♦ CONFERENCE OBJECTIVE

The Conference OBJECTIVE is to intensify the information exchange of the results in theoretical research and practical developments in the field of the e-Learning and m-Learning.

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The New Generations of Students and the Future of e-Learning in Higher Education

Aneliya Ivanova, Angel Smrikarov

Abstract: *In this paper is presented an analysis of the nature of newest generations – Y and Z as the social and technological factors that made impact on them are considered. Further are discussed the challenges these generations place before the Higher education. In the paper are also outlined the missions of Higher education for preparing Generations Y and Z to be successful supporters of the Digital society and the direction e-Learning should follow to adapt to the changed nature of students.*

Key words: *Generation gap, Generation Y, Generation Z, Higher education, WEB 2.0, e-Learning 2.0, PLE.*

INTRODUCTION: GENERATIONS AND GENERATION GAP

By definition generations are cohorts of people who were born in a certain date range and share a general cultural experience of the world. Each generation is shaped by the social and cultural values of the society where it grows up and by the technologies available as the generation matures.

Usually the generations are differentiated by periods of about 20 – 25 years. But concerning the latest generations, due to the explosive evolution of technologies, it became necessary to differentiate them for periods of about 10 years. The Digital revolution significantly influenced the children, born after 1981 and caused the appearance of Net-Generation. Further we are going to refer this generation as Generation Y.

The daily exposure to digital technologies formed their perceptions, skills and thinking style in a manner that absolutely differ this generation from the previous ones.

And this is just the beginning. Generation Z, born between 1994 and 2004 came of age and the Generation gap is becoming deeper.

In this paper we are analysing the nature of the newest generations – Y and Z considering the social and technological factors that made impact on them, and discuss the challenges these generations place before the Higher Education. We are also outlining the missions of Higher Education for preparing Y and Z to be successful supporters of the Digital society and the direction e-Learning should follow to adapt to the changed nature of students.

Before going further, we should ask ourselves: As lecturers, do we really manage to reach our students when we deliver our knowledge to them? In this sense, we believe, the Higher Education has a problem. It's time to admit that we have been losing the engagement of our students year after year. Now we teach the middle of Generation Y and we haven't find yet the most appropriate way to engage them.

The Higher Education is a conservative institution that is not so flexible to radical changes. But if we want to survive in the Digital world, we have to reorganize the training activities, reinvent the training tools and redefine the teacher's role. As research shows, Generation Y is still interested in Higher Education, but some researchers show apprehension that Generation Z will lose this interest and Universities will become useless after 20 years. This will really happen if we don't undertake radical changes.

The first step to problem's resolve is to understand the Generation gap between academic staff and the students. Below we are going to explore the differences between Generations X, Y and Z, considering Generation X is the younger part of the current academic staff that will have the engagement to teach the Generation Z when they become students. The Generation gap is analyzed from two general perspectives – technological and social.

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THE DIGITAL NATURE OF OUR FUTURE STUDENTS

When we consider the influence of technology on Generations X, Y and Z, we could summarize the following (Table 1):

Table 1. Technology influences

Digital Revolution:
Gen X **faced** the Digital revolution. Gen Y **came at age during** the DR. Gen Z **were born in a Digital World**…
Digital Technologies:
Gen X **started using** Digital Technologies. Gen Y **embraced** the DT. Gen Z **can not live without** DT…
Internet:
Gen X and Y **went** on-line. Gen Z **were born** on-line…
Which technologies shaped the generation?
As children Gen X were shaped mostly by **TV, Video and Video Games**. Gen Y were shaped by **PC, Computer Games and WEB**. Gen Z have at disposal **all the DT and gadgets available**…

For Gen Y, the continuous interaction with Digital Technologies has developed:

- twitch-speed and multi-channel information processing;
- multi-tasking;
- non-linear visual thinking;
- expectation of immediate feedback and reward;
- expectation of continuous connection to WEB and immediate access to multiple information sources.

We just have to emphasize these features in order to get a notion about the nature of Generation Z – The Digital Kids.

When we are seeking to find the most relevant way to teach Gen Y, it is very important to have an idea about the way our present and future students perceive the technologies. We usually say: "I am using technologies in my courses", but do our students really take them for technologies? The true is: they do not. They don't think in terms of technologies, they think in terms of interactions. Computers, mobile phones and WEB are not a technology. They are like roads – just have been there. They are not interested how a technology works – they just want to use it. They are not likely to try to program a computer. It is just a tool to enter their virtual world. And this is much more of importance for the Generation Z.

THE SOCIAL NATURE OF OUR FUTURE STUDENTS

When we consider the influence that parents have exerted on Generations Y and Z, we could generalize: as children Generation X were loosely controlled by parents – they were so called **latch-key kids**. As a result they became **self-directed and individualists**. Generation Y were nurtured by **helicopter parents** all the time deciding for their kids, so they became **rule-followers, close to their parents and team-oriented**. Generation Z are grown up mostly by Generation X parents, so they are likely to become **more self-directed and less team-oriented** than Generation Y.

What should we know about Generation Y students?

- Their parents treated them as special, decided for them and organized their lives.
- They have grown up with a huge array of choices and believe this is their birthright.
- They are very pragmatic and rationalistic with strong career orientation.
- They dislike doing any work that is not relevant to their personal goals.
- They are confident and tend to overestimate themselves.
- They don't respect authority, expertise, science and traditional sources of knowledge.
- Previously they have been target-based taught, tested, guided and mentored, so they have lost important for University study skills.
- Their learning style is visual-kinesthetic.
- Having short attention spans, they are poor finishers, due to their lack of patience and persistence.

Why Generation Y are bored and detached by the traditional training at the University?

- the delivery goes in a slow pace, with linear and logically sequent representation of knowledge;
- there is no immediate reward of efforts;
- the assignments are individual and require critical thinking, reflection and creativity;
- the training process is tied to the curricula – low flexibility and selectivity of courses.

Analyzing the nature of Generation Y we can point out the following

CRUCIAL CHALLENGES TO THE HIGHER EDUCATION

24/7 Facilitator

Years on end the students have been respected by the authority of the lecturers and have adapted to their teaching style. Now it is clear that the teacher-centered model does not work anymore. "Like it or not, our students cannot afford to engage in lots of educational exploration, improvisation or open-ended spontaneity. The heyday of the brilliant, if diffuse, lecturer whose wisdom might just "change lives" is over." [1]

Nurtured by Helicopter parents who decided for them and organized their lives from birth now, the incoming students will be absolutely helpless at the University life. So, they will insist on continuous and immediate help and guidance instead of trying to solve their problems and do their assignments alone. Generation Y students are more likely to treat their lecturers as facilitators rather as instructors. They would hardly appreciate and be inspired by lecturers' knowledge, expertise and experience. Contrariwise, some authors describe this generation as skeptic (not respected by authority, experts and traditional sources of knowledge) [2]. But at the same time they will need lecturer's mentoring to achieve their personal goals – getting high grades and credits.

Personalized and Adaptive Training

Since their early childhood Generation Y are addicted to environments (games, services, technologies, and all the gadgets they use) adapting to their preferences. When they come to the University they will expect the same adaptivity. Grown up as special, all the time having a variety of choices, the future students will insist on flexibility, personalized training and services, service selectivity.

Negotiation for Grades

Since they show general distaste for doing "busy work" that is not relevant to personal goals, *"respond best to external motivators and are highly rationalistic"* [3], they will overestimate their efforts and will negotiate for grades.

Lack of Qualities for University Study

From the Nursery they have been target-based taught, tested, guided, and mentored, so they have lost very important qualities as self direction, critical and innovative thinking, reflection of learning, creativity, exploration skills, understanding of abstract scientific concepts that are absolutely necessary for successful study at the University.

Researchers at King's College London asked 800 young teenagers to take tests measuring their understanding of abstract scientific concepts. The results showed that the number of exceptionally intelligent teenagers is far lower than a generation ago [4].

Professor Michael Shayar, who led the study, believes the decline in brainpower was due to target-based teaching. *"The moment you introduce targets, people will find the most economical strategies to achieve them. In the case of education, I'm sure this has had an effect on driving schools away from developing higher levels of understanding."*

University IT environment

For each successive generation "technology is only technology if it was invented after they were born." [5]

A challenge for Higher Education is the increasing gap between the institutional IT environment and the technology environments that Generation Y have created for themselves [5]. Today's students are avid users of Web, e-mail, telephones, and other IT resources; however, their rapid adoption of instant messaging, cell phones, blogs, wikis, social networking Web sites, and other resources that are not generally part of the core campus infrastructure leads to a host of new concerns.

After specifying the challenges we can outline the most important

MISSIONS OF HIGHER EDUCATION

1. The **first mission** of Higher Education is to provide adequate training to students, whose behavior, preferences, expectations, thinking and learning styles are far different from previous students' ones and to prepare itself for the incoming generation.

2. Despite of not having qualities for University study, Generation Y is still struggling to go to the University. However, this choice is not prompted by their wish for self-development.

Generation Y were born when the economic conditions were growing rapidly. As children they were financially secure and lived with comforts. These kids who were born during the economy boom do not know how to adjust with less. However, at the same time they have seen their parents work hard and hence know the value of hard work.

All these circumstances have formed a strong career orientation as the importance is set to payment. According to a research [6], pay is clearly the most important benefit for the future and cash is the best performance incentive for Generation Y.

The Generation Y is the largest in population living generation and the first representatives have already become employees. How do they perform at the workforce market?

Sue Honore, learning consultant at Ashridge business school has started a major research project to uncover how employers will need to adapt training and development to suit the Generation Y [7]. "*They expect employers to help them grow. Coaching and* *mentoring is a big part of this and they seem to respond positively to it," "I think we will probably start to move away from the idea of fixed formal training and move more towards flexible coaching and mentoring systems with Gen Y.*" Honore shares.

Here is **the second mission** of Higher Education – to develop the missing professional skills before the graduates enter the workforce market and to teach Generation Y how to become successful employees.

3. The notion “knowledge society” emerged toward the end of the 90s and is particularly used as an alternative by some in academic circles to the “information society” [8]. According to a definition the Knowledge society "creates, shares and uses **knowledge for the prosperity and well-being** of its people". Who actually creates this type of knowledge? Such type of knowledge is created by scientists as a result from sustained research work. Nowadays it is created by Baby Boomers and Generation X, but who will create it in the future?

We can be pretty sure the term “knowledge society” was coined by Baby Boomers. If we ask the Generation Y and Z to label the society they live, they would probably stamp it as “fun” society. Inspired by commercials, TV shows, and all the entertaining stuff offered by WEB and mobile technologies, they actually live for fun. To be sure, they are knowledge creators but the knowledge they consider as valuable is focused to celebrities, life-style, luxury, entertainment, fashion.

The other type of knowledge that we consider as valuable, they just consume in order to get diplomas and well paid jobs. They are able to acquire only short-term knowledge and do not manage to reach reflection because their brains are constantly overloaded by the digital lives they live.

“The research uses logical and systematic procedures in the comprehension and transformation of the reality, in order to elaborate new knowledge. That activity requires from the researcher, curiosity, scientific knowledge, **creativity** and **persistence**.” [9] Unfortunately, our students do not have these qualities. As mentioned before, Generation Y is missing out a large segment of learning – that of exploring more deeply, enquiring, and reflection. For this generation to be successful as the thinkers and leaders of the future they have to acquire those skills.

In 1995, within an experiment a group of students were asked to think about listing the traits of a good scientist. “The children's list included that a scientist must have the ability to read and write, be a good listener, pay attention to what they are looking at, have lots of ideas, study unknown things, and have patience. A visiting physics professor from UC Berkeley reviewed the list and stressed to the children that the key which they had forgotten was that a good scientist needs to be skeptical, ask questions, and not accept everything. A good scientist needs to continually ask why. A mission of our educational system must be to revitalize our children's imaginations. It is critical that we teach our children how to think abstractly and in a nonlinear fashion.” [10]

The author of [10] discussed the WEB as one of the means that will solve the problem, but unfortunately, 14 years later we see that although WEB helped in development of non-linear thinking, it actually contributed to killing the imagination and abstract thinking.

We believe the **third mission** of Higher Education is:

- to revitalize the Gen Y's interest to science;
- to teach Gen Y how to become researchers;
- to develop the missing learning segment – critical thinking, exploratory learning, reflection, creativity and persistence.

WHY SHOULD WE BOTHER ABOUT GENERATION Y AND Z?

The answer is pretty simple: Just because we are their creators. Baby Boomers and Generation X gave them birth and nurtured them, and Generation X developed the technologies that shaped them this way. As Jeff Gordinier, author of the book "X Saves the World", shares: "*We've created all these great Websites that now Millennials waste their lives on.*"

THE FUTURE OF e-LEARNING IN HIGHER EDUCATION

Before presenting our vision about the future of e-Learning in Higher Education, let's consider how the learning occurs for Generation Y.

We can honestly generalize that at present, the learning process for Generation Y is separated in two parts:

- **formal part** – at the University, where they go by necessity, without internal motivation, only to get credentials and as a result they are constantly bored with their formal learning;
- **informal part** – outside the University, where they are fully engaged, exited and motivated in their personal virtual spaces, including social networks, social media, social bookmarks, shared resources, IM communication.

When the formal part is weakening, the professional skills and knowledge of our graduates (actually the quality of our product) are becoming worst than ever.

What is actually happen outside the University? It is just WEB 2.0 – a social rather a technological phenomenon – the focus is to the people, connections and resource sharing.

The social WEB 2.0 services should not be underestimated – except for fun, they are largely used for a very creative purpose – as powerful tools for exchange of knowledge, ideas and experience between professionals and researchers. There are many examples of blogs that became research and professional forums, even virtual places for workshops and conferences. Social networking usage is only going to increase. According to Netpop Research, there has been a 93% increase in social networking usage since 2006 and a study by Pew reveals that 75% of the 18- to 24-year-old age group have a profile within a social network [11].

It's clear that we have to engage our students back to the formal education and the way we could achieve this is through integration of students' favorite and daily used social-WEB tools in the training process.

Many lecturers have adopted some of the digital nature of Generation Y, using intensively IT in their research work and private life. But it doesn't mean they are ready to educate this generation, not to mention the Generation Z. In order to understand these students, we have to understand their favorite WEB tools and services, but not in terms of technology, rather as behavior – connectivity, engagement, interaction.

The existing Learning Management Systems (LMS) could not anymore catch and hold the attention of Generation Y, since they place the student in a passive role of fixed content recipient. Actually the Y-students expect to be connected, community engaged, actively interacting and collaborating in a personalized learning environment, constructed and managed by them.

In 2005 a group of educational technologists starts the discussions about **personal learning environment** (PLE), and soon Scott Wilson from CETIS presents a conceptual model of next generation virtual learning environment. This model is the first graphical representation of PLE. Derek Wenmoth further develops the model, representing the interaction between PLE and existing LMS. The majority of LMS, currently in use, are server-based, and designed to be used as institutional systems. In the light of the idea about Virtual University, this creates a problem for students moving between institutions, since they may need to learn how to use different environments based at different institutions. The most significant benefit of a PLE is that the students have one set of tools suited to their needs, which they can use to interact with a number of different institutions throughout their studies.

Actually we believe **the evolution of e-Learning in Higher Education should take the following direction: the existing e-Learning environments participating in future e-Learning as content repositories, but the active part of learning process covered by PLE, where the students, using their favorite WEB services and tools, will construct their knowledge in constant collaboration.**

The challenge of evolving pedagogy to meet the needs of Net-savvy students is daunting, but educators are assisted by the fact that Generation Y values education. But what about meeting the needs of Generation Z?

WHAT TO EXPECT FROM GENERATION Z?

Being born in a digital world, **the Generation Z adapts to technology like no other generation and highly depends on it.**

They are very individualistic, and may not give too much importance to family values. **They also will be not team players.**

They are less career-oriented than the Generation Y but have strong opinions and do not take suggestions well. Psychologists are noticing a drastic behavior change from Generation Y to Generation Z. For the Generation Y, the emphasis has always been career and education whereas the Generation Z does not believe in career and formal studies either. **Education and work plays a minimal role in their lives and they do not see them as means of survival.** By the time the Generation Z starts working there might be severe shortage of professionals like doctors and scientists. But such professions may not hold any value for Generation Z.

Their communication takes place mostly on the WEB and they take it for granted. Therefore they show very little verbal communication skills and may not do very well in areas of public speaking. They also lack expression, confidence and interpersonal skills. In these qualities they are absolute opposite to Generation Y.

Generation Z processes information at lightning speed. They are used to instant action and satisfaction due to Internet technology and may be very impatient as they desire instant results.

Generation Z lives in the virtual world and they can reach out to any place through the WEB. They are less likely to travel and step out of their homes for anything. **They will try to get everything to the place they live**.

Generation Z being bad listeners have less regard for what others have to say and they do not pay attention to others. They don't believe in living according to social norms. Their society exists on the WEB where they speak their mind out and express their opinions.

Resli Buchel reveals ten reasons why the Internet-loving kids of today will become the technology savvy adults of tomorrow [12], facetiously proposing "The Ten Commandments of Generation Z":

1. You shall always be connected
2. You shall always be mobile
3. You shall use computers at work
4. You shall use computers at play
5. You shall have many friends that you will never meet
6. You shall have a second life
7. You shall be ultra-independent
8. You shall multi-task
9. You shall always be in demand
10. You shall invent a whole new language

CONCLUSIONS AND FUTURE WORK

It is more than clear that the Higher Education could not stay untouched by the radical changes in the nature of present and incoming students.

In order to survive as a vital institution the University should undertake crucial transformations concerning the teaching approach, the way of communication with the students and the organization of administrative services.

When we consider the training process, the adoption of WEB 2.0 services and e-Learning 2.0 techniques is unavoidable if we aim at catching up Generation Y and Z students. It is also necessary to directly engage the students in a dialogue about how they would like to see the faculty's use of technology to help them learn more effectively.

At the same time it is important for the academic staff to be aware that customization is central to the definition of technology for Generation Y and Z students – it is something that adapts to their needs, not something that requires them to change. The incoming students will have significant expectations regarding the use of technology to support learning, but, those expectations are tied to faculty members and their ability to use technology correctly.

According to administrative issues, Generation Y and Z will expect their problems to be solved – quickly and easily and the use of technology to improve student services will be critical to the University, since the students will expect services delivered through technology.

The Generation Z will place more daunting challenges to the Higher Education and the sooner we start preparing our training approach to address their learning style, the better we will manage to attract them to education, research and science.

REFERENCES

[1] Taylor,M.L. Generation NeXt comes to college. 2006 updates and emerging issues, A Collection of Papers on Self-Study and Institutional Improvement, Vol. 2, 2006.
Available electronically at:
http://www.taylorprograms.org/images/Gen_NeXt_article_HLC_06.pdf

[2] Wilson, M., L. E. Gerber. How Generational Theory Can Improve Teaching: Strategies for Working with the "Millennials", Currents in Teaching and Learning, Vol.1, No. 1, Fall 2008.

[3] Sweeney, R. Millennial behaviors and demographics, 2006. Retrieved 21 September, 2008 from: http://library2.njit.edu/staff-folders/sweeney/Millennials/Article-Millennial- Behaviors.doc

[4] Logan, G. Generation Y prove teenage intelligence is in decline, October 2008. Retrieved from: http://www.personneltoday.com/articles/2008/10/27/48120/generation-y-prove-teenage-intelligence-is-in-decline.html

[5] Hartman, J., P. Moskal, Ch. Dziuban. Preparing the Academy of Today for the Learner of Tomorrow, in Educating the Net Generation, EDUCAUSE, 2005.
Available electronically at: www.educause.edu/educatingthenetgen/

[6] Personnel Today: Generation Y Research by Ipsos MORI, August, 2008. Available electronically at:
http://www.personneltoday.com/Assets/GetAsset.aspx?ItemID=6798

[7] Research at Ashridge college: Generation Y Research. Available electronically at:
http://www.ashridge.org.uk/Website/Content.nsf/wFAR/Generation+Y+Research?opendocument

[8] Burch, S. The Information Society / the Knowledge Society, in Word Matters, May, 2006. Available electronically at: http://vecam.org/article517.html

[9] Lemos de Menezes, N., F. A. Villela. Scientific Research, SEED News Magazine, Main subject of March / April - year VIII n. 2

[10] Rose, K. Learning with the World Wide Web: Connectivity alone will not Save Education. Proceedings of the INET'95 International Conference, Hawaii. Reston, 1995, VA: Internet Society, 273-278.

[11] Why does engaging Gen Y on the social web make sense? Available electronically at: http://www.currencymarketing.ca/blog/Why-does-engaging-Gen-Y-on-the-social-web-make-sens

[12] The Ten Commandments of Generation Z, Time Out Sydney, Available electronically at: http://www.timeoutsydney.com.au/kids/the-ten-commandments-of-generation-z.aspx

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Basora Enterprise Search: A New System for Enterprise Information Retrieval

Maurice G. Wallé and Leon J.M. Rothkrantz

Abstract: *There are several issues at play within Enterprise Search (ES), a major one is that enterprises are finding it difficult to retrieve their data using current ES solutions. This research is a step towards improving this. By designing, implementing and evaluating a system for Enterprise Information Retrieval, with an improved search result presentation technique, which assists users during search tasks. This was accomplished by researching current ES systems and search result presentation techniques. This research resulted in finding two forms of document summaries, namely a textual document summary technique: Top Ranking Sentences (TRS) and a visual document summary technique: Thumbnails. These document summaries have been designed to support a user during information seeking activity. The system developed was named Basora Enterprise Search (BES) and was developed using an agile software development approach. It incorporates the TRS and Thumbnail into its search result presentation technique. The BES prototype was put through both a performance and user evaluation. The first test indicated that BES performs more or less equal to the Commercial Enterprise Search Solution IBM Omnifind 8.5, while providing the user with two extra forms of document summaries. The user evaluation focussed on evaluation the effectiveness of the new search result presentation technique. The results of the user evaluation show that there are various search tasks where the addition of these summary elements has a positive effect on relevance assessment and query reformulation. This research indicates that the BES system actually helps a user assess the relevance of a document, minimizing the amount of documents that need to be opened before the user finds the desired one. It also indicates that the additional visual and textual document summaries assist the user when reformulating a search query, decreasing the time it takes a user to complete a search task.*

Key words: *Enterprise Search, Search Result Visualization, Top Ranking Sentences, TRS, Thumbnails*

INTRODUCTION

Information Retrieval can carried out in several environments, two of these are: Web and Enterprise. For each of these environments a different type of Search Engine is required namely Web Search Engine or Enterprise Search Engine. Web Search entails, using a search engine to identify and retrieve information housed on the World Wide Web. While an Enterprise Search focuses on retrieval of information within Enterprises (i.e. Company's), this research focuses on the Enterprise Search environment. A term within Enterprise Search that is getting a lot of attention is "Findability". Its definition according to Frappaolo & Keldsen 2008 [4] is "The Art and Science of making Content Findable". The reason for this attention is that the volume of content within businesses is growing at a phenomenal pace, and finding relevant content using simple queries is not sufficient, so the need arose for Enterprise search to become a science hence the term "Findability". They also state that the ineffectiveness of Enterprise Findability is not the fault of a poor search engine but the design behind its deployment is flawed. These are some current issues within Enterprise Search, but when looking at this domain from a different angle it is possible to identify several ontology's namely the user, the system and the network. Each of these has its own set of hurdles, within the first ontology the user; there are cognitive aspects like, how a user defines a query, how does a user assess the relevance of a document etc. Furthermore the user interface plays an important role in the last aspect mentioned.

The system has its own hurdles, such as how to convert a user's query into application language so the system understands what to retrieve based on the users query. Another issue is how to represent and store the data for the search engine to access this quickly, keeping the response time to a minimal. The last ontology to consider is the network, one of the reasons is that network lag can seriously affect the response time of the Search Engine. It is also important to consider on what kind of system the search engine runs, because when running it from a PDA the network response time is slower than when using a computer. The topic of this research is to design, implement and evaluate a system for Enterprise Information Retrieval, which employs an improved search result presentation technique. This research focuses on the user and system aspect of Enterprise Search.

There are three challenges that lie at the centre of this research: The first one is that formulating and re-formulating good search queries is proved to be a cognitively challenging task for users. These search queries are often approximations of a user's underlying need, making it difficult to formulate a query in one try, to satisfy this need; consequently making the information seeking process an iterative one [5, 10, 11]. The second one is interpreting and assessing the relevance of documents in search result list, this is also imperative to the search process [5, 12]. Users are reluctant to examine large numbers of individual documents and they hardly look further than the first result page [5, 13]. So a user's decision to view a document or not is totally dependent on the available elements within the search results namely: document name, author, file type, snippets, etc. Lastly building a system that allows a user to search trough a dataset, which assists with re-formulating search queries and interpreting and assessing the relevance of documents retrieved. The first two challenges are user related while the last is associated with the system ontology.

RELATED WORK

By exploring current Enterprise Search systems, information could be gathered on how to tackle the last research challenge mentioned above. The anatomy of Google's1 architecture was reviewed to get a better understanding of the components of large scale search engines. Google was chosen because their success and ingenuity, which could be used in the development of the new Enterprise Search system. Also the differences between the components of an Enterprise and Web search engine are minimal. These components are shown in Figure 1 and discussed in the following paragraph.

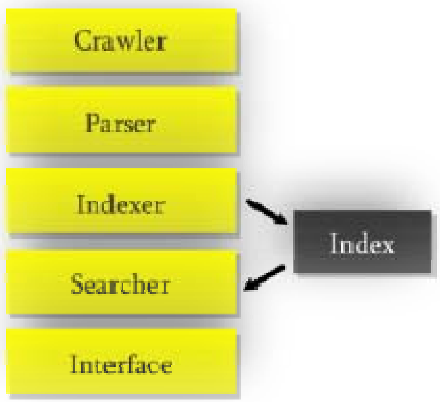

Fig.1. Basic Components of a Search Engine.

Next research was also performed on search result presentation techniques. This research led to finding two forms of document summaries, namely a textual document summary technique: Top Ranking Sentences (TRS) and a visual document summary technique: Thumbnails. TRS are up to three sentences presented in the search results that contain the query terms and are ranked according to several features. Their main purpose is to offer the user extra information about a document, so beforehand they can form a better opinion of what information a document contains [6]. The thumbnail is a miniature image of the first page of a document; this also increases ability of a user to make more accurate decisions about the relevance of search results [7]. These document summaries have been designed to support a user during information seeking activity. These user interface components were chosen for the development of the new

Enterprise Search system, because of the positive results of several studies using one of these or both of these components (Joho and Jose 2006[5], White et al 2005 [6], Tombros and Sanderson 1998 [15] and Dziadosz and Chandrasekar 2002 [7]).

Finally Solr 1.2 Search server2 and IBM Omnifind Search Solution3 were explored for their Indexer and Searcher components. Seeing that the main focus of this research was not to implement these components, and since an implementation already exists and which is well tested, the development of the Indexer and Searcher seemed unnecessary. Solr and IBM Omnifind were researched to be used for these components of the new Enterprise Search system. The Solr Search server was chosen because it's an open source project and could be manipulated to provide all the functionality needed for the prototype; while the IBM Omnifind Solution was less adjustable to the Basora prototype development requirements. It was also very difficult to access the Indexer and Searcher components of the IBM Omnifind Solution for integration into the Basora prototype. Another key factor was that the Solr server, was well documented and tested; the documentation was easily accessible, unlike the documentation for the IBM Omnifind Solution. This was very hard to obtain, often it was incomplete or to superficial. It was possible to contact the IBM support line, but this was usually quite a lengthy process. In the end Solr 1.2 was chosen because of its speed, agility and good documentation.

GLOBAL DESIGN

The design of the BES prototype can be split up into the components seen in Figure 2. Each of these components performs a vital role in order to allow the prototype to function. The Crawling, Parsing and Committing components are also referred to as the Basora Pre-processing stage, because this has to be done before-hand for the prototype to function.

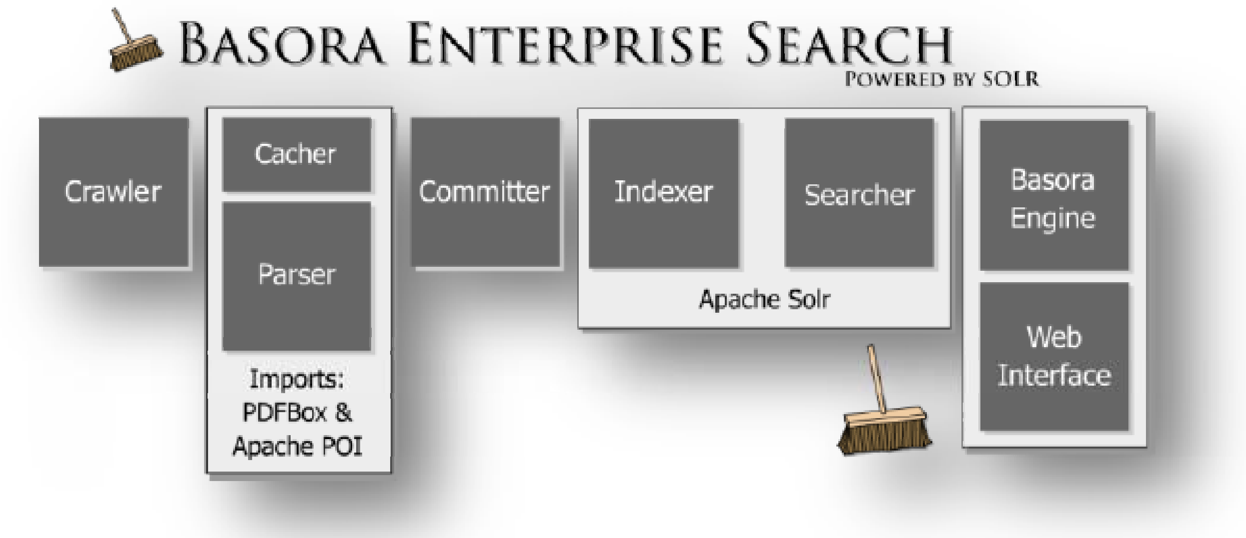

Fig.2. Basora Enterprise Search prototype components.

The Crawler component of the BES system is able to crawl a file system and retrieve the location of all the, Microsoft Word (.DOC), PowerPoint (.PPT), Excel (.XLS) and PDF documents (.PDF), along with the date and time it was last modified and it also assigns each document a unique identifier. This information is used when the file system is re-crawled, so it can check if the file has changed in between crawling sessions. Now the Parser component is responsible for extracting the metadata and text from the crawled documents. This is then formatted this into XML, so it can be committed to the Solr Indexer, because the Indexer only supports XML files. The Committer is the link between the Basora Parser and the Indexer; it is responsible for sending the Parsed XML files to the Indexer. It reads the parsed XML files one by one and sends them to the Indexer. Which has to index these by storing and caching them; for when a search query is submitted to the Searcher it can quickly retrieve the relevant documents. The Indexer and Searcher components of the BES prototype have been configured using the Solr Search server. These components were used because developing these is outside of the scope of this research and that it is already available and that Solr is a well respected and tested Search Server. The results are returned by the Solr Searcher in XML format, this contains all the necessary data to be able to extract the TRS. This is part of the responsibility of the Basora Engine; its main purpose is to function as a bridge between the Solr Searcher and the Basora Web Interface. A submitted query first goes through the Basora Engine where it is formatted and sent to the Solr Searcher. Then the results it obtains are parsed and formatted so these can be displayed to the user through the Web Interface. This interface offers an improvement over existing Enterprise Search systems. It addresses the first two research challenges (discussed in the first chapter) by adding a visual and a textual document summary to the result presentation namely Top Ranking Sentences (TRS) and a Thumbnail. TRS are up to three sentences presented in the search results that contain the query terms and are ranked according to several features. Their main advantage is offering the user extra information about a document so beforehand they can form a better opinion of a document's contents [6]. The thumbnail is a miniature image of the first page of a document, this increases ability of a user to make more accurate decisions about the relevance of results [7]. These elements are further discussed in the next chapter.

IMPLEMENTATION

The Basora Enterprise Search (BES) prototype's main purpose is to make a dataset searchable while assisting a user with query reformulation and relevance assessment. The design consisted of various components as discussed in the previous chapter. These were implemented using an agile software development approach, incrementally developing BES prototype. The Crawling Parsing and Committer components are the pre-processing steps of the BES system. These were developed from scratch using some essential libraries namely Apache POI & PDFBox (for reading PDF and Office documents). The pre-processing components are responsible for retrieving all documents from a file system, extracting the metadata and content from these, formatting this into indexable XML and finally committing this to the Indexer.

The Apache Solr Server was customized to provide Indexer and Searcher support for the BES system; Solr is a subproject of the Apache Lucene open source Java search library. It ensures that the pre-processed data is properly stored and also once a query is submitted to the Searcher it retrieves the results as quickly as possible. The Basora Engine's main purpose is to allow the Web Interface and the Solr Searcher to communicate. It is also responsible for extracting the TRS, and formatting the results in HTML so they can be displayed to the user through the Web Interface. This user interface allows users to interact with the BES system during the extent of their search. A screenshot of the main interface is shown in Figure 3.

Fig.3. Basora Enterprise Search Main Interface.

TRS ALGORITHM

Seeing that no actual TRS algorithm could be found, this was custom made, inspired by the literature available. The variables were chosen based on the work described in the paper White et al [6]. The system extracts all sentences in which the query terms occur and ranks all these sentences accordingly. The three characteristics used are discussed next.

The first one, "position of the sentence within the document" is determined based on its location within the document. A sentence that occurs in the upper or lower 20% of the document is usually part of the table of contents, the introduction, the executive summary, the abstract, or the conclusion. These components are very important so these sentences get a high ranking. If the sentence is located elsewhere in the document it will be given a low ranking. The proportions were obtained by gathering about 20 documents from the available dataset4 and calculating these. Then the second one, "term occurrence" is calculated by dividing the total occurrence of query terms within all sentences by the total occurrence of all these query terms within each sentence. Then multiplying this by 100 and rounded to an Integer. The final characteristic, "amount of terms per sentence" ranking is only calculated if the user submits two or more query terms to the engine. If this requirement holds, the engine calculates the amount of query terms within a sentence, and divides this by the total amount of query terms supplied by the user. Then multiplies this result by 100 and rounds this to an Integer.

Once these individual rankings have been gathered, the engine calculates the total ranking per sentence based on Equation 1. The equation treats the Position Ranking as the variable with the most influence over the total ranking and the Amount of Terms per Sentence Ranking as the variable with the least. This approach is taken because this characteristic is described in the literature as quite an influential one [6]. The exact values for the total ranking calculation were obtained by iteratively tweaking these. Once the entire algorithm was implemented it was tested to evaluate whether the ranking function actually ranked more relevant sentences higher than less relevant ones. This was done by first choosing five fixed query terms and analysing the sentences and respective ranking obtained. The final values were obtained by tweaking Total Ranking Calculation values (5, 3 & 2) and the Sentence Position variable until the desired results were obtained. This TRS algorithm was implemented in Java 1.6 using the standard Java libraries.

Equation 1. Total Ranking Calculation.

$$\frac{(5x + 3y + 2z)}{10}$$

x = Position Ranking
y = Term Occurrence Ranking
z = Amount of terms Ranking

Search Result Presentation Layouts

The BES prototype contains 4 different layouts (illustrated in Figure 4 to Figure 7) for search result presentation. The first contains the same amount of information as the current Enterprise Search Solutions provide to their users, this one is referred to as the baseline. While the other three layouts consist of the baseline components with the addition of either or both, the visual and/or textual document summaries (TRS and Thumbnail). The BES system's Web Interface was developed using the Java 1.6 programming language, Java EE, HTML 4.01, and CSS 2.0.

Fig.4. Layout 1: Baseline.

Fig.5. Layout 2: Baseline & TRS.

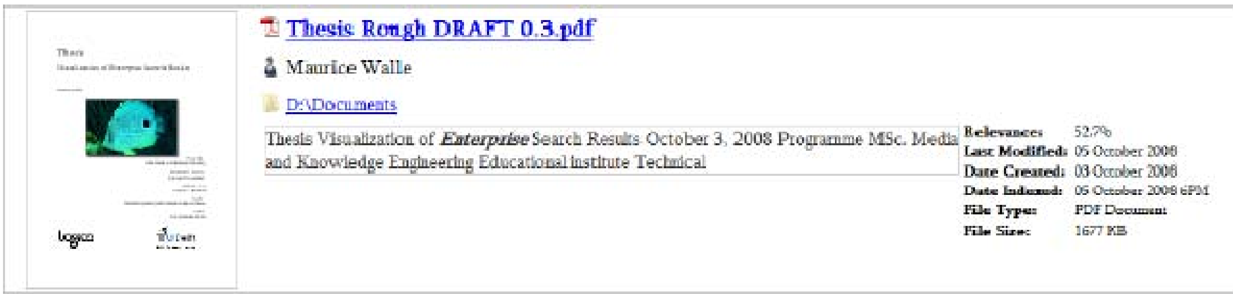

Fig.6. Layout 3: Baseline & Thumbnail.

Fig.7. Layout 4: Baseline, TRS & Thumbnail.

PERFORMANCE EVALUATION AND RESULTS

The performance and user evaluation was carried out on the same computer and using the same fixed dataset. The computer's specifications were: Intel Core 2 Duo T7500 2.20 GHz (2 CPU's), 800 MHz FSB, 2 GB of RAM, 100 GB Hard disk drive, and runs Windows XP Professional Edition SP2. The dataset consisted of 5408 documents: 50% Microsoft Word, 5% PowerPoint, 8% Excel and 37% PDF documents. For the performance evaluation the following variables were measured: the time it takes to pre-process the dataset, response time of the search engine and the average number of results it returns. These were taken from an Enterprise Search Engine evaluation guide by Google [14]. This document describes seven critical characteristics of an Enterprise Search Engine. Only three aspects were evaluated, because these were needed to indicate how the Basora Enterprise Search (BES) prototype performs compared to current Enterprise Search Solutions. Some of the other characteristics mentioned in the evaluation guide were: Security, How often it crawls the content, Costs and maintenance fees, these were outside of the scope of this evaluation. These variables were measured for both the BES system using layout 4 and the IBM Omnifind 8.5 Enterprise Search solution (used as benchmark).

Table 1. Pre-processing performance results

Search Engine	Crawling	Parsing	Indexing	Total Time
Basora	4 min	3 hour 42 min	10 min	3 hours 56 min
Basora *No Thumbnail generation*	4 min	1hour 41 min	10 min	1 hour 55 min
Omnifind	35 min	1 hour 40 min	1 hour 30 min	3 hours 45 min

First both systems were installed on the test computer, then both systems were put trough their pre-processing steps and clocked. In Table 1 the pre-processing times are shown, these indicate that the BES and Omnifind systems pre-processing time is more or less equal. There is a big difference between both systems: Crawling and Indexing times, because the exact procedure used within the Omnifind solution is not available one could only speculate why. One of the reasons could be that BES does not contain all the security and back-up features that the commercial solutions have. Another valid reason could be that the BES solution's parsing utility directly generates indexable XML that can be posted to the indexer. This procedure is probably different within the commercial Enterprise Search solution.

Table 2 shows the average response time and average number of results obtained from the search engine. This was carried out on both Enterprise Search systems, by first gathering 30 search queries from experts that continuously query the available dataset for information; then executing these on both the systems and gathering the data. BES's average response time was only 75 milliseconds longer than IBM Omnifind, while providing the user with two extra forms of document summaries. Collins 1994 [6] states that a user considers a process to be real time, if it takes less than 100 milliseconds; so this difference is not noticeable by the users, so they will not get frustrated by the time it takes for the results to be returned. Additionally the BES system returns about 11 times more search results then the IBM Omnifind system; this could be because the Omnifind engine has a stricter filtering function, but it could also indicate that the Omnifind engine indexes less of the documents contents than the Basora prototype does.

Table 2. Average Response Time and Average Number of results returned

Search Engine	Response Time (ms)	Num results returned
Basora	[Solr: 161, Basora Engine: 72] Total: 233	1558
Omnifind	158	133

USER EVALUATION AND RESULTS

The user test was done to evaluate the effectiveness of the search result presentation layouts, in order to assess if the two first research challenges (presented in chapter 1) were met. A total of thirty-two users (6 female and 26 male) participated. This was set up using the IMPACT [1] model for user evaluation. Each participant had to carry out four tasks; each task was done using a different layout (presented in paragraph 4.2). Every task either consisted of a Background search task, Decision making task, Known item task or Topic distillation task. These were formulated based on a simulated work task approach described in Borlund 2000 [9]. To reduce the bias from participants performing the same tasks with the different layouts all in the same order a Graeco-Latin-Square5 arrangement is used. The participants had to fill in an entry, a session and an exit questionnaire.

The first one established the users' age, gender, occupation, Enterprise Search experience and Web Search experience. From this could be gathered that the ages varied from 21 to 50 with an average of 26.9. Their experience with web search engines varied from 5 to 12 years with an average of 9.1 and their experience with Enterprise Search varied from 0 to 10 years with an average of 2.5. From these participants four were experts in the field of Enterprise search, with an average of 5 years of experience within this area, and an average of 10 years of experience using web search. The second one was suppose to gather the data needed to evaluate how easy it was to assess the relevance of a document based on the information available in the layout. This could be used to assess the relevance assessment and also to gather how much each of the layout elements6 contributed to the user opening a certain document. Finally the last questionnaire allowed the users to vote for their preferred layout and this also gave them an opportunity to comment on the evaluation and also the result presentation layouts.

In order to assess if the new system helps a user during query reformulation and relevance assessment the following measures were used: User interaction, Relevance assessment, Contribution of layout elements and Layout preference. These were used to tackle the first two research challenges (presented in chapter 1)) each of them is discussed in the following paragraphs.

