examined. So, at the every pressing the key means the examination if the key ENTER is pressed, and that the status of DataSet control is examined only when the first condition is realized:

The first condition at algorithm 5 is examination of DataSet control status. At every key pressing is examined if the key ENTER was pressed, and then DataSet control is only examined if the first condition was accomplished. The first condition at algorithm 5 is the examination of DataSet control, and the value of ASCII code of pressed code is searched, when mentioned status is in Edit or Insert.

The results of algorithm testing bring the conclusion that in algorithm 5 more often both conditions of the step 1 are examined, because of reason whenever the keys in the keyboard are pressed, when the procedure DBGridKeyPress is realized, those are the new changes or entries, what means that the condition of DataSet control to be in Edit or Insert mode is accomplished. Accordingly, the algorithm 4 is realized faster:
We will entrance the source code written on the basis of algorithm 5.

```
procedure TForm.DBGridKeyPress(Sender: TObject;
var Key: Char);
begin
  if TDBGrid(Sender).DataSource.DataSet.State
    in [dsEdit, dsInsert] then
    if Key = #13 then
      TDBGrid(Sender).DataSource.DataSet.Post;
    if Key = #27 then
      TDBGrid(Sender).DataSource.DataSet.Cancel;
end;
```

5. An Algorithm for Deleting the Data via Dbgrid Pressing the Key DELETE

The delete of selected record from shown in DBGrid, are realized by clicking the button DELETE on DBNavigator. (Picture2.). Before the delete of the application creates the possibility of acknowledgment or cancelling the delete, what is shown in picture 4.

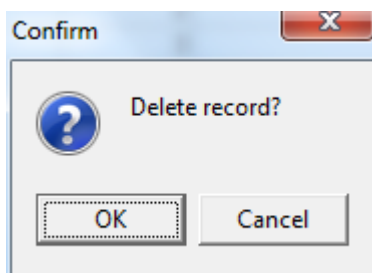


Figure 4. DialogBox for affirmation of delete taken by DBNavigator

The algorithm for deleting the records elaborated in this research enables the construction of questions about acknowledgement for delete, in the way the programmer choose with the corresponding language. After acknowledgement of delete, the method Delete above DataSet control is realized and the record is deleted.

The next succession of designing algorithm for delete in this research is that on the basis of it can be done the procedure DELETE by pressing the key on

the keyboard, what is the usual way for deleting Windows applications.

Algorithm 6: The delete of records shown in DBGrid pressing DELETE

- Step 1: Was DELETE pressed?
 - Yes:
 - Confirm the delete?
 - Yes: Delete.
 - No: Exit

The procedure which contains the source code written according to this algorithm, should be realized when the key DELETE is pressed. However, when the procedure DBGridKeyPress occurs, Windows doesn't register the press on the key DELETE. This algorithm was coded because of this. Here is the source code:

```
procedure TForm.DBGridKeyUp(Sender: TObject; var
Key: Word; Shift: TShiftState);
begin
  if MessageDlg('Jeste li sigurni da želite
brisanje podataka?', mtConfirmation, [mbYes,
mbNo], 0) = mrYes then
    TDBGrid(Sender).DataSource.DataSet.Delete;
end;
```

The source code for storing the data can be written in procedure DBGridKeyUp, to make one procedure contains the code for storing and deleting the data. However, that's not the good solution because of the reason that OnKeyUp method post is realized after the second pressing the key ENTER, what isn't usual task for saving the data entry. DialogBox with the message acknowledgement for deleting the data like in picture 5.

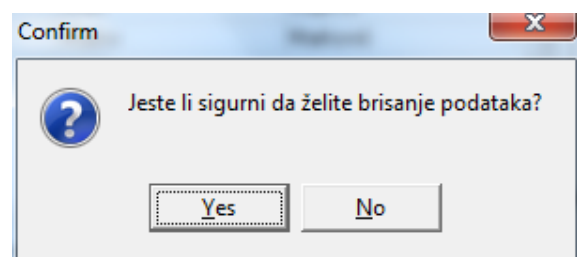


Image 5. DialogBox with message for affirmation of delete

A special attention should be applied to the standard function of key DELETE, which exists during the entry or change of the text. That is used for deleting the typed characters, so in in an algorithm should be examined the status for DataSet. The key DELETE should be used for deleting records from database only when the change or entry

of the data is operated in database, when the status of DataSet control isn't in Edit or Insert.

The algorithm should appear like following:

Algorithm 7: *The delete of records shown in DBGrid pressing the key DELETE when the change or new entry is not realized:*

Step 1: Was DELETE pressed?

-
- **Yes:**
 - Is it out of the status for change or entry?
 - **Yes:**
 - Confirm the delete?
 - **Yes:** Delete.
 - **No:** Exit
-

The procedure DBGridKeyUp was written on the basis of algorithm 7 and it is:

```
procedure TForm.DBGridKeyUp(Sender: TObject; var
Key: Word; Shift: TShiftState);
begin
  if Key = VK_DELETE then
    if (TDBGrid(Sender).DataSource.DataSet.State
    <> dsEdit) and
      (TDBGrid(Sender).DataSource.DataSet.State
    <> dsInsert) then
      if MessageDlg('Jeste li sigurni da želite
brisanje podataka?', mtConfirmation, [mbYes,
mbNo], 0) = mrYes then
        TDBGrid(Sender).DataSource.DataSet.Delete;
end;
```

The source code of this procedure will operate in every Delphi's project without any change of procedure of OnKeyUp above DBGrid.

6. An Algorithm for Sorting the Data in Dbgrid Pressing the Heading of the Column

In Windows applications that give the table display of the data, the value sorting from particular table is realized by clicking on the heading of the column. The sorting is realized in a growing chain with the first click, then the next click sorts the declining chain.

Standardly, Delphi's control of DBGrid doesn't contain this property. Common algorithm, according to the source code for sorting the data in DBGrid can be written, and is based on the questions if the declining chain has already been sorted. If it is, then the sorting in declining chain is realized. An algorithm for sorting the data in DBGrid according to the values in the columns from one chain, which compares and sorts in the terms of values, is in Delphi's method Sort which is realized at DataSet control:

Algorithm 8: Sorting the data DBGrid

- Step 1: Is sorting different from declining string?
 - **Yes:** Sort in a declining string.
 - **No:** Sort in a growing string.

For this algorithm in the source code is used term:

TCustomADODataSet(TColumn(Column).Grid.DataSource.DataSet) to come via argument a Column to DataSet control.

```
procedure TForm.DBGridTitleClick(Column:
TColumn);
begin
  with
    TCustomADODataSet(TColumn(Column).Grid.
    DataSource.DataSet) do
  begin
    if (Pos(Column.FieldName, Sort) = 1)
    and (Pos(' DESC', Sort) = 0) then
      Sort := Column.FieldName + ' DESC'
    else
      Sort := Column.FieldName + ' ASC';
    end;
  end;
```

The command for sorting the data in DBGrid is composed from two strings: the name of the field adjoined to the column field, where the sorting is realized as the code of the sorting, in a growing string (ASC) and declining (DESC). In the source code with the command **Pos** is examined the regulariry of the string by examining if there from the position 1 begins the field name (Pos(Column.FieldName, Sort)=1) and if string i ' DESC' is absent from string of sorting (Pos(' DESC', Sort)= 0).

The windows display will be shown with the sorted data about students with the index number and growing and declining string:

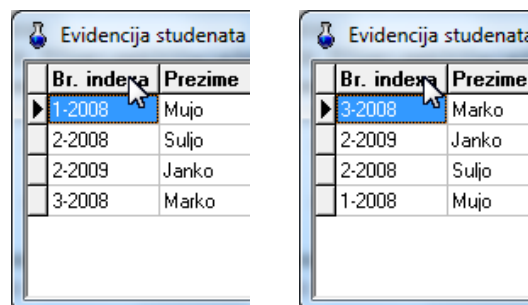


Image 6. Display of data in DBGrid soerted in a growing string (left) and decling string (right)

We can say for this procedure, that it will operate in any Delphi's project without any changes within the task OnTitleClick at DBGridom.

7. Conclusion

While realizing many Delphi's projects which represented unique information systems for the need of small companies, as examples for teaching the students, it proved that such projects can be realized easily with the use of ADO controls for connecting to the database and Data control of DBGrid and DBNavigator. The operation of the basic functions of DBNavigator is very often realized with the use of menu or toolbar, and DBNavigator is omitted.

The procedures described in this research were achieved that the basic functions of DBNavigator are realized in the way which is the most acceptable by the users of information systems, and it is by pressing the key on the keyboard and with the use of the mouse click on the heading of DBNavigator control. That makes the information systems more user friendly.

The simplicity and modularity of the source code from this research enables the Delphi's beginners to program and develop their projects related to what is achieved with the Delphi's standard controls for operating the database.

Concerned that the source code of the procedures described in this research was based on the modularity, the future work which can be based on this work is creating Plugin. That can be addition with already installed Delphi's applications, which contain DBGrid controls. This enables the two basic functions described in this work stay in the most usual way.

Reference

- [1]. Cormen T., Leiserson C., Rivest R., Stein C., *Introduction to Algorithms*, Cambridge, Massachusetts, London, 2002.
- [2]. Sukic C., Sukic E., *Informatika i računarstvo*, Graficolor, Kraljevo, 2010.
- [3]. Cantu M., *Delphi 7*, Kompjuter biblioteka, Čačak, 2003
- [4]. Bekim Fetaji, *Development and Analyses of Dynamical Visualization Process Tool in Run Time and its Usability Evaluation*, TTEM Technics Technologies Education Management, Journal ISSN 1840-1503, paper accepted for Vol. 6, No.2, 2011.
- [5]. Sukić Ć., Saračević M. (2012), *UML and JAVA as effective tools for implementing algorithms in computer graphics*, TEM JOURNAL - Technology, Education, Management, Informatics, Journal ISSN:2217-8309, e-ISSN:2217-8333, Vol. 1, No.2, 2012, pp.111-117.
- [6]. Mahfoozi A., *Improving Delphi TDBGrid*, CPOL, (web link: <http://www.codeproject.com/Articles/>), 2011.
- [7]. Pei-rong W., *The Development of Data Browsing Control Based on DBGrid*, Computer Knowledge and Technology, vol.35, 2008.
- [8]. *Delphi Knowledge Base* (2011), Delphi portal, link:<http://delphi-kb.blogspot.com/2011/04/how-to-sort-columns-in-tdbgrid.html>
- [9]. Gajic Z., *Sorting records in Delphi DBGrid by Clicking on Column Title* (2003), Delphi portal, link: <http://delphi.about.com/>

Corresponding author: Bekim Fetaji

Institution: South East European University, Contemporary Sciences and Technologies, Tetovo, Macedonia

E-mail: b.fetaji@seeu.edu.mk

The Application of Modern ICT in Increase of the Road Traffic Safety Level in Terms of Applicability of the Interdependence of Global Positioning System (Assisted GPS) and Dedicated Geographic Information System (GIS)

¹Mersad Mujevic, ²Camil Sukic, ³Dzafer Kudumovic

¹*Ministry of Finance of Montenegro*

²*Faculty of Information technology, University of Novi Pazar, Serbia*

³*Mechanical faculty, University of Tuzla, Bosnia and Herzegovina*

Abstract – In order to promote traffic safety, and specifically in the prevention of accidents on the roads, modern standards and procedures require the construction, constant monitoring and updating the database of geospatial data of importance for the spatial and temporal distribution, an analysis of the traffic accidents causes and consequences and the creation of an appropriate response to the traffic risk arising from road's factor as a geospatial entity. One of the possibilities for meeting the said requirements is the use of GPS technology. Constant monitoring and topographic inventory of changes in the domain of exploitation and technical roads features on the digital geotopographic materials in some of the GIS environment is one of the requirements, standards and procedures for the traffic risk management, but also for creation of a part of the national infrastructure of geospatial data on the principle of interoperability. This paper presents the characteristics of GPS device GeoExplorer® 2008, produced by U.S. Company Trimble, which integrates GPS receiver and a portable computer with the Windows Mobile operating system, and thus represents a functional, light, portable and durable device for field work, with the range of applications for geospatial data mapping and updating in a various and primarily in mobile GIS applications. GIS is a set of software tools, which enable the analysis of different types of data associated with geographic maps. Data on current road conditions and technical traffic control collected by mentioned device shall form the basis for filling in a database in dedicated, stationary GIS applications as a support system part for the traffic safety management.

Keywords – GPS Portable Computers, Geographic Information Systems, Prevention of Accidents on the Roads, Traffic Safety Management.

1. Introduction

The Global Positioning System is currently the only fully functional Global Satellite Navigation System. The Positioning System was developed primarily from grown military requirements and form

gained development level of satellite navigation and surveillance of units and ordnance. Satellites used by the Positioning system are high enough to overcome the problems typical for previous solutions, and they use technology that is precise enough to provide for positioning anywhere on the Earth, 24 hours a day. However, the original quality of the system is its potential.

With current technology of microprocessors and integrated circuits, positioning receivers have become small enough and cheap that anyone can have them and can be installed anywhere. The applications are almost limitless, because the Positioning system allows for each square meter of the Earth surface to receive its own unique address. That basically means that it is possible completely new way of life and work organization, because the Positioning system will give the world a new international standard for defining the location and distance, enabling countries and people to manage their natural resources more efficiently than ever before (Milojkovic, Marinkovic, 2007 : 42; Filipovic, Milojkovic, 2010:189). [3]

Modern Positioning systems include: the Global Positioning System (GPS - the real name is NAVSTAR - *Navigation System for Timing and Ranging*) developed by the Geodetic Service of the U.S. Department of Defense, operational since 1978, and the Global Navigation System (GLONASS) developed by the Geodetic Service of the Russian Ministry of Defense, operational since 1982. The Satellite Navigation System GALILEO, financed by the EU, is under construction and its use is planned from 2014. [9]

The Global Positioning System is definitely the best system available and free, proven and completely reliable, surely a promising system for

the future. It consists of three components, namely: the cosmic, control and user component.

Within the last years of the twentieth century there has been a remarkable improvement in the production of GPS equipment, which has become light, portable and easily available to users. Today there are more producers and hundreds of models of various GPS receivers (Trimble, Garmin, Magellan, Tom Tom, Lowrance, Mio, ViaMishelin etc.).

No matter how good and with no defects the system seems, still that system has several sources of errors, which to some extent can be eliminated by using the method of differential corrections. In many countries of the world, especially on the shores of the ocean, it was developed a network of differential GPS stations that continuously broadcast differential corrections for all users who are in their range. Where there is no such GPS infrastructure, the solution is setting up of temporary differential stations in the period when it is required by certain users. Presently, the predominant methods of GPS corrections distribution are GSM/GPRS and Internet. For the activities where correction is not needed immediately at the time of measurement, the data are recorded as "raw" and the correction is applied in post-processing.