User Interaction

Table 3 consists of 7 columns, the first two indicate the layout that was used and the average amount of queries that were submitted by the participants overall. The third and fourth columns represent the average query length; and the total amount of result pages that were viewed. Next the fifth and sixth columns presents the amount of result pages that were viewed per search query that was submitted and the amount of documents that were clicked per result page that was viewed. Finally the column shows the average amount of time it took the participants to complete a task using a certain layout. Each of these measures are averages taken over the amount of participants namely 32 (n = 32), except for the totals because the n here is 128. The values in each of the cells are the average and the standard deviation (between brackets). The original values were obtained during the evaluation procedure using a custom BES evaluation add-on.

Table 3. User Interaction

Layout	Queries submitted	Query length	Result pages viewed	Result pages per Query	Clicks per Result page	Time (min)
1	4.72 (2.32)	3.02 (0.94)	6.06 (3.60)	1.28 (0.39)	0.70 (0.47)	5.48 (2.41)
2	5.13 (2.69)	2.82 (0.81)	6.81 (4.21)	1.34 (0.48)	0.58 (0.41)	5.53 (2.16)
3	4.78 (2.43)	3.03 (1.06)	5.81 (3.69)	1.20 (0.29)	0.35 (0.32)	4.97 (2.27)
4	4.25 (2.82)	3.14 (1.85)	5.38 (3.87)	1.51 (1.77)	0.57 (0.60)	5.29 (2.75)
Total	**4.72 (2.56)**	**3.00 (1.22)**	**6.02 (3.84)**	**1.33 (0.94)**	**0.55 (0.47)**	**5.32 (2.39)**
n = 32 (Layout 1 to 4), n = 128 (Total)						

The query length column indicates that longer queries were submitted when using the fourth layout so the users formulated more specific queries when using this layout, this could suggest that they used the extra information available to reformulate more specific queries. The most documents were clicked when using the first layout; this indicates that the information provided in the baseline was not sufficient so more often they had to open a document to find out if this was relevant for their search. This was also seen during the user evaluation that users clicked fewer documents when using the layouts 2-4. Another interesting factor is that seeing that the underlying search engine is identical for all layouts and the users clicked fewer documents per result page when using layouts 2-4. It can be suggested that the participants interacted with the system more often when using the document summary layouts then when using the baseline layout. So TRS and thumbnails appear to increase the interaction between the user and search engine. From these results nothing concrete can be concluded because the standard deviations are all quite large, meaning that the results are spread broadly over the result space. Also the differences between the average values between the layouts are not very big, these only suggest slight differences. This may also be because of the assignments used; it is very difficult to set up assignments, which actually give a good representation of reality.

Relevance Assessment

This paragraph presents the participants relevance assessment from three perspectives as shown in the table below from the left to the right column respectively: “Ease of finding information using the current layout”, “Easy of finding new Information with the current layout after query reformulation” and “Easy with which the user could predict the contents of the documents based on the information available the layout”. For each of the perspectives the participants were asked to fill in a score, between 1 and 7, 1 indicating best/easiest and 7 worst/hardest. The values in each of the cells are the average and the standard deviation (between brackets).

Table 4. Relevance Assessment

Layout	Ease of Finding	New Information	Contents Prediction
1	2.72 (1.28)	3.28 (1.08)	2.41 (1.48)
2	2.72 (1.35)	2.88 (1.16)	2.28 (1.20)
3	1.97 (1.26)	2.69 (1.33)	2.03 (1.18)
4	1.78 (0.79)	2.59 (1.16)	1.78 (1.01)
Total	**2.3 (1.20)**	**2.86 (1.20)**	**2.13 (1.24)**
n = 32 (Layout 1 to 4), n = 128 (Total)			

The ease of finding is greater using the third and fourth layout; this suggests that the thumbnail contributed the most in facilitating the ease of finding for the user. While for the baseline and second layout the value is the same, this indicates that the ease of finding with the second layout is equal to the baseline, so the TRS do not contribute to this measure. The layouts 2-4 are preferred over the baseline layout when reformulating a query to attain new information. There is a definite difference between the baseline and the document summary layouts, which indicates that these assist a user with query reformulation. For contents prediction the results show that layout 4 is best followed by layout 3 & 2 and finally layout 1. This indicates that the contents prediction increases as the elements TRS and Thumbnails are added to the interface, this suggests that the users prediction accuracy increases as more information is available, which is quite a logical occurrence. This was also noted during the user evaluation that the users could complete several assignments faster, because the extra information allowed them to form better opinions on what a document contained. For each of the perspectives the best rated overall is it the fourth layout, this suggests that this is the most optimal layout and maximizes the user's relevance assessment.

Contribution of Layout Elements

In this paragraph the results obtained from the user tests concerning the contribution of the layout elements are presented. Each of the layout elements got a score from the participants that corroborated how much each of them contributed to the initial relevance assessment. The scores assigned were between 1 and 7, 1 indicating very much and 7 very little. The following layout elements were evaluated: Filename, Author, Snippet, TRS, Thumbnail, File type and File size. The results are shown in Table 5 where a strong contribution is represented by a low score. The values in each of the cells are the average and the standard deviation (between brackets). Note that the sample sizes differ across the layout features seeing that the layout elements TRS and Thumbnail were not available in all the layouts.

Table 5. Contribution of layout elements

Task	Filename	Author	Snippet	TRS	Thumbnail	File type	File size
1	2.34 (1.64)	3.38 (1.88)	2.66 (1.21)	3.88 (1.63)	4.06 (1.61)	6.19 (1.40)	6.66 (1.10)
2	3.13 (1.72)	3.75 (2.08)	2.84 (1.92)	3.00 (1.41)	5.31 (1.99)	6.22 (1.39)	6.59 (1.13)
3	2.06 (1.72)	2.28 (1.65)	4.00 (2.00)	4.56 (1.46)	1.25 (0.45)	3.06 (2.05)	3.31 (2.35)
4	2.78 (2.01)	3.00 (1.97)	4.34 (1.86)	3.50 (1.41)	1.00 (0.00)	2.13 (1.56)	3.69 (2.46)
Total	**2.58 (1.86)**	**3.1 (1.96)**	**3.46 (1.90)**	**3.73 (1.56)**	**2.91 (2.24)**	**4.40 (2.44)**	**5.06 (2.43)**
n = 16 (for TRS and Thumbnail in Task 1 to 4), n = 32 (the rest in Task 1 to 4), n = 64 (for TRS and Thumbnail in Total), n = 128 (the rest in Total)							

From the total row can be concluded that the participants found the filename was the strongest factor when determining whether or not to open a document. While the thumbnail comes second, again demonstrating its importance as in the previous paragraph. The difference between the TRS and the Snippet is not very significant but it does indicate that users tend to use the Snippet more. This could be because the participants are accustomed to the Snippet being a crucial element within the result presentation, and that they still have to get use to the TRS. This was also mentioned by several participants after the evaluation.

When the TRS and Thumbnail results are compared it is clear that TRS is given a stronger score for task 2 a decision making task, while the thumbnail is given a stronger score in task 4 a known item task. This suggests that the effectiveness of TRS and Thumbnails varies across tasks. And this also indicates that TRS may be more useful where Thumbnails are less effective, and vice versa. Another interesting observation is that the Thumbnail is given a very high score for the tasks 3 and 4, while the TRS is given its strongest score for task 2. This can be explained because for task 3 and 4 the user had to find documents of which the front page was known, so the thumbnail made finding the documents a breeze. While for task two the user had to search trough the dataset to figure out whether or not a project had been carried out or not, so for this task having extra information of the TRS was very useful.

A very interesting observation is that the author element was not rated very high for the first task where the objective was to find the name of the author corresponding to a certain project and vice versa. This was mainly because the author field information is extracted from the metadata that is gathered from the document and this is not always completely accurate. Sometimes it contains nothing or a useless variable. It could be suggested that a better means of acquiring the information stored in the metadata should be considered, or the use of metadata should be encouraged or facilitated.

Layout Preference and Participant Comments

Once the participants had completed all the tasks they were asked to rank all the layouts according to their preference. The scores 1 to 4 were used, 1 being the one preferred most and 4 least. In the figure and table below the results are presented. The clear winner among the layouts is layout four with an average of 1.5 followed by layout 3 as the runner up. Twenty of the thirty-two participants choose layout 4 as the preferred layout, while twenty-three participants choose layout 1 as the least preferred one. Some of the users did not rank layout 4 as the winner because they think it is a bit too cluttered, and they are used to the current search result presentation. This suggests that the new layouts take some getting used to.

Table 6. Layout preference

Preference	Layout 1	Layout 2	Layout 3	Layout 4
1 (Most)	0	1	11	20
2	6	4	13	9
3	3	20	7	2
4 (Least)	23	7	1	1
Average rank	3.53	3.03	1.94	1.50

An interesting observation was that layout preference is dependent on the type of search task that needs to be completed. If a user is looking for a PowerPoint presentation and they remember the image on the front page of the presentation it is very handy if there is a thumbnail available. One of the most noticeable comments was that TRS were experienced as being very handy, but the users did have to get use to the idea of them. Some users also thought this was a redundant element, others thought that maybe the TRS should replace the snippet. The thumbnails seemed to be the participants preferred addition; this indicates that this element can be very useful when performing a particular type of search. One of the experts implied that is was very obvious how for each of the evaluation tasks an optimal layout exists, showing that maybe a user should be able to choose a layout based on the search task that has to be carried out. The overall positive performance of layout 4 could also be that it offers a support in a wider range of tasks that layout 2 or 3.

CONCLUSIONS

This research demonstrates that this new Enterprise Document Retrieval system, Basora Enterprise Search actually helps a user assess the relevance of a document easier minimizing the amount of documents that need to be opened before the user finds the desired one. It also suggests that the additional visual and textual document summaries assist the user when reformulating a search query, also decreasing the time it will take a user to complete a search task. And finally it also indicates that it is possible to build a system that performs more or less equal to the to the current response time standards of Enterprise Search Engines, containing these extra useful components.

Implications

The results from this research project have several implications for the design of Enterprise Search Engine interfaces. Especially because they demonstrate that the addition of these textual and visual document summary elements has a positive effect on relevance assessment and query reformulation. Also because the system performs more or less equal to the to the current response time standards of Enterprise Search Engines, makes is attractive to consider adding this improved search result visualization technique to current Enterprise Search Interfaces. The participants of the user evaluation often found it easier to find relevant documents and new information when TRS and Thumbnail elements were added to the search result interface so this suggests that the current Enterprise Search engine's result presentation is not necessarily optimised and that there is room for improvement. The BES system is not completely optimized, especially the pre-processing steps parsing component because this relies on open source Java libraries that are work in progress. Another minor issue is that support should also be built in for the new Office document format, seeing that its popularity is increasing. These are some of the aspects that still need optimization but even so the system demonstrates that it can improve a user's search experience. It is not the intention of this research project to suggest that the current interfaces are useless, because this is surely not the case seeing that these have been used years and they are effective. But the intention is to show that the evolutionary cycle of Enterprise Search Engine Interface design, has reached a new stage. Serious considerations should be made in favour of this advance, because the addition of these document summaries not only facilitates query reformulation and relevance assessment. But also increases the level of interaction between the user and the search engine interface; also assisting in closing a gap the science of Human Computer Interaction.

REFERENCES

[1] Benyon, D. and Turner, P. and Turner, S. 2005, "Designing Interactive Systems", 1st edition, Harlow Essex England. 2005.

[2] Langville, A.N. and Meyer, C.D. 2006, “Google’s PageRank and Beyond: The Science of, 1st edition, Princeton University Press, Woodstock Oxfordshire England, 2006

[3] Collins, D. 1994, “Designing Object-Oriented User Interfaces”, 1st edition, The Benjamin/Cummings Publishing Company Inc. Redwood City, California, 1994

Papers

[4] Frappaolo, C. and Keldsen, D. 2008, “Findability: The Art and Science of Making Content Easy to Find”, in Market IQ Intelligence Quarterly Q2 2008, AIIM, 2008.

[5] Joho, H. and Jose, J.M. 2006. “A Comparative Study of the Effectiveness of Search Result Presentation on the Web”, In: Proceedings of the 28th European Conference on Information Retrieval, volume 3936 of Lecture Notes in Computer Science, London, UK, April 10-12, 2006, pages 302-313, Springer-Verslag, 2006.

[6] White, R.W. and Jose, J.M. and Ruthven, I. 2005, “Using Top-Ranking Sentences to Facilitate Effective Information Access”, Journal of the American Society for Information Science and Technology, 2005.

[7] Dziadosz, S. and Chandrasekar, R. 2002, “Do Thumbnail Previews Help Users Make Better Relevance Decisions About Web Search Results?”, in proceedings of the 25th annual international ACM SIGIR conference on Research and development in information retrieval , 2002.

[8] Brin, S. and Page, L. 1998. “The anatomy of a large-scale hypertextual Web search engine”, in journal of Computer Networks and ISDN Systems, Elsevier, 1998

[9] Borlund, P. 2000. “Experimental components for the evaluation of interactive information retrieval systems”, In: Journal of Documentation, MCB UP Ltd, Volume 56, Issue 1, pages 71-90. 2000.

[10] Belkin, N.J. and Oddy, R.N. and Brooks, H.M. 1982, “ASK for information retrieval: Part I. Background and theory”. Journal of Documentation, 38(2): pages 61-71, 1982.

[11] Belew, R. 2000, “Finding Out About – Search Engine Technology from a Cognitive Perspective”, Cambridge University Press, 2000.

[12] Hearst, M.A. and Pederson, J.O. 1996, “Re-examining the Cluster Hypothesis: Scatter/Gather on Retrieval Results”, in Proceedings of the 19th annual International ACM SIGIR Conference on Research and Development in Information Retrieval, Zurich, Switzerland: ACM 1996.

[13] Jansen, B.J. et al 1998, “Real Life Information Retrieval: A Study of User Queries on the Web”, ACM SIGIR Forum: A Publication of the Special Interest Group on Information Retrieval, 32(1): pages 5-17, 1998.

[14] Enterprise Search Evaluation Guide, “Seven critical characteristics your enterprise search solution must have”, 2006.

[15] Tombros, A. and Ruthven, I. 1998, “Advantages of query-biased summaries in information retrieval” , in Proceedings of the 21st Annual International ACM SIGIR Conference on Research and Development in Information Retrieval. Melbourne, Australia: ACM. 1998.

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SECTION 1

e-Learning'10

Influence of Personality on Information Diffusion in E-Learning Networks

Wladimir Bodrow, Markus Helfert, Martin Steinicke

Abstract: *This paper is the first of a series describing elemental parts of a project on modelling information diffusion in social networks. The projects objective is to develop methodological starting points and a prototype of an Agent-Based Simulation for simulating the spread of information in a social network. In this paper we describe the need for and application of measures to determinate the probability of information absorption and transmission of an individual actor in a social network.*

Key words: *e-Learning, Social Network Analysis, Agent-based Simulation, Personality Traits.*

INTRODUCTION

The diffusion of information between individuals and in groups, or even populations, can be considered a mayor stimulation for learning. While an information transmission from 1-to-1 or 1-to-n is a common method for initiating learning processes, e.g. teacher-to-class in school, the transmission from n-to-m in social networks may be assumed to be at least equally important. This is even more the case for e-learning, where participants activities are not bound by space or time, and/or in situations which focus more on knowledge generation than transmission. In both cases information diffusion is not only important for stimulating learning but for inter- and intra-group coordination and administration. Furthermore the simulation of information diffusion may help to identify and select individuals for e-learning courses who will additionally spread the acquired knowledge in their social network vicinity. Thus reducing the number of required training courses for an enterprise or organization. But not only does the simulation of information diffusion may reap benefits for the customer´s side, it provides mayor advantages for the organizations or enterprises that offer e-learning courses, too. When considering and optimizing information flow, the learning and group experience of all customers can be improved. Thus creating a good reputation and increasing the probability of future customer contacts.

SOCIAL NETWORKS AND GRAPH THEORY

One could define a network as a number of connected elements or entities. When these connections resemble interactions or relations (e.g. kin- or friendships) such networks might be called social networks. While the literature on social networks goes back at least to the work of Harary, Rapoport and others in the 1940s and 1950s [1], a typical analysis technique, the graph theory, even goes back to Leonhard Euler who described in 1735 the problem of „The Seven Bridges of Koenigsberg" [2,3]. In graph theory entities are called „nodes" or „vertices" and the connections „edges" [4]. These edges may have a certain weight attached, e.g. specifying the intensity of the relationship or the probability of an information transmission. Furthermore edges may be either directed or undirected. Directed edges contain information from a certain perspective, e.g. who phoned or loves whom. Whereas undirected edges simply imply a relationship that is equal to both sides, e.g. kinships. The decision how to model the relationships between the entities depends on the objective of the network analysis. Coming back on the "who phoned whom" example, one might be inclined to model this with directed edges. While this is intuitive, it might not be required. This can be showcased with the analysis objective of modelling the possibility of an information diffusion over synchronous communication channels in a social network. Here it might be suitable to model the edges as undirected relationships, as it can assumed that no matter who initiated the communication, both participants may utter information.

Considering the nodes themselves in information diffusion models there has been a certain lack of researching the effect of individual attributes. Exemplary for this is the simulation of innovation diffusion, which we consider as a special case of information diffusion. Here it is common to propose that the acceptance of an information and afterwards its propagation is sufficiently modelled by assuming that the nodes only possess a certain threshold value [5]. When the ratio of connected nodes that propagate the information exceeds this threshold the node accepts the information and from now on transmits it, too. In more sophisticated models the individual threshold values may vary belonging to one class, e.g. early adopter or laggard. Furthermore an additional value for individual versus social preferences is introduced and the modelling of nodes in a regular lattice has been abandoned in favour of a scale-free network [6]. In such networks, the number of connections per node may vary. In another publication where the spreading of information in a mobile phone network is considered, the nodes do not even possess a threshold [7].

The absence of further consideration of the nodes attributes in information diffusion models may be explained by the respective network research objective of basic statistical network properties. In contrast to that, recent publications researching positive and adversarial network effects on individual and group performance have started considering the influence of personality traits [8], too.

THE FIVE-FACTORS OF PERSONALITY

Some personality attributes can be considered more or less stable over a long period of time and are thus called personality traits [9]. One approach describes five factors or dimensions where each encompasses a large number of attributes. A model using this approach is the "five-factor model of personality" [10] another is often referred to as the "Big Five" [11]. Although both approaches have distinct origins, one being derived from questionnaires the other lexically, they yield "largely consonant models" [12]. The results propose categories or domains that cover the personality of individuals. These domains are commonly called: "extraversion", "agreeableness", "conscientiousness", "emotional stability" and "openness to experience". Following we will introduce the five factors, mainly following [8,10,11,12], and propose how these may influence the information diffusion in social networks.

OPENNESS TO EXPERIENCE

The domain "openness" encompasses personality traits like active imagination, preference for variety, intellectual curiosity, but also non-conformity and autonomy. Thus it may be assumed that people scoring high on questionnaires referring to openness would have a lower acceptance barrier for new information and thus will accept those with a higher probability(I). The lowering of the acceptance barrier does not necessarily mean accepting the new information as the information will very probable be only one of many, possibly contradicting, information available to this person. In equation (I) "p" represents the maximum influence of the openness trait on the message acceptance barrier. The parameter "N" models the scale of the openness trait and "x" the participants score. Commonly the scale of the five-factors questionnaires reach from 0 to 100, but this is not mandatory thus we modelled the scale as the parameter N. In contrast to people scoring high on openness, people scoring low prefer familiarity over novelty. Thus they probably resist information that does not match their view of the world and may even hinder the flow of information that contradicts and foster the flow of information that corresponds to their own world view(II).

$$y=p\cdot\cos\left(\left(\frac{\pi}{N}\right)\cdot x\right) \qquad \text{(I)}$$

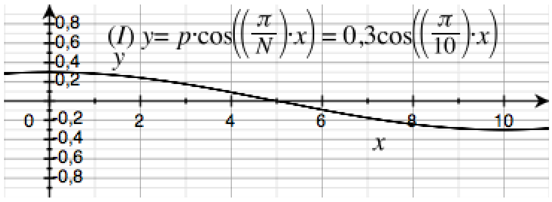

Fig.1: Eq. (I) with exemplary values for parameters.

In equation (II) we again use the parameter p that signifies the maximum influence but this time of the influence on the probability of information propagation. The parameter x denotes the degree of accordance of an information to the world view of the participant. While d denotes the distance of positive and negative boundary values to the midpoint, in scales with an equal number of positive and negative options. When considering the accordance of an information item to the world view of a node ranging between absolutely non-conform to absolutely conform and having additionally one option for moderately (non-)conform the value for the distance d would be 2. The parameter "s" represents the percentage score on a personality trait in the questionnaire. Thus (1-s) signifies the fact that the influence on fostering or hindering the flow of information is stronger for individuals scoring low on openness to experience.

$$y=\frac{(1-s)p}{d^3}\cdot x^3 \qquad \text{(II)}$$

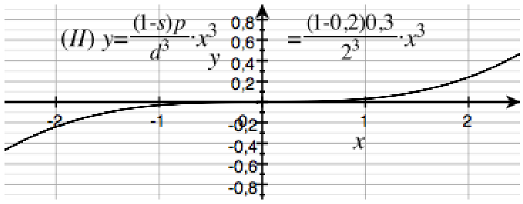

Fig.2: Eq. (II) with exemplary values for parameters.

AGREEABLENESS

The domain "agreeableness" encompasses personality traits like being generous, help- and trustful, cooperative and striving for social harmony. Thus people scoring high on agreeableness will probably not hinder information diffusion. Quite contrary they might even invest by actively querying information from their many connections when asked by another person, thus increasing the potential value of the propagated information(III). In equation (III) we describe this value increase in relation to the maximum influence p, the scale of the questionnaire N and x the score of the individual in the agreeableness domain.

$$y=\frac{p}{N^6}\cdot x^6 \qquad \text{(III)}$$

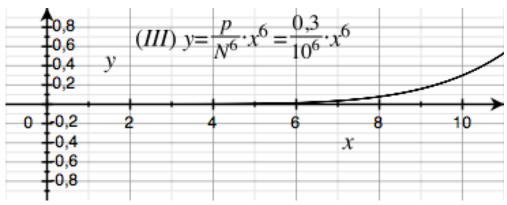

Fig.3: Eq. (III) with exemplary values for parameters.

Furthermore one can assume that information will be less scrutinized and thus more easily accepted. This can be modelled by reusing equation (I). Whereas people scoring low on agreeableness, are said to be manipulative in using their social relationships thus they might try to influence the flow of information to their own advantage. For example they might exaggerate (IV) or understate (V) the importance of an information item to the receiver hoping either to retain or gain such an advantage.

$$y=\frac{p}{N^{10}}\cdot(x-N)^{10} \tag{IV}$$

$$y=\frac{-p}{N^{10}}\cdot(x-N)^{10} \tag{V}$$

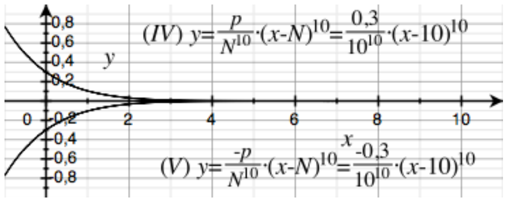

Fig.4: Eqs. (IV) and (V) with exemplary values for parameters.

CONSCIENTIOUSNESS

The domain of conscientiousness encompasses personality traits like being careful, self-disciplined, meticulous, organized, reliable and goal oriented. Thus it can be assumed that people scoring high on conscientiousness might inhibit the flow of information that might be considered rumour/unreliable or just because an information item is deemed insignificant by them. People scoring low on conscientiousness in contrast might inhibit the flow of information unintended due to being less organized, thus being prone to simply forget to tell somebody else. These two facts are described by equation (VI).

$$y=\frac{-p}{\left(\frac{N}{2}\right)^4}\cdot\left(x-\left(\frac{N}{2}\right)\right)^4 \tag{VI}$$

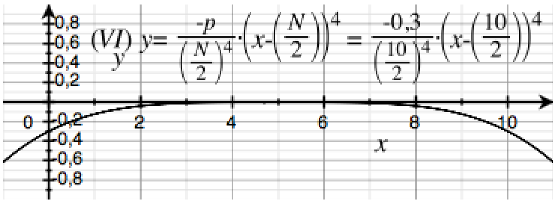

Fig.5: Eq. (VI) with exemplary values for parameters.

The being seen as meticulous and reliable may have the additional effect, that in case of publishing information connected nodes will value those to a greater extent than from other, less conscientious nodes. As these, less conscientious, nodes will be seen as unreliable the information from individuals scoring low will be devalued. The valuation of messages in relation to the level of conscientiousness of the sender is specified by equation (VII).

$$y=\frac{p}{\left(\frac{N}{2}\right)^3}\cdot\left(x-\left(\frac{N}{2}\right)\right)^3 \tag{VII}$$

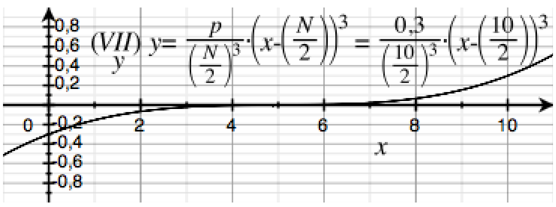

Fig.6: Eq. (VII) with exemplary values for parameters.

EXTRAVERSION

The domain of conscientiousness encompasses personality traits like being sociable, gregarious, assertive, attention seeking, taking pleasure in extensive social activities while seeking less time to spent alone. People scoring high in extraversion will foster the information flow due to their talkativeness and their many connections, increasing the possibility of a given message to be sent. To describe this fact we modify equation (I) to (VIII). Furthermore when combined with a high agreeableness individuals may invest even more time and resources in providing good information to nurture their many relationships. Nonetheless, in cases scoring extremely high, the talkativeness might result in a decrease of the perceived value or importance by receiving nodes, as these may suspect that the sender only talks, probably making things up, to be in the spotlight(VIII).

$$y = -p \cdot \cos\left(\left(\frac{\pi}{N}\right) \cdot x\right) \qquad \text{(VIII)}$$

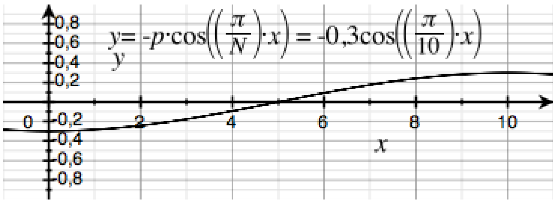

Fig.7: Eq. (VIII) with exemplary values for parameters.

Contrary to that, information sent by extreme introvert people might be perceived as more reliable or of particular importance. We therefore modify equation (VII) to (VIIII) by negation and increasing the exponent, thus accounting for the constraint on extremely high and low scores.

$$y = \frac{-p}{\left(\frac{N}{2}\right)^7} \cdot \left(x - \left(\frac{N}{2}\right)\right)^7 \qquad \text{(IX)}$$

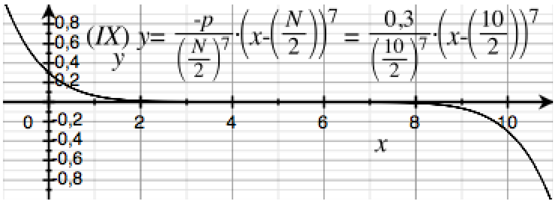

Fig8: Eq. (IX) with exemplary values for parameters

EMOTIONAL STABILITY

This domain is also inversely referred to as neuroticism and then encompasses personality traits like being moody, tense, anxious and emotionally reactive. While when being referred to as emotional stability it covers traits like being even-tempered. We will focus in this work on emotional stability as people scoring low being easily brought out of their equilibrium by both bad and good news, while people scoring high are less excitable. Following this line of thought we can assume that low scoring people tend to increase the flow of information that concerns themselves, of new things/ideas or experience made. An good example for the latter would be an unsatisfactory contact with a group member or e-learning tutor, where high scoring people might think nothing of it but people scoring low might boil with rage for days. Thus they can be assumed to spread a negative word-of-mouth for days, reducing group moral and performance. In contrast to that emotionally stable individuals actually may inhibit the flow of information as they might not get overly excited and thus find the information less interesting and assume that others share this opinion.

CONCLUSIONS AND FUTURE WORK

The diffusion of information between individuals and in groups, or even populations, can be considered a mayor stimulation for learning and influences important aspects of e-learning like administration and individual/group performance. The simulations of such diffusion processes will render important insights and thus may enable significant enhancements in a wide variety of e-learning concerns. We found that in simulations the modelling set-ups for attributes of nodes and edges are commonly rather simplistic and may thus influence the results negatively.

In this paper we focused on the attributes of nodes and discussed the implications of the five-factors of personality traits on information flow and message valuation. The five factor approach was selected due to its general acceptance as a promising (though not undisputed) approach [8,12] and as a compromise between modelling overly simplistic and trying to model every single personality trait. Furthermore the five factors are referred to as the "psychology of the stranger" as they describe traits that are easily perceivable but exclude non-public or context dependent aspects [13]. While this sounds like a disadvantage, for our project rather the opposite is true. As these traits can be checked relatively easy using standard questionnaires it can be assumed that real instead of stochastic values can be used. While discussing the domains one may have thought that some aspects of personalities are modelled implicitly even in simplistic approaches. When thinking about agreeableness and extraversion one may argue that these are implicitly modelled by the number or weight of edges a node possess, however this does not enable any prediction about the evaluation of message importance or selectiveness of nodes and neglects the other three dimensions. Thus we think it important to model the nodes closer to reality. Needless to say further research will be necessary to analyse the prediction improvement when contrasted with simplistic or more complex set-ups.

REFERENCES

[1] Newman, M.E.J; Watts, D.J; Strogatz, S.H. "Random graph models of social networks." PNAS 2002 www.pnas.org/cgi/doi/10.1073/pnas.012582999

[2] Euler, L.P. Commentarii academiae scientiarum Petropolitanae 8,1741,pp.128-140

[3] Euler Archive Retrieved: 01.06.2009 from www.math.dartmouth.edu/~euler/pages/E053.html

[4] Kleinberg, J.M.; Easley, D. "Graph Theory", Retrieved: 01.06.2009 from www.infosci.cornell.edu/courses/info204/2007sp/graphs.pdf

[5] Solomon, S.; Weisbuch, G.; de Arcangelis, L.; Jan, N. and Stauffer, D.: "Social Percolation Models", Physica A, 277 (2000) 239-247

[6] Delre, S.; Jager, W; Janssen, M.A. "The influence of network topology and social preference on diffusion processes" Retrieved: 05.06.2009 from www.uni-koblenz.de/~essa/ESSA2004/files/papers/Delre_Jager_Janssen_M2M2.pdf

[7] Barabási A.-L. et al. „Structure and tie strengths in mobile communication networks" PNAS 2007 www.pnas.org/cgi/doi/10.1073/pnas.0610245104

[8] Xia, Ling.; Yuan, Y. Connie; Gay, Geri "Exploring Negativ Group Dynamics: Adversarial Network, Personality and Performance in Project Groups" Ret: 05.06.2009 from http://www.allacademic.com/meta/p192590_index.html

[9] Allport, G. "The general and the unique in psychological science." Journal of Personality, 30, 405-421 (1962)

[10] Digman, J.M. "Personality structure: Emergence of the five-factor model." Annual Review of Psychology, 41(417-40) (1990)

[11] Goldberg, L.R. "The development of markers for the Big-Five factor structure." Psychological Assessment, 4(1), 26-42 (1992)

[12] Srivastava, S. "Measuring the Big Five Personality Factors." Retrieved: 14.07.2009 from www.uoregon.edu/~sanjay/bigfive.html

[13] McAdams, D. P. (1995). What do we know when we know a person? Journal of Personality, 63, 365-396

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Based on the Communal Constructivism Course Design – an Attempt to break up the Transmission Model of University Teaching

Roumiana Peytcheva-Forsyth

Abstract: *Holmes et al. (2001) have suggested that a new paradigm rises out of the symbiosis between the new immerging technologies and learning practice – the one of the communal constructivism as a further step in the development of social constructivism. Based on this paradigm design of learning experience promises to make a brake in the transmission model of teaching at the Universities.This paper aims to critically evaluate the usefulness of Holmes et al's ideas of "communal constructivism" through a case study of the way in which a blended course design based on the key ideas of communal constructivism supports students learning in a " ICT in an Social work" course at Sofia University.*

Key words: *Communal constructivism, social constructivism, case study, design and pedagogy*

INTRODUCTION

During the last decade the information and communication technologies (ICT) have become a crucial element of the university educational environment, as underlined by all key research documents of the European Union (2008). At the same time, the EC last report on e-learning registers a delay of this sector regarding the exploitation of the full potential of the ICT in the process of transforming the teaching and learning process, and in the redesign of curricula and modules.

Other reputable investigations in the field note, that regardless of the potential of the technology for revolutionary transformation of the education, the dominating learning model worldwide has not yet sufficiently changed (Garrison D.R. and T. Anderson, 2003).

That is why experts' attention has shifted from the ICT accessibility towards the problem of their ability to transform the learning process. Considering the enormous amount of information at our disposal, and technologies for its storage, processing and transfer, one of the most important questions now is the one about the most efficient way of transforming information for individual's personal use. This process is not technological by nature, but rather pedagogical physiological and social.

1. CONSTRUCTIVIST IDEAS AS AN E-LEARNING METHODOLOGY

Contemporary research clearly shows that the dominating theoretical and methodological platform underpinning e-learning throughout the world is constructivism with the theoretical variations it possesses and their practical application.

One of these variations is the communal constructivism. It is focused on constructing the learning experience in a way to create an opportunity for distributed cognition forming and functioning. As defined by B. Holmes and J. Gardner (2006), „communal constructivism is an approach to learning in which students not only construct their own knowledge (constructivism) as a result of interacting with their environment (social constructivism), but are also actively engaged in the process of constructing knowledge **for** their learning community." (Holmes and Gardner, 2006)

Salomon and Perkins note that the distributed cognition is characteristic for "learning to learn…***from*** the others, to learn ***with*** them, and to learn to facilitate their learning not only because of them, but also because of the contribution you make to the collective knowledge… The contribution to the collective knowledge most probably will lead to enhancing the personal knowledge as well."(Salomon and Perkins, 1998)

Communal constructivism is characterized by the integration and symbiosis of the tendencies in learning theories development and the development of technologies. In other words, the appearance of new technologies and the possibility to integrate them in education create new variants of the learning experience, respectively new approaches to their theoretical description. Thus theoretical and practical premises for enriching the social constructivism contents are created, which lead to its transformation into communal constructivism. The latter exists thanks to the appearance of e-learning environments, facilitating the communication and collective work of many users, without which its practical application is impossible. It is virtually the only variant of the constructivist paradigm whose existence depends on certain level of technology development.

A learning environment designed by the communal constructivist model according to Holmes and Gardner (2006) has the following features in comparison with the traditional,:

- The ideas of the learners are subject to investigation, the artifacts they produce are publically available, and are used to produce other, more sophisticated artifacts;
- The collective knowledge is of importance. The goal of the community is the permanent improvement, which requires investigation on the knowledge of the individual, followed by further development of this knowledge.
- The responsibility for learning is transferred to the learner. Students receive part of the responsibility for planning, managing, asking questions, and systematizing knowledge for the commune. These activities are part of the teacher's functions in the traditional classroom. The teacher in this model has the role of a "learning expert" and guides the practice of enriching communal knowledge.

2. COURSE DESIGN FOR "ICT IN SOCIAL WORK"

The characteristics from above were used to support the design of a course in ICT in Social Work, whose impact on the student learning experience was investigated. This paper presents the analysis of the data collected.

ICT in Social Work is a compulsory discipline for the students of Social Work specialty at Sofia University, Faculty of Education. The number of students varies from year to year and is between 40 and 60. The classes are 45 lectures and 45 seminars.

An important characteristics of the indicative content is that it is dynamic, contextually determined, undergoing constant changes in regards with the development of the contemporary technology and the diversity of social work contexts, in which they are integrated. Therefore it is very suitable for a course based on communal constructivism, in which the students are co-authors of the content.

Macro-design Level (H. Beetham, 2005)

The course can be described as a blended-learning type as part of the activities are performed in a virtual learning environment (VLE) Moodle[1], and part are in a traditional classroom.

The aim is students to develop knowledge about ICT and skills to use them, which to effectively apply in diverse professional context.

Activity management: students work in small groups of 4 to 5 people on a topic chosen in advance from a list of topics, they are also given the choice to formulate additional topic whose relevance and volume must be confirmed by the tutor.

Envisioned results: students work on a group project. The process consists of several stages: 1) investigating information resources on a given topic using traditional and online sources, developing the project structure with a reliable and up-to-date bibliography; 2) designing tools for researching opinion and conducting a research; 3) developing the topic and the presentation, and presenting the latter before audience. The presentation includes the result of research.

The assignments with the resources, as well as the presentations, are to be

[1] http://moodle.fp.uni-sofia.bg/course/index.php

uploaded in the VLE and are used by all students as sources for the final essay.

Micro-design level

I block of activities – introductory and information. Dominated by the traditional methods of teaching and learning (the first 5 weeks of the semester)

II block of activities – development of group projects. Characterized by balance between traditional and online modes of learning and student support. Use of the VLE for some of the activities.

III block of activities – dominated by online communication during the last stage of the course, with discussions as a main learning activity. All resources developed by the students and tutors are available for all students in order to support their preparation for the final essay on the course content.

3. THE CASE-STUDY: INVESTIGATING STUDENT OPINIONS AND ATTITUDES TOWARDS THE COURSE KEY ELEMENTS AS WELL AS THE DESIGN AS A WHOLE

The investigation on student opinion and attitude towards e-learning activities, their advantages and disadvantages over the traditional ones, towards elements of the course design and the overall educational efficacy of the course was conducted via a questionnaire, based on open and closed questions. The opinion of all 57 students who took the course during the summer semester of the academic 2007/2008 was researched on. The following conclusions and summary were drawn on the basis of this data analysis:

Most of the students evaluate extremely positively the overall quality of the course: more than 80% define it as excellent and very good.

Student opinion and their grading of the different elements of the constructivist learning design reflect the high level of realization of the model. For example, 84% of the respondents are positive about the way the tutors' team motivates them to do their best. They agree that "*this course indeed tries to make them do as much as possible"* (75%) and "*encourages them to develop their personal academic interest*" (67%). The knowledge and skills gained through the course have a great value for the future professional realization for 77% of the respondents.

Student opinion and attitudes towards the key characteristics of the design featuring constructivism and communal constructivism in particular:

- **Indicative content characteristics: flexibility and student choice**

One of the key elements of the constructivist design is flexible indicative content and an opportunity for the students to choose content and tasks to be performed. Students evaluate this element of the course as follows: 57% of the students believe that *"the course gives the opportunity to choose contents in the given field of knowledge"*, and 53% believe that they are given "*a lot of freedom to choose tasks to be done*". However, when analyzing these data should be taken into consideration that according to research on student learning styles a sufficient number of the students would prefer not to have such a choice and to receive strictly defined tasks with well structured content.

For example, the question "*Which of the statements best suit your preferred learning strategy?"* elicited 72% of responses under the well-structured content. 54% would use authentic sources. This fact could be explained by the dominating transmission teaching model in Bulgarian higher education, yet it is clearly a matter of a learning style as well. Therefore it is imperative to consider a balanced approach concerning the flexibility of the content and the choice of tasks in order to meet student needs.

- **Students as co-designers of the course content**

The question "*What do you think of a course design in which students create part of the content through project development and presentation before an audience?"* elicited ranking of the potential advantages. The answers could be seen in table 1.

Table 1. Student opinion on them being co-designers

	Yes	No
Helps me hear the lectures in a more comprehensive language	65%	35%
Overcomes the monotonous listening to tutor's lectures	70%	30%
Supports active internalization	70%	30%
Gives a chance for self-expression and experience of speaking before an audience	65%	25%
Hinders my study as my colleagues' lectures lack quality	15%	85%
I believe that it's tutor's job to deliver lectures and students have to study them	22%	68%

It can be concluded that the strongest sides of such a design are related to the active internalization, the opportunities for student self-expression, and the passive knowledge gaining. Notably, the students don't think that tutor's job is to deliver lectures and students have to study them.

These positive numbers lead to the conclusion that such a design has a positive impact on student learning.

- **Stimulating the individualized approaches to learning and student creativity**

Constructivist design ambitions to stimulate the individualized approaches to learning and student creativity were checked through statements such as "*Students have a substantial choice about how to study in this course*" and *"All I need in order to succeed in this course is good memory*". The former statement elicited 58% of agreement, and the latter - 62% of disagreement. It can be concluded that the majority of the students believe that they have a choice about how to study, and that their performance does not depend on memorizing the contents.

As for the individualization of the learning, a most of the students (69%) think that "*The tutors put a lot of effort in identifying the difficulties, which the students may encounter during their study*" and "*offer individualized support"* (89%).

- **Giving out varied and constant feedback on student progress**

Giving out varied and constant feedback on student progress is another key element of the constructivist design. That is why it is interesting to see how do students evaluate their assessment during the course. 76% of the respondents share that the feedback is permanent and intensive, and 62% of them believe that the assessment procedures are diverse and thorough.

In order to dig deeper in the positive evaluation the students give, we asked several open questions. They were directed towards identifying the advantages and disadvantages of the public availability of the student materials as published in the VLE, which contribute to the individual and community knowledge.

The open answers of the students are categorized and are ranked in table 2. As seen from the table, the largest number of the students put on the first place the opportunity to develop their ICT skills as an advantage. Second important is the chance for these materials to become the basis for discussions on other students' or tutors' side. The availability of the materials everywhere at any time was also acknowledged as an advantage. The students also mention that what is achieved by publishing the materials is not only availability, but also transparency, opportunity for self-expression and comparison with the others, acknowledgement and feedback, etc. it can be concluded that the advantages of this design have educational characteristics and are related to the substance of learning and its efficiency for each student.

Table 2. Student open question answers: advantages of publishing student materials

Development of ICT skills	51.79%
Discussions and comments	28.57%
Fast information retrieval (time-saving)	14.29%
Acknowledgement	7.14%
Compatibility, economy, comfort, opportunity to perform	5.36%
Competitiveness, well structured, gaining knowledge and skills	3.57%
Activity stimulation during the lectures, exchange of experiences, interest Being informed, choice, availability, no time restrictions, collaboration	1.79%

The analysis of the negative sides of publishing students' materials showed that their nature is rather technical, technological and ethical than pedagogical. As it can be observed in table 3 the most influential negative side is the opportunities for plagiarism and use of unreliable sources. Some of these disadvantages can be used by the tutors as a stimulating tool to encourage students to present better works: essays, reports, presentations. This can be done through the chance for all to comment (and criticize) a work once it has been published. The answers also show that the VLE makes students' incompetence and lack of information; a fact which can be used as a stimuli for better performance by itself.

Table 3. Student open question answers: disadvantages of publishing student materials

Plagiarism	32.14%
Unreliable topics / information	10.71%
Lack of Internet	5.36%
Competition	5.36%
Technical problems	5.36%
Differences in the software used	3.57%
Topics with incorrect content	1.79%
Unscrupulous colleagues can change the information	1.79%
Compulsory participation	1.79%
Illiteracy	1.79%
Limitation to publish on the topics only	1.79%
Dependence on third parties	1.79%
subjectivity	1.79%
Free upload	1.79%

CONCLUSIONS

It is evident that ICT cannot change the learning nature, as made clear by the research so far. Yet, in the good tutor designer's hands they are a reliable too for designing a flexible and adaptive environment, which to become a precondition for facilitating learning in all students, regardless of their background knowledge, skills and competences, learning styles, motivation, and needs. A design, based on the communal constructivist ideas is one of the possible approaches to promoting such environments.

It is also important to say that there is no universally good e-learning course at university level as the variables of the system, called education, are many and in complex interrelationships. Only the tutor can have an overview of them all the time, and to adapt the design according to their dynamics. What is important for the success of every course is that it has to be carefully designed and thought over in advance, to be applied flexibly, i.e. to be open for re-design, and to maintain constant student feedback about the design elements on the efficiency of their study. Following these directions to a great extent guarantees design efficacy, directed to supporting students in a student-oriented learning. ICT can be a reliable tool for achieving this efficacy.

REFERENCES

[1] Beetham, H. (2005) Review: developing e-learning models for the JISC Practitioner communities, http://www.jisc.ac.uk

[2] Garrison D.R. and T. Anderson, (2003). E-learning in the 21st century, RoutledgeFalmer

[3] Holmes, B. and Gardner, J. (2006) e-Learning. Concepts and practice. SAGE Publications

[4] Salomon, G. and Perkins, D. (1998). Individual and Social Aspects of Learning, Review of Research in Education, Volume 23, Available at http://construct.haifa.ac.il/~gsalomon/indsoc.htm

[5] The use of ICT to support innovation and lifelong learning for all – A report progress, Commission staff working document, Brussels, 09/10/2008, SEC(2008)2629 final, http://www.ifap.ru/pr/2008/n081201c.pdf, c. 8

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Modelling user behaviour characteristics for identification

Daniela Chudá, Maroš Majerčík

Abstract: *In the e-learning process is identification and authentication of user very important. This paper proposes a new form of passive authentication of user during his work with computer, which is based on behavioural biometrics. We use high level behaviour of the user for his identification, which is based on sensible action made in computer system. We have designed, implemented and verified a system for passive authentication of user, which is based on monitoring the events generated by operating system in response to user activity within the scope of arbitrary program.*

Key words: *User behaviour characteristics, identification, authentication, monitoring of user, behavioural biometrics.*

INTRODUCTION

Checking the identity of the user in e-learning systems is designed only to identification and authentication of the user at the beginning of e-learning process. The users can share the identity in systems by means of sharing the username and the password. The introduction of additional authentication techniques by modelling user behaviour characteristic provides an added level of security.

This paper is organized as follows: Section 1 describes the related works and Section 2. is about the our solution of modelling user behaviour, proposed algorithm, its implementation and Section 3 is about the testing and evaluations and the final section presents conclusions and suggestions for future work.

1. RELATED WORK

It was shown [3] that the same neurophysiological factors that shape our writing activities, and make it unique, are also responsible for the rhythm and dynamics of writing on the keyboard. It is a sign that it is for each individual characteristic and hardly imitable. For this reason, the model of keystroke dynamics provides of interesting opportunities in the field of electronic systems. We analyze previous work [5] on the topic keystroke dynamics, we analyze the type of used measures, the evaluation methods and the data used for testing. Some authors uses the statistics evaluation methods [2], [13] and some authors used as evaluation method the neural networks [18], [19]. The measure for keystroke dynamics are digraphs, trigraphs, flight time and dwell time. Mouse dynamics can be used for user identification [1] too. For this characteristic are use the mouse actions in the categories: mouse-move general mouse movement, drag-and-drop the action starts with mouse button down, movement, and then mouse button up, point-and-click mouse movement followed by a click or a double click, and silence no movement. This is a user behaviour on lower level, which is monitored the keystroke dynamics and mouse movement.

We can model user behaviour on higher level, which is based on his action in computer system. We analyze previous work to identified user behaviour patterns. Interaction between user and program can be analyze on the several levels of the abstraction [10], [11], from the lower level where are physical events to the higher level like windows system events, applications level,… The monitoring user work style and identifying different episode from the users actions [16] should by used for intelligent adaptive user interface.

2. OUR SOLUTION

We present the system for passive authentication of user, which is based on monitoring the events generated by operating system in response to user activity within the scope of arbitrary program. Our solution is based on analyze of the research [10], [11] and [16] and we propose the monitoring user work style without the time. Our system process and evaluate the events in several steps, see Fig. 1. We have implemented the modules for the capture events generated by the operating system using the Windows API libraries, a module for processing these events, a module for creating a user model, and finally evaluation module.

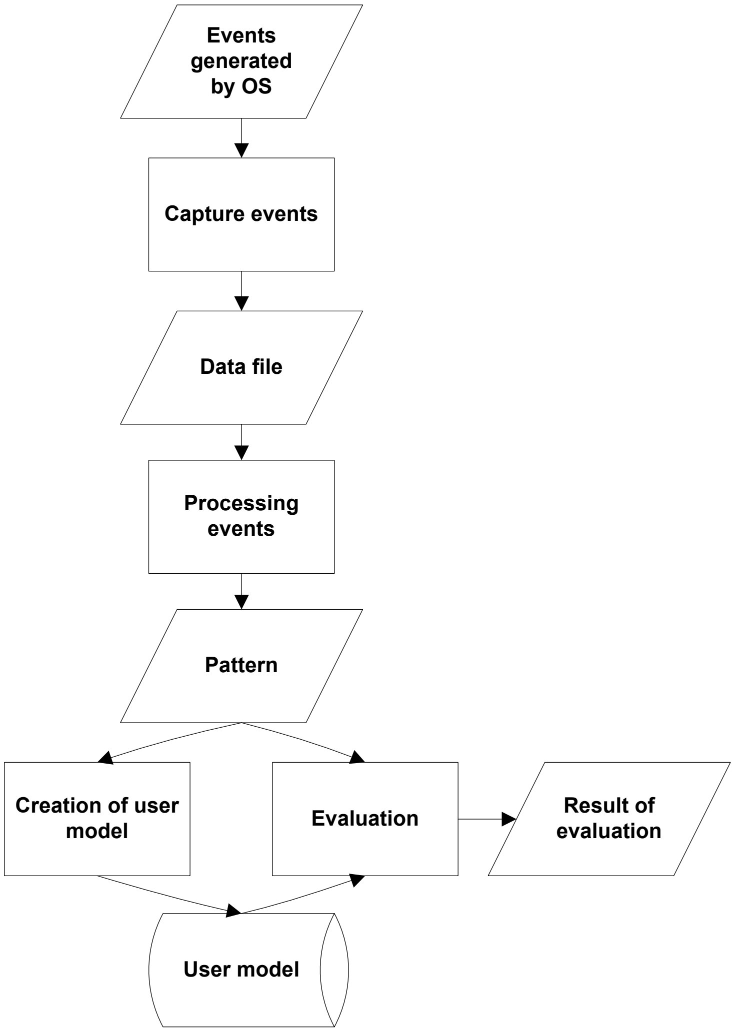

Fig.1. The diagram of propose system for modelling user behaviour characteristics for identification

We propose 3 comparative algorithms.

We propose comparative algorithm which is based on percentage of appearance events in patterns and events on the all user models. The winner is user model which is closest to the compatible model (our algorithm 2) [17].

$$\text{winner} = \text{Max}\{ \text{ each } m \text{ in } M : NEPEMm/NEP*100\% \} \quad (1)$$

Legend of (1):

NEPEM number of events in pattern which is equal to the model m,
NEP number of all events in pattern,
M set of all users models.

The model is created from user events generated by the operating system in response to user actions. Events are stored in the model as a unique set of events together with their frequency, which determines how often the event is generated in the work of a particular user. Model also includes basic information about the user who created it in addition to the events.

The module for capture events generated by the OS, logging module is implemented like a applications which generated a data file with system events. In the table 1 we can see the list of attributes monitoring events.

The systems events for monitoring:

- events applicable for higher level of user monitoring:
  - Accelerator event (A),
  - Control event (C),
  - Key event (K),
  - Language change event (LC),
  - Menu action event (MeA),
  - Menu select event (MS),
  - Sys command event (SC),
  - Window activated event (WA),
  - Window created event (WC),
  - Window destroyed event (WD),
- events applicable for lower level of user monitoring:
  - Key event (K),
  - Mouse action event (MoA),
  - Mouse move event (MM),
  - Mouse wheel event (MW).

Table 1: The list of attributes monitored events

Event / Attribute	A	C	K	LC	MeA	MS	MoA	MM	MW	SC	WA	WC	WD
Event type	x	x	x	x	x	x	x	x	x	x	x	x	x
Name of the process	x	x	x	x	x	x	x	x	x	x	x	x	x
Time	x	x	x	x	x	x	x	x	x	x	x	x	x
ID component	x	x	-	-	x	x	-	-	-	-	-	-	-
Tags	-	-	x	-	-	x	x	x	x	-	-	-	-
Key	-	-	x	-	-	-	-	-	-	-	-	-	-
Allocation of keys.	-	-	-	x	-	-	-	-	-	-	-	-	-
Coordinates	-	-	-	-	-	-	x	x	x	-	-	-	-
Identifier	x	x	-	-	x	-	-	-	-	x	-	-	-

3. EVALUATION

We are using for testing and evaluating [17] the data from 22 users, what is 471 hours of active work with computer in operating system. The data were first filtered to include only higher level events. Subsequently was all files distributed in the samples, while the limit for the distribution we used the number of events.

Characteristics for evaluation of model:

- FRR, system do not authenticated authorized user (FRR - False Rejection Rate, it also uses the term False Alarm Rate), error type 1 - a legitimate user is rejected,
- FAR, system authenticated impostor as an authorized user (FAR - False Acceptance Rate, also used the term Impostor Pass Rate), error type 2 - an impostor is accepted as a legitimate user."

For evaluating the our algorithm 2 we choice the threshold in range 50-80%. All calculated values FAR and FRR are on figure 2 and 3.

We managed to obtain sufficient amount of data, but not all users to provide sufficient amount of data to create a stable model of the user. This resulted in high levels of FRR in the number of users 11,13,18,20.

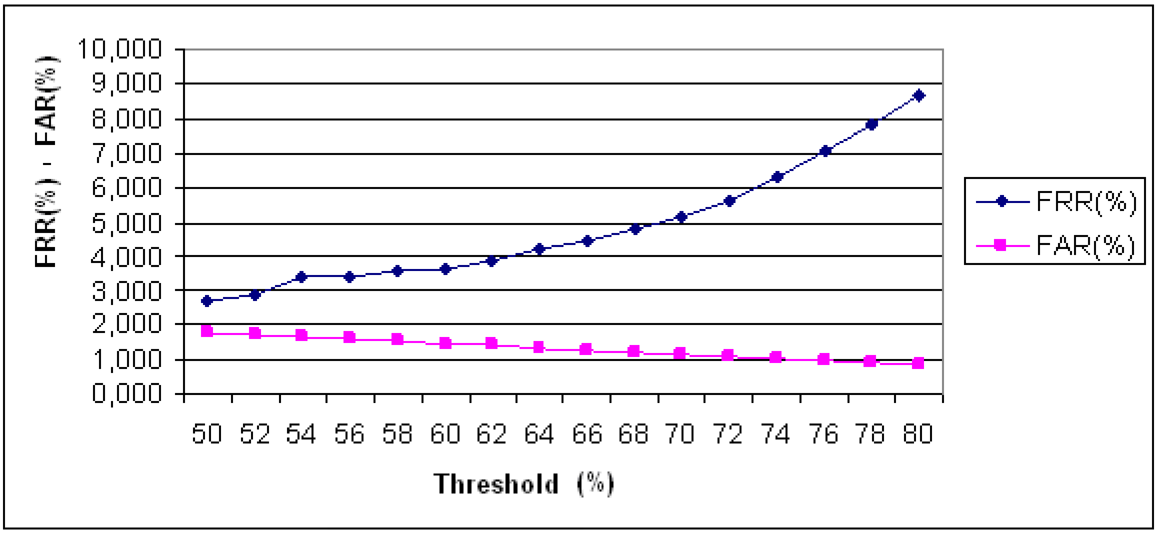

Fig.2. Calculated values FRR and FAR for threshold 50% - 80%, algorithm 2

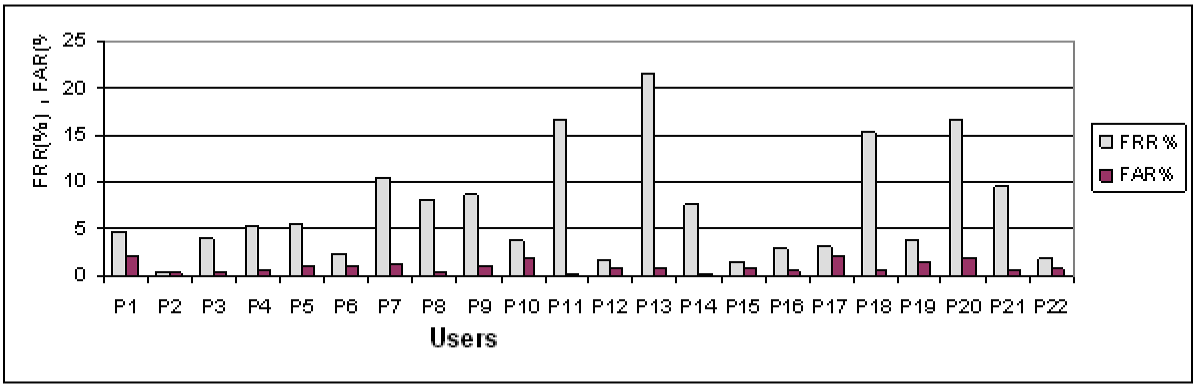

Fig.3. Calculated values FRR and FAR for users, threshold is 74%, pattern 300 events, algorithm 2

The results of our test shows that the algorithm 2 is capable of when the sample size of 100 events with relatively high accuracy to identify the user when the values of FRR and FAR 3.077% 2.289%. Please note that 100 events will generate an average user in the active work time for 1-2 minutes.

The constrains of our systems are in knowledgeable mimicking of user behaviour in systems and in changing of user environment - operating systems, software.

One of the main benefits of this work is to confirm the ability to identify the user based on his behavior at a higher level. For verification of the proposed solution has been shown that using high-level model of the user is able, with relatively high precision (FRR = 3.66% and FAR = 1.47%) to determine whether the computer works authorized user or an attacker. Important role in identifying and selecting appropriate play features (in our case, events) on the basis of which it is possible to distinguish the behaviour of multiple users.

Another benefit of high-level modelling in comparison with the modelling at the lower level is to improve the reaction time of the security system. In the case of writing on the keyboard this time around about 10 minutes [9], and we must take into account the fact that the user must use the keyboard at work. A similar situation is also in the case of work with the mouse, where you can calculate response time moving beyond the 13 minute [1], that we know with reasonable accuracy to identify the user. Again it is a condition that the user must work with the mouse. The advantage of the solution proposed in this work is the fact that the data are obtained simultaneously from both the input devices, allowing to reduce the response time to a level of 1-2 minutes (depending on the intensity of the work of the user) while maintaining acceptable levels FRR = 3.077% and FAR = 2.289%.

CONCLUSIONS AND FUTURE WORK

We propose a method for passive authentication of user when use the computer systems during e-learning process. Similar models can be employed in e-learning environments [12]. Module was implemented for the capture events generated by the operating system using the Windows API libraries, a module for processing these events, a module for creating a user model, and finally evaluation module. To verify the identity of the user in the evaluation module, we designed and tested 3 methods of comparison samples of compliance with the model. Verification of the proposed solution we make to set of 22 users, from which we obtained a total of 736 hours of work for a computer, which is about 1.14 * 106 high-level events. The effectiveness of different methods of comparison, we verify the calculated values FRR (number of authorized user rejection expressed in percentages) and FAR (the number of penetrations attacker as a percentage) for all 22 users. For best results we achieved user authentication with comparing, with which we are in the size of the sample 300 events measured value FRR = 3.66% and FAR = 1.47%, with 300 events in the active user will generate work for about 3-6 minutes.

For the above limitations and benefits that better results could be achieved by combining the two levels (upper and lower) and thus created a model of behavior, which would use the advantages of both approaches. The connection could it be implemented in several ways: combination of different models keystroke dynamics, mouse movements and users behaviour on higher level using systems.

ACKNOWLEDGEMENT

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REFERENCES

[1] Ahmed A. E. A., Traore I. A New Biometric Technology Based on Mouse Dynamics, IEEE Transactions on Dependable and Secure Computing, July-September 2007,vol. 4, no. 3, pp. 165-179.

[2] Bergadano, F., Gunetti, D., and Picardi, C. User authentication through keystroke dynamics. ACM Trans. Inf. Syst. Secur. 5, 4, Nov. 2002, 367-397.

[3] Bryan, W. L., Halter, N. Studies in the physiology and psychology of the telegraphic language. In: Gardener, E. H., Gardner, J. K.: The psychology of skill: Three studies. NY Time Co., NY 1973. s. 35-44. As consistent with: Obaidad, M. S., Sadoun, B.: Keystroke dynamics based authentication. In: Jain, A. K., Bolle, R., Pankanti, S.: Biometrics: Personal identification in networked society. IBM T. J. Watson Research Center, Yorktown Heights, NY, 1998, s.213-230

[4] Chandra, A. and Calderon, T. Challenges and constraints to the diffusion of biometrics in information systems. Commun. ACM 48, 12 , Dec. 2005, 101-106.

[5] Chudá, D., Ďurfina, M. Multifactor Authentication based on keystroke dynamics In: Compsystech 2009, Rousse, Bulgaria, 2009.

[6] Costa, P. C. G., Barbará, D., Laskey, K. B. et al. DTB Project: A Behavioral Model for Detecting Insider Threats. International Conference on Intelligence Analysis, 2005,

[7] Klein, D. V. Foiling the cracker: A survey of, and improvements to, password security. In Proceedings of the 2nd USENIX Security Workshop, pages 5–14, August 1990.

[8] Enhanced Online Banking Security - Zero Touch Multi-Factor Authentication. Entrust, Inc.

[9] Gunetti, D. and Picardi, C. Keystroke analysis of free text. ACM Trans. Inf. Syst. Secur. 8, 3 , Aug. 2005, 312-347.

[10] Hilbert, D. M. and Redmiles, D. F. Extracting usability information from user interface events. ACM Comput. Surv. 32, 4 , Dec. 2000, 384-421.

[11] Hilbert, D.M., Robbins, J.E., and Redmiles, D.F. Supporting Ongoing User Involvement in Development via Expectation-Driven Event Monitoring. Tech Report UCI-ICS-97-19, Department of Information and Computer Science, University of California, Irvine, April 1997.

[12] Ivanović, M., Pribela, I., Vesin, B., Budimac, Z: Multifunctional environment for e-learning purposes, Journal of Mathematics, novi Sad, vol.38, br. 2, str. 153-170, 2008.

[13] Joyce, R. and Gupta, G. 1990. Identity authentication based on keystroke latencies. Commun. ACM 33, 2, Feb. 1990, 168-176. URL: http://doi.acm.org/10.1145/75577.75582

[14] Lammers, A. and Langenfeld, S.: Identity Authentication Based on Keystroke Latencies Using Neural Networks. J. Comput. Small Coll. 6, 5 (Apr. 1991), 48-51.

[15] Lee, J., Choi, S., and Moon, B.: An evolutionary keystroke authentication based on ellipsoidal hypothesis space. In: Proceedings of the 9th Annual Conference on Genetic and Evolutionary Computation (London, England, July 07 - 11, 2007). GECCO '07. ACM, New York, NY, 2090-2097.

[16] Liu, J., Wong, C. K., Hui, K. K.: An adaptive user interface based on personalized learning. In: IEEE Intelligent Systems, Mar.-Apr. 2003, s. 52-57.

[17] Majerčík M.: Model používateľa pre jeho identifikáciu (), In: diploma work, Faculty of Informatics and Information Technologies, Slovak university of technology in Bratislava, may 2009

[18] Obaidat, M. S., Sadoun, B.: An Evaluation Simulation Study of Neural Network Paradigm for Computer Users Identification. Information Sciences Journal-Applications, Elsevier, November 1997, vol. 102, no. 1-4, pp. 239-258.

[19] Obaidat, M.S., Macchairolo, D.T.: An On-line Neural Network System for Computer Access Security. IEEE Trans. Industrial Electronics, April 1993, Vol. 40, N. 2, pp. 235-241.

[20] Schneier, B.: Sensible Authentication. Queue 1, 10 (Feb. 2004), 74-78.

[21] Urnphress, D., and Williams, G.: Identity verification through keyboard characteristics. Int. J. Man-Machine Studies 23, 3 (Sept. 1985), 263-273

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Towards Fully-Accessible e-Learning Systems: Some Eye Tracking Solutions

Virginio Cantoni, Marco Porta, Alice Ravarelli

Abstract: *With the ever increasing diffusion of e-learning in present society, Accessibility becomes more and more an issue, prompting the need for effective technological answers. In this paper we consider the application of eye tracking to e-learning, as a way to improve the machine-learner interaction process – as well as to make up for the missing capabilities of disabled learners. Detecting the user's gaze direction can in fact be extremely useful in presence of severe disabilities, which prevent normal use of keyboard and mouse. In this work we describe some of the projects we have recently developed at the University of Pavia, aimed at improving assistive technology for e-learning through eye-controlled interfaces.*

Key words: *Accessibility, E-Learning, Eye Browsing, Eye Tracking, Eye Writing, Perceptive Interfaces.*

INTRODUCTION

Machine perception can make Human-Computer Interaction more natural, imitating the ways we usually interact each other in interpersonal communication. If this is true in general, the e-learning sphere can particularly benefit from perceptive capabilities: by becoming more "human-like", a computer able to recognize what users do or what happens around them may also improve the learning process, through the enhancement of interaction procedures [2].

According to the World Health Organization, about six hundred million persons in the world are affected by disabilities of some kind, due to several causes [14]. Even if not all of these people have disabilities impeding computer or Internet access, it is however a great part of the world population. Nevertheless, nowadays practically all existing e-learning systems can only be navigated with the mouse, and are characterized by several other accessibility lacks. In the context of Information Technology, Accessibility deals with issues like these, to reduce (or even eliminate) any gaps between healthy and disabled people in information access. On the European side, the European Commission strongly promotes several initiatives about Accessibility. For instance, *eAccessibility* – within the e-Inclusion activity – aims at ensuring people with disabilities and elderly people access ICTs on an equal basis with others. Also, the new *i2010* initiative on e-Inclusion ("To be part of the Information Society") includes a strategy targeted on enhancing accessibility to the Information Society for all potentially disadvantaged groups [3].

In recent years, eye tracking systems [4] have greatly improved, beginning to play an important role in the assistive technology field. Eye tracking relates to the capability of some devices to detect and measure eye movements, with the aim to precisely identify the user's gaze direction (usually on a screen). The acquired data are then recorded for subsequent use, or directly exploited to provide commands to the computer. The eye tracker we use in our laboratory – the Tobii 1750, one of the most widespread eye tracking devices – combines video-oculography with infrared light reflection. The system, which looks like a common LCD screen, is provided with five NIR-LED and an infrared CCD camera, integrated in the monitor case. Infrared light generates corneal reflections whose locations are connected to gaze direction. Eye positions are recorded at a frequency of 50 Hz, and with a precision of about 0.5° of the visual field.

Eye tracking can be profitably exploited for *evaluation* purposes, allowing a great amount of data about users' behaviours to be obtained – for example, while interacting with e-learning systems. Thanks to the acquired information, users' gaze paths can be reconstructed, and possible focuses of attention identified. Analogously, eye tracking techniques are also valuable for advertising and marketing purposes.

However, it is when eye tracking is used as a direct input source for the computer that assistive interfaces can be built. These tools can significantly improve the accessibility of software interfaces, making them also usable by disabled people. Using a keyboard and a mouse is in fact impossible in all those cases where serious motor impairments – both temporary and permanent – impede easy hand movements. In these situations, the eyes may be the only communication channel for an individual.

Several eye-controlled systems have been developed to date, but there are still some open questions connected with human-computer interaction, and with accessibility in particular. Our activity is aimed at creating more accessible and usable interfaces based on eye tracking, which could make e-learning really available to everybody.

SOME EYE TRACKING PROJECTS AT THE UNIVERSITY OF PAVIA

Eye-S: a Full-Screen Input Modality for Pure Eye-based Communication

Eye-S is a system for pure eye-based communication, allowing the input of both text and generic commands [12]. E-learning systems often require some kind of input from the user, which however cannot be provided by a severely-disabled person.

The problem of writing through the eyes has been widely considered in the past, and a number of solutions have been proposed. The simplest approach is surely that based on on-screen keyboards and dwell time: if the user looks at a certain key for more than a predefined time interval, the key is considered pressed and the corresponding letter is typed. Several studies have been carried out connected to this kind of typing and related issues (e.g. [5] and [6], focused on the efficacy of dwell time and the importance of feedback). There are also variants where the dwell time is substituted with some kind of switches, such as physical buttons, eye blinking (e.g. [13]) or facial muscle activation.

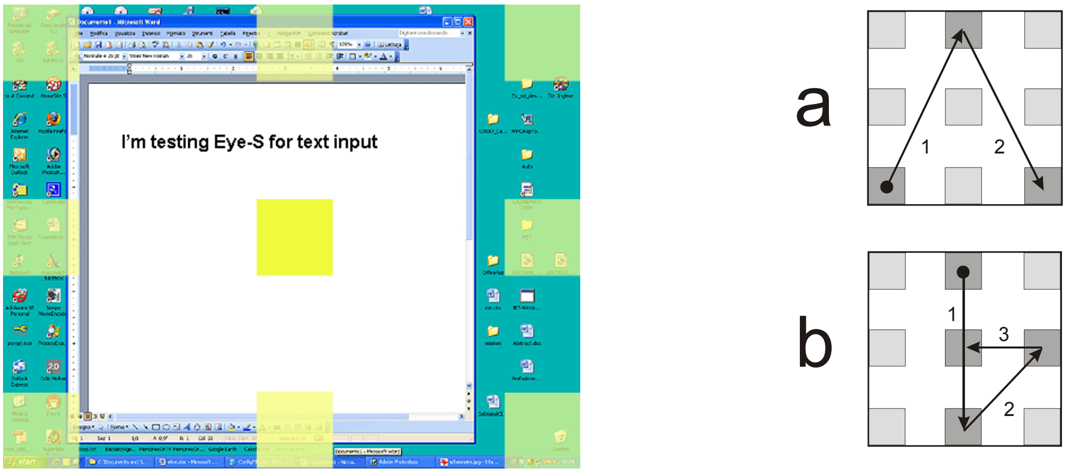
In the context of action-based gaze input (for example to perform drag and drop operations), Milekic [7] introduced the concept of "eye graffiti", where gaze gestures are used to form a vocabulary in a way similar to the text input mechanism used in personal organizers. In these devices, natural input is obtained by "drawing" letters, or parts of them, through a pen. Our work derives basically from a similar principle.

Compared to other eye writing systems, Eye-S has a main advantage: it leaves the screen totally free for the display of applications, since there is no need for specific graphical input interfaces. Using an "eye gesture" approach, the user creates alphabet letters, as well as punctuation marks or specific commands definable according to the particular application to control, by means of sequences of fixations on nine (hidden) predefined areas on the screen (Fig. 1a) – "squares" (called hotspots) placed in easily identifiable positions, even if not explicitly displayed: the four vertices of the screen, the middle of each side and the center.

Normally, hotspots are not visible. However, their position is evident, and almost no effort is required to the user to remember where they are. This means that the screen is totally available for displaying any content, and no area is occupied by specific interfaces for text input.

An *eye sequence* (from which the name Eye-S stems) is a succession of fixations on the hotspots. When the user looks at a hotspot for more than a given threshold (e.g. 400 milliseconds), a sequence recognition process starts. If other hotspots are looked at after the initial one within configurable time intervals, and if the succession of watched hotspots pertains to a set of predefined sequences stored in a "database", then a corresponding action is performed. If the system is being used for text input, the action will be the same as typing a key on a keyboard.

Eye sequences can be chosen arbitrarily, but in the writing context they will of course resemble the form of letters (possible eye sequences for the 'a' and 'b' characters are shown in Figure 1b).



a. b.

Figure 1. Eye-S: (a) Explicit display of hotspots on the screen; and (b) Examples of eye sequences for the 'a' and 'b' letters

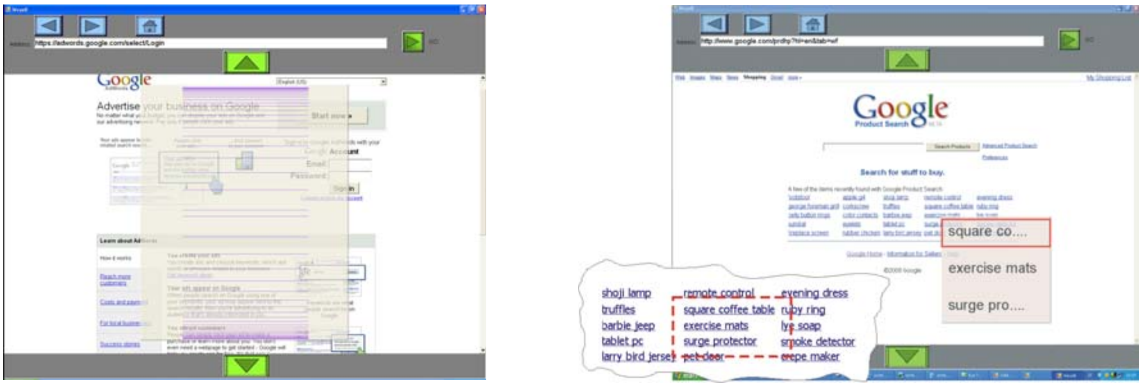
During system use, it is generally helpful to get a feedback about the sequence composition process. To this purpose, when the user looks at the first hotspot for more than the defined dwell time, a small green square is displayed within the hotspot itself. Such square contains a '1', to indicate that this is the first hotspot of a possible sequence. If the user looks at another hotspot within a timeout, then a yellow square appears, with a '2' written inside it (and the green square is deleted). If the sequence which is being recognized is three segments long, the same happens for the third hotspot (orange square and '3' as a sequence indicator). At last, on the final hotspot of a sequence — whether it is three or four segments long — a red square is displayed which contains the character or "action" recognized, in order for the user to immediately understand that the eye gesture has been successfully detected.

WeyeB: an Eye-Controlled Web Browser Hands-Free Navigation

WeyeB (from Web eye Browser) is an eye-controlled Web browser [11] enabling the two basic activities required when surfing the Web, namely page scrolling and link selection (a very common activity in e-learning systems, usually based on the Web and/or on hypermedia interaction styles).

Page scrolling can be activated by simply looking at one of two buttons, placed above and below the display area in the WeyeB interface. If the "watching time" (the dwell time) goes beyond a predefined value (e.g. 1 second), then the button is considered pressed. When this occurs, a semitransparent scroll rectangle is displayed over the page (Figure 2a). By looking within the scroll rectangle, the content can be scrolled, with a speed that is lower (or even null) when the user's gaze is in the central area of the rectangle, and increases progressively as it moves towards the upper or lower edges. The scroll rectangle is displayed as long as the user's gaze is detected within it. Once the user looks anywhere outside the rectangle for more than a certain time (2 seconds in our experiments), it disappears. This page scroll solution gives the user full control: no scrolling can occur accidentally, since the scroll rectangle must be displayed beforehand, and the explicit display of such a graphical element represents an important visual feedback.

For the selection of a link, the user must look at it for (at least) a dwell time. Subsequently, his or her gaze must be rapidly shifted upward, and then immediately downward, again (about) on the target link. This sort of "eye gesture", unlike other techniques, does not interfere with normal reading activities.



a. b.

Figure 2. WeyeB: (a) Scroll rectangle; and
(b) Link menu displayed after the acquisition of the snapshot

The detection of a selection gesture causes a "snapshot" of the area around the link to be acquired – the precision of current eye trackers is in fact limited, and the perceived gaze may not be exactly centered on the link. The rectangular region (which has a fixed size, e.g. 200 x 100 pixels, and is centered on the fixation point) is stored in the form of a bitmap image. Such image is then analyzed with OCR techniques to extract its textual content and identify possible (textual) links present in it (through a comparison with the content of all the <a> tags in the HTML code). If the snapshot contains exactly one link, the corresponding page is loaded. If it includes more than one link, a popup menu is shown which lists all the recognized links, easily selectable by gaze (Figure 2b). Lastly, if no textual links are identified in the snapshot (e.g. because it contains an image link), the mouse cursor is simply shifted to the initial selection point and a mouse click is generated.

e5Learning: an E-Learning Environment Based on Eye Tracking

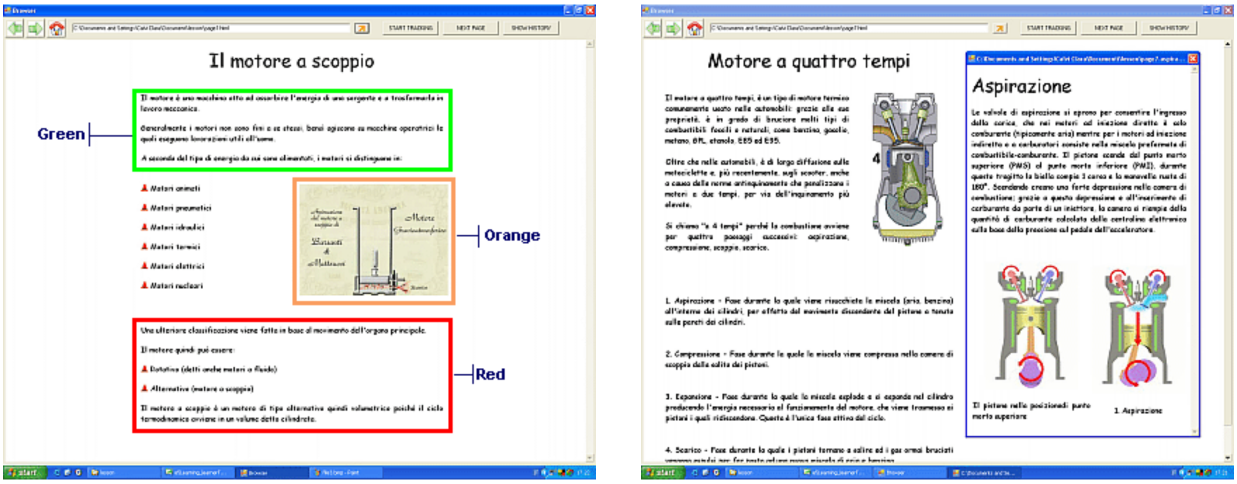
e5Learning [1][10], whose name stems from enhanced exploitation of eyes for effective eLearning, is an e-learning environment where eye tracking is exploited to allow the computer to get valuable data about users and their activities. Even if its functions are not directly related to accessibility issues, e5Learning can significantly improve the quality of distance learning, which is often the only possibility for a disabled person.

The system is characterized by three key functionalities: (1) detection of basic user activities, such as reading text and observing multimedia content, in order to maintain a "history" of user actions; (2) generation of additional content depending on the context (e.g. textual or multimedia descriptions shown when the user is reading a specific portion of text); (3) recognition of stress, high workload and tiredness states in the user, using physiological data obtainable from the eye tracker.

Thanks to the *Monitor of Accessed Screen Areas*, the author of the course can decide "how much attention" the user should pay to certain portions of content. In our prototype, a course is simply made up of web pages. We use an ad-hoc-built web browser which, along with page content, reads additional information defined by the author. Among other things, such information specifies the coordinates and sizes of screen rectangles (Regions of Interest, or RoIs) corresponding to relevant portions of content, and associated data. The *History Recorder* submodule relies on the Monitor of Accessed Screen Areas and keeps track of which portions of content (RoIs defined by the author) have already been accessed by the user, as well as "how much". If, for example, in a previous session the user did not devote sufficient time to a certain area, its content might be subsequently proposed before others, independently of its position in the logical structure of the course. Another strategy, which is the one we have actually implemented, explicitly highlights the regions which need attention. When the user presses the 'next' button to load the next page in the course, if in the current page there are ROIs that have not been fully read/observed, the system emphasizes them through colored rectangles (Fig. 3a).

Using the *Contextual Content Generator*, the creator of the course can associate new content to RoIs, and indicate the requirements for the additional information to be displayed (in the form of HTML pages appearing within a popup window, as shown in Figure 3b). A condition for the new window to be shown is that the fixation time within a RoI is higher than a threshold.

A third module composing e5Learning is the *Emotion Recognizer*. Several experiments, mainly carried out in the Psychology and Physiology fields, have demonstrated that the observation of eye behaviours can reveal much information about the user emotional state. For instance, pupil size is significantly larger after highly arousing stimuli than after neutral stimuli [9]. Other investigations suggest that the mental workload can be assessed by analyzing the fluctuation rhythm of the pupil area [8]. In particular, in our project we have considered eye factors to (potentially) identify two main user conditions: (a) high workload or non understanding, and (b) tiredness. For instance, if the average pupil size has progressively increased within a certain time interval, also user workload may have augmented. A decreased blink rate in the same period would further confirm such a supposition. When detected, these evidences could be used to dynamically modify the learning path, proposing a topic related to the main one but less complex (a sort of "break"). Or, if the user is potentially having problems in understanding something, extra information may be displayed.



a. b.

Figure 3. *e5Learning*: (a) Coloured rectangles highlighting RoIs; and
(b) Additional content displayed when the user looks at a specific RoI

CONCLUSIONS

In this paper we have presented some eye tracking systems that can be applied to e-learning to create new advanced and accessible computer-based teaching systems (also able to better "understand" the user). Eye tracking is now an extraordinary opportunity for assistive technology, enabling new advanced solutions for human-computer interaction. Although, due to their very restricted market, prices of eye trackers are currently very high, things may totally change when these devices will start to spread, hopefully in the next few years, and current research in this field can certainly help such expectation become a reality. We strongly think that *accessible e-learning* should become a priority in the near future: present technology is ripe to make education really available to *everybody*.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Calvi, C., Porta, M., Sacchi, D. e5Learning, an E-Learning Environment Based on Eye Tracking. Proceedings of the 8th IEEE International Conference on Advanced Learning Technologies (ICALT 2008), Santander, Spain, 2008.

[2] Cantoni, V., Cellario, M., Porta, M. Perspectives and Challenges in E-Learning: Towards Natural Interaction Paradigms. Journal of Visual Languages and Computing, Elsevier Science Publishing, 15 (2004), pp. 333-345.

[3] Communication "European i2010 initiative on e-Inclusion - to be part of the information society" – Europe's Information Society. Retrieved July 11, 2009, from http://ec.europa.eu/information_society/activities/einclusion/bepartofit/overview/.

[4] Duchowski, A. T. Eye Tracking Methodology – Theory and Practice (2nd Ed.). London: Springer-Verlag, 2007.

[5] Majaranta, P., Aula, A., Räihä, K. Effects of Feed-back on Eye Typing with a Short Dwell Time. Proceedings of ETRA 2004, San Antonio, Texas, USA, March 22-24, 2004, pp. 139-146.

[6] Majaranta, P., Mackenzie, I. S., Räihä, K. Using motion to guide the focus of gaze during eye typing. Proceedings of 12th European Conference on Eye Movements (ECEM12), Dundee, Scotland, August, 2003.

[7] Milekic, S. The More You Look the More You Get: Intention-Based Interface Using Gaze Tracking. Proceedings of the 7th Annual Museum and the Web Conference, Charlotte, North Carolina, USA, March 19-22, 2003.

[8] Murata, A., Iwase, H. Evaluation of Mental Workload by Fluctuation Analysis of Pupil Area. Proc. of the 20th Int. Conf. of the IEEE Eng. in Medicine and Biology, 1998.

[9] Partala, T., Jokiniemi, M., Surakka, V. Pupillary Responses to Emotionally Provocative Stimuli. Proc. of ETRA 2000, Palm Beach Gardens, FL, USA, 2000.

[10] Porta, M. Implementing Eye-Based User-Aware E-Learning. Proceedings of CHI 2008 Ext. Abstr., Florence, Italy, April 5-10, 2008.

[11] Porta, M., Ravelli, A. WeyeB, an Eye-Controlled Web Browser for Hands-Free Navigation. Proceedings of the 2nd IEEE International Conference on Human System Interaction (HSI 2009), Catania, Italy, May 21-23, 2009.