The application of GPS technology is very widespread, and its capabilities can contribute to more effective traffic safety management. In fact, one of possible applications of GPS technology in the traffic safety is related to the function of collecting data on clearly resolved spatial positions that are related to the traffic and technical road elements data (spatial entity characteristics of roads database), for the implementation of tasks related records on public roads, that is for the construction of adequate Geographic Information System (GIS) as a decision support system part in the field of road traffic safety. The U.S. Company Trimble Navigation Ltd. is a leading manufacturer of GPS equipment, which covers about 65% of the world market. Among the devices of mentioned company that are appropriate to the needs of traffic safety are: Trimble Juno in a standard mode of application (for massive data collection), Trimble Nomad in an advanced mode application (suitable for use in all weather conditions), and the world's first GPS field computer GeoExplorer® 2008 in a superb mode application in all geospatial and meteorological conditions.

2. The Main Features and Possibilities of Using GPS Receiver Geoexplorer® 2008 for the Traffic Safety Needs

U.S. Company Trimble was the first that applied the concept of integration of PDA computer and GPS receiver back in 2002 to the series GeoExplorer CE. By combination of GPS receiver and computer with the Windows Mobile operating system it was obtained a lightweight, portable and extremely powerful and durable device for field work. Besides the ability in positioning and orientation, displaying the current time and date, GeoExplorer® 2008 is ideal for mapping and geospatial data updating in various, primarily mobile GIS applications. The system supports an indirect measurements (calculation of an inaccessible position based on taking the range with laser rangefinder) as well as synchronized log data from various external sensors. That means that the fields of application primarily involve mapping of natural resources, environmental studies, and creation and work with database of the state government, big companies, public utilities, and so on. In addition, the GPS receiver registers positional data while user enters attribute data according to pre-defined structure of the user system (Milojkovic, 2009:223).[5]. GeoExplorer® 2008 receiver is also the most appropriate to the traffic safety needs. GeoExplorer®_2008 is a standard Windows Mobile computer whose specifications are given in Table 1. The computer is ergonomically designed, no cables, and all electronic components are stored in a robust and waterproof case and they are electrostatically protected. Also, all communication ports are hermetically sealed, which means that the receiver meets climatic and mechanical resistance by the high military standards (IP 65).

The receiver has a keyboard with 11 keys and a color TFT touch screen (touch screen). Options can be selected with dedicated stylus or just using a finger. The receiver's screen has a special anti-reflective coating, which makes the image extremely clear even in direct sunlight, changeable protective film and the possibility of display contrast adjusting. Also, the screen has a backlight for night work, which is automatically activated by clicking on the screen, and it has an integrated microphone and speaker. [8]

Due to the large memory and processor power, the device effortlessly displays scanned maps, air and satellite images which present an adequate basis for a variety of GIS projects. Additional slot for SD memory cards allows required memory expansion. GPS navigation is extremely simple, and GPS survey results are immediately visible on the screen.

General features	
Accuracy	0.10 – 3 m
H-Star Technology	Yes
EVEREST Reflection reduction	yes
Operating system	Windows Mobile 6
Processor	520 MHz X scale processor
Memory (RAM+Flash Disc)	128 MB + 1 GB
Screen size	8.9 cm
Screen type	Color TFT screen, Touch screen_
Bluetooth – wireless connection	Yes
Wireless LAN 802.11	Yes
Wight	780 gr.
Fallresistance from a height	0.9 m
Robustness – military standard	IP 65 standard
Working temperature	-20°C do +60°S
Battery duration	10.5 h

Table 1. Technical features of the Trimble GPS receiver brands GeoExplorer® 2008

The screen is similar to a desktop computer (icons, Start button and Taskbar range). There are installed the following standard programs: Windows Explorer Mobile, Internet Explorer Mobile, Inbox, Text Editor, Calculator, Sound Recorder, ActiveSync, Word, Excel, and PowerPoint Mobile, Windows Media Player, Connect to Remote Desktop and Networking. There are also a crucial purpose programs: GPS Controller to adjust the integrated GPS receiver and measurements planning and GPS Connector for connection of integrated GPS receiver with external communication ports.

In addition to standard software, GeoExplorer® 2008 can use application software for the collection and updating of GIS data (Trimble TerraSync, ESRI ArcPad), as well as different commercial applications for auto-navigation with detailed city maps (i-GO,

TomTom, Garmin, etc.). . Moreover, it is possible to develop user applications for various purposes using Microsoft programming tools (Microsoft Embedded Visual C ++, Microsoft Embedded Visual Basic, Microsoft Visual Studio Net).

GeoExplorer® 2008 use Windows Mobile 6 operating system. It is a Microsoft operating system for PDA computers. It may also install and use the software to support field applications. Namely, the operating system supports a wide range of communication options, so that it provides access to databases, internet and email even on the field, when needed.

If GeoExplorer® 2008 is to be connected to the Internet via a mobile phone it can call the GIS server directly from the field and download topographic maps for the ground on which the intervention is to be taken. Direct connection to the GIS Server is allowed by Trimble TerraSync software, dedicated application for navigate, and GIS data collection and updating. The direct connection to the GIS server does not only mean showing the map in the background, or downloading parts of the GIS database, but it also means updating of those databases directly in the field. The process of information updating on the site includes the following options: choice and navigation to the existing point, verification and change of positional and attribute data of existing facilities (if required) and registration of new or missed facilities.

GeoExplorer® 2008 device is manufactured in three models (GeoXM, GeoXT and GeoXN) that vary in the accuracy level of the internal GPS receiver.

All models support a differential correction in real-time as well as a post-differential correction (code and phase data) for which PC software for post-processing is necessary (Trimble Pathfinder Office).

GeoXT and GeoXN models provide high accuracy because they use EVEREST technology to eliminate rejected GPS signal. All models support the reception of differential corrections in real time from AGROS GPS network. Those corrections are received via the regular phone connected with Bluetooth wireless connection to the GPS receiver (GPRS communication) [10].

3. Application of GPS Device Geoexplorer ® 2008 for GIS Production in Terms of the Traffic Safety on Roads

GeoExplorer® 2008 GPS device has the ability to work with the TerraSync software, which is designed to collect new or update existing geospatial data directly in the field. The mentioned software is universal software for all Trimble GIS receivers. The software is localized into Serbian, which further facilitates the work. In addition, the software offers a wide range of functions that allow the user to perform data processing and verification even in the data collection phase. At the same time, it integrates different technologies such as mobile computers technology, modern operating systems, databases, mapping, GIS, GPS and mobile communication technology [4].

Within Trimble TerraSync software there is a module for planning of GPS survey. By this module it is possible to determine which satellites will be visible in a desired period of time and even track their animated movements. It is also possible to adjust GPS receiver parameters that affect the quality of the position (elevation mask, PDOP factor, the acceptable quality level of satellite signals). This provides a high quality level of position, when necessary.

Besides the simple mapping, Trimble TerraSync allows the transfer of GIS database to GPS computer. Thanks to this, it is possible to navigate to any facility in the database and to make updates of associated attributes right in the field (Figure 1).

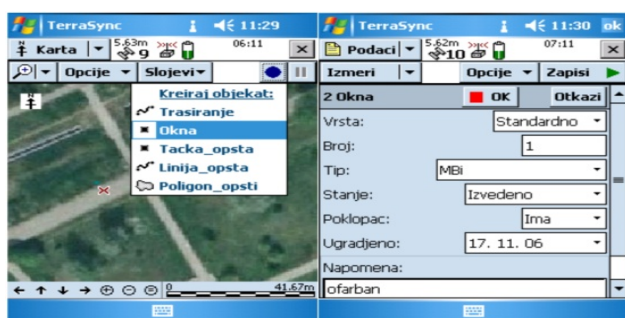


Figure 1. Data Collection and updating by Trimble TerraSync software

TerraSync, as the most of this type of software, supports different data types and formats in raster (.jpg, .sid, .bmp and .tif) and vector formats (.cor, .imp, .phs and .ssf file format). However, the

software has built-in functions for two-way communication ESRI shapefile, and just this possibility was used for presented thematic work, as it was used software package ArcGIS Desktop applications for the purpose of GIS production in the field of traffic safety [8].

For the construction needs of GIS pilot model in the field of traffic safety aiming to prevent the traffic accidents, it was used application of GPS device for mapping and data collection on the current state of some elements of the public road. This primarily refers to the position information: some road facilities, some facilities for road needs and traffic signs elements (primarily km marking). Pilot database includes much larger volume of data on a public road and traffic, which are spatially defined by fixed positions in GIS pilot model [1].

Data collection procedure implied the office preparation which has included software parameters setup (selection of coordinating system, selection of working units and GPS parameters definition), creation of new directory assistance and codes development of geometric and attributive data collection on quantitative and qualitative indicators of individual parts of the public roads pilot database. With readymade device, it was performed field collection of the necessary data for GIS pilot model. During data mapping on the dotted entities (kilometer markings, intersections, road damages, etc.), it is necessary to take pause for a period of one to two seconds, and then to perform position registration and entry of the necessary attributive data. Also, it is possible to record a voice message or record a detail on the road by digital camera or by a camera that can be with "bluetooth" connection delivered to a dedicated position of recorded facility or that can be add when processing in desk GIS application. The data can be collected by foot or by vehicles, with an obligation to stop for a period of one to two seconds prior to the registration point. [2] After completion of the field work, GeoExplorer® 2008 is placed on the substrate which is a USB device or a device connected with a serial line to a desktop computer. Microsoft AcitivSync software is used for undisturbed operation of files transferring. Collected data are exported in the shapefile form (.shp) and then are further imported into the GIS project.

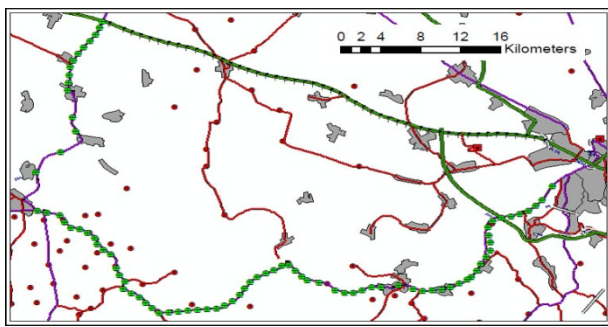


Figure 2. Appearance of GIS window of mapping territory by GPS device GeoExplorer® 2008

Figure 2 shows graphical visualization in the form of thematic map with presented geospace which formed a sample of mapping objects indicating on geometric and attributive data of kilometer markings (current position, type and condition), intersection, and damage on the road and so on, on explored part of the road network [8].

Namely, GPS device GeoExplorer® 2008 allows roads mapping with many features, such as the intersections with crossing manner (at grade, beyond the level, with other communications, with lower category road - lower significance road etc.) and traffic regulation manner (with traffic lights, traffic signs or traffic rules), pedestrian crossings, bridges, underpasses, overpasses, culverts, elements of road structure, embankments, cuts and notches, protective and retaining walls, slides, etc., [8] For mentioned geometric k-ke points, in addition to the above, it can be also collected the following attributive data: road mark, number of lanes, lane and pavement width, sidewalks with a width, formation width, substrate type, road importance, the type and characteristics of the damage on the road, as well as a large number of text with observations that can be recorded by voice and by a digital camera.

Figure 3 gives an example of one attributive table for an intersection on the main road M-19 with kilometer mark in the immediate vicinity, which is in the form of a metal pole in an upright condition.

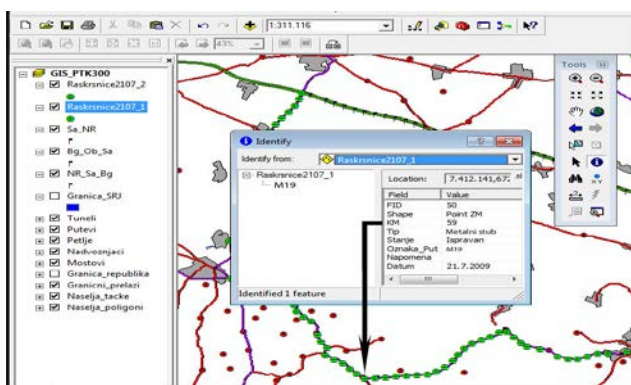


Figure 3. Attributive table of one part of the importance for the traffic safety

It is recognized the possibility of the application also to the other tools applications in the traffic safety, such as for example the traffic safety control, as there can be recorded multimedia data (in voice and image) on recognized risks causes such as: reduced visibility at the intersection due to leaved trees on the inside of the curve, dirt presence on the road inflicted with agricultural machines from the earth (dirt) road and so on.

When a database is established, it is easy to get reports on specific queries that are common in working with databases. Users of this database can be all those involved in the prevention of accidents on the roads, but special interest is showed by the road managers and scientific and research organizations. The road manager acquires a basis for decision making in the management process based on the actual situation while the scientific and research organizations have the opportunity to develop new management models and to provide high efficiency in the use of funds allocated for the traffic safety improvement.

There are several examples of implemented applications of collected data, using the above or similar GPS devices, for creation a basis for the databases development in the traffic safety. Researches were conducted in 2010 and 2011 at the Police Academies and relevant Criminal Services in order to create a database of traffic accidents in the countries of former Yugoslavia, aiming to apply modern methods of identification of hazardous locations and sections on the roads and streets, and definition of remedial measures for identified hazardous locations. Organized database of traffic accidents and their consequences provided a process for identifying the hazardous locations and sections using ArcGIS software package, based on the latest identification models of spatial risk accumulation in the traffic [6].

4. Conclusion

The traffic safety management is a systematic process that helps a state to reduce the number of traffic accidents through design for improvement of the traffic safety. Modern approach to traffic safety problem solution involves the application of modern methods that allow high efficiency in operation. However, the application of modern methods is

caused by the application of modern devices, especially when it is about GIS and software applications that support it. Therefore, it is very important to consider the possibilities of modern GPS devices, especially those that integrate multiple functions in one package to enable the collection of a large number of information important for decision-making in preventing of the traffic safety. Their use enables the creation and completion of GIS database on traffic accidents and roads, then also the use a database in the management procedure and the use of special tools to reduce risk on the roads.