[12] Porta, M., Turina, M. Eye-S: a Full-Screen Input Modality for Pure Eye-based Communication. Proceedings of the 5th Symposium on Eye Tracking Research & Applications (ETRA 2008), Savannah, GA, USA, March 26-28, 2008.

[13] Rasmusson, D., Chappell, R., and Trego, M. Quick Glance: Eye Tracking Access to the Windows95 Operating Environment. Proc. of 14th International Conference on Technology and Persons with Disabilities, Los Angeles, USA, March 15-20, 1999.

[14] World Health Organization. What is being done to improve the daily lives of people with disabilities? Retrieved July 11, 2009, from http://www.who.int/features/qa/16/en/, 2008.

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Framework for Evaluation and Development of Learning Objects in Codewitz

Wladimir Bodrow, Stefan Wolf, Irina Bodrow

Abstract: *The main focus of this paper is on the development of Learning Objects (LO) within the Codewitz Project (http://www.codewitz.net). This project is devoted to the implementation of the e-Learning tools to support the improvement of programming skills during academic and in the additional education. Here we evaluate the different methods, metaphors, and platforms used for developed LOs. The most important perspective for this research is the stringent didactical concept of knowledge transfer. According to it the understanding of the resources available in every modern programming language like Java, C++ or C# and the memorization of the facilities implemented in the different development tools like eclipse or Borland is of less importance. On the other side the growing/increasing the (cap)ability to solve business or other problems has the top priority. Based on this we formulate the decisive features toward the development of the common concept for Los.*

Key words: *Distance learning, programming education, knowledge transfer, knowledge visualization.*

INTRODUCTION

During the past decades the trend of learning supporting media went from a strict instructional design to Computer Based Training (CBT) and to Web Based Training (WBT). Today's claim of e-Learning is to achieve a maximum efficiency of knowledge transfer with a minimum effort. Using the perspective and/or concepts of knowledge management one can speak about the knowledge generation regarding the students.

In the last years almost 200 LOs were produced within the scope of the Codewitz Project by several international teams. A detailed overview of the categories and numbers of the produced LOs is available on the Internet site of the project [5]. Characteristic for Codewitz Project is the fact that there exist only a few basic rules for the design of the LOs which caused a huge variety of solutions that have been developed. Besides implementing different user interfaces and having divergent levels of user interaction all solutions have their specific understanding of knowledge transfer and a corresponding learning philosophy. All the experience gathered by producing and using these LOs need to be sorted and evaluated. Some of our evaluation results regarding in the project implemented LOs we presented before on several conferences [1, 2, 3, 4].

Accepted and mainly applied in distance education today the concept of blended learning allows the usage of various content available on the WEB. Just because the growing part of it is the open source and can be used for free [6] we observe the occurring wide integration of this open content into e-learning applications. But even if one can find in Internet encyclopedia like Wikipedia [7] well described and presented documents about all possible topics they are not a priori prepared/designed for learning as we defined it before – for empowerment to solve tasks or problems in particular situation or under special circumstances. Because of primarily orientation of Internet encyclopedia on scientific description of objects, events, processes, etc. they will never compete with FAQ which support the solution of real problems or tasks in the business and in the everyday life. From our point of view the acceptable distance education in general and e-Learning in particular has to combine both scientific and application oriented approaches. Especially important is it in such service oriented areas like programming skills.

2. LEARNING OBJECTS IN CODEWITZ

In this chapter we will briefly introduce the typical learning objects developed within Codewitz. This selection represents only our view on more than 200 learning objects and just because of the continuously growing contributions to the project it is not comprehensive for all LOs in the project.

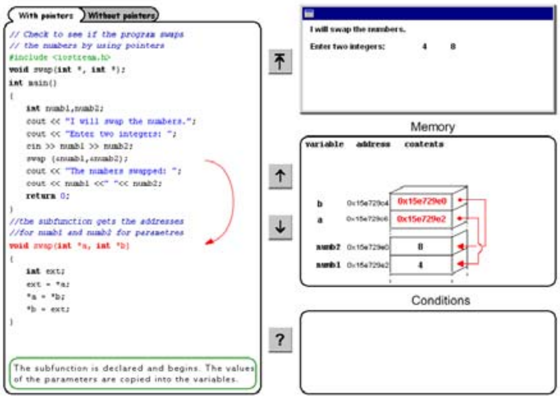

Fig.1. Example 1.

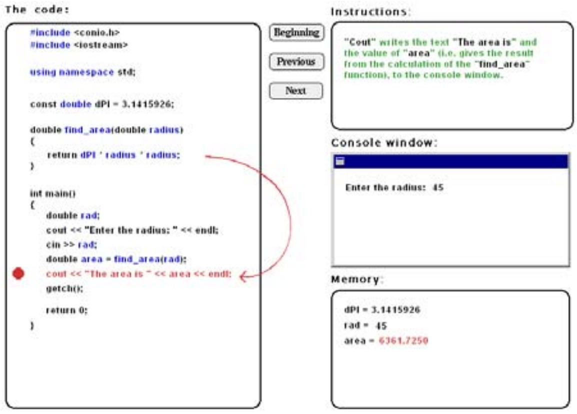

Fig.2. Example 2.

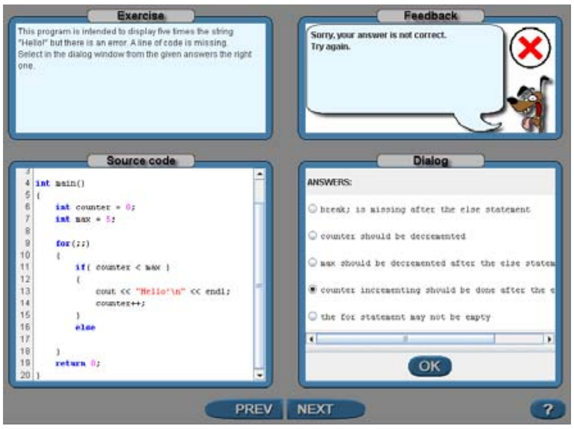

Fig.3. Example 3.

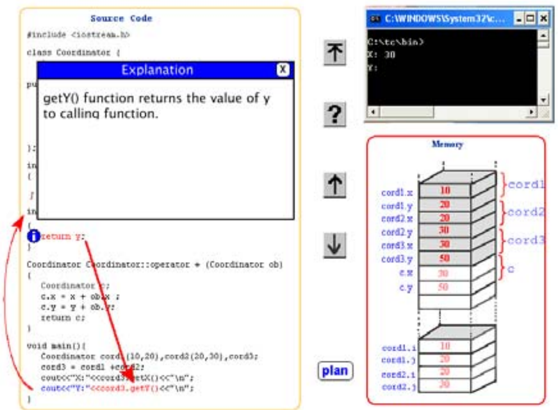

Fig.4. Example 4.

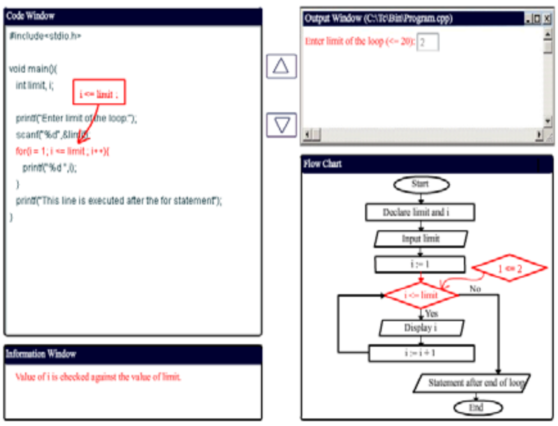

Fig.5. Example 5.

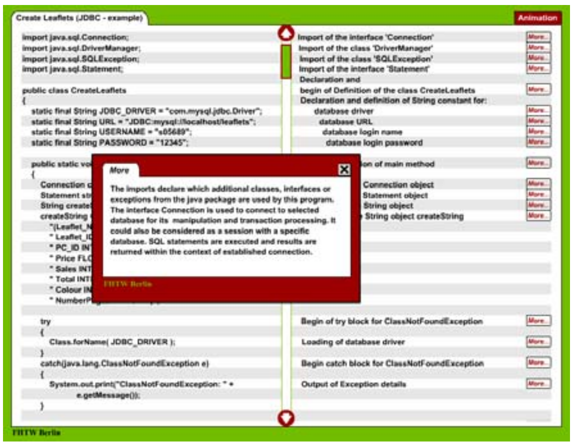

Fig.6. Example 6.

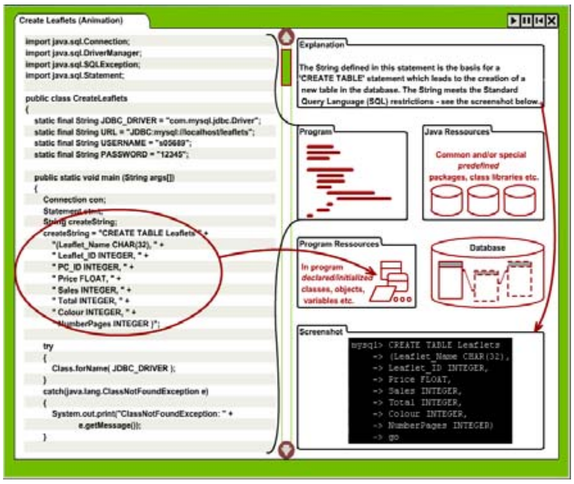

Fig.7. Example 6A.

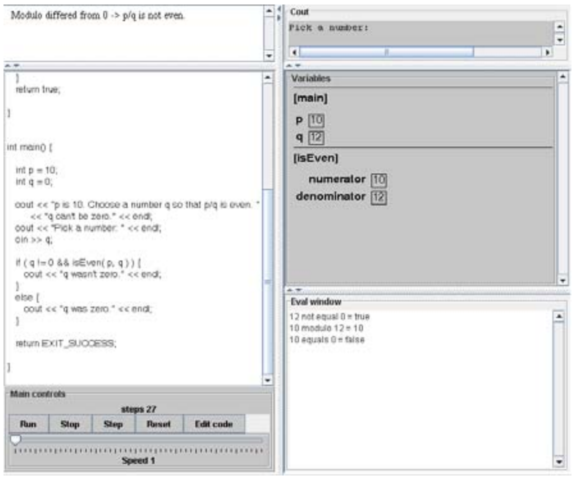

Fig.8. Example 7.

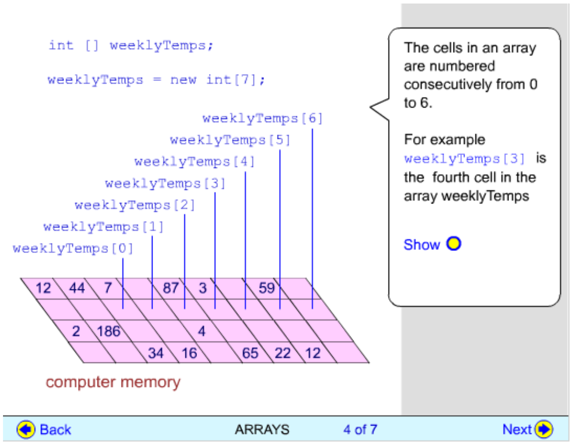

Fig.9. Example 8.

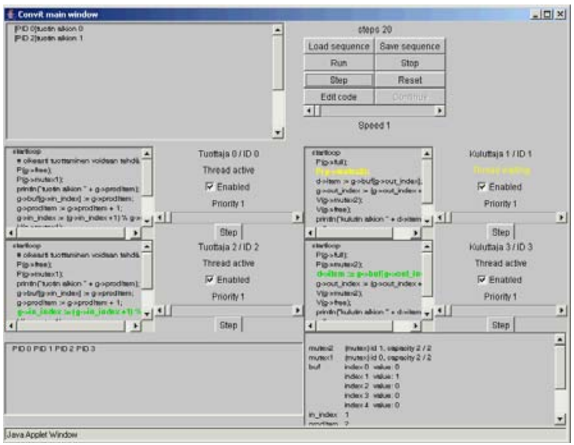

Fig.10. Example 9.

3. COMMON FEATURES

The analysis of pros and cons to presented LOs is reported in (Bodrow and Bodrow, 2006). Here we will figure out the common features and attributes to be able to find the similarities and discrepancies among these examples. These will be considered as the foundation to develop the new and to evaluate the existing Learning objects.

Firstly, the implemented LOs have very different look and feel:

- They differ in subdivision of the screen – in number, size, and placement of various windows, and in amount and quality of the content represented in them;
- Just developed to support the improving of the programming skills, some of them contain no windows with the source code of presented example;
- Some examples use different colours and graphic attributes like curves and arrows, where another are implemented with strong reduced colour palette;
- Very different is the usage of screenshots and animations.

Secondly, all (groups of) LOs follow different concept and corresponding structure for explanation, navigation, and interaction:

- Some Learning objects implement the instructional concept, where the others present the explanation of the knowledge to be submitted;
- Several solutions corresponds to constructivist approach and realize discovery learning;

- The explanations in many LOs are implemented to be used in the class, whether another solutions are prepared for non-supervised learning;
- Some LOs offer the two-level-explanations (short and extended) for new and experienced students. On the other hand, the short explanations could preferably be used in the class whereas the extended ones can be applied for the homework;
- The navigation concept also differs from one LO to another. Some provide flexible change from point-to-point while others implement step-by-step navigation;
- Some of the LOs require user input like numbers, reserved words or multiple choice selections.

Thirdly, various (groups of) LOs are prepared for different utilization:

- Main part of the implemented Learning objects are prepared for the teaching/learning in the auditorium. The (very) short explanation on the screen and the step-by-step navigation are the typical attributes of such solutions;
- There are several Learning objects which implement the task-metaphor. Here the students have to answer the question regarding the example presented on the screen to receive the feedback;
- Some implementations involve the input of numbers to explain e.g. the number of repetitions in some loop construction another present predefined examples.

Obviously the huge variety of LOs makes it difficult to figure out their comparable attributes. The analysis made allows the formulation of the following framework.

4. FRAMEWORK

To support the development of new and the evaluation of existing Learning objects following framework was defined:

1. Thematic orientation
2. Teaching/learning metaphor
3. Content visualization conception
4. Screen structure (corresponding to content visualization conception)
5. Navigation model
6. Interaction concept

All these elements have to be considered together accompanied by interdependencies to various environmental components. Because of the mentioned variety of the conceptions and resources used in the developed Learning objects the derived framework is very general and could be specified. To present the way of the further specification for this framework the development scenario for the Learning object will be considered in the next chapter.

5. DEVELOPMENT SCENARIO

In this chapter the scenario for the development of Learning object is presented. The most important decisions/steps are listed below including possible criteria.

- Decision about the topic/knowledge to be submitted
  a) Basic features/resources of programming languages (e.g. classes, objects, methods, variables, constants etc.);
  b) Standard concepts/algorithms with programming languages (e.g. loops, search or sorting algorithms, etc.);
  c) Special concepts/algorithms (graphical user interfaces, database programming, network applications, parallel computing, etc.);
- Decision about the metaphor for transferring the learning content:
  a) Supervised traditional classes versus non-supervised teaching/learning;
  b) Learning based on examples description;

c) Problem oriented explanation with focus on common problems;
d) Discovery learning (e.g. the exploration of the learning environment as part of the learning process to support adaptation of the learning process to the user requirements);

- Decision about screen design and placement of the screen elements:
  a) Important windows (e.g. source code, variables, control windows, memory, explanation, screenshot etc.);
  b) Labels of the windows on the screen;
  c) Placement of the windows on the screen;
  d) Consequent usage of the layout concept;
  e) Highlighting important parts of the screen (e.g. by different colours and fonts, etc.);
- Decision about navigation within the LO:
  a) Flexible change from point to point, according to user prompt;
  b) Simple step-by-step navigation through the learning content;
  c) Hyperlinks (e.g. for additional information);
- Decision about interaction during the session:
  a) Input of source code elements;
  b) Input of numbers and parameters that change the execution and the outcome of the LO;
  c) Selection of t
  f) Multiple choice test;
  g) Text input test;
  h) Test of reserved words;
  i) No test within
  d) he right answer (e.g. radio button);
- Testing the submitted knowledge:
  j) the LO (class based exams).

This list as mentioned before is not exhaustive and represents the basic level of the framework.

6. EVALUATION EXAMPLE

To demonstrate the usage of this framework we exemplarily apply the criteria to the before introduced LO example 6 from Codewitz shown in figures 6 and 7:

- Decision about the topic:

– The LO aims at supporting the understanding of database programming in Java. So it deals with special concepts of programming languages which requires the complex interaction of different resources.

- Metaphor for knowledge transfer:

– This example used the problem description at the beginning and the explanation of selected examples in the main part. Generally this LO is designed to be used in non-supervised learning.

- Screen layout and usage

– The screen is clearly subdivided into a source code window on the left and a brief explanation on the right. Within this explanation window one can find hyperlinks to additional information about the current line of code. These links open pop-up windows with text and sometimes visualizations aids.

– This particular LO offers a second view on the learning content. Besides the before described window with source code and short explanation one can browse it by starting an animation. The screen layout for this method of knowledge transfer also contains the source code on the left but on the right side it consists of several windows labelled "Explanation", "Program", "Java Resources", "Program Resources", "Database", and "Screenshot". During the animation arrows underline the execution steps in selected lines.

- Navigation within the Learning object:

  – The explanatory part of the LO empowers the user to navigate within the source code by scrolling buttons in the middle of the screen. This enables the student to focus on the lines of code to be learned in the session. It prevents from repetition of unnecessary code explanation. The second part, the animation, offers simple start and stop control buttons.

  – In this solution the user can follow both the step-by-step navigation as well as the flexible and user oriented point to point browsing through the content.

- User interaction:

  – In this LO there are no possibilities for the input of numbers or code fragments to change the execution or outcome of the example.

- Knowledge testing

  – The LO contains no integrated tests of knowledge. For the usage as additional teaching material it should be combined with class based examination.

CONCLUSIONS AND FUTURE WORK

The proposed framework represents the basis for evaluation of developed Learning objects. In addition it can be utilized for the development of new solutions in the Codewitz and similar projects. The detailed specification of the framework and further analysis of Learning objects is scheduled as the upcoming research activity.

REFERENCES

[1] Bodrow, W., Bodrow, I., Wolf, S., 2006. Didactics and Implementation of Content for non-supervised Distance Learning. In: Tampere Polytechnic Univ. of Applied Sciences, MMT2006 - Methods, Materials and Tools for Programming Education, pp. 57-60, Tampere, http://www.codewitz.net/papers/MMT_57-60_Bodrow_Wolf_Bodrow.pdf

[2] Bodrow, W., Bodrow, I., 2006. Interaction Concepts for Learning Objects in Codewitz. In: e-learning conference '06 Computer Science Education, pp. 125 - 129, FCT (Fundação para a Ciência e a Tecnologia), Coimbra

[3] Bodrow, W., Bodrow, I., 2007. Knowledge Engineering and Visualization for Distance Education in Programming. In: Proceedings of the 10th IASTED Conference in Beijing (CATE 2007) pp. 176 – 179, ACTA Press Zurich

[4] Bodrow, W., Wolf, S., Bodrow, I., 2007. Challenge for the Learning Objects. In: R. Sadananda, E. Kujansuu (Eds.) Proceedings of the ITE2007, pp. 30 – 32, Bangkok

[5] http://www.codewitz.net

[6] http://www.microsoft.com/education/default.mspx

[7] http://en.wikipedia.org

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Deterministic Investigation of Distributed Learning Environment by using Petri Nets Model

Radi Romansky, Elena Parvanova

Abstract: *The distributed learning is organized on the base of distributed access to remote learning resources, communication medium for transmission of user requests and learning objects (information resources, 3D components, multimedia, etc.), participation of different users (teachers, students, clients, etc.) and mechanisms of education. All these components organize a common Distributed Learning Environment (DLE) and for its architecture designing an adequate investigation is needed. The paper presents an investigation of DLE by using the deterministic apparatus of Petri Nets. The main goal is to build a model as an asynchronous Petri net completed by previously defined basic model primitives. In this reason a verification of these primitives is made and a global model is presented. The model execution is made and some analytical results are discussed.*

Key words: *e-Learning, Distributed Information Resources, Petri Nets, Discrete Modeling.*

1. INTRODUCTION

The contemporary Information Society permits to introduce the 3D modeling possibilities in the www environment. By joining the principles of e-learning, 3D modelling and communication medium of the global network is possible to realize a Distributed Learning Environment (DLE) that offers a set of knowledge in the area of 3D simulation and virtual reality. During the last years 3D virtual environments represent a new form of learning environment that can involve synchronous and asynchronous learning opportunities that provide a three-dimensional simulated learning situation, rather than replicating a traditional classroom, laboratory and university [1, 2]. In addition, the combination of X3D modeling language and Adaptive Hypermedia Architecture (AHA) is possible to represent 3D educational virtual environments [3]. All these prerequisites give a real possibility to make a DLE in the field of 3D simulation and virtual reality.

The paper presents a possibility for DLE architecture investigation by using the deterministic apparatus of Petri Nets [4, 5]. The main goal is to build a model as an asynchronous Petri net (PN) completed by previously defined basic model primitives for main participants in the processes of information servicing [6]. In this reason a verification of these primitives is made and a global model is presented. The model execution is made and some analytical results are discussed.

2. DLE ABSTRACT DESCRIBING AND BASIC MODELS VERIFICATION

A basic general abstract model of the learning interactions in the DLE is designed and is shown in fig. 1. The connection path between a user and an information resource is marked and basic participants in the distributed learning process are defined:

- ✓ Set of users $U = \{U_i / i = 1 \div N\}$, $U \neq \varnothing$;
- ✓ Set of learning resources $R = \{R_j / j = 1 \div M\}$, $R \neq \varnothing$;
- ✓ Set of transmitters $T = \{T_q / q = 1 \div K\}$, $T \neq \varnothing$;
- ✓ Distributor (D) that routs all information objects in the communication medium.

The basic models (primitives) describing these DLE components by using PN are presented in [6]. Two different interactions between nodes are defined:

- ✓ requesting a learning resource initialized by user $req : U_i \xrightarrow{T_q} R_j$ (for $\forall U_i \in U; \forall R_j \in R$);

✓ responding by sending the requested learning object (information block) $Inf : R_j \xrightarrow{T_q} U_i$ (for $\forall U_i \in U; \forall R_j \in R$).

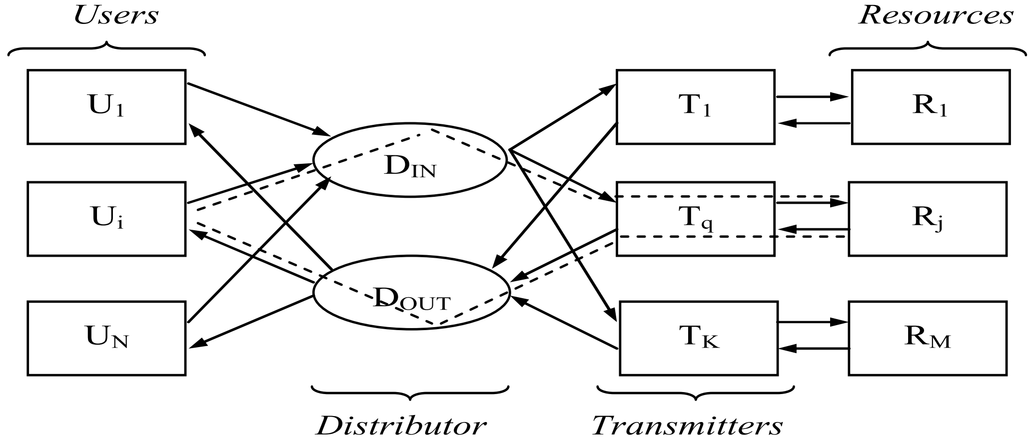
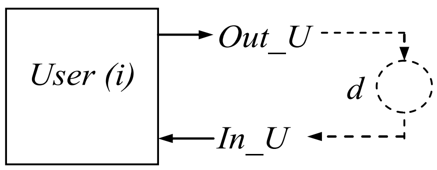


Fig.1. General abstract model of the DLE

A verification of the designed primitives should be made before the DLE construction. The goal is to detect the primitives' functionality and blocking absence.

• **User**

The testing of the model primitive "User" is made on the base of the modified abstract model presented in the fig. 2 where an additional passive place *d* is introduced.



D^-	p_1	p_2	p_3	d
t_1	2	0	0	0
t_2	0	0	1	0
t_3	0	1	0	0
t_4	0	0	0	1

D^+	p_1	p_2	p_3	d
t_1	1	1	0	0
t_2	1	0	0	0
t_3	0	0	0	1
t_4	0	0	1	0

Fig.2. Modified abstract model of the component "User" – initial marking $\mu_0 = (2,0,0,0)$

✓ Permitted transaction(s) defining – calculation by using $\mu_0 \geq e[j].D^-$ at μ_0:

t_1 ⇨ $\mu_0 = (2,0,0,0) \geq (1,0,0,0).D^- = (2,0,0,0)$ Permitted

t_2 ⇨ $\mu_0 = (2,0,0,0) \geq (0,1,0,0).D^- = (0,0,1,0)$ Not permitted

t_3 ⇨ $\mu_0 = (2,0,0,0) \geq (0,0,1,0).D^- = (0,1,0,0)$ Not permitted

t_4 ⇨ $\mu_0 = (2,0,0,0) \geq (0,0,0,1).D^- = (0,0,0,1)$ Not permitted

✓ Next marking(s) defining – if the transaction t_j is permitted for the next marking μ^* defining should be used the equation $\mu^* = \mu + e[j].D$, where $D = D^+ - D^-$ is incident matrix:

$$D = D^+ - D^- = \begin{bmatrix} -1, +1, & 0, & 0 \\ +1, & 0, -1, & 0 \\ 0, -1, & 0, & +1 \\ 0, & 0, & +1, -1 \end{bmatrix}$$

The model primitive execution is the following:

$\mu_0 = (2,0,0,0)$ ⇨ $\mu_1 = (2,0,0,0) + (1,0,0,0).D = (2,0,0,0) + (-1,+1,0,0) = (1,1,0,0)$

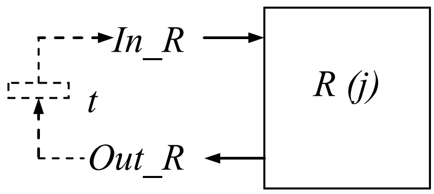
$\mu_1 = (1,1,0,0)$ ⇨ $\mu_2 = (1,1,0,0) + (0,0,1,0).D = (1,1,0,0) + (0,-1,0,+1) = (1,0,0,1)$

$\mu_2 = (1,0,0,1)$ ⇨ $\mu_3 = (1,0,0,1) + (0,0,0,1).D = (1,0,0,1) + (0,0,+1-1) = (1,0,1,0)$

$\mu_3 = (1,0,1,0)$ ⇨ $\mu_4 = (1,0,1,0) + (0,1,0,0).D = (1,0,1,0) + (1,0,-1,0) = (2,0,0,0) \equiv \mu_0$

• **Resource**

Modified model primitive (*t* is an introduced passive transaction) for the verification purpose is shown in fig. 3.



D^-	p_A	p_B	p_C	p_D
t_R	1	1	0	0
t_S	0	0	2	0
t	0	0	0	1

D^+	p_A	p_B	p_C	p_D
t_1	0	0	2	0
t_2	0	1	0	1
t_3	1	0	0	0

Fig.3. Modified abstract model of the "Resource" – initial marking $\mu_0 = (1,1,0,0)$

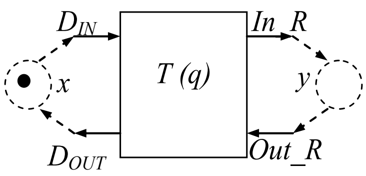
✓ Defining of the permitted transaction at $\mu_0 = (1,1,0,0)$ ⇨ t_R;

✓ Calculating of the incident matrix: $D = D^+ - D^- = \begin{bmatrix} -1,-1,+2,\ 0 \\ 0,+1,-2,+1 \\ +1,\ 0,\ 0,-1 \end{bmatrix}$;

✓ Model execution (PN evolution): $\mu_0 = (1,1,0,0) \xrightarrow{t_R} (0,0,2,0) \xrightarrow{t_S} (0,1,0,1) \xrightarrow{t} \mu_0$.

• **Transmitter**

Modified model primitive is shown in fig.4 and two additional passive positions (*x*, *y*) are added.



D^-	p_{T1}	p_{T2}	x	y
t_{T1}	1	0	1	0
t_{T2}	0	1	0	1

D^+	p_{T1}	p_{T2}	x	y
t_{T1}	0	1	0	1
t_{T2}	1	0	1	0

Fig.4. Modified abstract model of the "Transmitter"
(initial marking $\mu_0 = (1,0,1,0)$ and permitted transaction t_{T1})

✓ Incident matrix: $D = D^+ - D^- = \begin{bmatrix} -1,+1,-1,+1 \\ +1,-1,+1,-1 \end{bmatrix}$

✓ Evolution of the primitive's PN:

$\mu_0 = (1,0,1,0) \to \mu_1 = (0,1,0,1) \to \mu_2 = (1,0,1,0) \equiv \mu_0$

Conclusion: the evolution of all primitives is cyclic and without blocking.

3. GENERAL DLE-MODEL DEFINING

The modeling of the DLE is realized by using the verified primitives based on the infrastructure shown in fig. 5. The general formal PN-model of this network medium is defined below (for *j* = 1, 2, …, *K*):

$$
\begin{aligned}
&P = \{D_{IN}, D_{OUT}, \{p_{T1j}, p_{T2j} / j = 1 \div K\}\} \qquad T = \{t_{T1j}, t_{T2j} / j = 1 \div K\} \\
&I(t_{T1j}) = \{D_{IN}, p_{T1j}\} \\
&\quad O(t_{T1j}) = \{In\_R_j, p_{T2j}\} \\
&I(t_{T2j}) = \{Out\_R_j, p_{T2j}\} \\
&\quad O(t_{T2j}) = \{D_{OUT}, p_{T1j}\}
\end{aligned}
$$

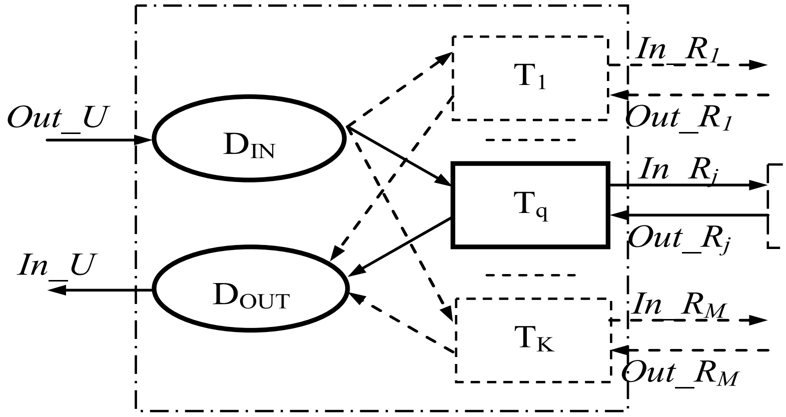


Fig.5. Abstract model of the network infrastructure

The graph presentation of a separate segment of the general DLE-model as a PN is presented in fig.6.

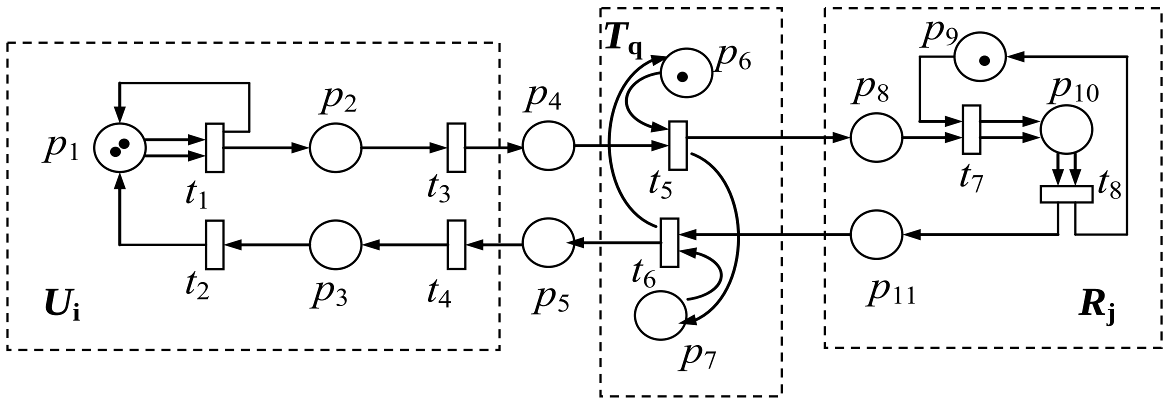


Fig.6. PN-model of the information servicing for a DLE-segment – initial marking μ_0= (2,0,0,0,0,1,0,0,1,0,0)

The matrix definition of the segment from fig. 6 is the following:

$$D^- = \begin{vmatrix} 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{vmatrix} \qquad D^+ = \begin{vmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \end{vmatrix}$$

4. EXECUTION OF THE DLE-MODEL AND INVESTIGATION

✓ *Permitted transaction(s) defining* – at the defined initial marking μ_0 only the transaction t_1 is permitted. This fact is defined by the checking of the condition (matrix approach): $\mu_0 \geq e[1].D^-$. It is realized because $e[1] = (1,0,0,0,0,0,0,0)$ and $e[1].D^- = (1,0,0,0,0,0,0,0).D^- = (2,0,0,0,0,0,0,0)$.

✓ *Calculating of the incident matrix:*

$$D = D^{+} - D^{-} = \begin{bmatrix} -1,+1,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0 \\ +1,\ 0,-1,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0 \\ 0,-1,\ 0,+1,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0 \\ 0,\ 0,+1,\ 0,-1,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0 \\ 0,\ 0,\ 0,-1,\ 0,-1,+1,+1,\ 0,\ 0,\ 0 \\ 0,\ 0,\ 0,\ 0,+1,+1,-1,\ 0,\ 0,\ 0,-1 \\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,-1,-1,+1,\ 0 \\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,\ 0,+1,-1,+1 \end{bmatrix}$$

✓ *Next marking defining* – for the presented μ_0 the next marking will be defined as follows:

$$\mu_1 = \mu_0 + e[t_1].D = \mu_0 + e[1].D = (2,0,0,0,0,1,0,0,1,0,0) + (1,0,0,0,0,0,0,0,0).D =$$
$$= (2,0,0,0,0,1,0,0,1,0,0) + (-1,+1,0,0,0,0,0,0,0,0,0) = (1,1,0,0,0,1,0,0,1,0,0) = \mu_1$$

The model evolution for a single time execution is presented in Table 1. Fig. 7 shows the general scheme of the model evolution (the tree of the reachability).

Table 1.

t	***μ***	***Places and marks***										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	μ_0	2	0	0	0	0	1	0	0	1	0	0
t_1	μ_1	1	1	0	0	0	1	0	0	1	0	0
t_3	μ_2	1	0	0	1	0	1	0	0	1	0	0
t_5	μ_3	1	0	0	0	0	0	1	1	1	0	0
t_7	μ_4	1	0	0	0	0	0	1	0	0	2	0
t_8	μ_5	1	0	0	0	0	0	1	0	1	0	1
t_6	μ_6	1	0	0	0	1	1	0	0	1	0	0
t_4	μ_7	1	0	1	0	0	1	0	1	0	0	0
t_2	μ_2	2	0	0	0	0	1	0	0	0	0	1

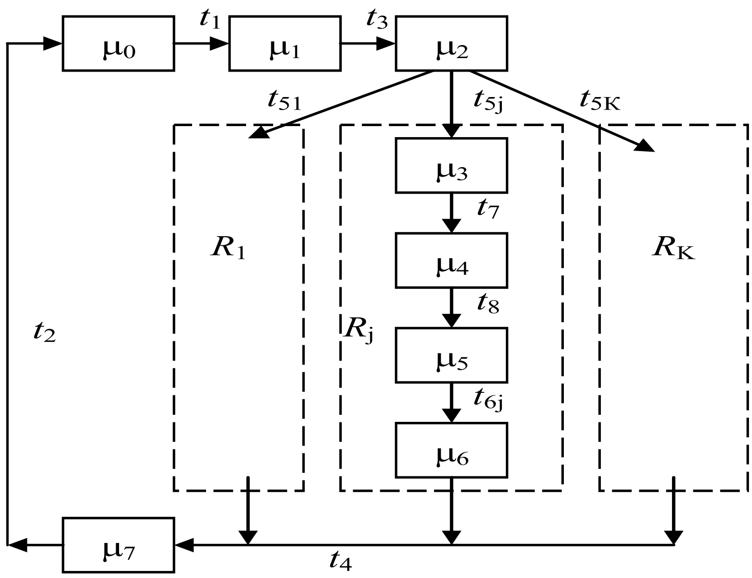


Fig.7. General scheme (tree of reachability) of the model evolution

The model investigation is realized by the analysis of the tree of the reachability and of the basic model conditions. The main results are generalized below.

✓ *Reachability* – the model allows cyclic execution of the basic phase of transactions fairing.

✓ *Liveliness* – the model is alive because the evolution permits at each step to fire (activate) at least one transaction (see Table 1).

✓ *Blocking* – no situation during the evolution can block the model execution at the one-user access to the learning resource.

✓ *Boundness* – the model is 2-bounded because $\Sigma\mu(p_i)\leq 2$ (see Table 1).

✓ *Safety* – it may be accepted that the model is safe because for all transactions the number of input arcs is equal to the number of output arcs.

✓ *Persistence* – the total number of marks in the model is the same during each execution step.

✓ *Conservativeness* – yes, based on the same reason.

5. CONCLUSION AND FUTURE WORK

The discrete modelling and investigation presented in the paper will help to define the most important points of the DLE architecture and the main problems connected to the organization of processes for information servicing. As a next phase in our work we plan to design suitable DLE architectural model and to realize 3D prototypes as a distributed information objects in DLE.

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REFERENCES

[1] Bischoff, A. Bandwidth saving synchronous collaboration environment for virtual universities. Proceedings of Virtual University, Bratislava, Slovakia*, Dec. 2004, pp. 44-48.*

[2] Bouras, C., T. Tsiatsos. Distributed virtual reality: building a multi-user layer for the EVE Platrorm. Journal of Network and Computer Applications, 27, 2004, pp.91–11.

[3] Chittaro, L., R. Ranon. Adaptive Hypermedia Techniques for 3D Educational Virtual Environments. IEEE Computer Society, July/August, 2007, pp.31-36.

[4] Hein, James L., Discrete Mathematics (2nd ed.), Jones and Bartlett Publishers, Sudbury, Massachusetts, ISBN 0-763-72210-3, 2003 (731 p.).

[5] Girault, Caude, Rudiger Valk. Petri Nets for Systems Engineering (A Guide to Modeling, Verification, and Applications), ISBN 3-54041-217-4, Springer-Verlag, Berlin, Heidelberg, 2003 (608 p.).

[6] Romansky, R., E. Parvanova. Organization of Distributed Learning Environment Modeling by using Petri Nets. Proc. of the 5th Int'l Conf. on e-Learning and the Knowledge Society, Berlin, Germany, 31.08-01.09.2009.

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Assessment of the Emotional States of Students during e-Learning

Leon Rothkrantz, Dragos Datcu, Iulia Chiriacescu, Alin Chițu

Abstract: *Emotions are assumed to have a great impact on our behaviour and also on our learning behaviour. In a face-to-face learning environment emotions can be expressed by (non-)verbal behaviour as way of speaking, facial expressions or words with an emotional loadings. In this paper we research the possibility to assess the emotional state of learners by analysis of nonverbal behaviour as speech analysis and analysis of facial expressions. We developed tools to extract features from sound and video recordings and used classifiers as SVM to label emotional states. We used discrete emotional states but also the well-known 2D valence and arousal score as a continuous score of the emotional state. From our experiments it proves that students show overt emotions under special conditions with strong emotional triggers. Our system was able to assess strong emotions up to some level.*

Key words*: Emotions, nonverbal behaviour, speech analysis, facial expressions analysis, e-learning.*

INTRODUCTION

It is commonly agreed that emotions have a strong impact on our behaviour. Students with well developed abilities and trained skills show the expected behaviour if they get motivated by internal or external emotional triggers. Strong negative emotions as fear and anxiety can block the learning behaviour. Happiness has a positive effect on the learning behaviour. But emotions and their impact on the e-learning behaviour are not well understood and a lot of research is needed. Some students miss the social support and interaction in e-learning environment. A strong motivation, discipline and time scheduled learning is needed to survive in a distant learning environment. For that reason the Open University invested a lot of effort in setting up networks and communities of students that are remote in space and time.

In the past there was a strong impact on the cognitive aspects in the learning theories. Emotions were neglected or researched independently from cognition. Only recently researchers studied the impact of cognitive and emotional aspect on learning. Goleman [8] introduced the concept of emotional intelligence similar to the classical cognitive intelligence. Researchers as Darwin [4], Damasio [5], Averill [1], LeDoux [11] contributed a lot to the understanding of emotions and their impact on learning.

In a face to face learning environment emotions can be assessed from the nonverbal behaviour of students. In distant learning without or with digital teacher the assessment of emotions is more complex. A common way is to use questionnaires. But questionnaires can not be used for continuous real time assessment of emotions. That is the reason we developed a surveillance system using cameras and microphones to record nonverbal behaviour of students and analysed those recordings with our EmoRec system.

After Darwin, Ekman [7] spent a lot of research on the automatic recognition of facial expressions. He claimed that 6 emotions are universal namely happiness, sadness, disgust, anger, fear and surprise. Many systems have been developed to recognise the six basic emotions in speech and recordings of facial expressions. But in daily life most emotions are not pure but blended and of varying intensity. And even the six basic emotions can be displayed in many ways. This can also be expected in an e-learning environment.