References

- [1]. *Real Estate Administration of Montenegro*, REA Informant January - October 2011.
- [2]. Lipovac, K., Jovanovic, D., Nesic, M., Jovanov, D. (2009) *Database of black spots on main roads in Serbia*, 4th IRTAD Conference, Seoul, Korea.
- [3]. Milojkovic, B., *Geo-topographic modern materials for the police needs- the characteristics and usage*, Safety, 49 (4), 108-139.
- [4]. Milojkovic, B., Marinkovic, D., *Global positioning systems and their importance in detecting and proving the crime*, Science-Security-Police, 12 (2), 41-59. , 2007.
- [5]. Milojkovic, B. *Police topography*, Police Academy, Belgrade, Serbia 2009.
- [6]. Milojkovic, B., Jovanovic, M., *GIS technology as a support to the traffic safety management in local community*, 5th Expert Seminar: The role of local community in the traffic safety," Criminal Police Academy, Belgrade ,Serbia, 2010.
- [7]. *The Law on Amendments to the Law on Roads* Official Gazette of Montenegro, No. 36/2011" of 27.07.2011.
- [8]. Milojkovic, B., Aleksic, V., Jovanovic, M., *Application of GPS technology for production of dedicated GIS in f-ji points for prevention of the traffic accidents on the roads*, 10th International Symposium: ROAD ACCIDENTS PREVENTION 2010", Novi Sad, Serbia, 2010.
- [9]. Atanasova, V., Krstanovski, N., *Data collection and analysis of traffic accidents*, Technical Faculty - Bitola, Department of Traffic and Transport, Bitola, FYR Macedonia.
- [10]. Gladovic, P., Popovic, V., *Modern information technologies in the road transport*, FTN Publishing, Novi Sad, Serbia, 2010.

Corresponding author: Mersad Mujevic
 Institution: Ministry of Finance of Montenegro
 E-mail:

Devising and Analyzing Expert Based Learning Methodology

Mirlinda Ebibi ¹

¹ South East European University, Computer Sciences, Ilindenska bb, 1200 Tetovo, Macedonia

Abstract – The focus of this research is to devise and analyse Expert Based learning Methodology and further compare its impact and benefits with the traditional academic learning. In order to realise this, review and comparative analyses of adaptive learning environments has been done. The intersection and combination of the insights from the reviewed and analysed concepts have been used to Develop Mobile Expert Learning Knowledge Management System. The expected impact is in improving learning knowledge transfer and performance and this system to open the doors for the community, who are interested in self learning and accessibility in real time and without constrains in time of delivery of content. Also contribution of the study is the PMQ (Performance Measurement Questionnaire) that is used for evaluating not only learning but also for developing performance measures.

Keywords – Expert based learning, knowledge management, m-learning, mobile devices,

1. Introduction

Research into mobile applications to be used in learning known as m-learning intersected with best insights and state of the art achievements from adaptive learning theories can place Universities and other institutions at the forefront of pedagogical excellence of learning practice, answering learners requirements for flexibility and ubiquity: ‘anywhere, anytime, and any device’ access to information.

The technology oriented economy of the 21st century focuses on sharing, organizing, managing and creating information [7]. This indicates that competition is driven by knowledge revolution in the future.

Expert based learning is something that is not researched and represents a very interesting opportunity of enhancing mobile learner’s knowledge management and problem based skills.

Integrating knowledge management into practical educational activities and especially combined with adaptive learning applied in mobile learning using the proposed Expert based learning (EXBL)

methodology as approach according to user feedback and Performance Measurement Questionnaire (PMQ) has shown effective solution that can improve the knowledge transfer substantially.

2. Background Research on Learning Modelling Approaches

In Software Engineering mobile learning software there is evidently a lack of support for instructional techniques and pedagogical learning models, as well as procedures or guidelines how, when and for what particular situation each pedagogical learning model should be supported in the software development process and its conjunction and correlation with the instructional strategies [1].

Instructional strategy is a very important concept that needs to be addressed because the main purpose of any learning activity should be clear to the learner [1].

Instructional design models typically specify a method in using the technology that if followed will facilitation of the transfer of knowledge, skills and learning process [7]. This learning dimension should provide the context of instruction and desirable outcome. The learning environments require high level of self-organization and metacognitive abilities from the learners engaged in the process of learning that should be captured by the instructional techniques.

There are several instructional strategies that are currently considered: Problem Based, Project based, Inquiry-based Learning, Task based and Game based learning [6].

Problem based learning represents the learning that results from working with problems that needs solving. The entire learning process is set around a problem introduced and the knowledge is developed as a consequence of trying to solve the problem.

Generally described as “an instructional strategy in which learners confront contextualized, ill structured problems and strive to find meaningful solutions and learn in the process of doing it.” In general it is an approach to learning focusing on the process of solving a problem and acquiring knowledge. The approach is also inquiry-based when learners are active in creating the problem. The learners are elevated to the position of analyst and problem-solver and have specific objectives and deadlines to meet. According to [7] there are two critical issues involved in presenting the problem. First, if the learners are to engage in authentic problem solving, then they must own the problem. A second critical issue in presenting the problem is to be certain that the data presented does not highlight critical factors in the case. Either the problem must be richly presented or presented only as a basic question. Learning should be synthesized and organized in the context of the problem.

Project-based learning (PBL) is a model that organizes learning around projects. Definitions of "project-based instruction" include features relating to the use of an authentic ("driving") question, a community of inquiry, and the use of cognitive (technology-based) tools [10]. Project-based instruction is an authentic instructional model or strategy in which learners plan, implement, and evaluate projects that have real-world applications beyond the classroom [10]. Projects sometimes go off track, with teachers and students pursuing questions that are peripheral to the subject matter of interest. The solution, according to [10] is to find ways for projects to center on "learning appropriate goals."

Inquiry-based Learning according to [7] represents an instructional strategy where involvement in learning implies processing skills and metacognitive abilities in order to seek answers to questions and issues while at the same time constructing new knowledge. "Inquiry" is defined as seeking information by questioning. According to [7] it usually begins with posing a problem or question, followed by generating and pursuing strategies for investigating, collaborating, reflecting, and justifying the solutions of the problem or answers to the question, and communicating the conclusions.

Task-based learning is an educationally sound, effective and efficient instructional strategy for

learning focusing the learning activities around tasks. The term "task-based learning" according to [10] originated primarily from the work done in language education. According to [10] the learning tasks play a fundamental role in determining the learning outcomes. According to [10] it has three advantages:

1. Learning built round tasks is more effective than traditional didactic memory-based or purely apprenticeship-type learning;
2. Learning structured round the tasks is an efficient approach to learning;
3. Task-based learning is likely to lead to more relevant and appropriate education.

Task-based learning offers action and reflection, while in contrast, rote learning is low in action and in reflection. According to [10] incidental learning, such as occurs in on-the-job learning, is rich in action but may be low in reflection. Classroom, or formal, learning is frequently high in reflection but low in action.

Game based learning or also lately referred to as digital game-based learning [10] goal based scenarios and instructional games and simulations are alternatively used to describe the instructional strategy where learning activities are organized around a game or simulation. The academic community regarded game based learning as part of problem based learning using simulations and did not give much of attention in its research, and still today there are a lot of opinions in this regard [7]. Educational games and simulations are defined as activities that have rules and constraints, a goal, and an emphasis on competition and also has the additional feature of having a primary objective of enabling a student to learn either facts, skills, attitudes, or all three. [7] and [7] suggests that transfer of knowledge is aided when students actively construct explanations for events. Perhaps the biggest benefit for game-based learning is the fact that it involves students who need to learn complex skills and need to transfer these skills to real life.

The design and development of m-learning cannot be based only in the existing practice of technology, it is necessary to understand the relation between theory and practice to ensure that the design

of practice is founded on the learning theory. This concept defined in [10] is given in the figure below:

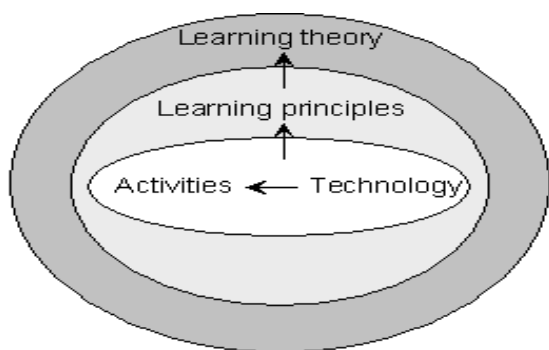


Figure 1. Theoretically grounded evaluation of technology [10]

It describes that the different learning activities that are driven in the learning environment are supported by the m-learning instructional technologies stated above. The learning principles are formed by the learning activities to be done to produce the learning outcome. The learning activities are crucial to define the features and abilities the learning environment has to support and are supported by the technology.

According to [1] the e-learning solutions development process adopts one of the following learning modelling approaches:

1. the content-oriented,
2. the tool-oriented, or
3. the task-oriented approach

The content-oriented approach deals with management of learning content. It is mainly concerned with supporting authoring, structuring, delivering, sharing, re-using, and querying the content [1]. The design and authoring of e-learning content requires major input from instructional designers, graphics designers, and programmers. Normally the instructors are expected to develop the content for e-learning on their own. However content creators search for a theoretical basis to justify their designs [6]. Normally the instructors are expected to develop the content for e-learning on their own. However they are not aware of the effective methods which can be used to present their content to users. Especially the novice instructors need additional support in developing interactivity since it involves programming. Support might include collaborative

tools for enriching the learning content by writing comments and annotations, tools for tracking the student progress with the content, or tools for adapting the content to the students' preferences [10]. Tool-oriented approach is based on using the technological infrastructure in the learning process. Learning sessions which follow this approach are organized around the use of the developed software [1]. The developed software solution is the main vehicle into increased transfer of knowledge. This learning modelling approach provides clear support and focuses the learning process around the developed tool of instruction as medium.

Task-oriented approach deals with learning tasks or learning activities which learners need to perform in their learning sessions. Those tasks are typically structured in very simple learning sequences that the students need to pass in a sequential mode [1]. This learning modelling approach clearly support and focuses the learning process on previously created scenarios of sequential tasks that will guide the learner activities into more efficient and higher level of knowledge transfer.

3. Review and Analyses of Adaptive Learning environments

The ideal of individualized learning (i.e., learning tailored to the specific requirements and preferences of the individual) cannot be achieved, especially at a "massive" scale, using traditional approaches. Factors that further contribute in this direction are different and among others include the diversity in the "target" population participating in learning activities.

Analyzed were several projects and research initiatives that deal with personalization have been shortly reviewed. The reviewed projects are the OPen Adaptive Learning Environment (OPAL), [5] and ADELE-Adaptive e-Learning with Eye Tracking [5]. The OPAL research shows personalization as difficult to achieve and "... are often expensive, both from a time and financial perspective, to develop and maintain" [5]. Therefore, a conclusion is drawn that learner personalization should not been addressed at to finely grained level. Typically, personalization at that starting level is not practical based on the findings of OPAL project [5] and since it has too include all of those learners preferences that change each time the learner uses the system clearly does not

represent a constant factor that can be addressed [3]. Instead, a recommendation is to use the defined approach with e-learning indicators as starting point when developing an e-learning initiative. Then after the measurements the learners are divided into groups so called "collectives" (in Universities these are the departmental levels) where personalization is offered to the specifics of the collectives majority primarily based on learning style categorization and type of learner they are. We have adopted the Felder-Silverman model for learning style categorization [11]. After that learner personalization can be designed and offered tailored to each collective [5]. Furthermore, based on the measurements of these e-learning indicators a design of a sustainable e-learning initiative can be supported. Each e-learning initiative is unique and involves specifics that cannot be taken under consideration in the form of "one-size-fits-all" solution.

According to [10] there are four categories of Adaptation in Learning Environments. The first category, Adaptive Interaction, refers to adaptations that take place at the system's interface and are intended to facilitate or support the user's interaction with the system, without, however, modifying in any way the learning "content" itself. Examples of adaptations at this level include: the employment of alternative graphical, colour schemes, font sizes, etc., to accommodate user preferences, requirements or disabilities at the lexical (or physical) level of interaction; the reorganization or restructuring of interactive tasks at the syntactic level of interaction; or the adoption of alternative interaction metaphors at the semantic level of interaction.

The second category, Adaptive Course Delivery, constitutes the most common and widely used collection of adaptation techniques applied in learning environments today. In particular, the term is used to refer to adaptations that are intended to tailor a course (or, in some cases, a series of courses) to the individual learner. The intention is to optimise the "fit" between course contents and user characteristics / requirements, so that the "optimal" learning result is obtained, while, in concert, the time and interactions expended on a course are brought to a "minimum". In addition to time and effort economy, major factors behind the adoption of adaptive techniques in this context include: compensating for the lack of a human tutor (who is

capable of assessing learner capacity, goals, etc., and advising on individualized "curricula"), improving subjective evaluation of courses by learners, etc. The most typical examples of adaptations in this category are: dynamic course (re-)structuring; adaptive navigation support; and, adaptive selection of alternative (fragments of) course material [1].

The third category, Content Discovery and Assembly, refers to the application of adaptive techniques in the discovery and assembly of learning material / "content" from potentially distributed sources / repositories. The adaptive component of this process lies with the utilization of adaptation-oriented models and knowledge about users typically derived from monitoring, both of which are not available to non-adaptive systems that engage in the same process.

The fourth and final category, Adaptive Collaboration Support, is intended to capture adaptive support in learning processes that involve communication between multiple persons (and, therefore, social interaction), and, potentially, collaboration towards common objectives.

This is an important dimension to be considered as we are moving away from "isolationist" approaches to learning, which are at odds with what modern learning theory increasingly emphasizes: the importance of collaboration, cooperative learning, and communities of learners, social negotiation, and apprenticeship in learning (Wiley, 2003).

4. Conceptual Model of Expert Based Learning

Currently there is not enough research conducted about Expert learning especially applied in mobile devices.

Expert Based Learning (EXBL) methodology we conceptualize and define as learning in depth from expert in the field in a form of the two instructional approaches: Project Based Learning, either from his/her project or as Problem Based Learning problem in a form of problem based assignments and then interacting with the expert on a forum type system, or by answering expert questions in the form of a multiple choice quiz type, that is easier to achieve in electronic software systems.

A well-designed project provokes learners to encounter (and struggle with) the central concepts and principles of a discipline and gives a lot of insights how to approach and do something and a finished project from an expert can be extremely good source of knowledge when provided as template to learn from.

Performance is assessed on an individual basis, and takes into account the quality of the work produced, the depth of content understanding demonstrated, and the contributions made to the ongoing process of project realization.

According to [10], adaptive learning systems have traditionally been divided into separate components or 'models'. While different model groups have been presented, most systems include some or all of the following models (occasionally with different names):

- Expert model - The model with the information which is to be taught
- Student model - The model which tracks and learns about the student
- Instructional model - The model which actually conveys the information
- Instructional environment - The users interface for interacting with the system.

Conceptually for the case study software solution decided to follow the instructional approach with Problem Based Learning. This decision is based upon testing learners learning style adopted from Felder-Silverman model. In here experts assign problem based assignments as learning tasks and then the next step is to assess their knowledge and performance using what we have defined as PMQ (Performance Measurement Questionnaire).

Once the PMQ is answered and sent automatically goes to the email of the instructor and outside expert engaged in clinical teaching within the course and it has the time stamp of date and time sent. This option is provided in the settings option of the software solution.

The PMQ (Performance Measurement Quiz) is used for evaluating not only learning but also and developing measures. It is based on the premise that measures should appraise, reinforce and rewards improvements in performance. PMQ is structured into 2 main parts:

- Part 1 asks respondents to answer problem based assignment questions and asses their knowledge.
- Part 2 asks respondents to score specific performance measures, of specific improvement areas, comparing before and after the leaning process.

In overall, PMQ assesses the knowledge and performance of specific improvement areas while allowing them further development, as well as proposing new insights and measures onto an existing system.

The research study contributes with new proposed Expert Based Learning (EXBL) methodology to be used for developing m-learning applications that according to the results has been shown effective.

Also contribution of the study is the PMQ (Performance Measurement Quiz) that is used for evaluating not only learning but also and developing performance measures.

5. Expert Based Learning versus Academic Learning

According to [10], adaptive learning systems have traditionally been divided into separate components or 'models'. While different model groups have been presented, most systems include some or all of the following models (occasionally with different names):

- Expert model - The model with the information which is to be taught
- Student model - The model which tracks and learns about the student
- Instructional model - The model which actually conveys the information
- Instructional environment - The user interface for interacting with the system.

Currently there is no research about Expert based learning. Expert Based Learning is synonymous with learning in depth from expert in the field either from his/her project or interacting with the expert on a forum type system. A well-designed project provokes learners to encounter (and struggle with) the central concepts and principles of a discipline and gives a lot of insights how to approach and do something and a finished project from an expert can be extremely

good source of knowledge when provided as template to learn from.

Performance is assessed on an individual basis, and takes into account the quality of the work produced, the depth of content understanding demonstrated, and the contributions made to the ongoing process of project realization. On the other hand the academic learning is organised in semester (15 week) based learning where the content is provided and organised in strictly organised lectures and practical's that ensure the learning and entire knowledge is gained in the process.

6. Experiment – Devising and Analysing Expert learning knowledge management system

The focus of this research study is reviewing current research on personalization and adaptive learning as well as Adaptive Learning Environments, focusing on Expert Based learning (EXBL) methodology to be used in mobile learning.



Figure 2. The interface of EXLMS Expert Based Learning Management system

In order to test the developed methodology a mobile software solution is created and tested the efficiency of the developed solution. The contribution of the research study is the proposed Expert Based Learning (EXBL) methodology to be used for developing m-learning applications. Also contribution of the study is the PMQ (Performance Measurement Questionnaire) that is used for evaluating not only learning but also for developing performance measures.

In order to investigate the Expert Based learning (EXBL) methodology that is recommended to be

used in mobile learning a software solution is developed and can be found online at the following link: <http://gproject.kodingen.com>.

The research concept is focused into implementing EXBL- Expert Based learning scenario using the project based learning and forum and in this manner to make the interface adaptable to different instructional approaches and learning styles.

Contemporary learning theory suggests that individual learners differ in the way they learn and that learning must be tailored to the individual learner. Consequently, learning environments must have the flexibility to adapt themselves for the individual learner. According to [2], adaptive learning systems have traditionally been divided into separate components or 'models'.

While different model groups have been presented, most systems include some or all of the following models (occasionally with different names):

- Expert model - The model with the information which is to be taught
- Student model - The model which tracks and learns about the student
- Instructional model - The model which actually conveys the information
- Instructional environment - The users interface for interacting with the system.

Currently there is no research about Expert based learning. Expert Based Learning is synonymous with learning in depth from expert in the field either from his/her project or interacting with the expert on a forum type system. A well-designed project provokes learners to encounter (and struggle with) the central concepts and principles of a discipline and gives a lot of insights how to approach and do something and a finished project from an expert can be extremely good source of knowledge when provided as template to learn from.

Performance is assessed on an individual basis, and takes into account the quality of the work produced, the depth of content understanding demonstrated, and the contributions made to the ongoing process of project realization. On the other hand the academic learning is organized in semester (15 week) based learning where the content is provided and has strictly organized lectures and practical's that ensure the learning and entire knowledge is gained in the process.

Learners in using EXLMS will be able to direct their learning by using one of the two modes that are offered: 1) learning from University Professor and instructors in academic organized manner organized in semesters or 2) learning from experts in their respective fields by viewing their published projects and problem based solutions the experts published in the system and learn by analysing experts work and communicating with them in clarifying something they need or solve some particular problem with their help. In the same manner the EXLMS will encourage on creating a “community of experts” that will be evaluated form learners as well as from their fellow colleagues.

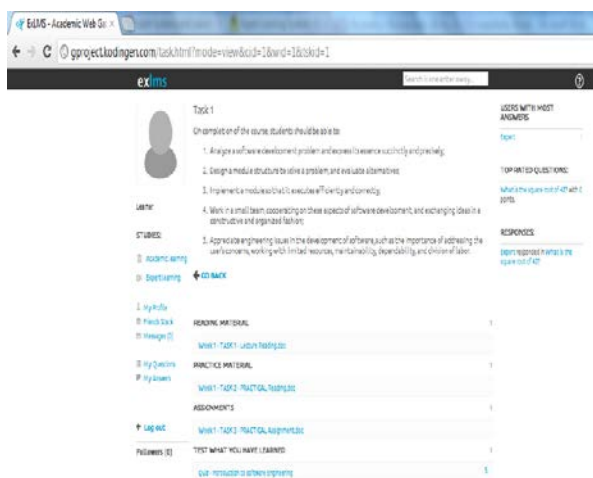


Figure 3. The learning interface

The academic learning interface presented in the figure above is supporting Task based learning, where the learner is not left alone but rather guided each week with 4 (four) tasks: reading the lecture for that particular week and then he can move to the next Task2 to read the practical part, and after the learner finishes this part can access the Task 3 which is solving a practical assignment. And finally Task 4 the learner has to undertake a Quiz that involves questions from the previous Tasks.

The system in this manner is self-sufficient in assessing automatically and independently the learners and in this manner provides them an overview of the learned content and measures their performance.

Creating expert learning systems allows the best content and content experts to respond to all learners. At the same time the intersection of Professor working with these expert systems would become

progressively more capable by facilitating these systems. The more they facilitate these programs, the more expert they become. Under these conditions learning would truly be a lifelong experience.

7. Conclusion

A conclusion drawn from the experiences from this research study shows that m-learning has large potentials and that EXBL methodology embedded in this mobile software solution according to learners feedback is quite high.

This methodology attempted to resolve some of the definitional and methodological difficulties encountered by previous researchers. It involved review and comparative analyses of Knowledge Management, Mobile Learning, Adaptive Learning Environments, focusing on Expert Based learning (EXBL) methodology to be used in mobile learning.

The future work is to implement the other EXBL scenario using the project based learning and forum and in this manner to make the interface adaptable to different instructional approaches and learning styles.

Contemporary learning theory suggests that individual learners differ in the way they learn and that learning must be tailored to the individual learner. Consequently, learning environments must have the flexibility to adapt themselves for the individual learner.

The conclusion is that in the near future, it is expected that learning will move more and more into mobile devices and outside the classroom and lectures halls into the learner's mobile environment both real and virtual negotiated by mobile devices.

The significance of the research is based in the fact that almost every student has a mobile device at all times while not everyone has a computer and internet connection at all times. The expected impact is in improving learning knowledge transfer and performance and this system to open the doors for the community, who are interested in self learning and accessibility in real time and without constraints in time of delivery of content.

A conclusion drawn from the experiences from this research study shows that m-learning has large potentials and that EXBL methodology embedded in this mobile software solution according to learners

feedback is quite high. It makes possible learners to learn at their own pace while at the same time once the quiz is sent automatically goes to the email of the instructor and outside expert engaged in clinical teaching within the course.

Moreover this approach combined with experimental approach to m-learning can bring new insights into the specifics of m-learning that might help in increasing the learning outcomes, especially knowledge transfer.

References

- [1]. Brusilovsky, P., & Nijhavan, H. (2002). "A Framework for Adaptive E-Learning Based on Distributed Re-usable Learning Activities" in World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. 2002(1), 154-161, [online], AACE, 2002.
- [2]. D. Keegan, "The Incorporation of Mobile Learning into Mainstream Education and Training," in mLearn 2005 - 4th World conference on mLearning Cape Town, South Africa, 2005.
- [3]. Ebibi Mirlinda, Fetaji Bekim, Fetaji Majlinda, (2012). "Combining and suporting Expert Based Learning and Academic Learning in Developing Mobile Learning Knowledge Management System", TEM Journal, ISSN: 2217-8309, Volume 1, Number 1, 2012.
- [4]. Fetaji, M., Fetaji, B. (2009), "Devising Usability Framework For Mobile Learning Software Solutions, EEEL 2009 : "International Conference on e-Education and e-Learning", Paris, France, June 24-26, 2009.
- [5]. Hendriks, P. (1999). *Why share knowledge management? The influence of ICT on motivation for knowledge sharing*. Knowledge and Process Management, 6 (2), 91-100 , 1999.
- [6]. Ebibi Mirlinda, Fetaji Bekim, Fetaji Majlinda (2012), "Expert Based Learning (EXBL) Methodology for Developing Mobile Expert Learning Knowledge Management Software System" , TTEM, ISSN: 1840-1503, Volume 7, number 2, 2012.
- [7]. Karagiannidis, C., Sampson, D., & Cardinali, F. (2001). "Integrating Adaptive Educational Content into Different Courses and Curricula" in Educational Technology & Society, Vol. 4, No. 3, 2001.
- [8]. Maryam, A. & Dorothy, E.L. (2001). *Knowledge management and knowledge management systems: conceptual foundations and research issues*. MIS Quarterly, 25 (1), 107-136, March 2001.
- [9]. Paramythis, A, and Reisinger, S, (2003), *Adaptive Learning Environments and eLearning Standards*, The Second European Conference on e-Learning ECEL-2003, Electronic Journal of eLearning 2004, Institute for Information Processing and Microprocessor Technology, Johannes Kepler University, Linz , Austria, 2003.
- [10]. Felder, R.M. (1993) "Reaching the Second Tier: Learning and Teaching Styles in College Science Education," J. Coll. Sci. Teaching, 23(5), 286—290, 1993.
- [11]. KUKULSKA-HULME A., PETTIT J., (2009) *Practitioners as Innovators: Emergent Practice in Personal Mobile Teaching, Learning, Work, and Leisure*, in the book, Ally, 2009
- [12]. Robinson .H.S., Anumba .C.J., Carrillo .P.M. and Al-Ghassani .A.M., (2006), *STEPS: a knowledge management maturity roadmap for corporate sustainability* , Business Process Management Journal Vol. 12 No. 6, pp. 793-808, 2006.

Corresponding author: Mirlinda Ebibi
 Institution: South East European University, Computer Sciences, Ilindenska bb, 1200 Tetovo, Macedonia
 E-mail: m.ebibi@seeu.edu.mk

Two Idea Implementation of Real-Time Systems

Piotr Konczak¹, Wojciech Zabierowski¹

¹Technical University of Lodz, Microelectronics and Computer Science, Wólczańska Street 221/223, B18, Łódź, Poland

Abstract – Currently Web portals which are providing real time services, required to implement two separate servers. One of them deals contact with the client and the other synchronizes data posted by users. Such solutions require the simultaneous work of two independent machines and write twice more code. A better solution might be a program which updates data when you try to use them.

Keywords – Real-Time Systems, Scattered Game.

1. Introduction

World that we know going forward intensely, together with it are developing technologies associated with all branches of our lives. Progress aims to increase benefits, make easier the work carried out, reducing operating costs. All of this does not bypass computer technology and the Internet. Each programmer trying to make its program more efficient. They optimize the code, which will be absorbed less computer resource and do the job in shorter time.

Let's take a closer look to scattered game running in real-time. We would like to write a game, that allows a large number of users competing with each other, in a virtual kingdom. In the surrounding fantasy world, players will possess the city and hire heroes. Through the management will acquire raw materials, waging wars, develop the infrastructure and upgrade skills. Will also be able to recruit units living in the kingdom to enlarge its troops. And many more. But the most important part is how it works. All events will take place in real time. For example, the construction time of a new building may take several days.

The game will be available via any Web browser. For its implementation we will use PHP language, which allows dynamic generating of Web pages. View of the page will be describe in HTML and CSS language. To improve the performance of our application we'll take some of the tasks on the client side. For this task, will use script language JavaScript. Also we use the jQuery library, to

enhance the visual experience of players. Also We will use AJAX technology to reloading only the parts of documents. This should speed up the functioning of the server which will have to generate smaller parts of the code.

2. Standard Solution

Under normal circumstances, to realize such a project should implement two separate servers (Figure 1).

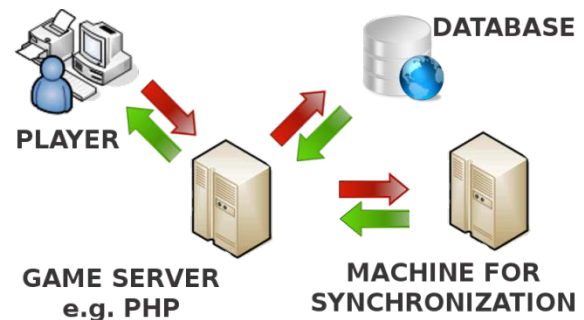


Fig. 1: Standard solution for real-time systems

Game server - its task would be communicate with the players. After receiving the request, would prepare appropriately crafted document. Inside which would be information looked by the customer. From the database would be retrieved information about the status of the player. Among the data would be found messages about activities or actions possible to taken. The customer should be able to obtain any information associated with kingdom.

Machine for synchronization – used to automatic and regular check the status of the game contained in the database. Each time, the downloaded data will be analyzed in detail. If it is noted that among them are data which term of validity has expired, to game server will be sent a request to update them.

Among the disadvantages of such a solution, we can mention:

- Need to implementation of two servers. It increases twice the amount of work for developers. While they definitely will not work for free.
- In most cases, the servers will be based on different programming languages. As a result, we will need a programmer or even more programmers familiar with both of them for system administration.
- Significantly grows the prospect of an error. When on one of the servers an error occurs continuing provision of services will become impossible. While the second server will still attempt to perform their task. This may cause completely unpredictable events of catastrophic consequences.
- In addition to having at equipment two machines, we need to maintain them. Due to the type of provided service it must be available for 24 hours a day throughout the year. Power consumption for such a solution shall be as small as possible, but it can be difficult to do.
- In specific cases desynchronization of data, misleading the customer. User read the information on the completion of certain events at a specified time, but the synchronizing machine did not work.
- When the synchronizing machine fails, users will still use the Web site. Using the data available to them, they will perform operations that may lead to a conflicting situation when the server of synchronizing will be fixed.