Most emotion recognition systems are based on classifiers. To train a classifier a huge database of emotional expressions is needed. Recording and annotating a database of emotional expressions is very time consuming. Most available databases are acted emotions by trained people and not recordings of spontaneous emotions. In case of recognition of facial expressions unsolved problems are varying lighting conditions, changing posture and occlusion. In case of speech, multiple speakers, background noise and reverberation are difficult to handle problems.

The outline of this paper is a follows. In the next section we will report about related work. In section three we will introduce the technologies used to recognize emotions in sound and video recordings. Next we report about our experiments and we will end with a section conclusion and future work.

RELATED WORK

In [14] O'Regan reports studies of online learning in which emotion plays an important role. The Web offers the perfect technology and environment for personalized learning. Martinez [12] studied individual learning on the Web with a focus on emotions. At eduweb [http://www.eduweb.com], the goal of the designers is to develop the most engaging and effective online learning experiences possible. To this end, we engage in research to better understand learning theory, learner preferences and engagement, and educational outcomes. Schaller and his colleagues report about the negative emotions students experience when they have to navigate the first time through learning sites. In [19] Wegerif centres on the sense of isolation that online study may engender among learners, a factor often ignored by many educators, but one that ignored by many educators, but one that may make the difference between a successful and an unsuccessful online learning environment for many students. The importance of a proper appreciation of the learners' social context is stressed, as is the concept of the 'virtual self' that individual learners may choose to portray during online communication. Ng [13] reported about online learners showing fear during electronic communication. Students educated with Twitter, Weblogs and Facebook probably require social and communicating abilities to handle his negative emotions. Hara and Kling [9] studied the frustration on line learners experience with badly designed or non-functioning online learning environments. In [15] Rothkrantz introduced e-learning in virtual environments. A virtual University was designed in Second Life. The focus was on the design of emotion in the social interactions of students represented as virtual characters (Avatars).

FACIAL EXPRESSION RECOGNITION

In the case of video data processing, we have developed an automatic system for the recognition of facial expressions for both still pictures and video sequences. The recognition was done by using Viola&Jones features and boosting techniques for face detection [18], Active Appearance Model – AAM for the extraction of face shape and Support Vector Machines –SVM for the classification of feature patterns in one of the prototypic facial expressions. For training and testing the systems we have used Cohn-Kanade database [10] by creating a subset of relevant data for each facial expression.

The Active Appearance Model – AAM [3] makes sure the shapes of the face and of the facial features are correctly extracted from each detected face. Starting with the samples we have collected from the Cohn- Kanade database, we have determined the average face shape and texture (Figure 1).

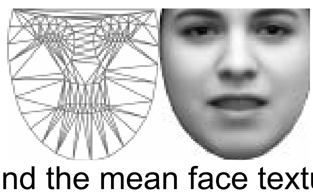

Fig.1. The mean face shape (left) and the mean face texture aligned to the mean shape (right).

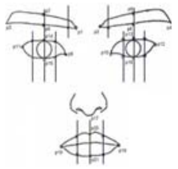

Fig.2. The Facial Characteristic Point FCP model.

Based on the AAM face shape, the recognition algorithm generates during the emotion classification stage a set of features to be used such as distances computed between specific Facial Characteristic Points – FCPs as shown in Figure 2. For the recognition of expressions in still pictures, the distances determined from one face form a representative set of features to reflect the emotion at a certain moment of time. In the case of recognition of facial expressions in video sequences, the features are determined as the variation of the same distances between FCPs as observed during several consecutive frames.

Our algorithm for the recognition of emotions in videos implies an initial processing of the multimodal data. Firstly, the audio-video input data is rescaled by conversion to a specific frame-rate (Figure 3). This process may imply downscaling by skipping some video and audio frames. Secondly, the audio data is processed in order to determine the silence and non-silence segments. The resulting segments are correlated to the corresponding audio data and constitute the major data for the analysis.

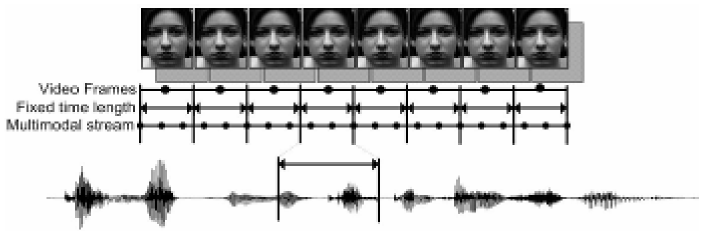

Fig.3. Multimodal frame rescaling algorithm.

In the case of facial expression recognition, within each segment an overlapping sliding window (Figure 3) groups together adjacent video frames. Based on the set of video frames, the recognition of facial expressions determines the most probable facial expression using a voting algorithm and a classifier trained on still pictures. For the video oriented classifier, the most probable facial expression is determined by taking into account the variation of the features extracted from all the video frames in the group. The identification of silence and non-silence segments is realized by using both acoustic and video information. The recognition of emotions is realized differently for silence segments and non-silence segments, namely for silence segments only the video stream is used. For the non-silence segments, the emotion recognition is based on the multimodal semantic fusion of the results of the emotion classification on single modalities. The input features in this case relate to only FCPs from the upper part of the face. The reason for not considering the FCPs of the mouth is explained by the natural influence of the phoneme generation on the mouth shape during the process of speaking.

EMOTION RECOGNITION FROM SPEECH

In the case of emotion recognition from speech, the analysis is handled separately for different number of frames per speech segment. In the current approach there are five types of split methods applied on the initial audio data. Each type of split produces a number of data sets, according to all the frame combinations in one segment. The data set used for emotion analysis from speech is BerlinDB – a database of German emotional speech. The database contains utterances of both male and female speakers, two sentences pro speaker. The emotions were acted by ten native German professional actors (five female and five male). The result consists of ten utterances (five short and five long sentences). The length of the utterance samples ranges from 1.2255 seconds to 8.9782 seconds. The recording sample rate is 16kHz. The final speech data set contains the utterances for which the associated emotional class was recognized by at least 80% of the listeners. Following a speech sample selection, an initial data set was generated comprising 456 samples and six basic emotions (anger: 127 samples, boredom: 81 samples, disgust: 46 samples, anxiety/fear: 69 samples, happiness: 71 samples and sadness: 62 samples). The Praat [2] tool was used for extracting the features from each sample from all generated data sets. According to each data set frame configuration, the parameters mean, standard deviation, minimum and maximum of the following acoustic features were computed: Fundamental frequency (pitch), Intensity, F1, F2, F3, F4 and Bandwidth. All these parameters form the input for separate GentleBoost classifiers according to data sets with distinct segmentation characteristics. The GentleBoost strong classifier is trained for a maximum number of 200 stages. Separate data sets containing male, female and both male and female utterances are considered for training and testing the classifier models.

In Figure 4 we display the architecture of a system that is able to recognize emotions given a speech input in a real time setting.

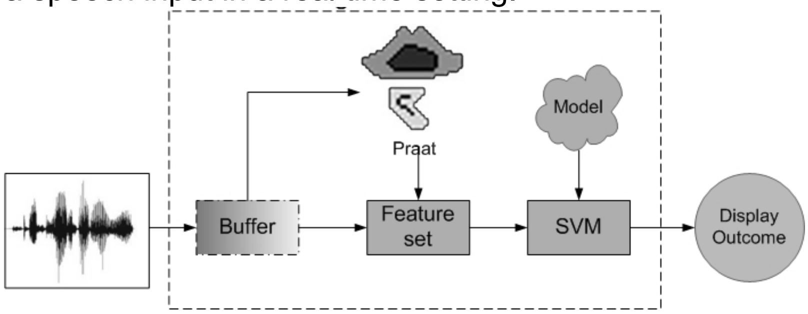

Fig.4. Architecture of the real time emotion recogniser from speech.

EXPERIMENTS

We performed some experiments in an e-learning environment. Twelve MSc-students (8 male, 4 female) in a student lab were connected to the Web via a PC equipped with Webcam and Microphone. The goal was to assess emotions in a multimodal way and to research what triggers those emotions. After the experiments the students were requested to fill in a questionnaire to evaluate the user experiences.

Experiment 1

Design: In the first experiment students took part in a Web-based Course on neural networks. Students were supposed to read some text, answer questions and do some exercises.

Results: Students showed some emotional expressions but we were not able to classify them as one of the basic emotions or as a point in the valence –arousal space. Some facial expressions were either nerve-tics, non-verbal utterances etc. Maybe because students were aware of the fact that their behaviour was recorded they controlled their emotional behaviour.

Experiment 2

Design: The design was similar to experiment 1. But there were many interruptions, such as network timed-out, errors, failures in saving and communicating answers.

Results: We observed different emotional behaviours. Some students showed frustration on their face, use dirty words, and even give up after some time and logged off for a coffee break. Other students showed sarcastic smiling and made funny remarks about the system, administrators and lecturers. All students started interaction to see if other students suffer from the same problems and were looking for social support.

Experiment 3

Design: In the third experiment students in subgroups of three students have to play a game with a race car simulator (TORC). There were three kinds of tracks: one straight line, a curvy track and a track with a lot of billboards with funny pictures or pictures of traffic accidents. The car drivers have to pass the tracks as soon as possible, Car crashes, violating the traffic rules results in penalties. Every member of the group has to drive, every player gets a score and the goal was to reach the high score as a team. The blink rate of the player was assessed by a sensor. The assignment was to find the correlation between the eye blink rate and the track condition.

Fig.5. TORC simulator.

Results: As expected a lot of emotions were shown by the players. The time pressures induced a lot of stress. But most stress was generated by the team mates, pushing the driver player to drive as hard as possible. Every mistake resulted in a lot negative comment of the team members, but also in some positive feedback. Some negative comments resulted in angriness of the drivers. The funny pictures on the billboards evoked smiling faces and laughing, the accidents fear or disgust. But the next rounds the effect of the billboards was minimal, probably the drivers concentrated only on the driving task (tunnel view). Because of the close to mouth microphone and because the driver was focussed on the screen (frontal pictures), we were able to process the video/audio streams.

CONCLUSIONS AND FUTURE WORK

Our conclusion is that emotions play an important role in e-learning environment. But it depends on the educational material, environment and conditions are clearly displayed by students by facial expressions or their way of speaking. Individual learners in traditional face-to-face learning or e-learning conditions show no emotions unless they are triggered by teachers/students or features from the environment or learning material. Especially serious gaming is able to evoke emotional reactions from students.

From the questionnaires we learned that students appreciated e-learning environments, generating emotions. They reported that they were more motivated to take part in the lessons and had positive feelings afterwards. The question is of course of the results of learning have a positive correlation with the amount of emotions.

One of the issues is if the shown emotions are acted or spontaneous. At this moment we repeat experiment three and record EEG signals using a brain cap. It is difficult to fake the brain processes, so we expect to measure the true emotional conditions of the students.

We agree with conclusion of many researchers involved in e-learning that the main challenge is not to imitate face-to-face learning but to go beyond that. Using serious gaming environments enables teachers to generate educational environments which cannot be realised in real life.

REFERENCES

[1] Averill, J *A connectionists view of emotion.* Emotion: Theory, Research and Experience, Vol. 1, *Theories of Emotions,* Academic Press, New York, pp 305-337, 1980.

[2] Boersma, P., Weenink, D., Praat: doing phonetics by computer (version 4.3.14) [Computer Program], 2005.

[3] Cootes, T. F., G. J. Edwards, C. J. Taylor, "Active appearance models", Lecture Notes in Computer Science, vol. 1407, pp. 484–98, 1998.

[4] Darwin, C., *The expressions of emotions in Man and Animals,* The University of Chicago Press, Chicago, 1872/1965.

[5] Damasio, A., *Descartes's Error: Emotion, Reason, and the Human brain*, Papermac, London, 1996.

[6] Datcu, D., L. J. M. Rothkrantz, "The recognition of emotions from speech using GentleBoost Classifier", CompSysTech'06, June 2006.

[7] Ekman, P., *The nature of emotion: Fundamental questions*. Oxford University Press, pp 7-19, 1994.

[8] Goleman, D., *Emotional Intelligence*, Bantam Books, New York, 1995.

[9] Hara,N. , R. Kling, Students' distress with a Web-based distance education course: An ethnographic study of participants' experiences, Center for Social Informatics, Indiana University, 2000.

[10] Kanade, T., J. F. Cohn, Y. Tian, Comprehensive database for facial expression analysis, *Proc. of the 4th IEEE Int. Con. On Automatic Face and Gestures Recognition*., France, 2000.

[11] LeDoux, J., *The emotional Brain: The mysterious Underpinnings of Emotional Life*, Phoenix, London, 1999.

[12] Martinez,M., Key design considerations for personalized learning on the Web, *Educational Technology and Society*, Vol. 4, No.1 pp 26-40, 2001.

[13] Ng, K-C., Using e-mail to foster collaboration in distance education. *Open learning*, Vol. 16, No. 2, pp 191-200, 2001.

[14] O'Regan, K. Emotion And E-Learning. *JALN* Volume 7, Issue 3, 2003.

[15] Rothkrantz, L.J.M. E-learning in virtual environments, *Communication & Cognition*, Vol 42, No. 1&2, pp 37-52, 2009.

[16] Vapnik, V.,*The Nature of Statistical Learning Theory*, Springer- Verlag, New York, 1995.

[17] Vapnik, V., *Statistical Learning Theory*, John Wiley and Sons, Inc., New York, 1998.

[18] Viola, P., M. Jones, Robust Real-time Object Detection. Second International *Workshop on Statistical and Computational Theories of Vision-Modeling, Learning, Computing, and Sampling*, 2001.

[19] Wegerif, R., The social dimension of asynchronous learning networks. *Journal of Asynchronous Learning Networks*, Vol. 2, No. 1, 1998.

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A Hybrid Method for Optimization Based Visualization

Antanas Zilinskas, Audrone Jakaitiene

Abstract: *Visualization is widely used for analysis of multidimensional data: a set of multidimensional points is mapped into 2-dimensional plane to enable heuristic analysis of the structure of the set of multidimensional points. Multidimensional scaling is a technique suitable for visualization since it maps from multidimensional space to 2–dimensional plane aiming to preserve the structure of distances between points in multidimensional space. The quality of mapping is defined by the STRESS function. The latter should be minimized but this minimization problem is multimodal. For this complicated problem a technique is developed combining a genetic type algorithm with a conjugate gradient descent routine.*

Key words: *Multidimensional data analysis, visualization, genetic algorithms, conjugate gradient algorithms, convergence.*

INTRODUCTION

Visualization is a technique for analysis of multidimensional data aimed for heuristic analysis of similarity/dissimilarity structure of the objects represented in multidimensional space by means of mapping of multidimensional points to 2–dimensional plane. Such a mapping can be implemented using methods of multidimensional scaling (MDS) aiming to preserve the structure of distances. The problem of MDS was formulated in [3] as a problem of minimization of *STRESS* function. The term "*multidimensional scaling"* was accepted by statisticians and users of this technique in social sciences ([6], [1]). The paper by Sammon [8] originated the development of a special version of MDS. The subsequent papers on implementation and application of Sammon's method use the term "*nonlinear mapping technique"*; see e.g. [2]. Applications of Sammon's method are normally oriented to the problems of pattern recognition. Although different aspects of MDS have been investigated, crucial implementation difficulties remain not resolved. In this paper MDS is considered as a specific problem of global optimization, and as a tool of visualization of information on search process in global optimization.

FORMULATION OF MDS PROBLEM

Let us give a short formulation of the problem. The matrix δ_{ij} , $i, j = 1,...,n$ gives the pair wise dissimilarities between *n* objects, and it is symmetric. Dissimilarities are data for MDS; for example, they can be obtained experimentally. In case the original data is a set of points in multidimensional space R^d, the dissimilarities are defined as distances in this space. The points $x_i \in R^m$, $i = 1,...,n,$ should be found whose inter-point Euclidean distances fit the given dissimilarities. The embedding Euclidean space normally is 2-dimensional (*m*=2), but other dimensionalities may be also interesting for some applications, (*m*<*d*). To find the points x_i the *STRESS* function *f (X)* should be minimized,

$$f(X) = \sum_{i<j} w_{ij} (d_{ij}(X) - \delta_{ij})^2, \quad X = (x_{11},...,x_{n1},x_{12},...,x_{nm}) \tag{1}$$

where $d_{ij}(X)$ denotes the Euclidean distance between the points x_i , x_j . It is supposed that the weights are positive: $w_{ij} > 0,\ i, j = 1,...,n.$

Although the *STRESS* function is defined by the analytical formula (1), which seems rather simple, it normally has many local minima. The minimization problem is highly dimensional, with the number of variables equal to *N*=*n*×*m*. At some points the function f*(X)* is not differentiable. The listed features make minimization of f*(X)* difficult.

LOCAL MINIMIZATION

It is well known [4] that *f(X)* is differentiable at a local minimum point, i.e. if *X* is a local minimizer, then the following equalities and inequalities are valid

$$\frac{\partial f(X)}{\partial x_{kh}} = 2\sum_{i \neq k} w_{ki}(1 - \frac{\delta_{ki}}{d_{ki}(X)})(x_{kh} - x_{ih}) = 0, d_{ij}(X) > 0,\ i, j = 1,...,n.$$

In fact, the more general result may be proven:

Proposition. Let *L(t), -∞<t<∞,* be a line in R^N, containing a point at which *f(•)* is differentiable. Then *f(•)* is differentiable at any point *L(t*)*$\in R^N$, where *t** is the local minimizer of *φ(t)=f(L(t)).*

It follows from the proposition that a local descent trajectory escapes the points of non–differentiability of *f(•)*. Therefore, a fast local descent method may be applied to find a local minimizer of *f(•).* It is well known that variable metric methods are efficient for local minimization of f*(X)* in case of not too high dimensionality *N.* For very high dimensionalities a conjugate gradient method seems promising. From a theoretical point of view the rate of convergence is most important feature of an algorithm. The super linear convergence rate of a conjugate gradient method may be proved under mild assumptions on an objective function. However, the quadratic convergence is proved assuming the norm of Hessian of the objective function be bounded from zero. Let us analyze the second directional derivative of *f(X)* at a local minimum point X_* with respect to the direction *S*:

$$\varphi(t, S) = f(X_* + t \cdot S),\ \varphi'(0, S) = 0,$$

$$\varphi'(0, S) = 2\sum_{i<j} w_{ij}\left(1 - \frac{\delta_{ij}}{d_{ij}(X)}\right)\sum_{h=1}^{m}(x_{ih} - x_{jh})(s_{ih} - s_{jh}),$$

$$\varphi''(0, S) = 2\sum_{i<j} w_{ij}\{d_{ij}^2(S) - \frac{\delta_{ij}}{d_{ij}^3(X)}(d_{ij}^2(S) \cdot d_{ij}^2(X) - [\ \sum_{h=1}^{m}(x_{ih} - x_{jh})(s_{ih} - s_{jh})\ ]^2)\}.$$

At a local minimum point the inequality $\varphi''(0, S) \geq 0$ holds for any *S*. For the directions *S* corresponding to the translations and rotations of the embedding space the inequality is reduced to the equality $\varphi''(0, S) = 0$. The latter equality implies the degeneracy of Hessian. To ensure the quadratic convergence of the conjugate gradient method the problem should be regularized. The simplest regularization is the fixation of several variables to exclude invariance with respect to translations and rotations of the embedding space; see e.g. [9]. However, specific positions of few points have no advantages for heuristic analysis of the images in the embedding space. The regularization can be achieved excluding invariance with respect to translations and rotations (in the 2–dimensional case, *m*=2) by the equality constraints:

$$\sum_{i=1}^{n} x_{i1} = \sum_{i=1}^{n} x_{i2} = \sum_{i=1}^{n} x_{i1}x_{i2} = 0. \qquad (2)$$

Proposition. The Polak – Ribiere conjugate gradient method converges to a local minimizer of regularized minimization problem quadratically with respect to the number of iterations including *2n-3* exact line searches.

Since the analytic expressions of the first and second directional derivatives are available, then a high precision line search method based on forth degree polynomial interpolation may be easily implemented.

A HYBRID METHOD

Several algorithms of minimization of the *STRESS* are available. The theoretical results of the previous section show that the non–differentiability of (1) is not a concern if a local descent method is used. Therefore, a conjugate gradient method with regularization of minimization problem is a strong competitor for other well known methods. The latter method may successfully cope with high dimensionality. Therefore, the real difficulty is caused by the multimodality of the *STRESS.*

The majorization method, which is especially tailored for MDS, may escape some local minima. However, like the other local methods, it provides a solution essentially depending on a starting point [1]. A local descent may be extended for multimodal problems using the tunneling approach. The possibilities of such an extension for MDS are discussed in [1]. The combination of majorization method with genetic type choice of starting points was proposed in [5]. In the latter the genetic algorithm based method of Mathar and Žilinskas [7] was modified substituting a variable metric local descent with majorization method. The results of limited experimental testing showed that a genetic type approach can be suitable for global minimization of (1). In the references on “nonlinear mapping” various versions of descent method are of primary interest. However, combinations of descent with general global search methods, e.g. simulated annealing, are claimed promising in [2].

The proposed combinations of a local descent method and global search normally consider the *general global search* schemas. The idea of this paper is to tailor a *specific version* of a genetic type global search based on assumptions on the features of the *STRESS*.

The majority of the authors consider the unconstrained minimization of (1). In such a case the same minimum value may be obtained at different points on the orbit of local minimizers corresponding to invariance of f*(X)* with respect to translation and rotation of the embedding space. Therefore several copies of the same local minimum may be obtained, but with very different minimizers. It is difficult to handle such information on local minima to perform rational search for a global minimizer. In our conjugate gradient algorithm the ortogonalization (2) prevents multiplication of the minimizers. The analysis carried out for several sets of data shows that different local minimizers are located rather close each to other. Geometrically this feature of the *STRESS* may be explained as a small structural difference between the graphs in the 2–dimensional embedding space corresponding to different local minimizers of *f(X).* The geometric interpretation implies a hypothesis that graphs corresponding to local minimizers are composed of similar semi-optimal sub-graphs.

Different local minima are considered as the ideal representatives of different breeds. They are used for crossover. The initial population of the size *p* is generated by means of local descent method from the random initial points. The parents are chosen at random with uniform distribution. The structure of chromosomes is not known. The graph in the embedding space is considered the phenotype. The hypothesis is accepted that crossover of chromosomes imply the crossover of characteristics of phenotype. The latter is modeled as the crossover of the graphs in the embedding space, i.e. some points $x_i \in R^2$ of one parent graph and remaining points of the other parent graph are taken to compose the descendant graph. The break position is generated randomly with uniform distribution in the interval [1, *n*]. The larger number of points is taken from the fittest parent. The mutation is modeled as the random summands to the components of graph coordinates; the distribution of the random variable is uniform in the interval [-*r, r*]. Two selection mechanisms have been investigated: 1) the descendants survive and the parents die; 2) each descendant competes with a randomly chosen individual of current population. The number of generations modeled to find the global minimum is denoted *g*.

EXPERIMENTAL TESTING

To assess the efficiency of the regularized conjugate gradient method (CG) for local minimization of (1) CG was compared with the known method based on majorization approach (MA) [5]. The convergence of MA to local minimum point is proved, e.g. in [6]. Moreover, it may be expected that bad local minima will be avoided. Both methods (CG and MA) were implemented in MATLAB.

Two known sets of data were used. The first set, presented in Table 1 a), contains δ_{ij} for ten soft drinks whose dissimilarities are obtained by means of experimental testing [1]. The second set of data corresponding to the proximities of 13 facial expressions [1] is presented in Table 1 b).

Table 1. Data for visualization.

a)

1.27	1.69	2.04	3.09	3.20	2.86	3.17	3.21	2.38
	1.43	2.35	3.18	3.22	2.56	3.18	3.18	2.31
		2.43	3.26	3.27	2.58	3.18	3.18	2.42
			2.85	2.88	2.59	3.12	3.17	1.94
				1.55	3.12	1.31	1.70	2.85
					3.06	1.64	1.36	2.81
						3.00	2.95	2.56
							1.32	2.91
								2.97

b)

0.405											
0.825	0.254										
0.557	0.269	0.211									
0.115	0.267	0.898	0.378								
0.297	0.388	0.927	0.605	0.234							
0.434	0.853	1.187	0.978	0.712	0.136						
0.490	0.131	0.256	0.421	0.590	0.518	0.847					
0.625	0.188	0.074	0.045	0.477	0.545	1.020	0.263				
0.155	0.484	0.925	0.492	0.222	0.417	0.544	0.545	0.710			
0.168	0.581	0.792	0.542	0.434	0.472	0.431	0.379	0.658	0.198		
0.657	0.743	0.830	0.893	0.816	0.466	0.157	0.649	0.977	0.493	0.483	
0.393	0.451	0.847	0.348	0.160	0.489	0.918	0.605	0.655	0.412	0.351	1.265

To compare the performance of both methods 100 runs have been performed with both sets of test data. The starting points were generated randomly with uniform distribution in the cube $[-1.2,1.2]^N$. Both methods used the same random starting point and the same stopping condition: $\| \nabla f(X_k) \| = \varepsilon < 0.001$. The averaged values of results are presented in Table 2.

Table 2. The comparison of the performance of CG and MA algorithms

	STRESS	Time (s)	Iterations
CG, Test 1	13.18	2	36
MA, Test 1	13.30	5	213
CG, Test 2	0.684	2	22
MA, Test 2	0.684	3	77

The known best value of the *STRESS* with the first set of data is 11.746, and region of attraction of the corresponding minimizer makes 4% of the feasible region. By means of CG a minimizer with the value better than 11.75 has been found five times, and by means of MA has been found once. 75 times the value found by means of CG was better than the value found by means of MA.

The second set of data defines the *STRESS* function, which is very likely unimodal. All 100 runs for both methods stopped in the vicinity of the same local minimizer. Average time of minimization of this rather simple function by CG is again considerably better than by MA. In all runs a found minimum was slightly better for CG than for MA.

Time of local descent to a local minimizer depends on dimensionality of a problem and on the stopping condition. The dimensionality of minimization problems corresponding to Test 1 and Test 2 is equal to 20 and 26 correspondingly. The third test problem is 2-dimensional representation of vertices of the 5-dimensional cube. The vertices are numbered according their digital representation. Since the number of vertices is equal to 32, then the dimensionality of the minimization problem is equal to 64. The local descent for the problems of such a dimensionality is time consuming. In the Table 3 the results of two runs are presented. The results show that the time of local descent for 64-dimensional problem is considerably larger than the time for the 20-dimensional cases. The solution with the prescribed tolerance of gradient norm by means of MA was not found.

Table 3. Dependence of computing time on the stopping condition

	Time (s)	Iterations	Time (s)	Iterations
	ε =0.001		ε=0.01	
CG	35	73	32	63
MA	228	1000	228	1000

Since the CG has been shown faster than MA, the former was used to construct a global search algorithm. The size of population, number of generations, crossover method, and mutations intensity has to be chosen experimentally. The experiments were performed with the Test 1. Summarizing the results, the following parameters may be recommended: p=10, g=3, competition selection mechanism, r=0.3. The averaged results of 100 runs for Test 1 are the following: the *STRESS* value equal to 11.77, number of line search iterations equal to 812, minimization time equal to 351. Minimal function value with accuracy no less than 1% was found 95 times. The average results obtained by means of evolutionary algorithm are considerably better than those obtained by means of local descent method from the random initial points.

The evolutionary algorithm was applied also to Test 3. The best-found value of the *STRESS* function was 141.11, number of line search iterations was 1470, and solution time was 7044. The 2–dimensional image of vertices, corresponding to the global minimizer, is presented in Fig.1 (left-hand side). In Fig.1 (right-hand side) the image corresponding to a local minimizer is presented. Although the difference of the *STRESS* values is insignificant, there are clearly visible differences of the images.

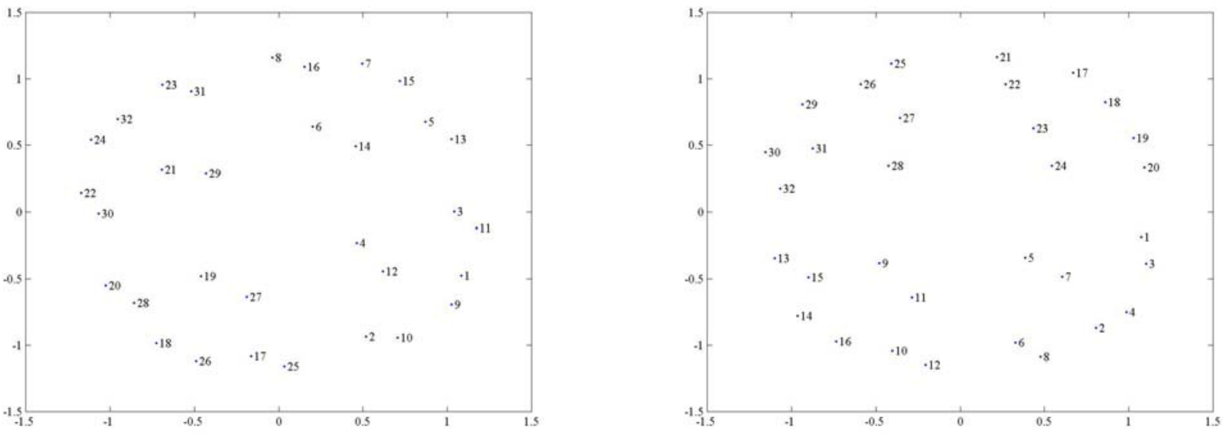

Fig 1**.** 2-dimensional image of vertices of 5–dimensional cube: global minimum on the left - 141.11; local minimum on the right - 141.63.

The 2–dimensional images of the results on search process may be useful for understanding of character of multimodal objective functions. In Fig.2 the images of trajectories of local search from seven random initial points (squares) are presented. The function (1) with the data of Test 1 was minimized. The picture supports the hypothesis that different local minimizers of (1) are close each to other.

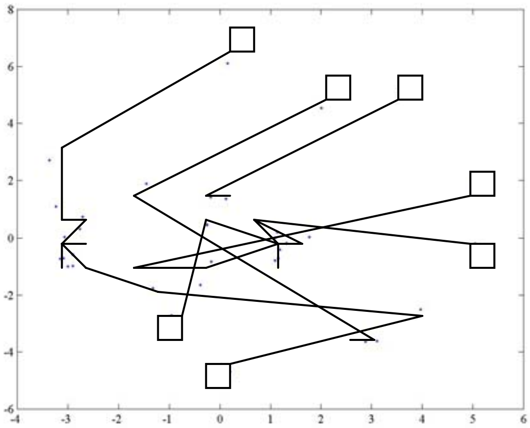

Fig 2. Two-dimensional image of descent trajectories in 20 - dimensional space

CONCLUSIONS

The hybrid method combining genetic type algorithm with a conjugate gradient descent routine is prospective to solve a difficult global minimization problem of MDS. The latter is useful for visualization of information on a global search process.

REFERENCES

[1] Borg I., and P. Groenen. *Modern Multidimensional Scaling,* NY: Springer, 1997.

[2] Dzwinel W. How to make Sammon's mapping useful for multidimensional data structures analysis, *Pattern Recognition* Vol.27, No.7, 949-959, 1994.

[3] Kruskal J. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika,* Vol.29, 1-27, 1964.

[4] De Leeuw J. Differentiability of Kruskal's *STRESS* at a local minimum, *Psychometrika,* Vol.49, 111-113, 1984.

[5] Mathar R. A hybrid global optimization algorithm for multidimensional scaling, *Classification and Knowledge Organization,* Eds. R.Klar and O.Opitz, Springer, 63-71, 1996.

[6] Mathar R. *Multidimensionale Skalierung, Mathematische Grundlagen und Algorithmische Konzepte,* Preprint, RWTH Aachen, 44p, 1995.

[7] Mathar R., and A. Žilinskas. On global optimization in two – dimensional scaling, *Acta Applicandae Mathematicae,* Vol.33, 109-118, 1993.

[8] Sammon J. A nonlinear mapping for data structure analysis, *IEEE Trans. Comput.* Vol.C-18, 401-409, 1969.

[9] Žilinskas A. On quadratic convergence of a visualisation algorithm. *Proc. of 4th International Conference on Pattern Recognition and Information Processing, Minsk-Szczecin,* Vol.1, 200-204, 1997.

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An Online Peer Assessment Platform for e-Learning Environments

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Abstract: *Peer assessment is an educational procedure in which students are requested to act as both reviewers and authors, evaluating the work of their fellow students. Peer assessment has been found to help students improve the quality of their work and better understand the educational material. E-learning can especially benefit from the use of the aforementioned process to provide trainees with quality feedback regarding their projects while not increasing the instructors' workload. In this way students are more involved in the educational process, feel less isolated and more part of the online community. In this paper, an online peer assessment platform is presented. This platform has been designed to support the Learning Management System of the course is user-friendly and provide all the necessary functionality to online deliver the peer assessment procedure. It is thus expected to enhance the educational experience of both the instructors and the trainees.*

Key words: *Peer Assessment, e-Learning, Online Educational Platform.*

INTRODUCTION

The advent of the World Wide Web has introduced new possibilities for providing education to large amounts of students. E-learning presents significant advantages compared to classical education in that it can provide educational services to students without posing spatiotemporal restrictions. The above have led to the increased popularity levels of this type of education and have contributed to its adoption by many educational institutions worldwide. However, due to the fact that e-learning lacks face-to-face communication, it has been observed that learners do not receive the same amounts of feedback regarding the quality of their work, as they would typically receive in traditional education courses.

A solution to this problem can be achieved through the use of peer assessment. According to this methodology, students evaluate each others' work, acting as both reviewers and authors. Peer assessment has been found to benefit the educational procedure since students receive more feedback and gain deeper understanding of the course material [1 - 3]. Instructors also benefit from this methodology, since the quality of the projects they need to assess is better, a fact that decreases the workload for this task and enables them to focus on more constructive aspects of their work.

In this paper, an online peer assessment platform and its functionality are presented. The rest of this paper is organized as follows: The second section describes the course upon which the peer assessment platform was applied, as well as the methodology steps followed. The next section provides a detailed description of the online platform. The final section concludes the paper and provides possible future extensions of this work.

PEER ASSESSMENT FOR E-LEARNING COURSES

The developed platform was used in an introductory level e-learning course on "Web Design". The course is provided by the Multimedia Technology Laboratory e-learning team of the National Technical University of Athens [4], through the Moodle open-source LMS platform [5].

The course is offered twice a year: at the Spring and Fall semesters. It is of introductory level and is targeted towards adults of various educational backgrounds that range from high-school graduates to master degree holders. It consists of seven educational sections, during which learners are presented with the educational material. At the end of each educational section, students are required to submit a project, in the form of a web site, using the material taught in this section.

Then, students are requested to participate in the peer assessment procedure. Specifically, learners are asked to provide comments on two randomly selected projects of their fellow classmates. Thus, at the end of a peer assessment step each student will have reviewed two projects and will have received the comments of two reviewers. Students grade each others' projects by filling in a form with questions regarding the design, technical soundness, functionality and overall impression of the project under evaluation. Each question is answered through a five item Likert scale, ranging from 1 (negative impression) to 5 (positive impression). To evaluate if the reviewer has helped the author to enhance the quality of his work, each student is asked to rate the reviewer's comments, regarding his perceived degree of usefulness. It should be noted that students are considered potential reviewers for the peer assessment procedure of a section, only if they have submitted a project for this particular section. Finally, to prevent vandalism, the peer assessment procedure is validated by the instructors who can read and, if necessary, edit student comments prior to sending them the authors.

PLATFORM DESCRIPTION

The developed platform has been designed to facilitate students and instructors to implement the peer assessment procedure. The platform has been developed through the PHP and AJAX technologies.

To this end, the platform can support different Learning Management Systems and automatically extract student data regarding submitted projects and possible reviewers. The platform uses a database, separate from the one used by the LMS, to store the necessary data. This local data storing feature helps in reducing the response times of the platform and ensures its independency from the LMS used in a specific course.

The developed platform can be used by both the instructors and the students. The first have access to a number of tools that help them organize and administer the peer assessment procedure of a class while the second view a more simplified aspect of the platform.

Instructor's View

The teacher has the following options:

- Course Overview: Using this feature, the instructor can see the course description, which includes general information regarding the course goals and material.
- Insert and edit questions: Through this option, the teacher is able to edit the review form that the reviewers will be asked to fill in, upon evaluating the project of their fellow students.
- Peer assessment overview: This option is one of the most important and most frequently used. Through this platform function, the trainer is able to view the number of submitted projects per section, the possible reviewers per project, as well as the number of projects that have not yet been commented by a reviewer (Figure 1).
- Section overview: Through this functionality the instructor can select and manage a specific course section. The actions that can be taken in this level are: assigning reviewers to authors, viewing and validating new uploaded comments.
- Student overview: According to this function, the teacher can see the total number of projects that each student has been assigned to review, the number of projects that the student has not commented and the total number of comments that this trainee has submitted. This option has been designed to be available from every page of the platform, using the AJAX technology, enabling the instructor to view the status of the students whenever it is necessary (Figure 2).

- E-mail notifications: Using this functionality, the instructors can send e-mails to the students to inform them about a new comment or a new project for review.
- Platform messages: The platform displays messages to the instructor regarding the number of comments that need to be validated and projects that have not yet been matched with a reviewer.

Fig.1. Peer assessment overview - instructor view

(b)

Fig.2. Section and student overview – instructor view

Student's view

Upon entering the platform, students view the start page that informs them about the peer assessment procedure in detail (Figure 3). It consists of general guidelines and frequently asked questions regarding the procedure. The student view of the platform is less complex and consists of fewer functions compared to the view of the instructor, in order to familiarize students with the whole procedure and motivate them to participate.

Fig.3. Peer assessment instructions – student view

The platform provides the following options to the student:

- Read the reviewer comments: Through this functionality students can view the comments that the reviewers have made on their assignments and rate the quality of each review received.
- Evaluate projects: According to this option, students make comments on the projects that they have been assigned to.
- Platform messages: Through this option, students are informed about new reviews on their assignments and about projects that they need to evaluate (Figure 4).

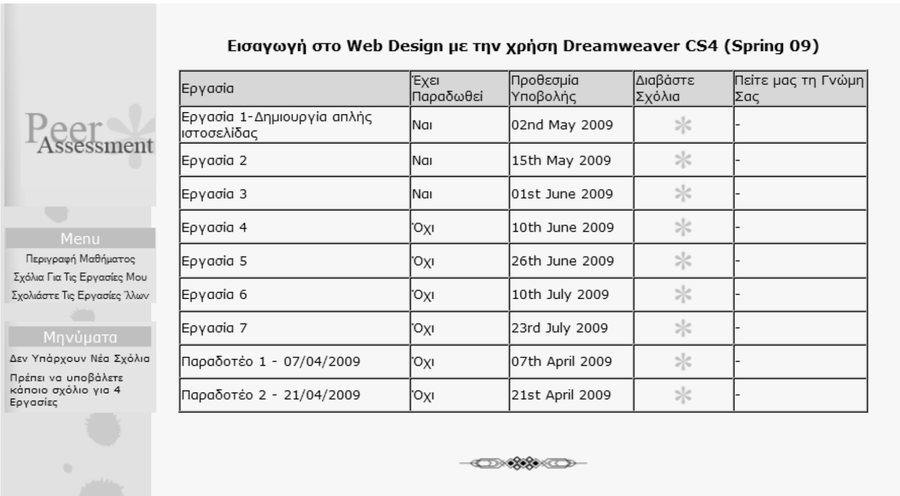

Fig.4. Platform functionality – student view

CONCLUSION

In this paper, an online peer assessment platform for e-learning environments has been presented. The developed platform is user-friendly and is expected to benefit the educational procedure in terms of increasing the quality level of the submitted projects and reducing instructor workload. Future work may include examining the platform usefulness in a large-scale e-learning environment and enhancing it with adaptive characteristics based on the specific needs of each student.

REFERENCES

[1] Sluijsmans, D. M. A., Brand-Gruwel, S., Merrienboer, J. J. G. v., Peer assessment training in teacher education: effects on performance and perceptions, Assessment and Evaluation in Higher Education, vol. 27, pp. 443–454, 2002.

[2] Topping, K., Peer assessment between students in colleges and universities, Review of Educational Research, vol. 68, pp. 249–276, 1998.

[3] Wen, L. M. C., Tsai, C.-C., University students' perceptions of and attitudes toward (Online) peer assessment, Higher Education, vol. 51, pp. 27–44, 2006.

[4] Medialab, E-Learning Services, Multimedia Technology Laboratory, National Technological University of Athens, http://elearn.medialab.ntua.gr/, 2009.

[5] Moodle, Moodle LMS, http://moodle.org/, 2009.

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Some aspects of the process of registration in the applications for distance-learning

Jordan Stoyanov, Georgi Todorov

Abstract: *This article describes some of the specifics of the process of registration of new users in the distance learning systems. It presents a packet of user data types and an example of a "road map" for registration of users. Statistics are published for the registration of users of a system for "Provision of information on survival in times of crisis by Hand Held devices"*
Key words: *Computer Systems and Technologies, m-Learning.*

INTRODUCTION

Higher education institutions throughout the country are legally obliged to offer distance learning as equal to the other forms of education. In the Web-based environments developed for distance learning, the basic method for identification of users is to register them. This causes some inconvenience for participants in the learning process and imposes requirements to them. Some aspects of the registration process in a system for "Provision of information on survival in times of crisis by Hand Held devices" are discussed further below.