3. Alternative Solution

To implement such systems may be used a different approach. Must be created a system based on actions and reactions. We completely resign from the additional synchronizing machine. Updating logic put in code of the game. When a player tries to open page containing information changing in time, will be checked for their expiry date already does not expired. In the case where the data update time has passed, the updating function will be called. When it ends its operations, the data will be sent to user (Figure 2).

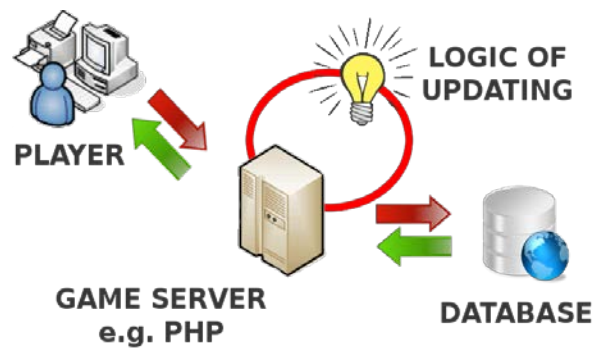


Fig. 2: Alternative solution based on appearance of user

Let us take the specific case from game. The player opens tab of the city, which belongs to him. A few hours earlier, he ordered start the construction of a new building. Information readed then, said that the work be completed until the next visit. During examination it appeared that the specified time has really passed. Updating function introduced into the database, information about recently constructed building. And from now user was able to use it.

Let us describe another one, more complicated case. Players use their heroes to fight wars among themselves. During each battle will be able to prove their strategic skills. To do this they will be able to command troops to move or attack. The action shall take troops on change in the order of possessed initiative. However we want to avoid a situation where a player due to a long absence has blocked the battle and the other players. For this purpose, we determine maximum time which will have a branch to execute the action. During the downloading information for the user, check whether the specified time has does not expired. If so, the updating function takes control of the division, made the most profitable action and give movement to next unit. It should be noted that the branch whose action was automated does not have to belong to the player retrieving the page. It is also necessary to verify whether the time since last visit is not long enough that the branch next in line should also lose the ability to perform the action.

The benefits of this solution:

- Need only one server. We save all the costs associated with the synchronizing machine. The cost of purchase, maintenance and software.
- Lower risk of error occurs. We use only one machine that can be damaged. When such event

will take place immediately know on which occurred.

- The risk of data desynchronization does not occur. If the data are already out of date will be updated. User will never get information while time has already elapsed, but he is still unable to use them.
- There is no risk that customers will use from the Web site when synchronized machine will not function. This eliminates the possibility of conflicting data.

4. Troubleshooting

Carrying out such a system, we need to define at the beginning events related the execution in real time. However, in a standard solution also must be determined. Once when define design objectives, has to be put appropriate fields holding date of expiry into the database. In addition, must be specified all of use cases where will need to update the data. It will be as simple how a situation when the user will want to use his data. But also more complex when one player will be refreshing the data associated with many others.

The data that will be currently refreshing should not be at the moment available for other users. This involves the necessity of implementation global variables informing about busy of the data. For example, the described functionality provides me the database. PostgreSQL automatically takes care of the atomicity of stored data (Figure 3).

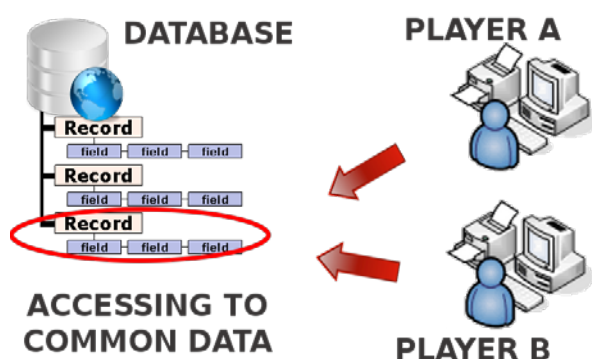


Figure. 3: Attempt of simultaneous access to shared data during the update

Operations executed recursively until get the current data, may take a long time. Such code should

be treated especially, by devoting more time to its optimization. Should be also prepare a notice informing user that his request is being processed. Such a document could contain information about the approximate time of waiting.

5. Results of Work

Figures of numbers 5-9, represent results of work on example game described in Chapter . After logging a player is taken to a page summarizing the events taking place in the kingdom – Figure 5.

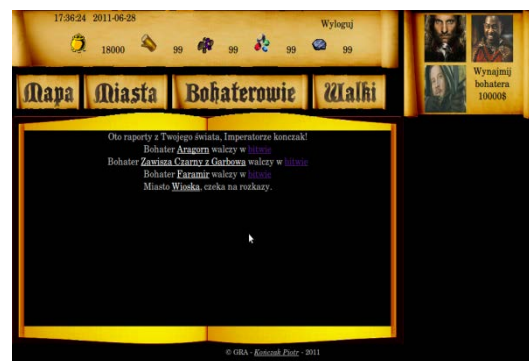


Figure 4. Welcome page of logged user

View of map and from its level giving orders to heroes – Figure 6.



Figure 5. Map of kingdom

Figure 7 is a schematic view collecting essential information about a hero.



Figure 7. Hero view

To develop infrastructure of the city is used tab like in the Figure 8.



Figure 8. Tab of the city infrastructure

The armed conflict will be resolved on the battlefield, like shown on Figure 9.



Figure 9. Battlefield

6. Conclusion

The presented system does not provide for the implementation of projects based on the regular collection of information from the outside. E.g. an application to get information about current weather, subscribing condition in every 15 minutes.

For web applications operating as a real-time services, we can use only one server. Will allow us to

save money and time. Reduce the risk of errors and costs of their possible repair. However, requires a precise definition of use cases. And implementation data updating logic before use of them. Should also be done protection that customer does not wait infinitely, and was informed about progress. In the case of simultaneous attempts to access shared data does not perform a double updates. The logic of refreshing the data only at the time of demand, will not work for systems receiving information in regular intervals.

References

- [1]. Matt Rutledge, *PHP. Programowanie gier*, MIKOM, Warszawa 2005.
- [2]. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, *Algorytmy i struktury danych*, Helion, Gliwice 2003.
- [3]. Tomasz Starczyński, Andrzej Zoła, *PHP5. Programowanie z wykorzystaniem Symfony, CakePHP, Zend Framework*, Helion, Gliwice 2010.
- [4]. Refsnes Data, *Sposoby użycia różnych technologii Internetowych*, pierwsza połowa 2011, [http://www.w3schools.com/].
- [5]. Bruce Eckel, *Thinking in Java*, Wydanie IV, Helion, Gliwice 2006.
- [6]. Kirkpatrick, Marshall, *Explaining the Real-Time Web in 100 Words or Less*. ReadWriteWeb, 2009.
- [7]. Chris Newman, *PHP w mgnieniu oka*, Helion, Gliwice 2005.
- [8]. George Lause, Gottfried Vossen, *Obiektowe bazy danych*, Wydawnictwo Naukowo-Techniczne, Warszawa 2000.

Corresponding author: Wojciech Zabierowski

Institution: Technical University of Lodz, Microelectronics and Computer Science, Poland

E-mail: wojtekz@dmcs.pl

E-Bibliotherapy System : Book Contents for Improving Quality of Youth's Life

¹Wilawan Phornphatcharaphong

¹*Faculty of Informatics, Mahasarakham University,
Kamreing, Mahasarakham, Thailand*

Abstract – Youth, the important stage of life, between kids to adults. Youth confronts dangerous things, alcohol, smoking, violence, stress, internet addict. The aim were developing and evaluating e-Bibliotherapy system, innovation for improving quality of youth's life from risk situations. Methodology were applied in four stages 1) survey of reading, 2) develop e-Bibliotherapy system at <http://202.29.22.177/aom/bibliotherapy> 3) investigate youth's problem 4) evaluate system. Sampling was 224 youths. The result shown the popular books of youth, Harry Potter, Marketing on Facebook, and Life on the Rock. The system was the stage for sharing content between youth and building friendship network of quality media.

Keywords – e-Bibliotherapy, Youth Problem, Information System, Reading, Media

1. Introduction

Bibliotherapy is an adjunct to psychological treatment that incorporates appropriate books or other written materials, usually intended to be read outside of psychotherapy sessions, into the treatment regimen. [4] There are various ways bibliotherapy can help people cope with problems: The use of literature and poetry in the treatment of people with emotional problems or mental illness. Bibliotherapy is often used in social groups and group therapy and is reported to be effective with people of all ages, with people in institutions as well as outpatients, and with healthy people who wish to share literature as a means of personal growth and development [7].

With every period of time, children and young adults growing up face a number of challenges that can impede their ability to lead a healthy, normal life. Just as the years progress, the number of challenges that children face continue to mount. Childhood seems to be getting shorter and shorter as the words "changes in the onset and duration of adolescence have had an important impact on the way teens grow up today" This, combined with other elements, leads to a teenager different from the teenager of past decades.

Finally, Bibliotherapy is an important counseling technique that can potentially help many adolescents better understand, relate to, and work with the conditions that may affect their lives. The need exists, however, to locate young adult literature that represents rare, unknown, or underrepresented conditions so that the audience that would benefit from bibliotherapy could be expanded.

In Thailand 2012, Cabinet approval of the reading national agenda. Ministry of Education proposed the promotion of reading as a national agenda to create a society of lifelong learning as follows [6].

- Reading is as a national agenda.
- Designate April, 2 each year, is as "Reading Day." April 2, is the birthday of HRH Maha Chakri Sirindhorn's. who love of reading.
- Notice the years 2009-2018 as the Decade of the reading of the country.
- Promote reading and lifelong learning by the committee This activities will be a mechanism for encouraging the reader to come up with concrete.

Finally, the research was developed from the concept of awareness of the whole important things ; agenda of reading, teens dangerous situation, and bibliotherapy technique. Then, the output will improving quality of new generation's life.

2. Literature Review

2.1 Overview of Teenager

Human development is commonly described in term of period. Development period occur in childhood, adolescence and adulthood. Adolescence is part of the life course and as such is not an isolated

period of development. Besides, it is the period of human development based on categories as follows : [8], [9].

2.1.1 Childhood

Childhood included the prenatal period infancy, early childhood, and middle and late childhood. The prenatal period is the time from conception to birth – approximately 9 month. Infancy is time that extends from birth to 18-24 months of age. Many psychological activities –language, symbolic thought, sensorimotor coordination, social learning, and parent-child relationship-begin in this period. Early childhood is the development period about 5-6 years of age. They develop school readiness and spend many hours in play and with peer. Middle and late childhood is period that extends from the age about 6-10 or 11 years of age. In this period, called elementary school years. Children master the fundamental skills of reading, writing, and arithmetic. Achievement becomes a central theme of the child's development and self control increase.

2.1.2 Adolescence

Adolescence is a period of transition between childhood and adulthood that involves biological, cognitive, and socioemotional changes. A key task of adolescence is preparation for adulthood. Although the age range of adolescence can vary with cultural and historical circumstances, in the United States and most other cultures today, adolescence begins at approximately 10-13 years of age and ends between the ages of about 18-22. The biological, cognitive, and socioemotional changes of adolescence range from the development of sexual function to abstract thinking processes to independence. Many psychologists prefer to divided teenagers as follow :

- *Masculinity* : Traditional, masculinity men were supposed to be aggressive, strong, forceful, self-confident, virile, courageous, logical, and unemotional. To be a man, a male must be a sturdy rock with an air of toughness, confidence, and self-reliance. He must never be emotional or reveal tenderness or weakness. Men are never to express affection toward other men so as to avoid all suspicion of homosexuality. These

stereotypes of masculinity are considered socially desirable by some people today.

- *Femininity* : The traditional concept of femininity were supposed to be submissive, sensitive, tender, affectionate, sentimental, dependent, and emotional. A feminine female was never aggressive, loud, or vulgar in speech or behavior. She was expected to be soft-hearted, to cry easily, to get upset at time over small things. She was expected to be dependent and sub massive and to be interested primary in her home. Today, few social groups hold these stereotypes of femininity, indicating that significant changes have taken place in people's concept.

2.1.3 Adulthood

Adulthood is not a homogeneous period of development. Development a lists often describe three periods of adult development: early adulthood, middle adulthood, and late adulthood. Early adulthood usually begins in the late teens or early twenties and lasts through the thirties. It is time of establishing personal and economic independence, and career development intensifies. Middle adulthood begins at approximately 35 to 45 years of age and end at some point between approximately 55 and 65 years of age.

2.2 Teen Problems

Problems that teenagers are faced with today can take so many forms. Even in stable, solid family units, teenagers will face confusion and uncertainty with themselves and life. But in today world of divorce, broken homes, unsafe sex and alcohol abuse, teenagers face issues that show themselves in different ways to different individuals. Common teenager problems include eleven areas : Body Image, Sibling Rivalry, Divorce, Teenage Pregnancy, Practicing Safe Sex, Teen Dating, Schooling & Jobs, Drugs & Alcohol, Eating Disorders, Weight Struggles, Acne [11].

2.2.1 Body Image

Here are some interesting facts about Body Image and why many of teens may be suffering from a poor body image: for example, In 1920, this was the first year of the Miss America Pageant. A poll

conducted by a popular women's magazine found that 75% of women thought they were "too fat." Eating disorders are more prevalent among females than males. This gender specificity is apparent in that over 90% of patients with anorexia nervosa or bulimia nervosa are women. Body image is associated with suicide risk for girls, not for boys. Culture places a higher value on physical beauty in the evaluation of females than males. Women felt more embarrassed when asked about their weight, than when they were asked about their masturbation practices, or occurrences of homosexual affairs. Women and girls are also consistently taught from an early age that their self-worth is largely dependent on how they look. The fact that women earn more money than men in only two job categories, those of modeling and prostitution serves to illustrate this point.

2.2.2 Sibling Rivalry

This problem, Sibling rivalry occurs when a brothers and sisters fight with each other and don't get along well. Often there is a certain amount of problems that arise out of one sibling being older than the other and being able to do more than the younger. Sibling rivalry is a normal part of any kid or teens life. The word rivalry involves the idea of a competition - and that is what most sibling rivalry is - a competition between the two siblings for their parents or others attention. Everyone experiences feelings of rivalry and competition. Often rivalry involves arguing. Siblings fight for a number of reasons, for example, they fight because they want a parent's attention. They fight because they are jealous and they fight because they are growing up in a competitive society that teaches them that to win is to be better:

2.2.3 Divorce

In family, when parents have a disagreement, that does not include yelling at each other or raising their voices they are having an argument. When the arguments get louder - they could be called fights. These fights can be loud and things can be said that aren't the nicest - and this can be scary for a kid or teen who is listening. Sometimes, as a member of the family, a teen or child may feel that they had some part in creating the fight between the parents. It is

important for children to know that these fights and arguments are part of any healthy relationship. Besides, a teen or child may think that because their parents yell and scream at each other and have a fight that they do not love each other anymore or that they are going to get a divorce. It is normal for a teen or child to feel upset when they hear their parents fighting. They may feel upset, sad, angry at one or both of the parents or fearful of what the fight may mean. This may end up interfering with the school work and social activities of the child.

2.2.4 Teen Pregnancy and parenting

The BIG risk of next step for teens that become sexually involved – pregnancy. As a general rule, sexual intercourse (genital-to-genital penetration) between a guy and a girl is necessary for pregnancy to occur. STDs and unwanted pregnancies are not the only thing to worry about from sex. There are other conditions and diseases that get transmitted from sexual contact, such as crabs. One increasingly common disease to worry about is molluscum contagiosum. The first step in protection is education. *Condoms* (outer surface barrier methods) are the only effective contraception in STD prevention. Both the male and female condoms are effective but do not offer 100% protection from transmission. However, the following activities will not (ever) cause pregnancy; abstinence, holding hands, dancing, kissing, heavy petting or making out with clothing on, making out in a hot tub or swimming pool, oral sex, touching of genitals with hands, and Homosexual relations.

2.2.5 Teen Dating, Love & Sex

Dating is one of the biggest milestones during teenage years that mark change from a kid into an adult. However, no one ever teaches teens how to talk to the opposite sex, how to flirt and how to ask someone on a date. The world of dating can be a confusing and mysterious place. By the way, dating will be useful in that teens can get to meet different people and find the ones teens would like to get to know better and possibly have a relationship with. Other reasons that people go on dates are because; they are fun, they are exciting, everyone is doing it, it is something to do, They create closeness between people, they are physically attracted, they want more

popularity, they want to have sex, They want approval, and they just want a friend.

2.2.6 Schooling & Jobs

A big event in any teenager's life is high-school. It may mean more freedom of choice in teen education, more responsibility and maybe even leaving behind some of friends. Teens are suddenly in a huge new environment and there isn't anyone to hold hand. Teens have got to find the way around school, find own locker, meet tones of new people and deal with those older students that seem so confident and self-assured. Now teens have to eat lunch in the cafe and there is no such thing as recess. However, most teens are afraid of the work. High school will forecast a different type of work in each teen.

2.2.7 Teens and Drugs & Alcohol

Alcohol is fermented fruits, vegetables and grains. These are fermented when the sugar in the fruit, vegetables, and grains is allowed to change chemically with the use of yeast in alcohol. According to the National Center on Addiction and Substance Abuse found almost 80% of high school students have tried alcohol. American teens drink alcohol since 14 years old. Teens who drink put themselves at risk for many problems - problems with the law, at school, and with their parents just to name a few.

2.2.8 Eating Disorders

As a teenager, the body is changing from that of a child's into that of an adult. For many **teens**, it is hard to adjust to these changes. Some teens may feel they are too big and don't like the weight that they are gaining. Some teens may feel they are underdeveloped - and may wish that they could be as tall or as muscular as their peers. Some may feel that they are developing too fast and this is bringing them unwanted attention and perhaps more responsibility than they are ready for and some teens may feel that they are not developing fast enough and being left behind their peers. Whatever the problems are that you may be facing - it is important to have a positive body image and to understand what everybody is going through. Parents, physician and

teachers can help teen. Teen can talk to a trusted adult about what they can do to become more healthy and fit whenever they look obesity. By the way children who have fewer weight can be related health problems than adults. Overweight children are at high risk of becoming overweight adolescents and adults. Overweight people of all ages are at risk for a number of health problems including heart disease, diabetes, high blood pressure, stroke and some forms of cancer.

2.2.9 Acne: Causes and Cures

Acne is common among teens - 73% of teens between the ages of 12 and 19 have problems with acne. The cause of acne is heredity which determines skin type. During puberty hormones cause the oil glands in ones skin to become more active and this can produce blackheads and pimples. For mild acne, a teen should wash their face daily to help keep pores open and remove oil. Also, washing their hair gets rid of excess oil around the face. For acne on the back, a teen should use an antibacterial soap and back scrub brush. For more severe cases of *acne* where washing isn't enough, teen should go see physician or a dermatologist that will be able to prescribe gels, lotions and oral medications to help with the acne. However, It is important for parent to do not think that teen will simply grow out of their acne. If acne is left untreated it can cause scars, cysts and emotional problems that affect self-esteem. It is important that parents get their teen help as soon as possible. Also, parents should inform teen that eating right, drinking water and keeping clean will help, as will safe, over-the-counter remedies.

2.3 Media

In the broadcast sense of the world, a medium is a channel which a message travels from the source to the receiver, for example, print media, electronic media, chemical media –book, magazine, newspaper, television, radio, movie, and Internet. Media usually are thought of as sources of news and entertainment. The power of media to change people's minds directly is very limited. If influence were limited to changing people's mind directly, the media would not be particularly influential. The most obvious and prevalent example of mass media influence is advertising. Through catchy slogans and constant

repetition, they make people remember. Not only the ad, but also the other media effect the youth behavior. For example, Violence, most the movies on television turned to increasing graphic violence, it can lead to aggressive behavior. Drugs and alcohol, ad can increase youth to drink and alcohol abuse [1].

2.4 Bibliotherapy

Bibliotherapy is defined as "a process of dynamic interaction between the personality of the reader and literature - an interaction which may be used for personality assessment, adjustment and growth." Its history originates from World War I when wounded soldiers were given books with emotional content to read in order to calm them down and help them express their feelings. Bibliotherapy simply means "to experience healing through reading," and it can be used alone or as an adjunct to therapy with a counselor. Readers identify with the characters in a book and realize that they are not alone with the problems they experience in their lives, then when readers become emotionally involved in the story they find it easier to express their own emotions, learn to problem solve and gain alternative perspectives [2].

Bibliotherapy has evolved into two distinct approaches, "didactic text" and "imaginative literature." Didactic texts refer to the standard self-help books that most adults tend to buy in order to work through their problems without having to attend a doctor's office, pay for it, and be labeled in the process. Yet "imaginative literature" refers to using fiction, fables, and drama to understand the human condition.

The goals of bibliotherapy can include the following: [5].

- To develop an individual's self-concept.
- To increase an individual's understanding of human behavior or motivations.
- To foster an individual's honest self-appraisal.
- To provide a way for a person to find interests outside of self.
- To relieve emotional or mental pressure.
- To show an individual that he or she is not the first or only person to encounter such a problem.
- To show an individual that there is more than one solution to a problem.
- To help a person discuss a problem more freely.
- To help an individual plan a constructive course of action to solve a problem.

2.5 Information System and SDLC Concept

Information system, an integrated set of components for collecting, storing, and processing data and for delivering information, knowledge, and digital products. Business firms and other organizations rely on information systems to carry out and manage their operations, interact with their customers and suppliers, and compete in the marketplace. For instance, corporations use information systems to reach their potential customers with targeted messages over the Web, to process financial accounts, and to manage their human resources. Governments deploy information systems to provide services cost-effectively to citizens. Digital goods, such as electronic books and software, and online services, such as auctions and social networking. By the way, The Systems Development Life Cycle (SDLC) is a process used in the development, creation, and maintenance of an information system. This process is often used in the creation or updating of a database system, and can serve as a useful tool for anyone trying to undertake a large database project. The SDLC has five phases: The Planning phase, the Analysis phase, the Design phase, the Implementation phase, and the Maintenance [10], [12].

3. Methodology

There are four stage of methodology as follow:

1. *Survey of book reading* - The tool as interview to ask about What's book that teen read? What are the details of the book? Why teen enjoy read that book? By the way the comment about the books can share in webboard that access at <http://202.29.22.13/aom/>



Book ID	Book Title	Author	Year	Score	Comments
0000	White My House
0001
0002
0003
0004
0005
0006
0007
0008
0009
0010
0011
0012
0013
0014
0015
0016
0017
0018
0019
0020

Figure 1. Webboard for sharing and voting for book

2. *Investigate problem of youth in daily life* - The interview begin in this phase about what kind of problem for teen? -love, education, family, internet, money, health, alcohol, gambling. This phase will recheck in the e-Bibliotherapy system after teen add information.

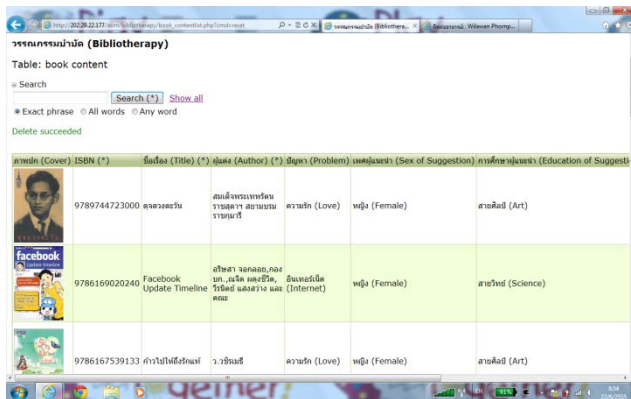


Figure 2. e-bibliotherapy system : present all favorite books, problem of teens, and situation to apply that books

3. *Develop e-Bibliotherapy system* - That sampling can be accessed at:

<http://202.29.22.177/aom/bibliotherapy>.

The process will allow teen to suggest of their favorite book. It is a stage as a zone to share book idea, problem, situation, detail of books

4. *Evaluate of the system* - This phase use a questionnaire as evaluate of e-Bibliotherapy system

4. Results

The results presented in four stages.

4.1 Survey of book reading

From the interview teen and webboard share about what their reading in 2012. From 224 teens, Only 205 teens (91.51%) presented ten title as follow :

No.	Title	Teens Votes (N=205)	Percentage
1	Love too much?	80	39.02
2	Woman cries, Man could not hear	29	14.15
3	Watermelon Cartoon	26	12.68
4	Get Anyone to do Anything	20	8.93
5	Life on the Rock	17	8.29
6	Harry Potter and the Prisoner of Azkaban	13	6.34
7	Visual Basic 6	7	3.41
8	Harry Potter and the Order of the Phoenix	6	2.93
9	Marketing on Facebook	4	1.95
10	Survey Inner	3	1.46

Table 1. Ten book for Teens Vote



Figure 3. Book over of teen voting

4.2 Investigate problem of youth in daily life

The interview begin in this phase about what kind of problem for teen? -love, education, family, internet, money, health, alcohol, gambling. From 224 teens, Only 208 teens (92.90%) presented ten problem as follow :

No.	Problem	Teens (N=205)	Percentage
1	love	60	28.85
2	education	53	25.48
3	family	33	15.87
4	money	23	11.06
5	acne	16	7.69
6	friend	14	6.73
7	internet	3	1.44
8	game	3	1.44
9	alcohol	2	0.96
10	gambling	1	0.48

Table 2. Problem of teens

4.3 Develop e-Bibliotherapy system

That sampling can be accessed at:

<http://202.29.22.177/aom/bibliotherapy>

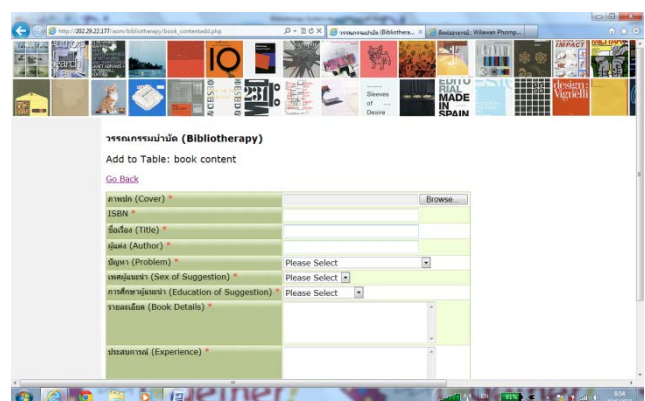


Figure 4. e-bibliotherapy system (<http://202.29.22.177/aom/bibliotherapy>)

The process will allow teen to suggest of their favorite book. It is a stage as a zone to share book idea, problem, situation, detail of books. The

process to develop of e-Bibliotherapy system began with Web design, install Apache Web Server, PHP, MySQL, Design Database and Table, Upload webpage with SSH Client Software to Server no. 202.29.22.177. Finally, user can access <http://202.29.22.177/aom/bibliotherapy>



Figure 5. e-bibliotherapy system : search for interest area to study each problem

4.4 Evaluate of the system.

This phase use a questionnaire as evaluate of bibliotherapy system. From the 224 teens, all them (100.00%) presented in ten evaluate choices as follow :

The score means level of satisfaction

1.00-1.49	=	bad satisfaction
1.50-2.49	=	poor satisfaction
2.50-3.49	=	moderate satisfaction
3.50-4.49	=	high satisfaction
4.50-5.00	=	highest satisfaction

Topic	\bar{x}	meaning
Simply connection	3.96	high satisfaction
Easy to use	3.99	high satisfaction
Design of Webpage	3.89	high satisfaction
Design of Webboard	3.92	high satisfaction
File Attach	4.04	high satisfaction
Clear communication	3.98	high satisfaction
Access Time	4.09	high satisfaction
Information Presentation	4.11	high satisfaction
Current Information	4.07	high satisfaction
Security	4.08	high satisfaction

Table 3 : Evaluate of : e-bibliotherapy system

5. Conclusion

e-Bibliotherapy system began with the concept of book can cure of suffering. Then, youth means the stage of life that transition from kids to adults. If youths are suffer, they will be suffer further. If they are happy, their next stage will be happy too. Not only the benefit to cure of youth suffering, but also building the friendship networking between youth by using books as media friend. The access at <http://202.29.22.177/aom/bibliotherapy> will be the safe zone, caring zone, educational zone and cheer zone to every youth who feel sad, lonely, stress, and love to read book.