LAYOUT

User registration in the applications for distance learning is required to identify the users. The provided username and password enable the user to use the educational resources from different workstations and personalize the learning process. The registration at this stage is considered a necessity, which imposes certain aspects in the activities of the students. It has the following characteristics:

1. Users understand the need for registration but evaluate it as an annoying requirement of the site
2. The users are especially critical of the following fields of the registration form:
   - 2.1. Fields which have no relation to the purpose of the site and the interests of the user, so obviously the data is needed for studies of the target groups.
   - 2.2. Fields which require filling of data about other people related to the user.
   - 2.3. Fields which require data that violates the confidential use of the site resources or data that reveals the physical identity of the user.
   - 2.4. Fields of the following type: "text field" or „text area", which require text input from the keyboard.
   - 2.5. Fields that require a creative description or a position on a certain topic, especially if it takes longer to consider the answer.
   - 2.6. Fields which require the information to be filled in a foreign language, especially when the data is of descriptive nature.
   - 2.7. Fields which require completion of difficult to understand anti-spam code.
   - 2.8. Fields which require a high degree of uniqueness of the data.
   - 2.9. Fields with a high degree of data validity verification by the server.
3. Users understand the need for confirmation of registration via E-Mail, but they complete it with some nervousness and reluctance.
4. The users are not sure if their personal data is stored under the Law on personal data, so they often fill in false one.
5. The users are fairly critical to some administrators' attempts to verify the accuracy or validity of the submitted data in some special ways.
6. Having registered, users do not accept to be treated as beginner users with limited rights to use the web site resources.

The registration process is carried out by the site administrator. How effectively for the system the registration will be done depends on administrator's knowledge and skills, and what initial impression of the site will be received by the user who has passed with approval its "Welcome zone". Some of the most common mistakes of the site administrators are listed here below:

1. It is considered true that if a user is registered on the site, he is motivated to visit it regularly in the future.
2. The registration process discourages users with lower motivation from using the site resources.
3. Registration is an opportunity to collect statistical information about the target groups of visitors. It is also a way to identify the scope of site usage.
4. Registration on the web site "estranges" the user from visiting other sites with similar contents.
5. Registration is considered a process of identification with the group affiliation and hierarchical position in the social communities.
6. Registration is accepted as an act of goodwill and commitment to the rules of site usage.
7. Registration, in particular, the publication of personal data, is an act of user's trust in the site. Accordingly, the web site administrator is to establish further contacts with that user.
8. Registration on the web site is an opportunity to announce, or popularize the use of other services offered on the site, or even those of third parties.
9. The following statement is considered true that any future user will carefully read the rules of site usage and will conscientiously observe them.
10. The administrator, as a managing authority, has the right to impose sanctions against unfair users. Good policy, in respect of unfair users, is to hamper the implementation of their mercenary plans.
11. Administrators often cannot strike the balance between data security, user's convenience and quantity of acquired information, and verification of the information submitted in the registration forms.

Registration of new users can be classified in three groups, as follows:

1. Single and complete - all necessary data is required at the beginning.
2. In depth - necessary data is gradually required at each stage of training.
3. Combined type

In order to implement effective distance learning, some data about the users is required. A range of data types obtained empirically through the use of a system for "Provision of information on survival in times of crisis by Hand Held devices" is listed here below and at the following address: http://hand.danysto.info. On concept level, they are consistent with the standards IEEE PAPI and IMS LIP.

1889 users have been registered for the period of existence 2006 - 2009. Time for registration of each user has been surveyed. The results are presented in figure 1.

The selected type of registration is single and complete. The user fills in information in an entry form with fields classified in the following way:

- Total number of the input controls - 17.
- Number of "required fields" - 10, of which 3 are „combo box" and 7 are "text field" type.
- Input language - Bulgarian [10] and English [2] and 5 fields "in Latin".
- Number of „text field" boxes – 11 as some of them has "default" values.
- Number of „combo box" fields - 5.

From user's point of view, there are help instructions for all of the registration form controls. There is a colour indication for data validity at the fill-in stage. The client checks the validity of all data. The server verifies all data submitted.

Table 1. A set of data types and a "roadmap" of the registration

#	Type of required information	IR	ST				Stage of certification
			OS	IST	BST	FST	
1	2	3	4	5	6	7	8
1	Name, Middle name, Surname						x
2	User name	x					
3	Password	x					
4	E-mail address	x	x	x	x	x	
5	Postal address						x
6	Telephone number (mobile)		x				
7	Type of the mobile phone (Hand Held).		x	x			
8	Which features of the mobile phone are used most often?		x	x	x	x	
9	Occupation (field)		x	x	x	x	x
10	Position		x	x	x	x	x
11	Allocation of time over activities (most preferred time for work and study)		x	x	x	x	
12	PIN						x
13	Year and date of birth						x
14	Sex						x
15	Education (latest diploma)						x
16	Monthly income						x
17	Place of birth						x
18	Chat agent		x				
19	Interests (including educational ones)		x				
20	Hobby		x	x	x	x	

Number of analyzed types of information - 20.	IR - Initial registration
Number of direct results - 15.	ST - Stage of training
Number of indirect data results - 5	OS - Organizational stage
	IST - Initial stage of training
	BST - Basic stage of training
	FST - Final stage of training
	SC - Stage of certification

Table 2 Parameters of the statistical interval - registration time

Parametres of the statistical interval	Value [s]
Top limit of the interval	650
Bottom limit of the interval	90
Highest value	624
Lowest value	103
Middle value of the interval	242
Width of the interval	521

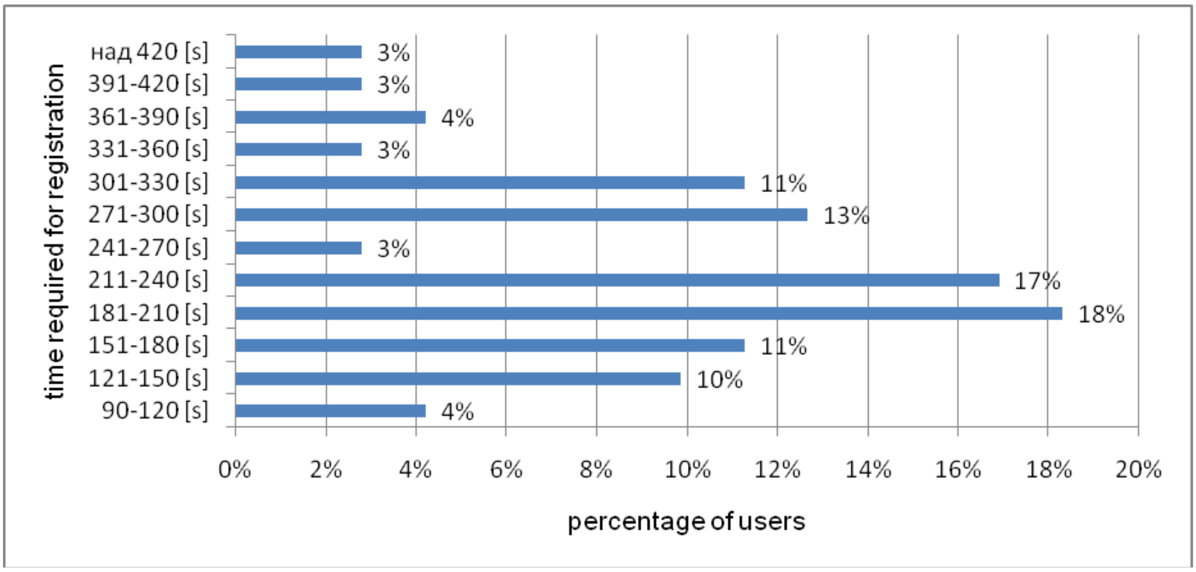

Fig.1. Allocation of time required for registration in discreet intervals of 30 seconds.

If all data of Figure 1 is presented cumulatively then:

- Only 4% of the users are included in the period of 2 minutes' registration.
- About 50% of the users need 4 minutes to register.
- 90% of the registered users manage to complete a 6 minutes' registration.

There is a strong correlation between the number of registrations from a populated area and the number of its inhabitants. The coefficient of correlation is 0.919141.
The users are offered the options to change the data in their profile, as well as to submit additional information to it.

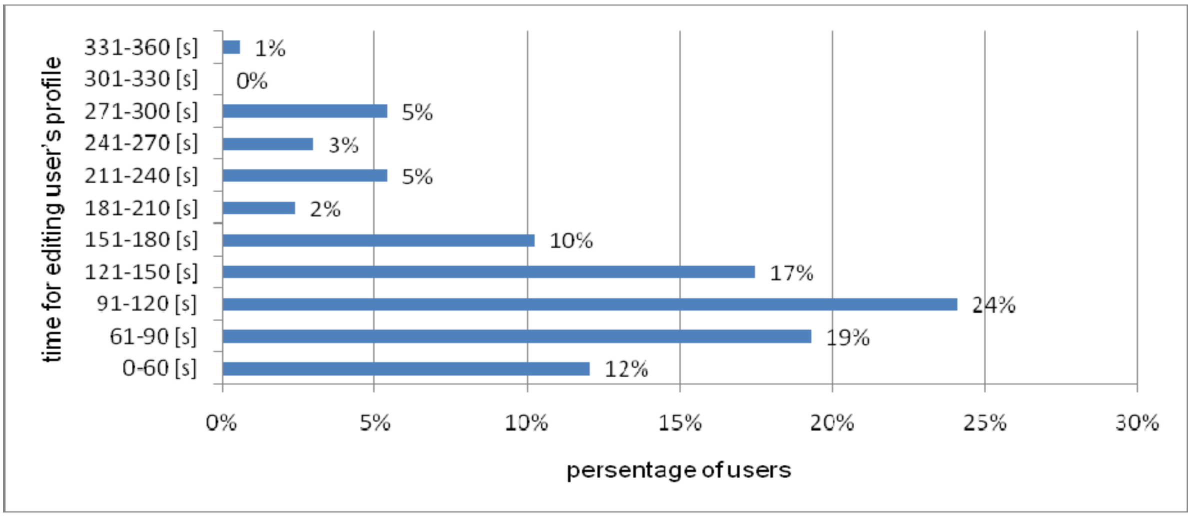

Fig.2 Allocation of time for editing of user's profile [s].

Only 9.98% of them have edited the information input in Bulgarian and 2.88% have changed the information input in English. The allocation of time for editing the profile in the discreet intervals of 30 seconds is presented in Figure 2.

Table 3 presents the parameters of the statistical interval:

Table 3. Parameters of the statistical interval – time for profile editing.

Parameters of the statistical interval	Value [s]
Top limit of the interval	360
Bottom limit of the interval	0
Highest value	345
Lowest value	23
Middle value	123
Width of the interval	322

Data related to the frequency of user profile update, the number of inactive users and the number of those who regularly use the resources on the site is highly important.

The password is an essential part of the registration process. It provides data protection to the user, prevents from "identity theft" and is directly related to the job security of the web site.

It is a matter of particular importance to comply with certain rules, some of which are described below:

Good practices for passwords:

The size of the password is chosen by the administrator and is usually 4-10 characters long. In a secure password a symbol is not used more than once. It is recommended that all symbols of the password be different - capital and small letters, numbers. The keyboard consists of 256 symbols, and 200 of them can be used in the password.

The length of the password is of great importance. Commonly, the system requires a minimum of 4 symbols. The secure password is not shorter than 8 symbols. If someone obtains an encoded file with passwords, the easiest passwords to be decoded are the shortest ones.

When choosing a password, provided that you choose a letter symbol on the right hand side of the keyboard, select a capital letter. In the future, if you enter your password while being watched by your colleague, you can press the Shift key imperceptibly with the little finger of your left hand.

Well-known names are not appropriate for passwords. Otherwise, the password can easily be guessed.

It is not recommended to change the password the day before the weekend or before going on a leave.

Never use the same password for all applications.

Besides the types of data presented in Table 1, other types are also needed for the successful management and development of the web site. They mainly concern the behaviour of the web site users and reflect their motivation to use the published applications. Some aspects of their use and collection are described below:

A good solution is to install and maintain a forum on issues corresponding to the purpose of the site. A forum appears to be the best place on the Net to identify the needs and problems of the target group of users. Likewise, groups of interests, social networks and others have been established and maintained.

To create conditions for confidential use of the resources on the web site but the behaviour of the users is to be closely studied, and namely: through which advertisement channel they entered the site; through which port they accessed the site; which applications of the so called "Welcome zone" they were interested in; how long it took them to familiarize with certain applications reported; how long it took them to register; which location on the Net they accessed the web site from and what their destination was after leaving it; what is their speed of learning under the specified syllabus (curriculum); to analyze the chosen user names and passwords.

To analyze the hardware and software resources of the end terminals: monitors – resolution, number of colours, operating system, type and version of the browser.

Use of public sources of information. For example, if motivated by the better adaptation of the site to users, the latter have filled in their job. This suggests more opportunities for acquiring information from the public sources for these users.

Web site developers are facilitated by specialized environments for analysis of published contents in Web and traffic on the web site, such as: Google analytics, Get clicky and etc.

CONCLUSIONS AND FUTURE WORK

1. At present, registration of users is a reliable and efficient method for their identification and adaptation of the web site to their work.

2. It is necessary that administrators of Web-based learning systems continuously monitor the parameters of the process of registration of their customers and continuously optimize it.

3. The statistics published about the system for "Provision of information on survival in times of crisis by Hand Held devices" shows that the process of registration needs to be optimized, namely: reducing the time for initial registration and increasing the motivation of consumers to systematically update their user's profile.

REFERENCES

[1] David S. Metcalf, M-Learning: Mobile E-Learning, HRD Press, Inc. ISBN, 0874259061

[2] Norbert Pachler, Ben Bachmair, Mobile Learning: Structures, Agency, Practices, Springer, ISBN 1441905847

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Virtual University 2.0

Galina Ivanova, Aneliya Ivanova, Angel Smrikarov

Abstract: *The paper gives an overview of what Virtual University 2.0 (VU 2.0) is and analyzes the impact of Web 2.0 to e-Learning. Some challenges before VU 2.0 are discussed. The basic differences between Virtual University 1.0 and Virtual University 2.0 are analyzed and some weaknesses of existing Virtual University model are pointed out. The paper also discusses the new student generations and the new methods of learning. Good practices of next generation Virtual universities are presented.*

Key words: *Virtual University, Web 2.0, E-learning 2.0, Virtual Learning Environments, Personal Learning Environment, Social Software.*

INTRODUCTION

Web 2.0 and e-learning 2.0 [7] concepts require an advance development approach and have placed significant pressures on higher education to become more productive. The Virtual University would also not remain untouched. Now we should think for implementation of Virtual University 2.0 concept rather than sticking with Virtual University 1.0 model. Today's knowledge is being delivered outside the Virtual University and access to that knowledge is becoming free. A new generation of virtual universities with innovative structure to compete are needed nowadays. But in which direction virtual universities need to change and how can this be done? What will be the role of Virtual University 2.0 (VU 2.0) in a Web 2.0 world?

CHALLENGES BEFORE VIRTUAL UNIVERSITY 2.0

Some of the top jobs that will be in demand in the future did not exist today. So VU 2.0 is challenged to prepare students for jobs that don't exist yet using technologies that haven't been invented yet. VU 2.0 is intended to provide students with complex understanding and problem solving skills in different technical subjects to allow them to be successful citizens in future digital society.

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The use of Web 2.0 technologies in VU 2.0 change the paradigm of learning: from a top-down VU 1.0 model focused to the teacher to a networked approach where teachers should change their roles to become facilitators of the learning process. The change in learning paradigms of Virtual University 2.0 is presented on Fig.1.

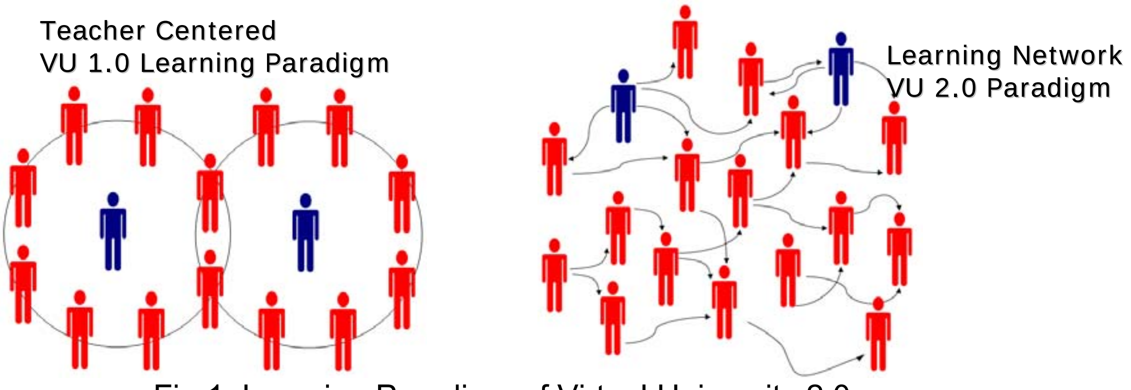

Fig.1. Learning Paradigm of Virtual University 2.0

Learning by doing, collaborative and active learning are essential approaches in Learning Network VU 2.0 Paradigm.

WHAT IS VIRTUAL UNIVERSITY 2.0?

Virtual University 2.0 is a new concept of knowledge management that will affect future virtual education. VU 2.0 is a term describing the impact of e-Learning 2.0 to higher education from a teaching and research perspective. VU 2.0 focuses to: increasing motivation by cooperation + competition, innovation, creativity and entrepreneurship.

WHAT'S WRONG WITH THE EXISTING VU MODEL?

Most Virtual Universities 1.0 were built and designed to function effectively in a single geographic location to a specific group of people. As the world moves toward a global economy and information can be accessed from anywhere in the world, universities need to think more critically about how they want to teach future students in the new digital age, and how they can use WEB 2.0 services in their training process.

VU 1.0 vs VU 2.0

VU 1.0 maintains systems designed to control student's access to learning resources by using software solutions like Managed Learning Environment (MLE).

VU 2.0 is allowing students to make their own decisions about information access, creating learning content and encouraging the use of WEB 2.0 services.

To get sense of VU 2.0 we will start with analytical comparison of VU 1.0 and VU 2.0. In Table 1 are given the basic differences between VU 1.0 and VU 2.0.

Table 1. VU 1.0 vs. VU 2.0

VU 1.0		VU 2.0
Hierarchiral / Centralized VU model	⟷	Distributed shared-services VU model
Closed network infrastructure	⟷	Open network infrastructure
"push knowledge method"	⟷	"pull knowledge method"
Old Digital Content order	⟷	New digital (dis)order
Copyright learning content	⟷	Open access and content remix
E-learning platforms	⟷	Social read-write platforms
Expensive e-learning platforms	⟷	Open source, 0 cost solutions
Students as consumers	⟷	Students as creators
Virtual web site portal	⟷	Personal aggregators
Teacher Centered Model	⟷	Learner Centered Model
Teacher generated learning content	⟷	Student generated learning content
Knowledge management	⟷	Community knowledge
Individual work	⟷	Co-operative team work
Expository learning	⟷	Discovery learning
Online chat classrooms	⟷	Three-dimensional virtual world
Linear slow progress	⟷	Exponential quick network progress

CHARACTERISTICS OF VU 2.0

- ✓ *VU 2.0 is driven by people* – VU 2.0 is about people creating content and sharing their ideas in order to create further information;
- ✓ *Users Add Value* – VU 2.0 allows users to contribute in increasing the value of existing learning content by providing new content;
- ✓ *VU 2.0 delivers a new way of access and interaction with knowledge* – Students are encouraged to learn continuously and build a leaning network. At the moment students are using many different mechanisms for collaborative learning: Wikipedia, Facebook, Notemesh, Flickr, etc;
- ✓ *VU 2.0 students shift from consumers to active users* – participating as curators and learning content creators;
- ✓ *VU 2.0 is a perpetual beta* – VU 2.0 releases new learning tools getting feedback from users;
- ✓ *VU 2.0 data is a competitive advantage* – Everybody can contributes as a VU 2.0 students and work in progress research;
- ✓ *VU 2.0 provide open access delivery system*: VU 2.0 encourages students to deliver content and share with all;
- ✓ *VU 2.0 services are beyond single devices* – VU 2.0 usage is device independent;
- ✓ *Collaborative culture* – VU 2.0 adopts creative commons where reuse is permitted and encouraged.

In VU 2.0 not only learning models are changed – content organization models are also challenged. VU 2.0 learning content is organized as: dynamic (real-time content, such as e-mails, instant messages, or conference calls); and moderated (social writing platforms or wikis that capture information where we did well and how we did it). Learners in VU 2.0 will assemble relevant material on their real-time needs, rather than a structured situation where someone else dictates what kind of learning they need. Teachers will not dictate structured learning. They will sort through all kinds of different learning resources and guide students in the right direction for their particular learning need. The training professional will give them the resources and let them chat, collaborate, share, and discover what they need to learn.

VU 2.0 is going to teach in a way similar to TV networks, where the control of customers (students) is not possible. There will be no more scheduling courses or agendas. VU 2.0 learning institutions should be customer-oriented, just-in-time and flexible. The VUs that understand this will be the ones that survive the longest.

FUTURE STUDENTS GENERATIONS

First of all we have to answer the question: Do we really have students who can use VU 2.0 technologies to enhance their learning?

"Our students have changed radically. Today's student are no longer the people our educational system was designed to teach" [9].

Today's students are not only digital natives – they are also digital learners [8]. They prefer to meet with their teachers and colleagues one day a week, and then to use virtual simulations and surf in WEB the rest of the week to complete coursework.

Today's teenagers are "Google Generation Students" – they are experts at using WEB, but they have problems when it comes to understanding the results displayed on screen. Although today's digital natives are familiar with advanced technology, they still don't know everything about using the information they find and they will need us to guide them through the masses of information available to them. This means that teachers still have a key role to play in VU 2.0 learning.

To find out what future student's generations will look like, a short analysis of the YouTube clip "A Vision of Students Today" will be presented [2]. The Clip is created by students in cultural anthropology and faculty staff at the Kansas State University. It starts with a student eye view of an empty lecture hall, before presenting the findings of a survey into the student experience through placards held up by individual students. The clip is created from an online text edited 367 times by 200 students, who are surveyed. The clip demonstrates how useful WEB 2.0 can be for universities in market research. At the same time, it is an example of how effective WEB 2.0 technologies are in projects involving collaboration. The survey shows that on average respondents expected to read eight books, 2,300 web pages, and 1,281 Facebook profiles that semester. Students would write 42 pages for class, but they would write another 500 pages of emails. Some interesting student's responses will be summarized:

- ✓ Students buy hundred dollars textbooks that they never open;
- ✓ Students bring their laptops to class, but they do not work on class stuff;
- ✓ When students graduate they will have probably a job that doesn't exist today;
- ✓ Students complete readings that are not relevant to their life;
- ✓ 18% of the teachers know students names;
- ✓ Future class size will be more than 100 students.

Digital learners are significantly busier than we were when we were students. Today's students: get 7 hours of sleep each night; spent 1,5 hours watching TV each night; spent 3,5 hours a day online; listen to music 2,5 hours a day; spent 2 hours on their cell phones; spent 3 hours in class; 2 hours eating; work 2 hours every day; 3 hours studying - > Total 26,5 per day.

Other surveys show that: 35% of all teens blog; 54% post photos online; 19% post videos; 39% share their own artistic creations online; 26% remix content; 27% maintain web pages; 28% have created their own blogs.

VU 2.0 learning depends on an interaction between teachers who are expert in the academic use of the technologies for learning and students who are definitely experts enough to use VU 2.0 learning tools.

WEB 2.0 LEARNING TOOLS IN VU 2.0

Some Virtual universities have started using WEB 2.0 services in their training process: lecturers are allowing students' access to podcasts and videos of their lectures; others are encouraging students to collaborate through wikis and using RSS feeds to organise their own work; many are now giving feedback on essays using Skype or social sites; others conduct seminars on Second Life Virtual Worlds.

WEB 2.0 learning tools offer lots of challenges. Sites like Facebook, Wikipedia and MySpace are going to get bigger: 200 million users on MySpace, 53 million on Facebook, 75 million blogs, 5 million articles in Wikipedia, 100 million videos seen on YouTube every day and 2 billion pictures on Flickr. So how will VU 2.0 use them in the future? One of the most important advantages of this is that most of WEB 2.0 services can be setup or use for free.

Social Writing Platforms: As with most WEB 2.0 tools the key concepts here are collaboration, sharing and forming communities. Social Software, for example, can be used by VU 2.0 for allowing students to join groups, offering them a unique way of communication and getting extremely valuable feedback. VU 2.0 learning content can be partially generated by users. Students can have facebook groups dedicated to specific classes – with discussions on some topics, what additional resources and literature can be used and etc. Social Writing Platforms are useful tools for a variety of university needs. These services offer an alternative platform for peer editing and supporting asynchronous writing for distributed members.

Wikis are very popular today. In VU 2.0 context they can give students an easy way of creating WEB content, without having any skills in WEB programming. Students can use wikis for knowledge management and as a knowledge repository. There is criticism about the use of Wikipedia for academic purposes, because of the misunderstanding of the power of community. In Wikipedia anyone can add or change content and therefore the critics think it is not guaranteed to be a perfect source of objective information. VU 2.0 students do not need to cite Wikipedia, they can use it for example to get a quick overview of a topic related to the one they are studying or to quickly determine the scope of a topic and what other sources are important. Often academic texts only talk about a simple aspect of a topic. Wikipedia entries are usually developed by a community of people with different interests, so a broader treatment and a list of external links will help to gain a broader perspective on a topic.

Social bookmarking can be used as a location to store links and support pages for VU 2.0 lessons: building a source of materials for students, adding commentary, making a shared space for students to edit or add their own recommendations. The ability to create multi-authored bookmark pages can be useful for team work in VU 2.0.

RSS feeds are very popular now. Students sign up to something interesting that further is automatically feed into a personal page so they don't have to keep checking multiple sites. It's an easy way for students to be kept informed, without being bombarded.

Second Life is a three-dimensional virtual world. There are more than 10 million users of Second Life. Hundreds of leading universities and school systems around the world use Second Life as a vibrant part of their educational programs. Gartner Group [6] is predicting 80% of active internet users will have a 'second life' by 2011. Second Life is used by many universities as a promotional tool and to teach real classes to students. Today's students do not prefer to use an online environment like a chat room to meet. Second Life engages distance learners in a way that email, instant messaging and chatrooms do not quite manage. Students can use movements as well as labels to get other's attention, and a user can take all the class with him (her) to another area of the cyberworld. The user can very clearly see who is contributing to the discussions and paying attention, and who is not. It can bring distance learners together in what feels like a closer physical relationship than other online technologies. Second Life can give them a possibility to attend classes in a world where the students can fly, change body types, appearance, age, gender and color. For example at university lectures you can be a slim blonde in your 20s by the name of GalaZorca. At home, you are a little less slim, a little less blonde, aged 30 and called Galina Ivanova. In SecondLife we start to talk about cyberculture or the way the internet is transforming our culture without actively participating in it (Fig.2).

Fig.2. SecondLife

*PodCast - W*eb lectures and podcasts have become an integral part of universities' e-learning portfolios. They can be created by simply recording a lecture and publishing it into special client software applications known as podcatchers, for example iTunes. More and more students ask the lessons to be available online. Lecturers can develop new didactic concepts and produce podcasts including not only the lectures, but also additional materials. Students can produce audio-visual content as user-generated e-learning objects. YouTube can be used also as a platform for VU 2.0 video lessons.

PLE - Concepts like "PLE" are going to evolve in VU 2.0 [1]. Students will be able to effectively manage their own online identities, resources and their relationships with more than one VU. They will be able to select what kind of relationship they want to have with each VU. Perhaps they can take their first year mathematics courses from VU X, chemistry from VU Y, physics from VU Z, and etc. VU 2.0 is going to become a place for students to come together, to collaborate and work on common research. Teaching and learning activities will be supported by VU, but they will be managed by the students in PLE.

EXAMPLES FOR GOOD PRACTICE

The Universities provide some experiences in use of new WEB 2.0 learning technologies [12]. We will cite only a few: Digital Ethnography at Kansas State University [3], Future University, Podcasting University, Ohio University Second Life Campus, MIT Open Course Ware, Stanford on iTunes U, University of Warwick, Universitat Oberta de Catalunya, BipApp at University of Wisconsin-Madison [10] and etc.

The Virtual University of Edinburgh (VUE) [11] is a virtual educational and research institute bringing together all those interested in the use of virtual worlds for teaching, research and outreach related to the University of Edinburgh. VUE has been involved with Second Life since 2004 when the first class of students participated in "Campus Second Life" program. Since this time, VUE students have led a variety of learning experiences in Second Life, including: conducting "open houses" for The Second Life Planetarium, a virtual facility created by Professor Crider for demonstrating the motions of the stars. Approximately 30 students wrote astronomy shows for the planetarium in Fall of 2006.

University of Houston design economics course of real live modeling of business practices in a virtual world where designers can try their design and entrepreneurial skills against an entire market rather than the code of simulation software. SecondLife provides a real time simulation with real time economy and fickle customers.

Digital Worlds Institute of University of Florida [4] exists to nurture leading edge research and education between the arts, engineering and the sciences, utilizing advanced media systems and digital culture. Through the use of interactive tools and technologies, the Institute promotes transdisciplinary creativity across classrooms, continents and cultures.

Xavier University Web 2.0 strategy [5] is a project that brings into focus the WEB services as a way of meeting future student needs. Xavier moved the WEB site from a very static and non-student focused one, to a more personalised and active place, where the students published pictures and videos showing what they thought good about Xavier and the incoming students graded these to sort out the best which were then used on the WEB site. Students were also encouraged to build their own Facebook-like pages to allow them to connect with other students having similar interests. This approach helps to build points of engagement and connects prospective and current students.

CONCLUSIONS AND FUTURE WORK

The adoption of VU 2.0 is a complex process. There are some problems that have to be discussed in the future: How to manage intellectual property in VU 2.0? What about the ownership? How to compete being open? How to manage human resources?

Ownership: The University owns its research and teaching content. In VU 2.0 the idea is to share with all, so who owns the copyright to the learning content? Copyright and intellectual property issues involved in WEB 2.0 are not yet entirely clear.

Trust: VU 2.0 will change the way people consume information. All forms of information are now available on Internet, this information is getting organised by different people: students, institutions, experts and etc. How to trust any publications online? What about the quality of research and research results?

Issue of control: VU 2.0 is challenging copyright because of the open source paradigm that allows open access and creation of remix contents. Some questions about "unsanctioned usage", need of policies and usage guidelines have to be discussed.

VU 2.0 institutions should be active and continually growing and updated, rather than a static VU WEB page. VU have to change their content creation and content distribution model to remain relevant in a WEB 2.0 World.

REFERENCES

[1] Иванова, А., Г. Иванова, А. Смрикаров. Бъдещето на електронното обучение – eLearning 2.0 и персонална среда за обучение?, Трета национална конференция по електронно обучение във висшето образование, Свищов, 2009.

[2] "A Vision of Students Today" http://www.youtube.com/watch?v=dGCJ46vyR9o

[3] Digital Ethnography at Kansas State University
http://www.netvibes.com/wesch#Digital_Ethnography

[4] Digital Worlds Institute of University of Florida - http://www.digitalworlds.ufl.edu

[5] Dood D. W., D. Ruschman. Xavier University's Web 2.0 Strategy: The Virtual Learning Commons, EDUCAUSE Annual Conferences, 2007.

[6] Gartner Group - http://www.gartner.com

[7] Ivanova, A., G. Ivanova, A. Smrikarov. eLearning 2.0 and Higher Education – Possible Implications, Proc. of E-learning Conference, Istanbul, Turkey, 2007.

[8] Ivanova, A., G. Ivanova. Net-Generation Learning Style – a Challenge for Higher Education, Proceedings of CompSysTech'09, Ruse, 2009.

[9] Prensky, M. Digital Natives, Digital Immigrants. On the Horizon. NCB University Press, Vol. 9 No. 5, October 2001.

[10] Unsworth John. University 2.0, 7th Frankfurt Scientific Symposium, Universitat Frankfurt am Main, 2007.

[11] Virtual University of Edinburgh (VUE)
Available online at: http://slurl.com/secondlife/Vue/205/53/30

[12] Baytak A. Web 2.0; Open Opportunities for Turkish Universities. Akademik Bilisim' 2009.

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SECTION 2

e-Learning'10

Moodle and Traditional Teaching

Janusz Jabłonowski

Abstract: *We are observing now emerging of a new way of teaching – e-learning. It is quite natural that the new approach is based on the experiences gained from traditional teaching. But it is also worth mentioning that the new approach should not be treated as a rejection of the traditional way of teaching. Not only both of them may (and should) coexist but also traditional teaching may gain a lot adopting tools and solutions from e-learning. In this paper it is showed how Moodle - a tool designed entirely for e-learning - can prove itself to be extremely useful in traditional teaching.*

Key words: *e-learning, traditional teaching, Moodle, programming teaching, object-oriented programming.*

INTRODUCTION

Thanks to enormous progress in available technology new methods of teaching became available in recent years. Without a doubt the most important new teaching approach is e-learning (or in a broader sense distance learning). E-learning gives millions of people a chance to find better teaching possibilities (or even just *the* teaching possibility) than using conventional approach (for example because of a lack of proper teaching infrastructure on their place of living). It also gives much broader opportunities of adjusting the teaching process for ones limitations (such as time constraints for example).

But it is also important to observe that e-learning cannot solve all problems of education and that it should not be considered as a replacement for the traditional way of teaching, There are just cases where e-learning suits better to the educational demands and in other cases the traditional way of teaching will give better results. This observations lead also to the idea of blended learning – composing the teaching process from the traditional and the new approach.

But this is not the only way in which the newer and the older approach may collaborate. While it is self understood that the newer one borrows a lot from experiences of the older one it is also interesting to note that an influence in the opposite direction is not only possible but it does appear nowadays in many cases. In this paper we show on an example taken from teaching at the University of Warsaw that not only stationary learning and e-learning may be used together, but also that the traditional approach itself may be enriched by the use of tools developed solely for e-learning.

We concentrate here on an example based on object-oriented programming teaching. There are quite a few reasons for selecting this example. One is the popularity of the object-oriented approach. It is nowadays so dominating in software industry, that almost all (or maybe all) higher schools with software engineering curricula have lectures devoted to object-oriented programming or design. Hence such example may be interesting for many universities. Other important reason for such a choice is the fact that the teaching of object-oriented programming is quite difficult (more on that topic we have written in [2]) so the exchange of experiences of a broad range of computer science departments is vital. Next reason for selecting this example is connected to the wide range of possible interactions between the lecturer and students – in particular the diversity of possible kinds of assignments given to students. We show here that all these tasks may be easily handled by Moodle [3] – the tool selected here.

FEW WORDS ABOUT MOODLE

Moodle (Modular Object-Oriented Dynamic Learning Environment) [3, 1] is a free and open-source Course Management System. It has about 35 thousands of registered and validated sites in almost 200 countries around the globe with more than 2 millions courses and almost 25 millions of users [4]. It is a web application written in PHP using MySQL or PostgreSQL database.

There is quite a number of available environments for e-learning. They offer various tools supporting the teacher. These tools may be divided in the following groups:

- tools for managing the course,
- tools for providing students with required information,
- tools for enabling the communication and cooperation between the teacher and students.

Moodle mainly belongs to the third group, although it has some features of the other two groups.

MOODLE IN STATIONARY TEACHING

Although Moodle is a tool developed specifically for distance learning it can also be used in traditional teaching. But this paper is not about a possibility but about the usefulness of using Moodle in stationary courses. We will examine how Moodle features can be used in an example course in Computer Science.

As can be seen on fig. 1 Moodle is quite broadly used as a supporting tool for stationary courses at Institute of Informatics of UW (all the listed courses are stationary ones, all but one course categories are for stationary courses). It is our aim to have Moodle counterparts at least for all regular courses at out Institute. This shows that we are treating Moodle support for our teaching very seriously.

Fig. 1 Moodle main site at Institute of Informatics University of Warsaw

The sample course described in this paper is presented on fig. 2. It is a regular course in Object-Oriented Programming given for the students of the first year of Computer Science.

Let us now examine various facilities provided by Moodle and used in our sample course. One important remark: this are by far not all features of Moodle, our aim here is not to describe the entire platform, but only those of its aspects which we have found to be valuable in traditional teaching.

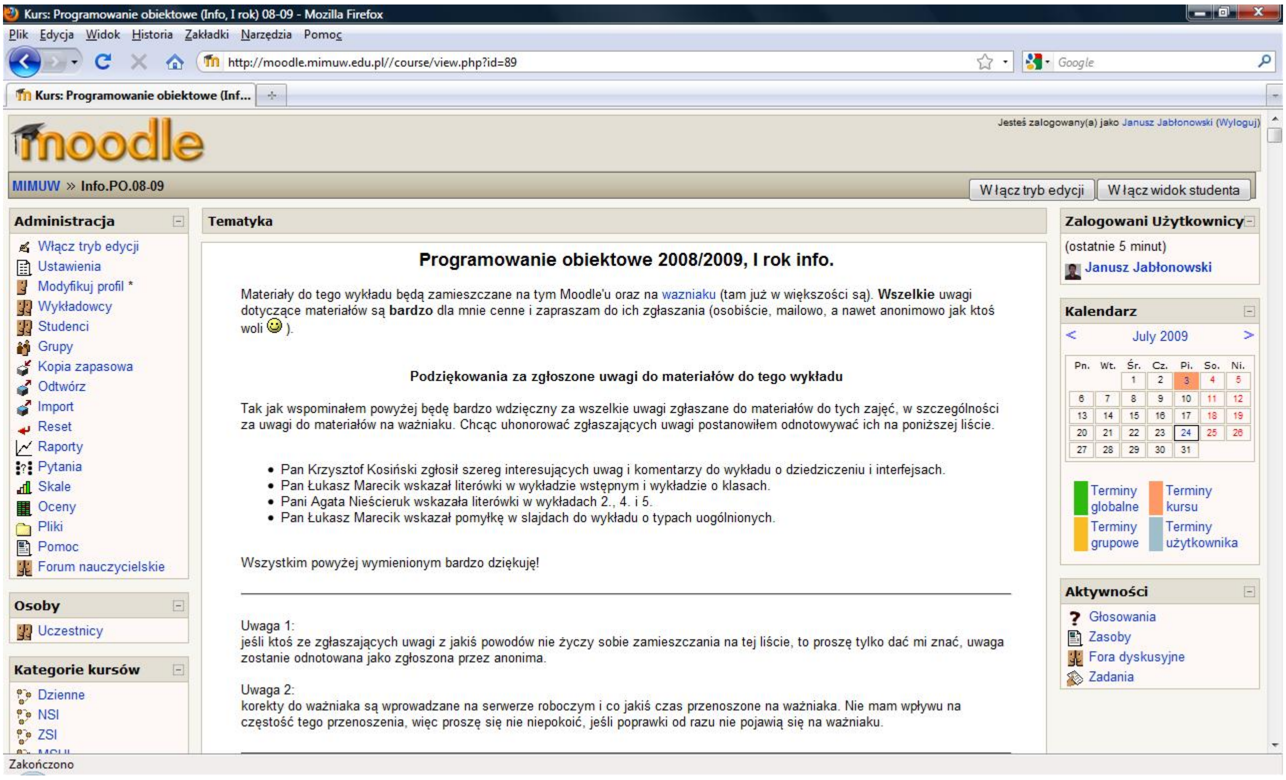

Fig. 2 Object-Oriented Programming course in Moodle

Modules

This is a fundamental feature of Moodle – the course contents is organized in modules. It is also an extremely useful one for our purposes. In fact we are using modules in two different roles. The first role is just to reflect in Moodle's course organization the fact, that the real course is divided into 15 weeks. We just want to make easy for students to find resources related to a specific lecture (the recent one or the last one before a break like winter holidays). Each module is labeled with subject of the lecture given in corresponding week and the lecture date. All resources connected to that lecture are grouped in one module. This is illustrated in fig. 3.

It is worth to emphasize that just the sole organization of all activities during a course into clearly defined modules is beneficial not only for students, but also for all the teaching staff. It definitely makes easier planning, organizing and controlling the course. And simplifies the communication between members of the teaching team – for example a question like “what shall we do next week” usually stated personally or by e-mail can now be resolved just by looking into Moodle.

Yet another gain from this course organization is connected to laboratories. Teaching assistants do not have to take with them any additional materials (like texts of assignments for current week) because they have them all ready in our teaching platform.

It was our first use of modules, concerned with students' perspective. But we use modules also for another purpose. One of Moodle's features is the ability to control which resources (this includes entire modules) are visible for students. Hence we have created a secondary structure of modules, invisible for students, where we put all materials reserved only for teaching staff. Here we put for example model solutions of assignments.