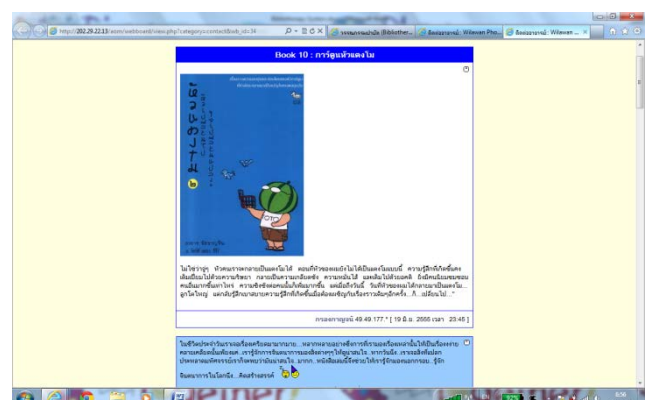


Figure 6 : Webboard for share experiences of Teens

Here some words from teens idea :

"We should concentrate to the problem and think. What is the problem come from? What is the solution? Tries to do. Solve it. This problem will go away from us."

"With Facebook suddenly it became the Timeline automatically, which is a complex play is chaotic because Facebook is a part of CMU communication via the Internet is learning, friends, family, etc. It became a part of the operation. everyday life."

References

- [1]. Baran, Stanley J. *Introduction to Mass Communication*. Boston : McGraw-Hill, 2006.
- [2]. Banting, Celia. *Bibliotherapy for Suicidal Teenagers - Is It Beneficial?*
<<http://ezinearticles.com/?Bibliotherapy-for-Suicidal-Teenagers---Is-It-Beneficial?&id=6180393>
- [3]. Encyclopedia Britannica. "information system," <<http://www.britannica.com/EBchecked/topic/287895/information-system>

- [4]. Encyclopedia of Mental Disorders, 2012
<<http://www.minddisorders.com/A-Br/Bibliotherapy.html>>
- [5]. Jake, Laurie. *Bibliotherapy Applications for Recreation Therapy*
<<http://www.recreationtherapy.com/articles/bibliotherapy.htm>>
- [6]. Ministry of Education. *Thai Cabinet approval of this national agenda.*
<<http://www.moe.go.th/moe/th/news/detail.php?NewsID=11600&Key=news6>>
- [7]. Pardeck, John T. *Using literature to help adolescents cope with problems – bibliotherapy.*
http://findarticles.com/p/articles/mi_m2248/is_n14_v29/ai_15622147/
- [8]. Santrock, John W. *Adolescence*, Boston : McGraw- Hill, 2007.
- [9]. Santrock, John W. *Adolescence*. Boston : McGraw- Hill, 2005.
- [10]. SDLC,
<http://databasemanagement.wikia.com/wiki/SDLC>
- [11]. Teen Problems.
<http://www.teensadvisor.com/teen-problems.html>
- [12]. What is systems development life cycle (SDLC)? <<http://searchsoftwarequality.techtarget.com/definition/systems-development-life-cycle>>

Corresponding author: Assist. Prof. Wilawan
Phornphatcharaphong
Institution: Faculty of Informatics, Mahasarakham
University, Kamreing, Mahasarakham, Thailand
44150
E-mail: wilawan.c@msu.ac.th

Lean Startup in Croatia - Does the Croatian Startup Scene Develop Effective Enterprises?

Maja Lalic ¹, Marina Klacmer Calopa ¹, Jelena Horvat ¹

² Faculty of Organization and Informatics, UniZg, Pavlinska 2, Varaždin, Croatia

Abstract - In times of general business uncertainty, when the companies face challenges upon which their further existence depends, one of the reactions of the management board is influencing the processes which lead to a relatively quick decrease of expenses and general rationalization of the company's business. The method, or what many refer to as a management philosophy, which is recommended to be used in crisis periods, is the lean method. Having in mind the extremely volatile business environment, lean startup approach has raised to surface recently since it takes the basic principles from the lean production. Although it was primarily developed for technical domain, the lean startup approach to management is flexible, and can therefore be applied in every industry. It uses the experimental way of approaching the innovation cycle, as well as a continuously evaluated process of learning about the organization with the goal of rigorous and measurable validation of the development hypotheses for the new products and services. The lean startup approach tries to systematically and very precisely lead the entrepreneur in discovering the valuable parts of a business vision, and in rejecting the parts which are not realistically founded. This paper analyses the Croatian startup companies by using a customized questionnaire. Besides an overview of the companies' founding profiles, financing sources, the development phases of startup companies, business areas and metrics used by startup companies, as well as information sources, the research showed that the Croatian startup scene is familiar with the principles of lean startup methodology and it is successfully implementing it in business.

Keywords - Lean Startup, BML Cycle, Croatian Startup Scene.

1. Introduction

Lean startup approach aims to systematically and precisely lead the entrepreneur in discovering the valuable parts of his/her product and business vision, as well as discarding the parts which are not realistically founded.

In relation to other European states, especially in relation to Silicon Valley, one of the economically most developed parts of the world and an area with the highest concentration of IT industry, the Republic

of Croatia (RC) is a small country, and its startup scene is in its beginnings. However, the domestic market is showing an increasing number of entrepreneurs who are developing startup companies focused on solving the concrete customer problems, and for which the world investors are starting to show more and more investment interest. One of Croatian problems is the non-existence of a startup company's registry containing the data on their founders, investments made so far, and so on.

1.1. The goal and research hypothesis

The goal was to design a Croatian startup companies database by doing independent search and, with support of the leaders from the Croatian Business Angels Network (CRANE) and Netokracija, a regional internet magazine dedicated to internet business, marketing, culture and media, discover whether the startup companies in Croatia are *lean* (flexible, adjustable) and whether they are familiar with the *lean* startup method and *lean* startup principles.

Based on the gathered and analyzed research up to date, defined problem and determined research goals, a research hypothesis was set. Besides the hypothesis, the paper also poses some research questions.

H1. Croatian startup scene is familiar with the principles of lean startup methodology.

Research questions for the Croatian startup scene:

1. The profile of the Croatian startup company founder?
2. Financing sources of the Croatian startup companies when being founded?
3. Current development phase of the Croatian startup companies?
4. Familiarity of the startup companies in Croatia with the *lean* startup methodology?

5. The most important *lean* startup principles for Croatian startup companies, and which ones are the most difficult to implement?
6. Business areas for which the startup companies conduct documenting of the assumptions on product market viability?
7. Metrics used by the Croatian startup companies when determining the level of customer satisfaction?
8. The sources of useful data and advice for the Croatian startup companies?

1.2. Research methodology and expected scientific contribution

While implementing and confirming/rejecting the set scientific hypotheses, several different scientific methods were used: content analysis method, data gathering method and statistical analysis, descriptive statistical analysis and description method, generalization method, compilation method, deduction method, correlation method, Chi square test and t-test which all helped process the gathered data and determine the basic characteristics of the sample. Data analysis was conducted using the Excel program as well as the statistical program package SPSS 19.0. As a measurement instrument for the implementation of the research, an online questionnaire was created using Google Docs tools. Gathering of primary data was conducted by the method of mailing the questionnaires to the email addresses of Croatian startup companies.

The expected scientific contribution supplements the development of the scientific thought on *lean* startup method which takes its basic principles from *lean* production, and which according to many is a management philosophy recommended to be used in times of crisis. Its contribution can be seen in the fact that there is a relatively small amount of papers, especially in domestic literature, which would research the mentioned issues. Therefore, the conducted research can contribute to a better understanding of *lean* method which facilitates bringing rational business decisions. The presented and interpreted results could provide a useful basis as well as encouragement for further research in this or similar topics related to a startup scene in Croatia. All this would show whether Croatian startup companies are developing effective enterprises.

2. Overview of Papers Containing Up To Date Theoretical and Empirical Research

The term *lean* designating flexible, vital or adjustable organization is applicable today in every business process. *Lean* principles were firstly defined by Toyota managers in the 30ies of the last century in order to optimize the production and set up an ideal flow of materials throughout the supply chain, so that they could achieve competitive advantage on the market over the strong American companies such as Ford and General Motors [1]. This is how the idea on decreasing expenses and the effort of the workforce came to existence, as well as an idea on how to shorten the time needed to develop a product. This led to the creation of *Just- In- Time* philosophy and Toyota Production System whose principles as well as the entire methodology was explained in detail by the inventor himself - Taiichi Ōno (1988) [2], in his book *Toyota Production System: Beyond Large-Scale Production*, which was later updated by James M. Morgan and Jeffrey K. Liker (2006) [3], in the book *The Toyota Product Development System: Integrating People, Process and Technology*.

In the scientific article *Startup, six sigma and startup sigma: fads or real process improvement methods* by Dag Näslund (2008) [4], the author explains that in many respects *lean* is in fact an updated version of JIT system, and that these methods are highly interconnected and dependable, and therefore one method cannot be implemented without the other. The *lean* system process, being the one which aims to eliminate losses in order to create added values, is explained by Earll M. Murman (2002) [5], in his book *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*. On the other hand the *lean* system and *lean* process philosophy were described in the book *The Machine That Changed the World* by James P. Womack, Daniel Roos and Daniel T. Jones (1991) [6]. The principles of the *lean* system were explained by P. Womack and Daniel T. Jones (2003) [7], in the book called *Startup Thinking: Banish Waste and Create Wealth in Your Corporation*. Startup company concept was explained in a paper by Carmen Nobel (2011) [8], *Teaching a 'Lean Startup' Strategy*, while Jerry Kaplan (1995) [9], defined it among the first in his book *Startup: A Silicon Valley Adventure*. Ash Maury (2012) [10], wrote on the topic of startups and development phases of a startup in his

book *Running Startup: Iterate from Plan A to a Plan That Works*.

Finally, the term *lean* startup appears, and it takes the basic principles from *lean* production, with the aim to decrease the activities in the entrepreneurial world which do not yield value, so that a startup company would be helped to achieve its business vision more promptly. Mindaugas Kiškis (2011) [11], argues that the whole concept of *lean* system within a startup company was enabled by the so-called cybernetic space, i.e. the space of virtual reality and technologies. Thomas R. Eisenmann (2012) [12], describes *lean* startup companies as being the ones that follow the approach based on certain assumptions or hypotheses while evaluating market entrepreneurial opportunities. However, Eric Ries (2011) [13], is considered to be the real founder of *lean* startup method. Ries is also the author of the book *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* in which he defines startup companies as organizations or institutions of people formed in order to create something new in the conditions of extreme uncertainty; he also describes in detail his own experience in the startup world.

Among the empirical researches, it is worth to mention the *Startup Genome Report* [14], which included an analysis of more than 650 web startup companies in the USA, as well as a research by EBAN [15], which presents a detailed structure of business angels from Europe and the USA and does a comparison of these two startup scenes. It is worthwhile mentioning a research contribution by Christian Kählig (2011) [16], entitled "*Facilitating Opportunity Development: Increasing Understanding of the Startup Approach in Early Stage High-Tech Entrepreneurship*" during which a research on startup scene in Germany was conducted.

3. *Lean* startup concept and its meaning

The *lean* production concept is based on a continuous improvement of the system in small steps, and on focusing on removing losses and eliminating harmful actions in any form in order to achieve market competitiveness. Therefore, *lean* startup takes its basic principles from *lean* production, and it tries to decrease the activities which do not add value and do not help a new enterprise to achieve its business

vision. *Lean* startup represents a new managerial approach (theleanstartup.com) which facilitates bringing rational business decisions and strives to encourage the entrepreneurs to continue doing big and good quality projects.

The concept *lean* startup [16], was created in Silicon Valley, which is the accelerator of startup scene, investors and mentors in the area of entrepreneurship, while today the concept has spread through the entire world.

Lean startups [12], are the companies which follow the approach based on certain assumptions or hypotheses while evaluating the entrepreneurial opportunities on the market. In *lean* startup companies, the entrepreneurs implement their own vision in business models, after which they test their primary hypotheses. After that, based on users' feedback, the entrepreneurs must bring a decision whether they will continue with the initial business model or whether they will change it (pivot).

One of the most important principles of the *lean* startup methodology is a closed circle or loop symbolizing the validated (confirmed) learning [10]. The goal of BML (Build-Measure-Learn) cycle is making the entrepreneur realize which of his hypotheses has a real basis, which is market justification. The real object that goes through the BML cycle is an experiment testing whether an instance of the product or its part has functionality, control, and whether it will be accepted on the market (market justification).

The process of validated learning starts from an idea, followed by programming (coding), connecting of modules, testing, and so on, in order to come to the actual product, service or application, i.e. to the implementation of the initial idea.

4. Empirical research

The goal of researching the Croatian startup scene was to find out whether the startup companies in Croatia are *lean*, and the extent to which they are familiar with the *lean* startup methodology.

Startup companies [17], are defined as high technology scalable projects (the existence of a standardized product) that are not limited to the region, but instead develop their solutions for the world. Therefore, with the help of CRANE, Netokracija (regional internet magazine), and through independent search, a list of Croatian

startups was made corresponding to the previously mentioned definition. Afterwards, 42 questionnaires were sent to the email addresses of the Croatian startup companies. The questionnaire was answered by 23 Croatian startup companies that are 54.76% of the participants which was evaluated as satisfactory for the needs of this research. A sample of 23 startup companies is representative, and it is assumed to represent the features of the entire population, i.e. of all the startup companies in Croatia.

4.1. Results of the empirical research on the Croatian startup scene

Descriptive statistics determined certain statistical population features, after which the statistical connections, gained by correlations, were shown between the variables.

- **First research question:** The results of the analysis showed that a typical Croatian startup company founder is male (96%), with a university degree (35%), between the age of 25 to 34, comes from Zagreb (57%), has so far participated in 3 startup projects (82%), and has more than 11 years (52%) of professional experience in the entrepreneurial world.
- **Second research question:** The biggest number of Croatian startup companies was financed independently (74%), the so-called *bootstrapping*, i.e. they had no external investments, and afterwards were helped by friends and family (30%), so-called 3Fs – Friends, Family and Fools. Besides that, many were helped by the Croatian Business Angels Network (CRANE), as well as business angels from other countries (43%).
- **Third research question:** Most startup companies on the Croatian startup scene were founded in 2011 (48%), and almost half of the questioned companies are in a phase in which the accent is put on the increase of sales of the already existing products, service or services (43%). Five Croatian startup companies (22%) are only at their beginning, i.e. they have an idea they are trying to develop into a complete product, service or services. In doing so, the main challenges that the new companies are facing at their beginning are related to creating a need for the product, service or services on the

market offered by the company itself, as well as visibility, lack of courage and knowledge on lean startup principles, finding the right mentors, and so on.

- **Fourth research question:** Most Croatian startup companies are well familiar with the *lean* startup methodology and principles (52%), and 44% of the participants have used their knowledge and familiarity with the *lean* startup principles in at least one project (startup). Almost 70 % of participants said they were included in implementing *lean* startup activities in their own startup company. In doing so, some of them had a very small role, however many were involved to a great extent and were tightly connected and involved in almost all the startup activities within their own startups.
- **Fifth research question:** The most important *lean* startup principles are *Talk to your customers* (78%), and *Build minimum viable product or product with the least possible set of functionalities which yields some value to the customers* (57%). The *lean* startups which are most difficult to implement, according to the opinion of the Croatian startup entrepreneurs, are *Build minimum viable product* (32 %) and *Quick iterative repetition* (26%).
- **Sixth research question:** Croatian startups document their assumptions related to all important business areas, in which most put emphasis on documenting those hypotheses relating to their customers, business partners, and business offers (50%). However, 23% of the participants stated to not document their business related assumptions at all.
- **Seventh research question:** Most Croatian startup companies (91%) use, as the basic metrics for determining the satisfaction level of their customers, the customer feedback, as well as the market feedback, the number of newly registered customers, return on investment, and the number of followers on social networks. Some use the agile methods, some measure the number of visits on their web sites, the number of received *emails*, some are familiar with the sales data, and so on. However, the Croatian startup companies use measurements, and they implement the customer feedback for further

improvements, learning, *bug* correction, and development of products/services/applications.

- **Eight research question:** The Croatian startup entrepreneurs try to find the numerous useful information and advice related to the startup and entrepreneurial world in general by following blogs of the renowned experts in this area, such as Eric Ries (42%), Dave McClure (53%) or Steve Blank (21%). Besides that, they use social networking (Twitter, LinkedIn), they try to participate at a number of international conferences, talk and share their experiences

with the other startup companies, investors, read books, forums, and so on.

4.2. Statistical correlations between the correlation-derived variables

In order to come to a conclusion, correlations were conducted on several most interesting variables. The first correlation was conducted between the level of theoretical knowledge on *lean* startup methodology, and practical knowledge implementation and experience in *lean* startup methodology. The results showed a strong correlation among these three variables (Table 1).

Correlations

		Practical knowledge implementation	Practical experience implementation	Theoretical knowledge level
Practical knowledge implementation	Pearson Correlation	1	.732**	.718**
	Sig. (2-tailed)		.000	.000
	N	23	23	23
Practical experience implementation	Pearson Correlation	.732**	1	.715**
	Sig. (2-tailed)	.000		.000
	N	23	23	23
Theoretical knowledge level	Pearson Correlation	.718**	.715**	1
	Sig. (2-tailed)	.000	.000	
	N	23	23	23

** . Correlation is significant at the 0.01 level (2-tailed).

Table 1. Correlation between familiarity, knowledge and experience of the questioned startup company founders on lean startup methodology

As Table 1 shows, the overall number of participants is 23, the data is statistically relevant since the significance coefficient is less than 0.05, while Pearson correlation coefficient is in the range from 0.715 to 0.732, depending on which of the three analyzed variables is taken into account. The correlation results indicated a high level of theoretical knowledge on *lean* startup methodology among the Croatian startup companies, and also the implementation of that knowledge in actual startup

projects, as well as involvement in the implementation of *lean* startup principles and all other activities related to *lean* startup methodology.

The second correlation was conducted between the level of familiarity with the *lean* startup methodology, and the participation at conferences and other programs in order to network and meet other business people from the world of startup companies (Table 2).

Correlations

		Conferences	Familiarity with the <i>lean</i> method
Conferences	Pearson Correlation	1	.062
	Sig. (2-tailed)		.778
	N	23	23
Familiarity with the <i>lean</i> method	Pearson Correlation	.062	1
	Sig. (2-tailed)	.778	
	N	23	23

Table 2. Correlation between the familiarity with the lean method and networking

The correlation results shown in Table 2 indicate that there is no statistically relevant correlation between the ones familiar with the *lean* method and those who participate at conferences and different other programs in order to do better at networking; the importance of this was emphasized by Eric Reis in his book.

The following correlation was conducted between the level of practical knowledge implementation on *lean* startup methodology and the participants who have so far either begun a startup company, or were one of the first 5 employees of a new startup company (Table 3).

Correlations

		Practical knowledge implementation	Number of founded startups
Practical knowledge implementation	Pearson Correlation	1	.563**
	Sig. (2-tailed)		.005
	N	23	23
Number of founded startups	Pearson Correlation	.563**	1
	Sig. (2-tailed)	.005	
	N	23	23

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Correlation between the practical knowledge implementation on lean method and the number of founded startup companies

Correlation results shown in Table 3 indicated the existence of a moderate statistically significant correlation between the two previously described variables. The moderate statistically significant

correlation was also gained in the correlation between the level of practical experience on *lean* startup method and the overall number of founded startup companies (Table 4).

Correlations

		Number of founded startups	Practical experience level
Number of founded startups	Pearson Correlation	1	.541**
	Sig. (2-tailed)		.008
	N	23	23
Practical experience level	Pearson Correlation	.541**	1
	Sig. (2-tailed)	.008	
	N	23	23

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4. Correlation between the practical experience of lean method and the number of founded startup companies

Correlation was conducted between the variable relating to the fact that the participants prior to starting their own startup company conducted testing on their potential customers, and on the other hand

relating to the overall number of the newly founded startup companies. Table 5 shows a moderate statistically relevant correlation between the previously mentioned variables.

Correlations

		Number of founded startups	Tested ideas
Number of founded startups	Pearson Correlation	1	-.562**
	Sig. (2-tailed)		.005
	N	23	23
Tested ideas	Pearson Correlation	-.562**	1
	Sig. (2-tailed)	.005	
	N	23	23

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5. Correlation between the tested ideas and the number of the newly founded startups

The following correlation was conducted between the variable which implies the customers should be given the product to use in the earliest possible phase of development, and the other variable which implies

correction of *bugs* while the customers were already given the product to use. Table 6. shows the result of implemented correlation which indicates moderate significant correlation between these two variables.

Correlations

		Open-alpha version	Correction of bugs
Open-alpha version	Pearson Correlation	1	.515*
	Sig. (2-tailed)		.012
	N	23	23
Correction of bugs	Pearson Correlation	.515*	1
	Sig. (2-tailed)	.012	
	N	23	23

*. Correlation is significant at the 0.05 level (2-tailed).

Table 6. Correlation between the customers who use the product in open-alpha version and correction of bugs

4.3. The Hypothesis Conclusions and Research Limitations

The hypothesis comprised of verifying whether the Croatian startup companies are familiar with the *lean* startup methodology. Through research based on qualitative and quantitative analysis, descriptive statistical analysis, method of generalization, compilation, deduction, correlation analysis, as well as analysis of research questions through the description method, the hypothesis was confirmed.

The Croatian startup companies are familiar with all the principles of *lean* startup methodology. Besides that, startup companies mentioned which are, according to them, the most important key *lean* startup principles, as well as those *lean* startup principles which are the most difficult to implement in a certain startup company. The results have shown

that even in that case (depending on whether these are the key, i.e. *lean* startup principles most difficult to implement), there is a difference between the founders of startup companies with more professional experience in entrepreneurship, and those who have so far participated in more than three startup projects.

While researching the Croatian startup scene, the basic limitation is the size of sample, since it is impossible to know with great certainty what the percentage of included startup companies in this research is. The data on the number of startup companies are based exclusively on information gathered by our own resources, and by the leaders of CRANE association, as well as Netokracija portal. The limitation is related to a lack of previously

conducted research in the area of the Republic of Croatia against which the results of the conducted research could be compared.

5. Conclusion

It is generally known that a very small number of startup companies succeeds, and after the launch of their products or services manages to further develop their products (services) and earn profit. Startup companies, which are mostly defined as just founded companies, and are most frequently linked to high-technology projects, get very often lost on their way from being founded as startups to achieving business success.

In order for a startup company to face more effectively the uncertainty of the market and the problems which arise when founding a new company, a lean startup method was founded with the aim to lead the entrepreneur during the development process of those products and services which the customers really want. However, there is no secret to success, and the success itself is a result of work, preparation and learning by doing mistakes. Neither does the lean startup method indicate any magic activities which should lead a startup company to success.

Results of research showed not only that the Croatian startup entrepreneurs are familiar with the lean startup principles, but they also implement them, since most of the questioned companies tested their products/applications before they presented them on the market. Most supported the claims that it is very useful and above all necessary to give the product/application to the customers for use as soon as possible, i.e. in the earliest possible development phase, and the bugs which appear can be dealt with „on the go“. On the other side, the results of the research showed that most Croatian startup companies have not been changing their business model, i.e. have not been applying pivoting.

It is important to conclude that the Croatian startup scene, although young and small, in terms of knowledge on and familiarity with the startup world, lean startup principles and in general the level of awareness, is no different than most bigger and older European startup scenes or USA startups.

References

- [1]. Stefanic N., Tosanovic N. (2010), *Upravljanje znanjem i promjenama – Lean proizvodnja*. ftp://161.53.116.242/Predavanja_vjezbe_programi_rokovi/Upravljanje%20znanjem%20i%20promjenama/20_04_2011__12766_Startup_proizvodnja.pdf, 20.02.2012.
- [2]. Ōno T. *Toyota Production System: Beyond Large – Scale Production*, Productivity Press; 1St Edition, 1988.
- [3]. Morgan J.M., Liker J.K. , *The Toyota Product Development System: Integrating People, Process and Technology*, Productivity Press, 2006.
- [4]. Näslund D. *Lean, six sigma and lean sigma: fads or real process improvement methods?* , Business Process Management Journal. Vol. 14 Iss: 3, pp.269 – 287 , 2008.
- [5]. Murman E.M. , *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*, Palgrave, 2002.
- [6]. Womack J.P., Jones D. T., Roos D. , *The Machine That Changed the World: The Story of Lean Production*, Harper Perennial, 1991.
- [7]. Womack J.P., Jones D.T. *Startup Thinking: Banish Waste and Create Wealth in Your Corporation*, Free Press, New York, 2003.
- [8]. Nobel C. (2011), *Teaching a 'Lean Startup' Strategy*. <http://hbswk.hbs.edu/pdf/item/6659.pdf>, 20.04.2012.
- [9]. Kaplan J. , *Startup: A Silicon Valley Adventure*, Houghton Mifflin, 1995.
- [10]. Maurya A. *Running Lean: Iterate from Plan A to a Plan That Works*, O'Reilly Media; Second Edition, 2012.
- [11]. Kiskis M. , *Entrepreneurship in cyberspace: What do we know?*, ISSN 2029-7564 (online), SOCIAL TECHNOLOGIES, 1(1), pp. 37–48. 2011.
- [12]. Eisenmann T.R., Ries E., Dillard S. (2012) *Hypothesis-Driven Entrepreneurship: The Lean Startup*. Harvard Business School. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2037237, 20.04.2012.
- [13]. Ries E., *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Crown business, New York, 2011.
- [14]. Marmer M., Hermrmann B.L., Berman R. (2011.) *Startup Genome Report 01, A new framework for understanding why startups succeed*, http://www.wamda.com/web/uploads/resources/Startup_Genome_Report.pdf, 20.04.2012.
- [15]. EBAN Secretariat (2010) *Statistics compendium 2010*, http://www.eban.org/components/com_virtuemart/shop_image/product/EBAN_StatisticsCompendium_Full_060111.pdf, 20.04.2012.
- [16]. Kählig C. (2011) *The Lean Startup Research Project*, Results of the Lean Startup Approach survey, <http://www.slideshare.net/ckny/110515-2228-embamasterthesischristiankaehligslapproachsurveyresultsnopcmn>, 10.04.2012.
- [17]. Brezak Brkan I. (2012) *Sto je startup (na 'Balkanu')? Vodič kroz osnovne pojmove i rušenje nekoliko učestalih mitova*. <http://www.netokracija.com/startup-vodic-27580>, 15.04.2012.

Corresponding author: Marina Klacmer Calopa
Institution: Faculty of Organization and Informatics
Varaždin, UniZg, Croatia
E-mail: marina.klacmer@foi.hr

Preparing the Camera Ready Paper for TEM Journal

First Author ¹, Second Author ², Third Author ³

¹First affiliation, Address, City, Country

²Second affiliation, Address, City, Country

³Third affiliation, Address, City, Country

Abstract – In this paper the instructions for preparing camera ready paper for the TEM Journal are given. The recommended, but not limited text processor is Microsoft Word. Insert an abstract of 50-100 words, giving a brief account of the most relevant aspects of the paper. It is recommended to use up to 5 keywords.

Keywords – Camera ready paper, TEM Journal.

1. Introduction

In order to affect high quality of Papers, the authors are requested to follow instructions given in this sample paper. Regular length of the papers is 5 to 12 pages.

2. Instructions for the authors

Times New Roman 11 point's font should be used for normal text. Manuscript have to be prepared in a two column separated by 5 mm. The margins for A4 (210×297 mm²) paper are given in Table 1.

Paper size	A4
Top margin	20 mm
Bottom margin	20 mm
Left margin	20 mm
Right margin	18 mm
Column Spacing	5 mm

Table 1. Page layout description

Regular paper may be divided in a number of sections. Section titles (including references and acknowledgement) should be typed using 11 pt fonts with **bold** option. For numbering use Times New Roman number. Sections can be split in subsection, which should be typed 10 pt *Italic* option. Figures should be one column wide. If it is impossible to place figure in one column, two column wide figures is allowed. Each figure must have a caption under the

figure. For the figure captions 10 pt font should be used.

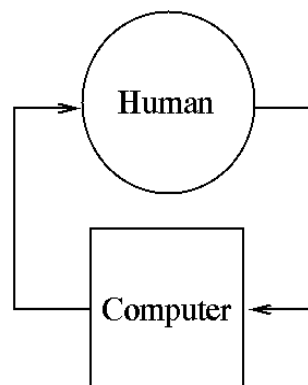


Figure 1. Text here

3. Conclusion

Be brief and give most important conclusion from your paper. Do not use equations and figures here.

Acknowledgements (If any)

These and the Reference headings are in bold but have no numbers.

References

- [1]. Wong BBM, Kokko H, *Is science as global as we think?* Trends Ecol. Evol 20: 475–476. 2005.
- [2]. S. Haykin, *Neural Networks*, New York, IEEE Press, 1994.
- [3]. Akerlof, George A. , Kranton, Rachel, *Identity Economics*, The Economists' Voice: Vol. 7: Iss. 2, 2010.

Corresponding author:

Institution:

E-mail:

CIP - Каталогизacija y nybykaciji
Hapodna byblijoteka Cpbiye, Beograd004

TEM Journal : journal of association for
information communication technology
education and science / editor Ćamil Sukić. -
Vol.1, No.3, (2012)- . - Novi Pazar (Hilma
Rozajca br. 15) : UIKTEN - Association for
Information Communication Technology
Education and Science, 2012 (Kraljevo :
Grafikolor). - 30 cm

Tromesečno
ISSN 2217-8309 = Tem Journal
COBISS.SR-ID 188848396