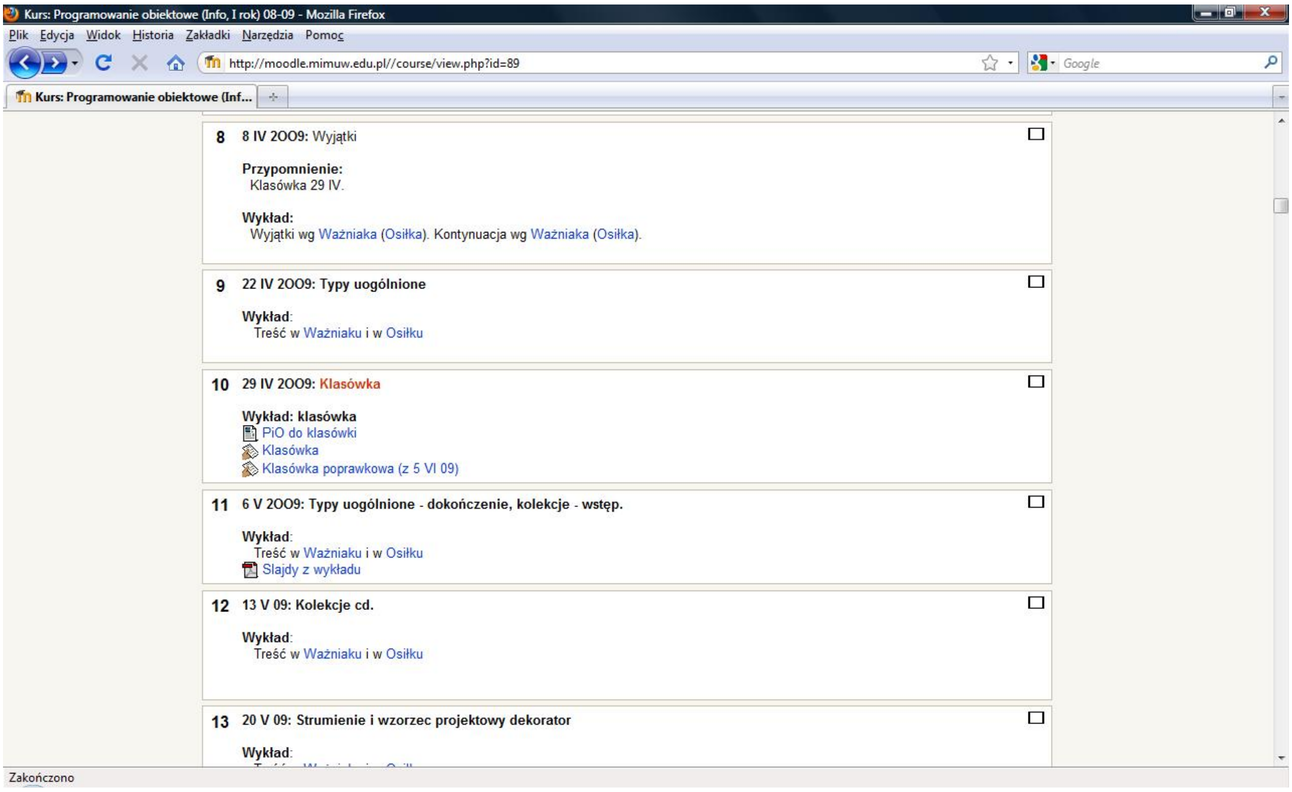

Fig. 3 Modular course structure in Moodle

Assignments

Teaching of programming requires a lot of assignments. Teaching of object-oriented programming requires assignments of various types (not only programs but also designs). Having all assignments in one place (i.e. not only the texts of assignments but also all solutions sent by students) is already valuable. But even more valuable is that we can give students the possibility to send their solutions on any suitable for them time (before deadline of course) and to resend improved versions - and all this communication is done without any emails with attachments sent to the teaching staff. And this can be easily done with Moodle's assignments. Assignments in Moodle are illustrated on fig. 4.

One objection against electronic systems for assignment management, objection which can be often heard, is the statement that such systems are suitable for only very few kinds of assignments. While it is certainly true that some kinds of them are really difficult to be adopted to electronic representation it is worth observing that in many cases there are quite natural solutions available. As an example let us take a look at designs of programs. Projects are extremely important in teaching of object-oriented programming. Usually they require not only ASCII text but lots of drawings representing various diagrams. So it may seem that it is difficult to send a design as a file. But it is quite the opposite. There are many tools available for creating UML diagrams (like Visual Paradigm [5] which we are using). Hence the use of Moodle as a mean for transferring assignment results not only does not restrict assignment form but also encourages the use of proper tools and methodologies.

Of course there may be situations where sending solutions as files will not be applicable or when there are specialized tools for assessing the solutions (like it is in the case of programs, where there are systems for automatic compilation and testing of sent programs). Moodle certainly is not a solution for all problems, but in our case the ability to have better control over the assignments was more important than the lack of automatic testing of sent programs.

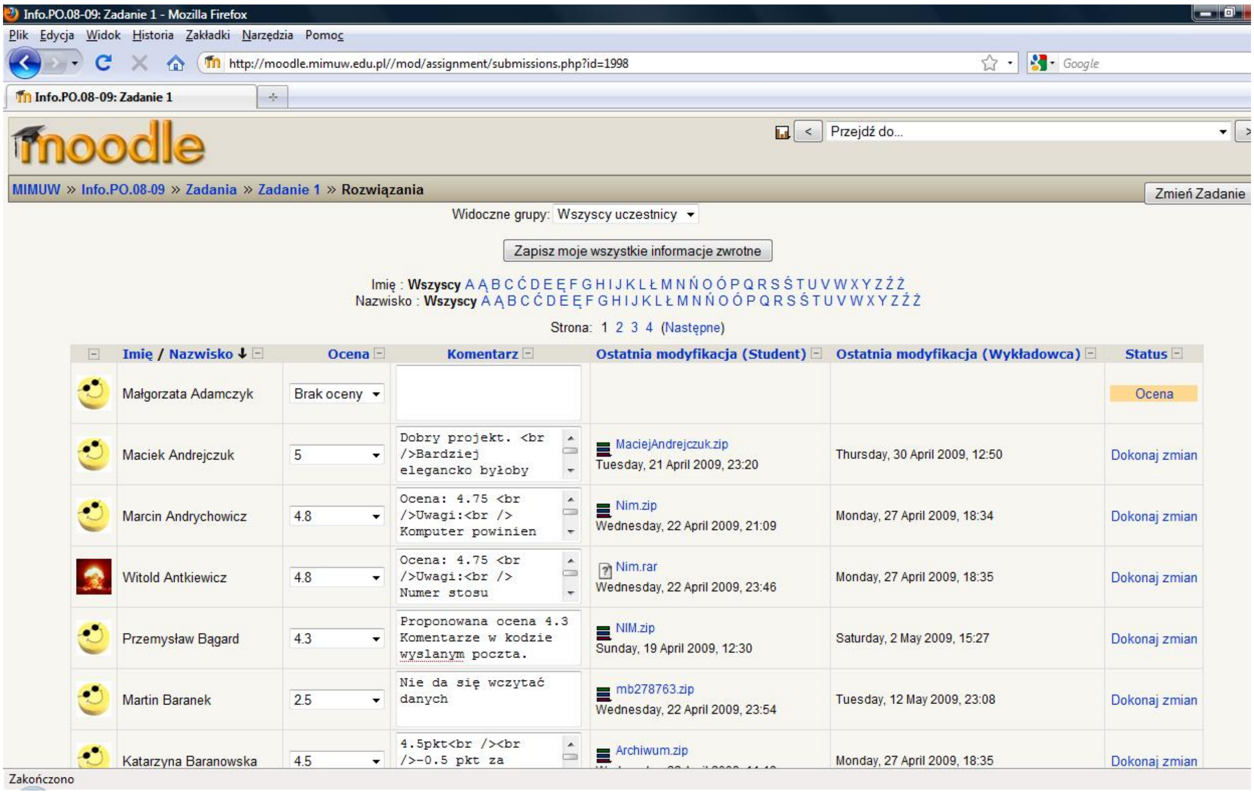

Fig. 4 Assignments can be easily controlled in Moodle

Forums

At first sight it may seem that forums in a stationary course are not needed since students meets with us every week during lectures, classes, labs and additionally we have contact hours. But in some circumstances forums proved to be extremely handy. In our course we have used forums as a tool for quicker answering students questions concerning labs assignments. And thanks to the public nature of forums all students benefited from the answers we have given for every single question.

Choices

The ability to collect opinions from all students attending our course was useful in some cases. Mainly because stating organizational questions (like those concerning the date of next written test) is quite time consuming and disturbing during a lecture.

Resources

The content of a course may be given in Moodle in many forms (as text pages, web pages, even with labels for small notes). We are using all of them. Main part of materials used during this lecture is stored on a website [6] where we have collected content of most of our courses. Additional materials are mostly given as pdf files or web pages stored inside Moodle.

Just to summarize the benefits of using Moodle for our teaching:

- High accessibility of course materials. All of them are stored in Moodle or in our web service called wazniak [6]. Thanks to that students may easily recover all previous lectures. Even if they could not attend them (because of flu for example).
- Ease of organizing labs and classes. All teaching assistants know where to put or find examples for next classes or labs, it greatly reduces the number of mails send each week during preparations.

- Ease of collecting home assignments. Students may put them even at night into Moodle (but of course not after a previously set deadline). Teaching assistants do not have to search their e-mails (or pen-drives) to find last version of solution given by each student.
- Ease of solving various organizational problems. There are many circumstances when students want to ask a question after a lecture or contact hour. Thanks to Moodle's forums they may do that, and since their questions and lecturer's answers are publicly available also other students may benefit from it - without asking questions personally or by e-mail.

CONCLUSIONS AND FUTURE WORK

In a world of fast changes also teaching has to undergo some modifications. The main problem with changing teaching practices is that results of amendments in this area are difficult to compare, because they usually can be seen and assess after few (or more) years and they may influence in various ways people who were taught with new tools or methods. Therefore all these changes has to be made very carefully and with highest responsibility. On the other hand it is necessary to look for new, more effective and better suited for today's demands ways of teaching. Therefore it seems to be extremely important to disseminate experiences with various successful approaches to improving teaching quality.

Adopting new tools is certainly important and promising way in that direction. We only have to assure that the new tools are used not just because they are new but because they are really useful. In this paper we tried to show that using e-learning tools for regular, traditional face-to-face courses is beneficial. We used as an example the Moodle e-learning platform which has many virtues (like being free, open-source and broadly used) but of course similar advantages may be gained with other platforms.

There are many features of Moodle we have not described here. We are also sure that Moodle (and also other CMSs) will develop. We will certainly look for other uses of this valuable tools in our teaching.

REFERENCES.

[1] J. Cole, H. Foster; Teaching with the Popular Open Source Course Management System; O'Reilly Media; 2nd ed. 2007.

[2] J. Jabłonowski, Some remarks about OO teaching, CompSysTech 2009, Russe.

[3] Moodle, http://moodle.org/.

[4] http://moodle.org/stats/

[5] http://www.visual-paradigm.com/product/vpuml/

[6] Ważniak, http://wazniak.mimuw.edu.pl/.

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Web-based Information System for e-Learning

Elisaveta Trichkova, Krasimir Trichkov

Abstract: *E-Learning, referring to learning via the Internet provides people with a flexible and personalized way to learn. This article begins with a general introduction into the field of e-learning and e-learning environments. The main part of this article examines, analyses and evaluates Dokeos open source system for e-learning. What follows is a brief description how and where is integrated this system. The final part of the article gives an overview of few alternative systems for e-learning similar to Dokeos system and gives some suggestions for the future.*
Key words: *E-Learning, Information system and technologies, LMS, LCMS, CMS, VLE.*

INTRODUCTION

The popularity of distance learning is explained by the fact that there are a number of indisputable advantages compared with traditional. Distance learning (LMS - Learning management system) is a promising type of training relevant to the dynamics of social and personal needs, one of the most modern educational tools that influence complex on the active personality and enhances cognitive activity of students. It is built on principles such as interactivity, self and through self-testing systems, flexibility and pre-negotiated, economic efficiency, openness and dialogue in the planning of training, freedom of choice of time and place, pace and technology training, operational interaction with teachers, consultants, associates and partnership in all respects, the opportunity for lifelong learning.

SELECTION OF LCMS

During the selection of LCMS were considered all the results of the investigation phase: established characteristics and needs of students and teachers. We were looking for a LMS (Learning Management System) or LCMS (Learning Content Management System) that support synchronous and asynchronous technologies.

Minimal feature set of an LCMS should include [1]:

- Authoring tool –enables teachers to create content and assessments.
- Assessment services – enables students to do assessments and view scores.
- Learner tracking tool – enables teacher to monitor the progress of their students.
- Learner record tool – enables recording data about learners and enables students to introduce themselves in virtual school community.
- Course catalogue and registration tool.
- Asynchronous communication functions - email, discussion forum and announcements.
- Synchronous communication functions - chatting or video conferencing system.
- E-learning environment administration management tool – provides administration of all users, courses and classes.
- Courses administration tool – create, modify, back-up and restore courses and to monitor usage of course.
- Tool for administration - create users and classes, this tool should support at least 3 roles: learners, teachers and administration.
- Supporting e-learning standard SCORM. The e-content should be independent of e-learning environment. If an organization decides to change the platform all old contents must be available without special

changes or upgrading. The Shareable Content Object Reference Model (SCORM) is an XML-based framework used to define and access information about learning objects so they can be easily shared among different learning management systems (LMSs). SCORM is a specification of the Advanced Distributed Learning. It was designed to facilitate moving course content and related information (such as student records) from one platform to another, to make course content into modular objects that can be reused in other courses, and to enable any LMS to search others for usable course content.

After functional analysis of the few LMS, CMS and LCMS, the decision was made to use the open source freeware LMS Dokeos. The main reasons were: Dokeos is free of charge, appropriateness regarding operating system – Dokeos runs on different operating systems (including Linux), set of features – Dokeos is capable to meet all functional requirements, content delivery according to e-learning standards such as SCORM and IMS, feasibility to develop and deploy one's own e-educational components, Dokeos is continuously evolving.

DOKEOS SYSTEM FOR E-LEARNING

Dokeos is a web-based open source e-learning system. The code of the system is accessible to all and can be modified or adapted for specific requirements by anyone. This system also offers a wide range of e-learning tools and provides abundant scope for creating and organizing interactive multimedia-rich training content and assessment (tests) in an engaging manner. [2]

Dokeos offers an efficient user friendly e-learning environment with online content and assessment creation tools, collaboration tools, as well as sophisticated tracking and reporting tools for monitoring user activity and progress. [2]

Training in this platform is organized around a basic unit called training. In each course the teacher is able to organize students in groups. The platform provides conditions for self-sufficiency of each group through the virtual space accessible only to members of the group. [3]

Each group has a place for sharing different files or links to websites, with a forum that allows active asynchronous communication, with the wiki, which allows group editing of a text, with the chat for synchronous communication. The interface is simple and accessible, and work with these tools is intuitive and requires no special computer skills.

Teacher is able to put a special task to group to organize synchronous and asynchronous communication through the forum and chat. Students have the opportunity to leave the documents and work with documents left by other students, to give opinions on the documents and to obtain the opinion of their colleagues.

Through the system for testing the knowledge, the teacher is able to monitor the daily preparation of students.

Additional modules, which include the system, are: the curriculum, the ability to publish announcements from the teacher, questionnaires for students, sends private messages between students, RSS reader.

Figure 1 is presented the main page of the system, which is used for training students in five disciplines at the Department of Management at University of Economics - Varna. [4]

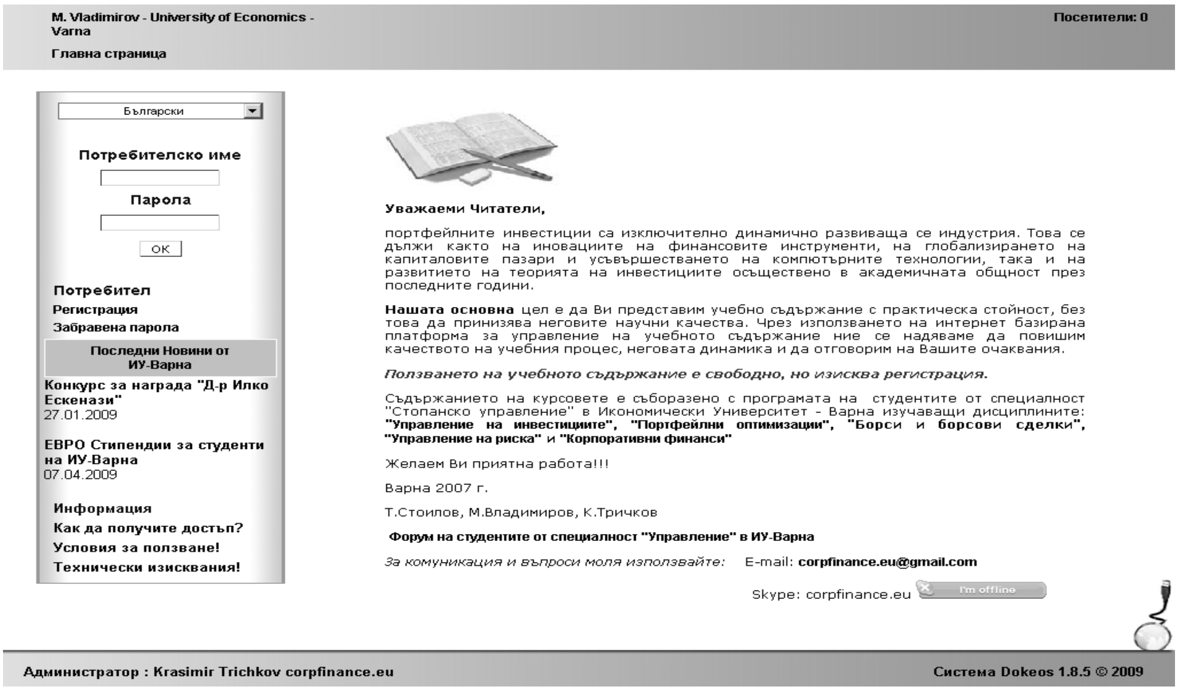

Fig.1 Main page of the system

The system is available in 34 languages. It allows the publication of materials with different formats and the integration of an additional virus scanner module, based on ClamAV.

Figure 2 is presented the administrative module of the system. It enables management of both, the system of training and introduced courses and users. [4]

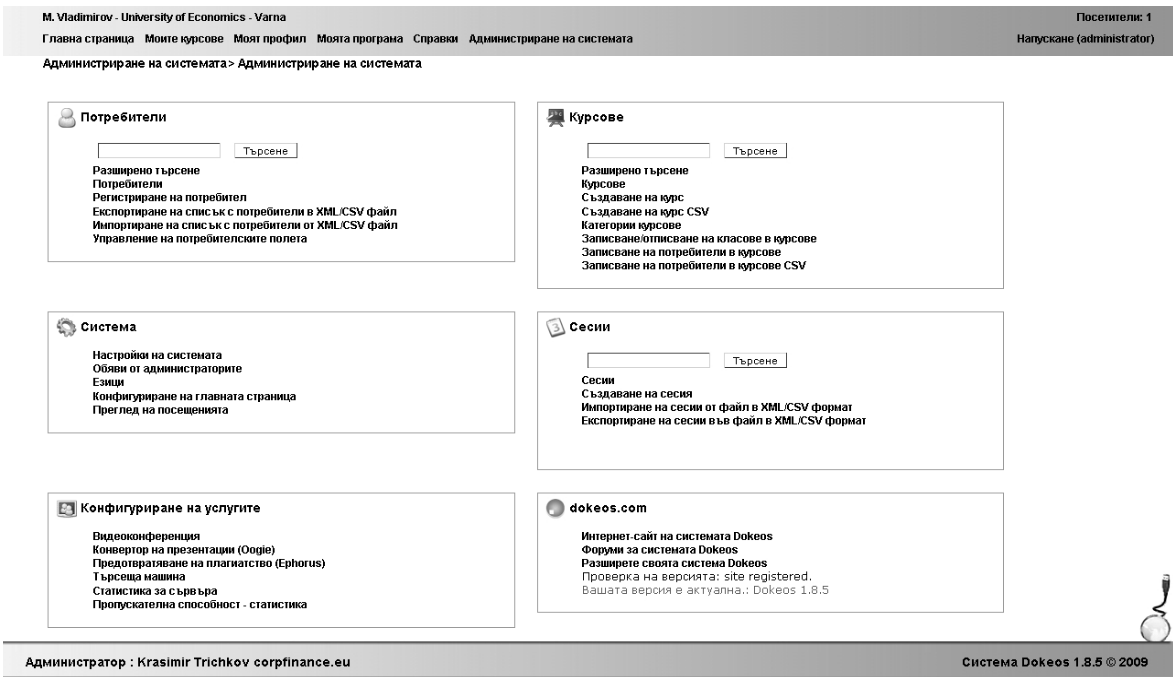

Fig.2 Administrative module

Additionally there is the possibility of a video conference. Figure 3 presents a video connection from one to many, and in Figure 4, the type many to many. This allows visual contact between teacher and students and among all participants simultaneously. [4]

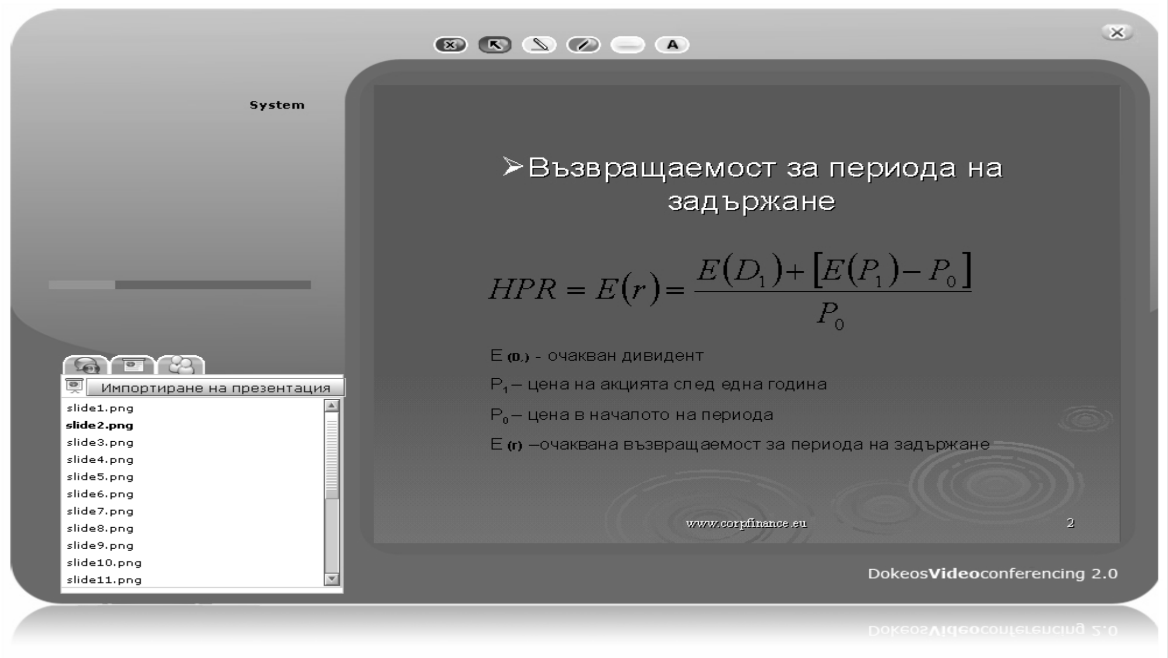

Fig.3 Video connections from one to many

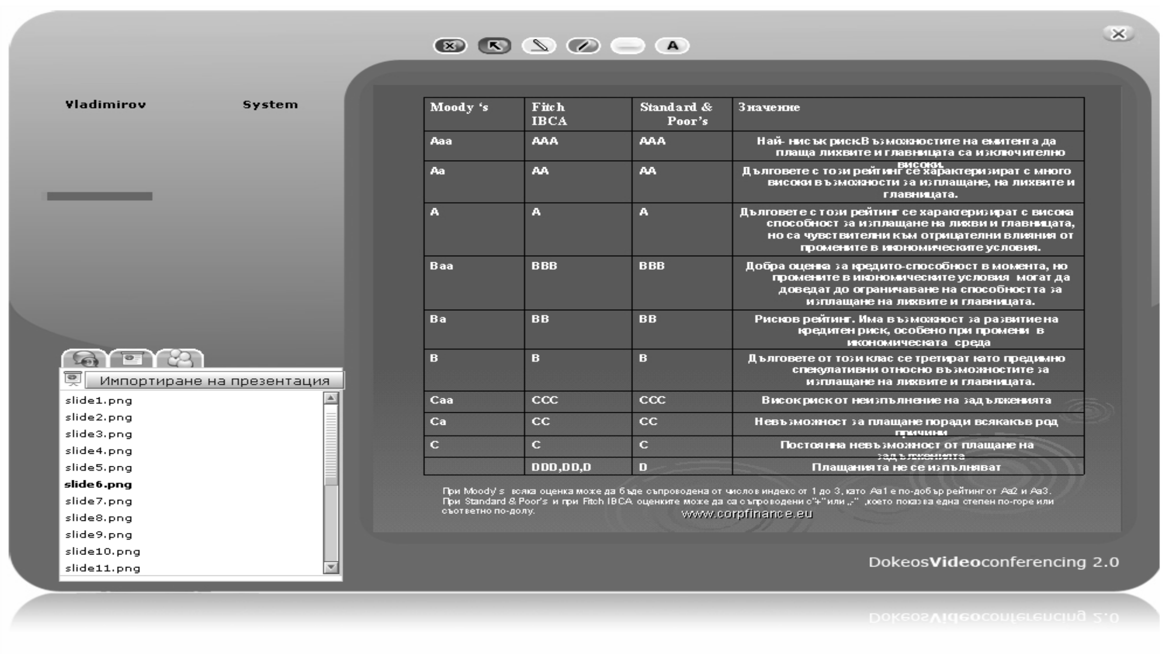

Fig.4 Video connections from many to many

The system supports additional converter presentations, prevention of piracy, search engine, statistics for server, and statistics for bandwidth capacity.

Functional module for authorization allows the teacher to permit and prohibit access to the system.

Advantage of Dokeos system is light and clean interface for operation and administration.

Basic system requirements needed for optimal use of the system include:

- Apache web server - no requirements to versions.
- PHP - the lowest version with which the system can function, but with certain restrictions is 4.3.0. To use the full package of options is necessary version 5.2.0.

- MySQL - no requirements to version.
- For the video connection and conversion of presentations are required Open Office, Java RTE 1.5, RED5 Open source flash server.

The system is implemented and used by students of the University of Economics - Varna and is available at http://corpfinance.eu. In addition is integrated alternative forum to the students of Department of Management and application reporting statistics.

ALTERNATIVE SYSTEMS FOR E-LEARNING

This section of the paper gives an overview of two alternative systems for e-learning similar to Dokeos.

CLAROLINE: Training in this platform offers similar opportunities for the organization of group work like in the education system Dokeos. Education in this platform is also organized around a basic unit called training.

System imported SCORM compliant learning objects created by other means. Used teaching materials in .pdf, .txt, .doc, different image formats, html and multimedia materials created with Flash and Power point, interactive simulations. [5]

The system offers services such as chat, discussion forums, wiki, tools for group or individual work project, announcements.

Through the module for testing the students' knowledge, the teacher creates self-tests, like such may include images. The system automatically evaluates the tests. There is an option for ordering the questions in a random manner.

The system maintains a calendar to assist students and training schedule.

Basic system requirements to enable effective work with the platform are:

- Apache web server version 1.3 or 2.0, and Microsoft IIS.
- PHP - version higher than 4.1.
- MySQL - version higher than 3.23.6.

The system is available in 36 languages. Compared with Dokeos, this system was developed at a lower level, with fewer opportunities for students and not enough clean interface to work and administration.

MOODLE: In addition to the forum and all the other spaces for group work that provide Dokeos and Claroline, Moodle has a wide range of activities such as various types of interactive tests, job, working studio, dictionary, wiki, activities about which the teacher can organize the group work with opportunities for various interactions between group members and making a product with the active participation of all trainees, at all stages of its development. This platform allows the teacher to put "online", not only static content and many resources. It allows such an organization in which the trainees themselves can participate in creating these materials. [6]

In Moodle each of the participants in the learning process is able to monitor the activities carried out by other participants in a group or individually. Moreover, the trainee can observe the reactions of their colleagues to understand the way they have achieved a result and thus to draw conclusions about the process of learning.

Also, Moodle allows the delegation of certain rights for students, or some of them, that generally belong to the teachers. Thus, students may be more active as moderators of certain forums or creators of questions to be included in the interactive tests. Putting in place to its teachers, student better start to give account of the learning process, thus helping their own learning, support the work of the teacher directly or indirectly support the training of their colleagues.

Basic system requirements to enable effective work with the platform are:

- Apache web server - no requirements to version, Microsoft IIS.

- PHP - for Moodle version 1.4 is required minimum php 4.1.0 or php 5.1.0. For version 1.6 of the system - php 4.3.0 or php 5.1.0. For version 2.0 there is not support in php4. A minimum requirement is php 5.2.0.
- MySQL - no requirements to version.

The system is available in 78 languages and their variations. As functionality in terms of services and amenities, it outperforms the previous two. In some degree, as disadvantage may be adopted a heavy structure.

CONCLUSIONS AND FUTURE WORK

In the academic and business world the term e-learning is used as a new term for distance learning through internet or web based training.

This paper examines, analyses, evaluates and presents the main features of the integrated information system for e-learning Dokeos. Description of how and where is integrated this system was produced. Considered are the possibilities of alternative systems Claroline and Moodle. Defined are their functional features and software dependencies. Defined are the advantages and disadvantages to them. The system is available in http://corpfinance.eu. As a future work our plans include optimisation, developing and management of this system.

E-Learning will become more and more important and pervasive in our lives.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Kastelic M., T. Lončarič. A Model of Introducing E-learning System at Vocational College for Business Secretaries, Issues in Informing Science and Information Technology, Volume 4, 2007.

[2] http://www.dokeos.com

[3] Тричков К., М. Владимиров. Анализ и оценка на системата DOKEOS за електронно обучение, XI-TA Международна научна конференция „Управление и устойчиво развитие" 20-22 март 2009, Юндола, България.

[4] http://corpfinance.eu

[5] http://www.claroline.net

[6] http://moodle.org

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Applying Blended Learning in ERP Training

Iuliana Scorta, Anca Andreescu, Adina Uta

Abstract: *Enterprise Resource Planning (ERP) systems are enterprise wide systems that, because of their integration, automate all of a company's business processes. They have rapidly become the de facto industry standard for replacement of legacy systems. There is evidence that the overwhelming majority of ERP implementations exceed their training budget and their time allocations. Organizations today are looking beyond automation of traditional training models to new approaches of knowledge transfer and performance support that are better aligned with business goals and deliver measurable results. In consequence, in this paper we have analyzed the training methods used in ERP implementation in order to provide a solution that could help us maximize the efficiency of an ERP training program. We proposed a framework for an ERPTraining system that can be integrated with an ERP system and which provides an ERP training management that is more personalized, effective and less expensive.*

Key words: *ERP systems, training methods, blended learning.*

INTRODUCTION

ERP (Enterprise Resource Planning) systems are comprehensive packaged software solutions that aim for total integration of all business processes and functions. The vendors of fully integrated software offer software that is capable of processing all commercial functions of any company, no matter how large, diverse or geographically disparate the company's components may be. Moreover, the software is not limited to specific industry sectors: it can be configured for retail industries, mining companies, banks, airlines etc. The major ERP vendors are increasingly targeting small and medium sized enterprises (SMEs) to generate new sales. Vendors and users are also moving beyond core applications to extend ERP systems to support Web-based applications, e-commerce, customer-relationship management, and business planning. The growing demand for ERP applications has several reasons, for example, competitive pressures to become a low cost producer, expectations of revenue growth, ability to compete globally, and the desire to re-engineer the business to respond to market challenges. Benefits of a properly selected and implemented ERP system can lead to considerable reductions in inventory cost, raw material costs, lead-time for customers, production time, and production costs. Researchers (Shanks and Parr in 2000) defined ERP implementation as "the process of developing the initial business case and planning the project, configuring and implementing the packaged software, and subsequent improvements to business processes". ERP implementation is considerably different from any traditional information system implementation for many reasons [18]:

1. The integrated nature of ERP applications causes dramatic changes on work flow, organizational structure and on the way people do their jobs;
2. ERP systems are not built, but adopted and this involves a mix of business process reengineering and package customization;
3. ERP implementation is not just a technical exercise, but it is a socio-technical challenge as it poses new set of management procedures.

Many researchers have identified training as a critical success factors in the implementation of an ERP system because it is expensive, time consuming and it requires an accurate human resource management.

TRAINING IN ERP IMPLEMENTATIONS

By studying the academic literature we identified 26 training methods that can be used in an ERP implementation to support the training activity: Classroom instruction, Print-based material, e-Learning (asynchronous), Conference calls, Email, In person mentoring tutoring, LMS (Learning management systems), Online assessment and testing, Online references, e-Learning (synchronous), Simulations, Portals, Video broadcasts, LCMS (Learning content management systems), KMS (Knowledge management systems), Instant messaging, Online mentoring tutoring, EPSS (Electronic performance support systems), Games, Communities of practice, Wikis, Virtual labs, Chat rooms, Mobile learning, Blogs and Podcasts. Each training method presents advantages and disadvantages when applying it into an ERP implementation. Many researchers stated that none of these training methods guarantees the success of a ERP training program.

eLearning Guild research has made a comprehensive study in 2008 (by interrogating 3000 respondents), regarding the trends in using the above mentioned training methods for corporative training. The results are depicted in Figure 1 and are proving that traditional training methods are still widely used compared with the computer based training methods. The study used the following rates: (a) 5 points: widely used; (b) 4 points: often used; (c) 3 points: used; (d) 2 points: less used; (e)1 points: rarely used; (f) 0 points: not used;

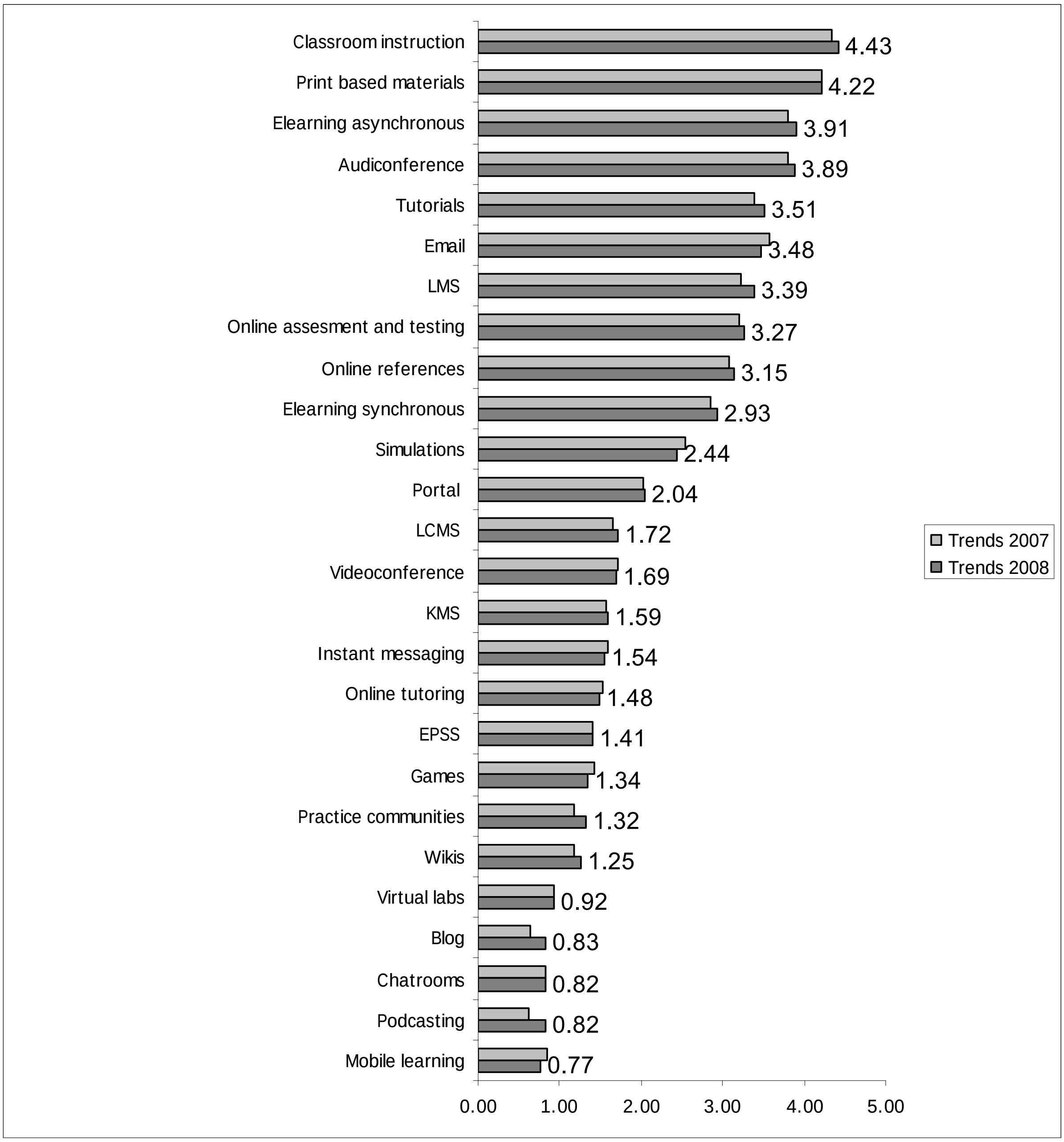

Fig.8. Trends in training methods based on the eLearning Guild Research study

KOLB'S LEARNING STYLE INVENTORY

Nowadays most researchers favor the idea of personalized training. In consequence we choose to focus on Kolb's model (Figure 2) as the concept of individual learning style proliferated by Kolb seems to be extensively applied in theoretical and empirical studies. Kolb's Learning Style Inventory (KLSI) includes four learning styles [7]: (1) *converger,* who can be classified as someone who wants to solve a problem and who relies heavily upon hypothetical-deductive reasoning to focus on specific problems; (2) *diverger,* who can be classified as someone who solves problems by viewing situations from many perspectives and who relies heavily upon brainstorming and generation of ideas; (3) *assimilato*r who can be classified as someone who solves problems by inductive reasoning and has the ability to create theoretical models; (4) *accommodator* who can be classified as someone who solves problems by carrying out plans and experiments and adapting to specific immediate circumstances.

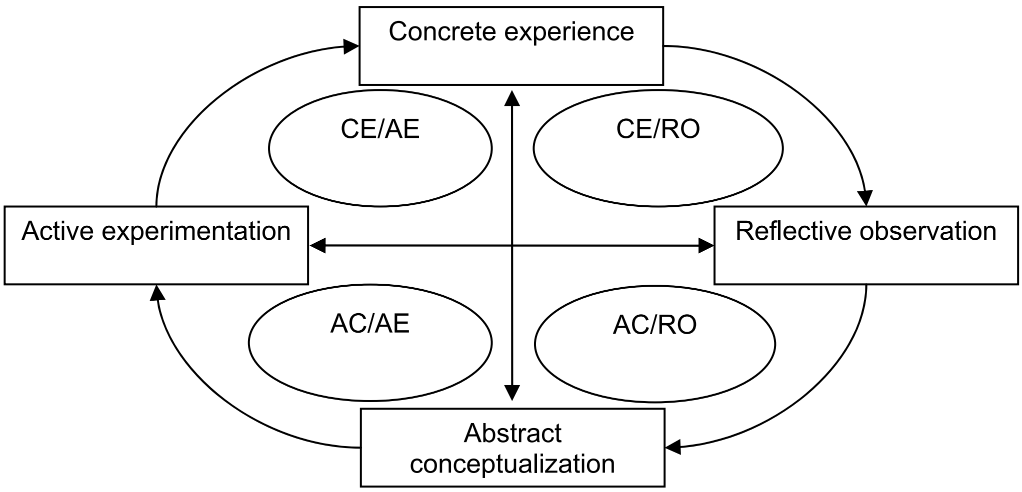

Figure 9. Kolb's learning styles (adapted after [1]).

An additional note should be made about Kolb's learning cycles as the KLSI also measures learning cycle preference. Kolb defined four learning cycles which are tied into the learning styles [4]: (1) concrete experience (CE): where learning from feelings or reactions to experience influence your learning; (2) reflective observation (RO): where learning from watching and listening influence your learning; (3) active conceptualization (AC): where learning from thinking or analyzing problems in a systematic method influence your learning; (4) active experimentation (AE): where learning by doing or results driven influence your learning.

Many researchers [16], [13], [14] stated that there is a connection between the individual learning style proliferated by Kolb and the training methods, thus we propose that the training methods should be delivered in accordance to the training style.

In ERP implementations it is likely to encounter users with all four learning styles Kolb described. Applying training methods that are not correlated with the individual learning styles will probably be rejected by the ERP systems users.

In consequence, we consider that the Blended Learning theory (that can be described as a learning program where more than one delivery method is being used with the objective of optimizing the learning outcome and cost of program delivery) it is the best approach in an ERP training implementation. Blended Learning focuses on optimizing achievement of learning objectives by applying the "right" learning technologies in order to match the "right" personal learning style and to transfer the "right" skills to the "right" person at the "right" time [8].

ERP TRAINING SYSTEM FRAMEWORK

Starting from the concepts and observations presented above, we have designed a framework for an ERPTraining system that will help us apply the concept of blended learning in an ERP implementation environment. This module is based on a training delivery method that favorites the training process personalization and also delivers the right knowledge in real time for the ERP user. In Figure 3 we present the framework adapted to the SFA (Sales Force Automation) module of a Romanian ERP system.

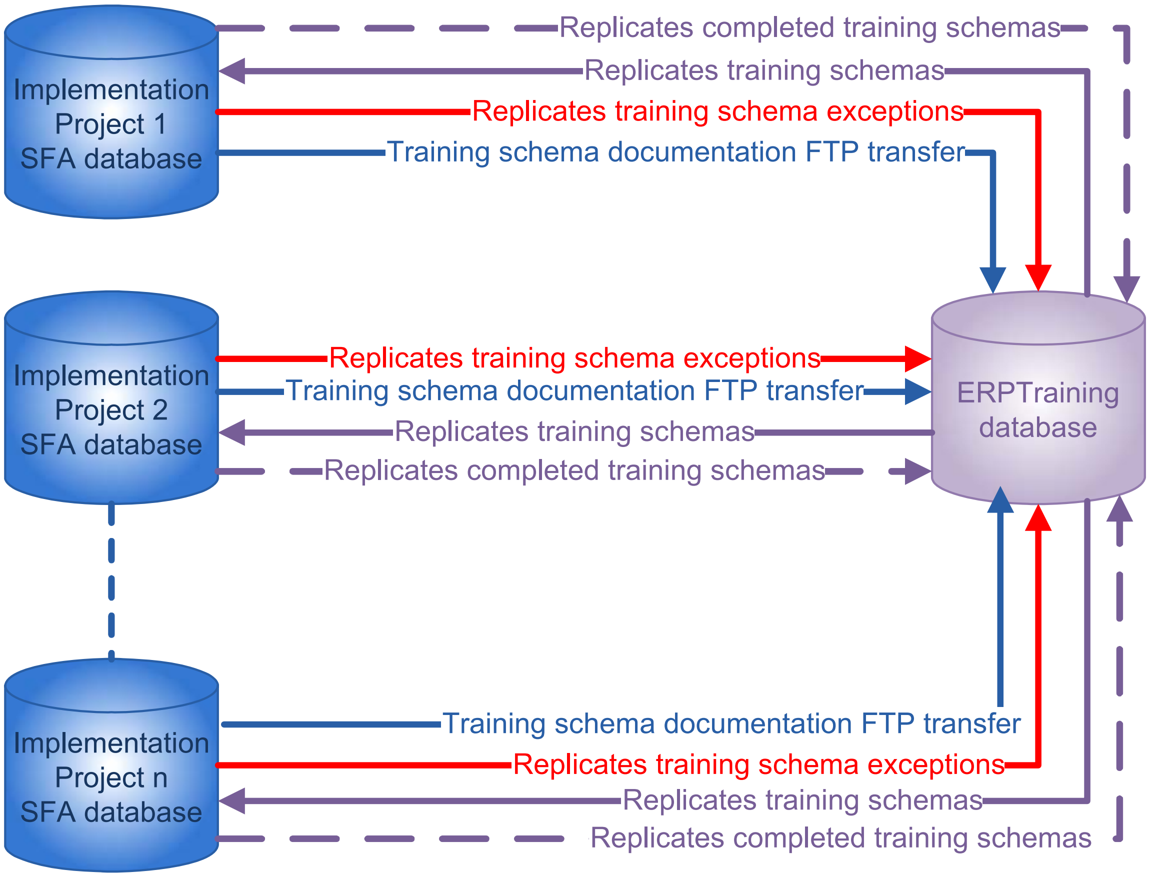

Figure 10. The ERPTraining system framework

The ERPTraining system is design to offer the subsequent functionalities:

– Automatically evaluate the individual learning style of each user by applying Kolb's Learning Style Inventory;

– Automatically deliver a training method adapted to the user's role and individual learning style;

– Allow the ERP training project manager to define any training method and attach to it training schemas for each business process users should be able to understand;

– Allow the user to automatically view the training schema documentation (made by a consultant and sent via FTP transfer) which will guide him in order to properly select the fix and variables parameters and introduce data in the ERP system in a correct manner; a training schema provides a standard that the user should follow while introducing a specific business process data in the ERP system. A training schema is defined by fix and variables parameters. The fix ones represents a mandatory selection that a user should make while introducing data and a variable parameter depend on the selection of one or more fix parameters or other constraints stipulated for a certain business process.

– While the user is operating the ERP system will automatically detect any exceptions from the training schema the user is generating while introducing data; any document the user is processing will be validated in the ERP system only if the data was introduced in the ERP system according to the training schema standard, otherwise the document will be invalidated and the user will be informed about the mistakes he made;

- Allow the exceptions from the training schemas to be replicated from the ERP system database to the ERPTraining database using a replication system;
- Allow the real time monitoring of the cost and time it takes a consultant to teach an user (for example, if the user wants to participate in tutorial sessions) or the cost and time a user needs to be trained to use a certain command of the ERP system;
- Provide the ERP training manager and the organization's management with reports and indicators that show the advances made in the training process in real time.

If implemented, this system will offer a series of relevant quantitative measures:

- Indicators and reports for the organization's management members, that will help them:
    - Have a clearer evidence of the personnel professional quality and efficiency;
    - Apply training methods adapted to the individual learning styles of the employees;
    - Notice if the personnel manifests resistance in approaching new business processes;
    - Justify in real time the time and the costs for training each employee to use the ERP system;
    - Justify in real time the time and the cost for the entire ERP implementation project;
- Indicators and reports for the ERP training team and project manager, that will help them to:
    - Monitor each consultant daily activities;
    - Identify the level of experience each consultant has in a certain domain;
    - Notice possible inaccuracies in the consultants professional training;
    - Compare the level of professional training of consultants;
    - Identify domains in which the company requires additional expertise;
    - Identify possible improvements in the user training process;
    - Identify possible improvements in the ergonomics or functionalities of the ERP system;
    - Properly evaluate the time and costs for new ERP implementation projects based on previous experience;

CONCLUSIONS AND FUTURE WORK

The ERPTraining system framework demonstrates a real possibility of introducing new features on how to achieve a better knowledge transfer in an ERP implementation environment. The system proposes a significantly improved alternative for monitoring the training activity in an ERP implementation environment, which creates added value for both organizations involved in the implementation process. As future work we propose to design, develop and implement an ERPTraining system adapted to a Romanian ERP system for SMEs.

REFERENCES

[1] Chapman, David Kolb's learning styles model and experiential learning theory (ELT), Whitepaper, wwww.businessballs.com.

[2] Vincent, D. Ross, Personalize training: determine learning styles, personality types and multiple intelligences online, The Learning Organization, Volume 8, Issue 1, 2001, Pages 36-43.

[3] Weiss, TITAN's Training Makes a Game of ERP, Whitepaper, available at: www.oracle.com, 2007.

[4] D. Robotham, Self-Directed Learning: The Ultimate Learning Style?, Journal of European Industrial Training, Volume 19, Issue 7, 1995, Pages 3-7.

[5] E. Valkanos, I. Fragoulis, Experiential learning – its place in in-house education and training, Development and Learning in Organizations Volume 21, Issue 5, 2007, Pages 21-23.

[6] E.T.G. Wang, C. C. Lin, J. J. Jiang, G. Klein, Improving enterprise resource planning (ERP) fit to organizational process through knowledge transfer, International Journal of Information Management, Volume 27, Issue 3, 2007, Pages 200-212.

[7] H. Henke, Learning Theory: Applying Kolb's Learning Style Inventory with Computer Based Training, Course on Learning Theory, 2001.

[8] H. Singh, Achieving Success with Blended Learning, Whitepaper, www.instancy.com.

[9] H.Tadinen, Human resources management aspects of Enterprise Resource Planning (ERP) Systems Projects, Master's Thesis in Advanced Financial Information Systems, Swedish School of Economics and Business Administration, 2005.

[10] I. Scorța, The replication mechanism in a Romanian ERP system environment, Revista Informatică Economică nr.1(45), 2008, Paginile 140-146, ISSN 1453-1305.

[11] J. E Scott, Post-implementation usability of erp training manuals: the user's perspective, Information Systems Management, Volume 22, Issue 2, 2005, Pages 67-78.

[12] J. Wu, Y. Wang, Measuring ERP success: the ultimate users' view, International Journal of Operations & Production Management, Volume 26, Issue 8, 2006, Pages 882-903.

[13] K. Buch, S. Bartley, Learning style and training delivery mode preference, Journal of Workplace Learning, Volume 14, Issue 1, 2002, Pages 5-10.

[14] M. Motter-Hodgson, Meeting the Needs of Diverse Types of Learners*,* CyberCorp Inc's newsletter, 1998.

[15] M. Wong, An evaluation on the employees' retraining programmes in Hong Kong, Employee Relations, Volume 20, Issue 4, 1998, Page 404.

[16] N. Manochehr, The Influence of Learning Styles on Learners in E-Learning Environments: An Empirical Study, Computers in Higher Education Economics Review, Volume 18, Issue 1, 2006, Pages 10-14.

[17] R. E. Yellen*,* A New Look at Learning for the Organization, Information Technology Newsletter, Volume 17, Issue 2, 2006, Pages 29-31.

[18] She-I Chang, "ERP Life Cycle Implementation, Management and Support: Implications for Practice and Research", Proceedings of the 37th Hawaii International Conference on System Sciences – 2004.

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e-Learning Solutions for Polymer Science Education

Yordan Denev

Abstract: *Computer programs for implementation like modules in e-learning environment in chemical technology fields are developed. The aim of the present work is a development of programming solutions for virtual training studies. This makes possible to exchange real experimental work in every e-learning shell with simulation exercises. This simulation stuff is fully operational in borders of electronic education system. The developed virtual laboratory exercises are stage of Web-based education system global building.*

Key words: *e-learning, computer simulation, polymer science, education.*

INTRODUCTION

The actuality of the problem of e-learning (particularly distance learning) was prompted mainly by the globalization of society worldwide, and by the incredibly high rates, which are developing communication technologies, especially the global network Internet. The aim of distance learning is to adapt existing teaching approaches and resources for learning and communication between trainers and learners to modern electronic means and methods for virtual communication between people [2,7].

There are some projects for polymer e-learning consist of different types of tools for performing e-learning (Excel Macros) which are suitable for education of topics such Materials Rheology, Processing Methods etc. [10]. Some authors use the attractive technologies such Flash Active Content and Shockwave Objects to illustrate some basic principles of polymer synthesis and processing. The main characteristics of the polymer materials are described too [11].

There are some electronic content that covers some aspects of polymer education (the main part is video content) [12]. There is and a good source of polymer content suitable in university education [13]. Some interesting projects covering story of polymer science and glossary with main terms explanation are available on [14].

The interest may be focused and on organization like POLYED that is a consortium of groups interested in science education in general and polymer education in particular [15]. Information on plastics used in our modern world is available on [16].

All of the described projects use a web tools in the development process but there's some difficulties when they are used for the real experiment simulations. The need an Internet connection too.

The purpose of this work is a development of application software suitable for incorporation as a module in a electronic-based training system for conducting e-learning in the field of technical sciences in particular – polymer technology. The developed computer programs are Internet independent applications which every teacher can use on a single computer not connected to others in a network. For their execution computer programs need only installed operating system on the computer.

LAYOUT

The proposed computer programs were developed using the environment for rapid develop of application programs MS Visual Basic. NET Standard Edition, designed by MICROSOFT Corporation, which contains within it the tools that allow to significantly speed up the process of development and creation of application software [4,8,9]. The choice of MS Visual Basic is by the following reasons:

- MS Visual Basic is object-oriented language, i.e. language, which operates sites on which to act;
- Programming environment has opportunities to carry out close monitoring on the construction of the project;

- MS Visual Basic has amended the programming approach to its predecessors (Basic, Qbasic, etc.), namely Decomposition of the code of procedures and classes that could be called a random spot in the program.

As a further advantage can be emphasized and the possibility of establishing a convenient installation modules for each application facilitating an easy installation on every computer system.

In terms of users involved with the process of e-learning benefits of the graphic interface is indisputable: there is a unified environment containing controls inherent in all applications - buttons, menus, etc., making all programs working by a similar rules.

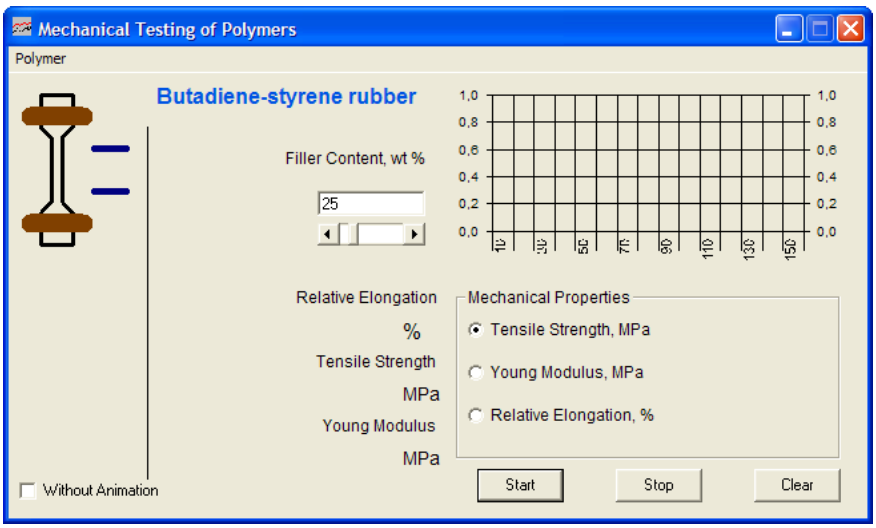
The first demonstration program (or module in the system of e-learning) is designed to enable implementation of virtual laboratory exercises in the field of mechanical testing of reinforced polymers [6].

The study of the mechanical characteristics of filled polymers is an important step in studying of their technological behaviour. These experiments need many hours, which could find hardly in a limited period of time, as are laboratory exercises. For this and other reasons, it is appropriate to develop computer programs that demonstrate the conduct of such tests and interpretation of results obtained from them. The development of such a program is possible only in the presence of extensive and accurate experimental material selected on the basis of which, by the methods of mathematical modelling to analyze the necessary functional dependencies and the mathematical models derived for the main stress-strain characteristics (tensile strength, modulus at 100 % elongation, relative elongation). On the basis of the values students could get acquainted with the technological problem of determining the optimums of reinforcing.

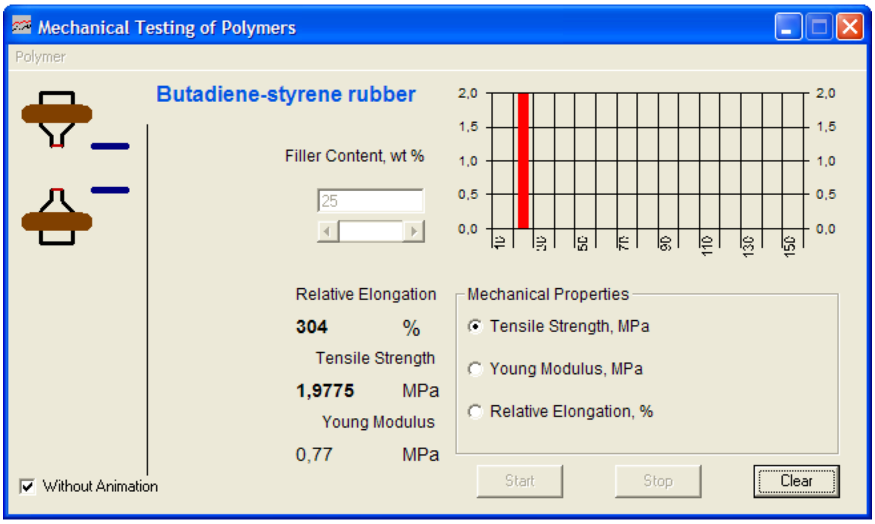
In the computer program are considered three different in their chemical nature and properties rubbers: SBR, EPDM and NBR. Based on these rubbers, for the preliminary stage of development of the program vulcanizates reinforced with phosphogypsum are prepared. The content of the mineral filler varies from 0 to 150 wt % [1, 3].

After extraction of the mathematical models for the mechanical properties [3] demonstration program was developed. This application includes the models that describe the change of the values during the stress-strain tests. As a visual model for such analysis is the approach in the tests conducted using an electronic dynamometer of company "INSTRON"-England (INSTRON-402). Like most computer programs this application consists of one main window, which through its various components includes all the functionality of the application.

The main window of the program that conduct virtual laboratory exercises in the polymers reinforcing and their mechanical testing is shown in Figure 1.



a)



b)

Fig.1. Main window of module for stress-strain testing:
a) At test start; b) At test end

In the left side of the window the tested sample is presented. It is visually the same as the most used samples in the experiments in practice. In the menu the student can choose the specific type of rubber which will participate in tests. The program menu for choosing the type of studied rubber is shown in Figure 2.

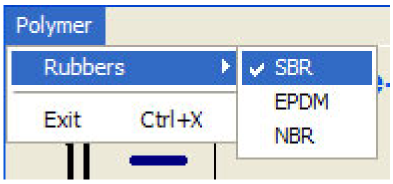


Fig.2. Main menu of module for stress-strain testing

This approach is appropriate because in the course of implementation can be assigned different values of this interval, leading to a change of speed (in this case the deformation speed of the test sample, which can also be defined by different values in tests performed by an electronic dynamometer).

Border, which should continue this deflection is determined by the relative values for extensions obtained from the mathematical model derived for the vulkanizate under the relevant degree of filling.

The degree of filling with phosphogypsum set at the beginning through the slider below the corresponding text box labelled in the working window of the program. After starting the test (by pressing the Start button) animation begins. Upon reaching 100% relative extension, the label indicating the module in this extension gets its value, calculated as set out in model. Upon completion of the analysis (i.e. after the destruction of the sample) in the respective record labels are the values of tensile strength at break and the relative elongation which actually defines the end of the test. Finally the test is completed by pressing the *Clear* button, which leads to recovery of the starting shape and size of the sample and reset the value of the degree of filling.

In the right part of the application stays a graphical component visualizing the variation of a property in the range of filling. The choice of this property is through radio buttons placed within study parameters. The presence of such a graphical control leads to full and easy discover of filling optimum with phosphogypsum.

It is also possible to stop the trial has already begun by *Stop* button. This is necessary in case of wrongly entered or repetitive value for the degree of filling. The return to the starting position of the model here is by the *Clear* button.

The code and the program in general are optimized for operation of each computer system operating in terms of Windows XP/2000 operating system with installed .NET Framework.

The program is based on a huge experimental material obtained investigating possibility of phosphogypsum using as light mineral filler for polymers [1, 3]. The main used approach is systematic collecting of experimental data and their processing with an author developed programming tools (statistical and experimental design modules). After these steps developed equations are turn into algorithms used in the subsequent programming process.

The second program developed concerns the possibility of conducting a simulated study of the process of ionic-coordination polymerisation of ethylene (polymerisation using the catalysts of Ziegler - Natta) [5, 6].

The polymerisation is a process that requires a long and strict observance of technological parameters for its implementation. Some of technological conditions are slightly dangerous for students too. Therefore, in developing methods for its study is necessary to resort to search for opportunities to facilitate the visualization of the parameters affecting it.

The developed demonstration computer program allows monitoring of the effects of seven parameters influencing the progress and products of ionic-coordination polymerisation of ethylene.

The technological parameters are:

1. Mixing frequency, rounds/minute;
2. Reactor temperature, °C;
3. Heating speed, l/min;
4. Catalyst amount, g;
5. Isobutylene amount, vol. %;
6. Hydrogen amount, vol. %;
7. Ethylene amount, depending on pressure, MPa.

In calculating process of the characteristics of the product of polymerization - polyethylene have been used different functional dependencies.

The part of source code for the final parameters calculation written in Visual Basic is shown below in Listing 1 (*see Appendix*):

It is very important to mark that the simulation of the ionic-coordianation polymerisation can work in two different conditions: permanent or variable. Depending on the process state the final results obtained by students have different values.

The parameters whose effect is examined by the proposed program are represented by labels and text boxes located adjacent to them. The values that they represent introduced through sliders in a limited space ahead. There is a possibility for eliminating errors by the student which may occur when entering unbecoming values.

The determination of baseline parameters is by pressing the *Calculate* button. It is also possible to check the zero input values for certain parameters, which may lead to different programming errors (e.g. division by zero if the parameter involved in the denominator as a dependency).

In this case the user is prompted for entering of right value. To the text box showing the values of the yield of polymer, the density and melt index of progress, are bands that give a visual idea to what extent the resulting values are compared to the minimum and maximum values for the parameter.

The main window of the program and has an appearance shown in Fig. 3:

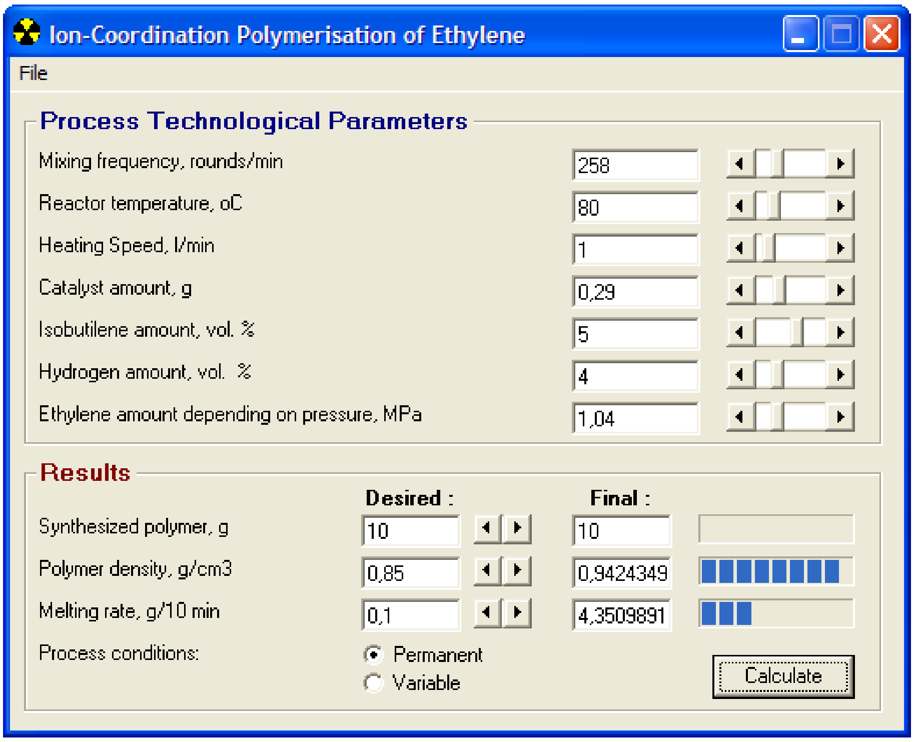


Fig.3. Main window of the simulation application for the process of ionic-coordination polymerisation of ethylene

The final stage at this process examination can be the investigation of the optimal values for technological parameters by experimental design methods. For this purpose different type of statistical software can be used.

CONCLUSIONS AND FUTURE WORK

1. Demonstration computer programs simulating the stress-strain tests of reinforced polymers and ionic-coordination polymerization of ethylene have been developed.

2. Using available software and modern approaches for developing and programming design modules have been created, providing basic functionality for incorporation within the training system for polymer science education.

3. The developed modules are subject to a logic embedded in their functionality, which is a guarantee for their excellent timing in the course of their joint work within the e-learning system.

4. The developed computer programs make possible education within two fields of polymer science which requires many hours experimental work that is impossible in the laboratory learning conditions.

5. The proposed computer programs are used experimentally in polymer education of Department of Material Science, Prof. Dr. Assen Zlatarov University – Burgas, BULGARIA.

REFERENCES

[1].Denev G., Polymer Compositions filled with phosphogypsum and its modificates, First International Conference Technomat 97, 1997.

[2].Denev Y., A. Popov, G. Denev, Modules for creation of Web-based education system, Proceedings of Scientific Conference with International Participation Stara Zagora 2005, v.5, p.303

[3].Denev Y., G. Denev, A. Popov, Utilization of phosphogypsum like a mineral filler for elastomers, International Scientific Conference "Bulgarian Association Rubber Industry", 18-20 October 2007

[4].Petroutsos E., Mastering Microsoft Visual Basic 2008, Sybex, 2008.

[5].Kafarov V., Cybernetics Methods in Chemistry and Chemical Technology, Chemistry, Moscow, 1971 (in Russian).

[6].Kurenkova V., Laboratory Experiments in Polymer Science, Chemistry, Moscow, 1990 (in Russian).

[7].McCormack C., D. Jones, Building A Web-Education System, John Wiley & Sons, 1997.

[8].Petroutsos E., Mastering Visual Basic .NET, Sybex, San Francisco, 2002.

[9].Roman St., VB .NET Language in the Nutshell, O'Reilly, 2001.

[10].http://ptlonline.org.uk

[11].http://www.plastics-elearning.com/

[12].http://www-sul.stanford.edu

[13].http://www.chemheritage.org

[14].http://www.pslc.ws

[15].http://www.uwsp.edu/chemistry/polyed/

[16].http://www.americanchemistry.com/plastics/

APPENDIX

Listing 1

```
P = txtP * 100
S = ((P * txtC) / (203 + txtR * 1000) + 1) * txtT
If S > 102 Then
   MsgBox "Lower Temperature", vbExclamation, "Correction"
   lblT.ForeColor = vbRed
End If
J = (P - P * 42 / S) * txtC * (1 - 0.005 * (txtH + txtB))
J = J * (0.002 * txtY - (0.001 * txtY) ^ 2 + 0.001)
If P / J < 1.3 Then
   MsgBox "Lower Temperature", vbExclamation, "Correction"
   lblT.ForeColor = vbRed
   Stop
End If
Q = 0.94 * J / txtC
n = Q * txtC
J = (0.0007 * S / 4 - 0.01)
D = J + (1 + Q) / ((0.01 * txtB + 1.05) * Q + 0.5)
'Check <>
If n < 10 Then
   n = 10
End If
If n > 100 Then
   n = 100
End If
If J > 15 Then
   J = 15
End If
If D > 0.95 Then
   D = 0.95
End If
txtN.Text = n
txtJ.Text = J
txtD.Text = D
```

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Learning Content for Technology Enhanced Learning – Experiments and Solutions

Danail Dochev, Radoslav Pavlov

Abstract: *The paper deals with the authoring of learning content for Technology Enhanced Learning applications, considering content- and context-sensitive features of learning materials to facilitate their accessibility and re-use. It presents the data models, the architecture and the authoring process in a platform for ubiquitous (any place, any time, personalized) learning, developed under an IST FP6 project. Some conclusions from the platform experimentation and a direction for future research are outlined.*

Key words: *Technology Enhanced Learning, Learning Content, Learning Objects, Authoring Tools.*

INTRODUCTION

Nowadays it is widely recognized that Technology Enhanced Learning /TEL/ has to provide information and create learning situations, enabling activities for constructing learner's knowledge by the learner himself with the teacher's or peers' assistance [1]. Current TEL systems and tools facilitate the development of various learning situations by exploiting specific characteristics of the learning process and its participants, reducing substantially the time and space limitations. In classical education as well as in eLearning activities learning content has always been regarded as keystone for all learning situations. Understandably the authoring of learning materials is one of the most important and labour-intensive activities in the modern TEL practice. The present paper discusses means to facilitate the authoring and the access to learning materials by exploiting their content- and context-sensitive presentation, based on the work in a just finished 6FP IST project LOGOS "Knowledge-on-demand for Ubiquitous Learning". It also presents some observations on the project results and a direction for future research.

LOGOS PLATFORM ARCHITECTURE

The project LOGOS /2006-2009/, developed by 15 partner organizations from 8 countries addressed innovative developments for all the e-Learning processes components – resources, services, communication spaces. The primary target group of the project consisted of eLearning actors (authors of courses, lecturers, advanced learners, learning content providers), creating learning materials for university students and/or for adult learners in non-formal and informal education. The secondary target group considered eLearning providers (companies and training institutions) and technology providers (DTV-companies, mobile operators), interested of cross-media delivery of learning materials. The project main objective was to create a platform for ubiquitous (any place, any time, personalized) learning which combines:

1/ a subsystem, called "Authoring studio" for creation of learning materials from existing digital repositories by semantic annotation and access.

2/ facilities for cross-media courseware delivery through digital video broadcasting, mobile and IP-based communication channels.

The architecture of the LOGOS authoring studio [3] is based on the following hierarchy of data models for the information objects:

- **Media objects** - 'raw' multimedia (MM) objects, catalogued in the repositories with some technical characteristics orientated to multiple channel delivery;
- **Digital objects** - media objects, annotated with technical and administrative, as well as with content describing semantic metadata, based on domain ontologies;

- **Learning objects** (presentational and assessment objects) - digital objects, enriched with educational metadata (LOM);
- **Courseware objects** - graphs of learning activities associated with learning objects.

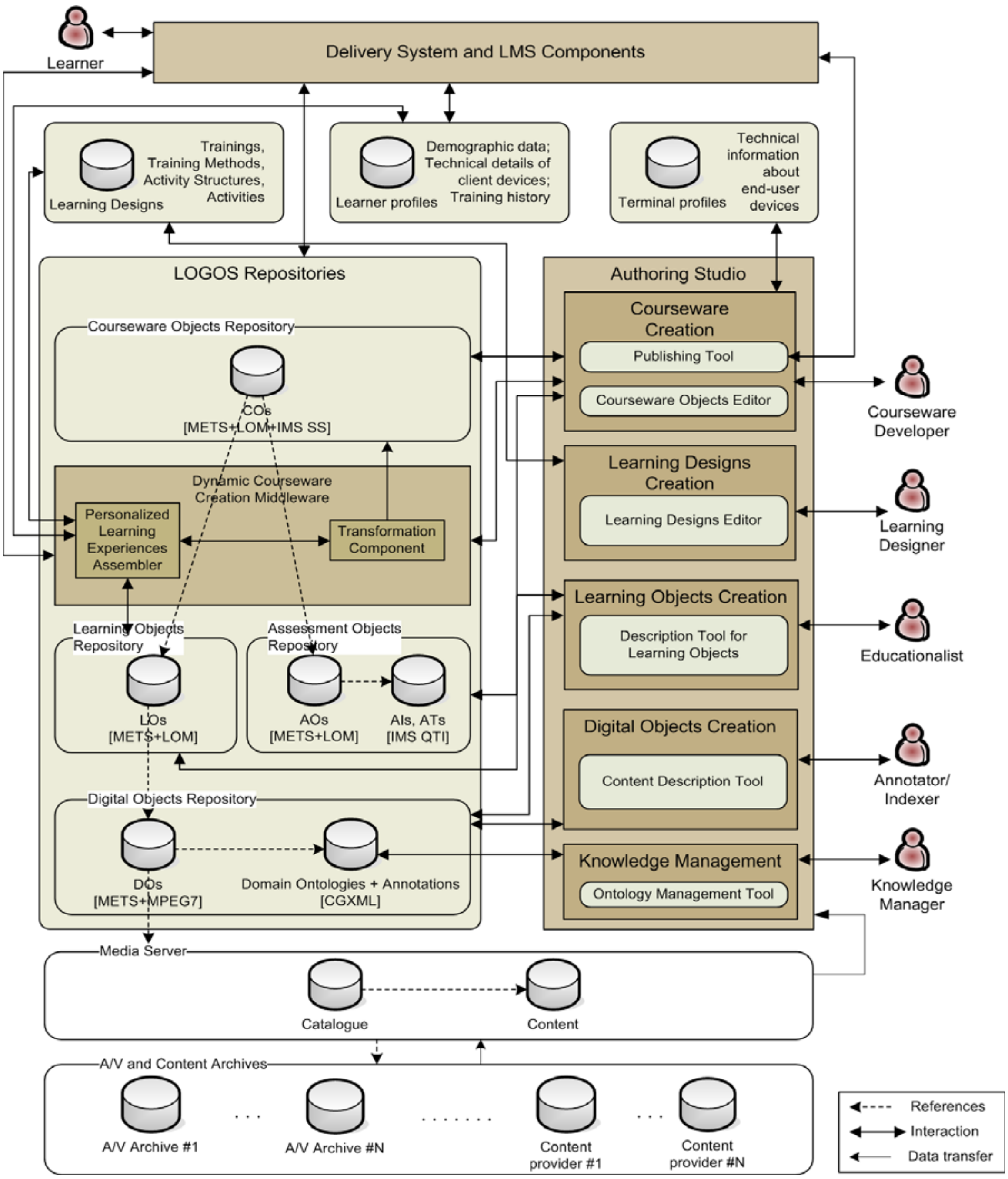

Fig.1 LOGOS platform architecture

The LOGOS platform takes in consideration the following user roles:

- **Knowledge Engineers** – their involvement in the development of learning resources is to create and maintain domain-specific ontologies, necessary for the semantic description of MM content.
- **Annotators** - they are involved in the development of learning resources by annotating, segmenting and semantically indexing the raw MM material in order to create and maintain digital objects.
- **Educationalists** - they create reusable learning objects by sets of digital objects, enriched with educational metadata.

- **Learning Designers** - they create abstract learning scenarios for dynamic development of personalized courseware.
- **Courseware Developers** - they create, maintain and publish courseware for learners.

The Architecture of the LOGOS platform is shown on Figure 1. Its main blocks are:

- **Ontology Management Tool** for creation and management of multilingual domain ontologies with graphical, intuitive and user friendly interfaces that could be efficiently used by domain experts (knowledge managers). The tool can create and manage knowledge inference rules, constraints and templates in order to reduce the indexation effort. Uses Conceptual Graphs formalism.
- **Content Description Tool** - produces LOGOS Digital Objects by segmentation and indexing of the MM objects, their annotation, se-mantic description and necessary format transformations. Uses semantic indexing templates created by the OMT to guide the annotation process.
- **Description Tool for Learning Objects** [6] - produces reusable LOGOS Learning Objects by pre-selection and organization into a hierarchy of relevant Digital Objects for a given pedagogical use. Provides means to create educational (LOM) metadata.
- **Courseware Objects Editor** - produces Courseware Objects, including quizzes (learner assessments), by combining appropriate Learning Objects.
- **Publishing Tool**: Publishes indexed, annotated, translated and enhanced audiovisual segments in appropriate formats to be used by Learners using different devices such as PCs (SCORM objects), mobile phones and ITV.
- **Dynamic Courseware Creation Middleware:** for automatic creation of personalized courseware (eventual further editing by **Courseware Objects Editor**) according to specific learning needs expressed in Learner Profiles and using a set of Learning Designs.
- **Learning Management System components:** for delivery of courseware to Learners encapsulating functionality to adapt the learning material to user needs/delivery devices (not part of the Authoring studio).

The LOGOS platform includes also the following repositories:

- **Media Server** - manages **Media Objects** coming from external content archives;
- **Digital Objects Repository** - manages **Digital Objects** created on top of Media Objects or parts of them annotated and indexed with administrative and semantic metadata;
- **Learning Objects Repository** - manages **Learning Objects** built on top of Digital Objects and enriched with educational metadata;
- **Assessment Objects Repository** - manages **Assessment Objects** (Assessment Items or Tests) enriched with educational metadata.
- **Courseware Objects Repository** - manages **Courseware Objects** utilizing the underlying **Learning Objects** and **Assessment Objects** and corresponding to learning experiences that can be delivered using different delivery devices.

AUTHORING LEARNING MATERIALS IN THE LOGOS PLATFORM

The Authoring process in the LOGOS platform, covering the creation of different types of information objects, is visualised on Figure 2. Details about the phases and activities during the authoring of learning materials for a specific subject domain are discussed in [8]. The ontology design and annotation of digital objects by the LOGOS Authoring studio tools are presented in [4].

The functionality and usability of the LOGOS implementation were evaluated through extensive experimentation on specific use-case scenarios by combination of specific inspection technique with user-testing:

- Formative evaluation - an evaluation of an unfinished application, made by IT experts, aiming to expose usability problems that exist in the development iteration. It stimulated the development of user-friendly manuals and the component integration.
- Summative evaluation of a complete interface with "human factors testing," done by end-users: 17 Authors and 90 Learners in 8 countries (Bulgaria, Finland, France, Greece, Hungary, Italy, United Kingdom and Slovakia) with a common shared methodology.

Details and results of the evaluation study may be found in [7].

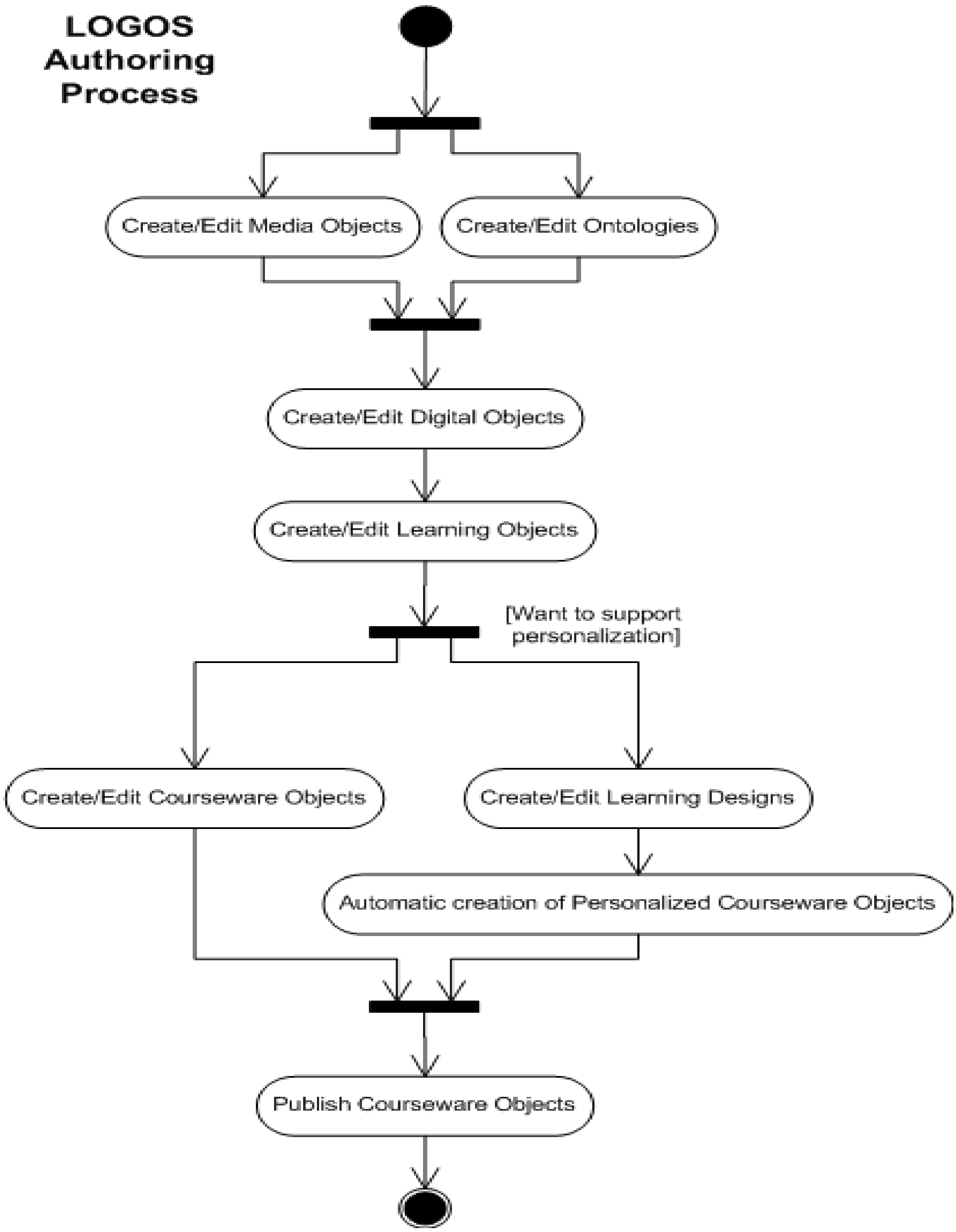

Fig.2 LOGOS Authoring Process

CONCLUSIONS AND FUTURE WORK

The experimentation with the LOGOS Authoring studio supports the following conclusions:

- The effectiveness of TEL platforms development and maintenance should be increased by creating “lightweight” versions of authoring tools, based on well defined and well understood use cases.
- To increase the effectiveness of the preparation of semantic resources it is desirable to use and combine limited-world domain ontologies, reflecting viewpoints on the subject domain of specific well defined user groups in order to increase the effectiveness of the preparation of semantic resources.
- Special attention has to be paid on facilitating the manual high knowledge- and labour-intensive work to annotate digital (especially multimedia) resources by providing templates and finding similarities with existing annotations.
- In order to support effectively the indexing and re-purposing of learning content the authoring tools should be more dedicated and end-user-friendly.
- The authoring tools have to be validated and experimented with different user groups to fit well enough with significant use cases for the different user roles, supported by the TEL platform.

The traditional approaches to create learning objects typically rely on expertises of the author/s only, and have very limited capability for reusing existing blocks. In the TEL tools based on current eLearning specifications and standards (IMS-LD tools, LAMS etc.), a LO can be considered as a static and monolithic block, since once created, it is rather difficult to change or modify its inner resources and/or to add/remove services and resources at run-time.

A possible approach to increase the effectiveness of preparation and use of adaptable learning content is the trend to shift the current data- and metadata-based paradigm towards dynamic service-oriented approach based on Semantic Web Service /SWS/ technologies. Currently a number of research teams are exploiting virtualisation mechanisms (by which each resource is virtualised as a service) to obtain common mechanisms and tools for reusing the learning materials and other already developed building resources (e.g. ontologies, learner models, didactic methods) during the LO building, enabling automatic search and late binding of resources and services [5].

The authors work in a team on a current Bulgarian NSF project SINUS “Semantic Technologies for Web Services and Technology Enhanced Learning” (http://sinus.iinf.bas.bg/), which aims at providing a framework for development of TEL-oriented applications, based on SWS technology [2]. The project SINUS stands on methods and tools developed, as well as on lessons learnt in LOGOS and another IST FP6 research project INFRAWEBS (“Intelligent Structure for Generating Open (Adaptable) Platforms for the Development of Distributed Applications, Based on Internet Services in Decision Making and Multi-Agent Systems”). The project research objectives are:

- Developing new methods for dynamic composition of Semantic Web Services suited for eLearning
- Developing a new framework, based on Semantic Service-Oriented-Architecture and oriented to eLearning applications to facilitate reusability and repurposing of learning objects.
- Developing new methods and tools for creation and semantic annotation of learning objects compatible with SWS methodology.

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REFERENCES

[1] Aceto S., C. Delrio, C. Dondi (Eds.). E-Learning for Innovation. Executive Summary of Helios Yearly Report 2007, ISBN: 2-930429-13-5,p.25, http://www.education-observatories.net/helios (last accessed August 2009)

[2] Agre G., D. Dochev - An Approach to Technology Enhanced Learning by Application of Semantic Web Services. "Cybernetics and Information Technologies", Vol. 8 (2008), № 3, pp. 60-72.

[3] Arapi P., N. Moumoutzis, M. Mylonakis, S. Christodoulakis. A Framework and an Architecture for Supporting Interoperability between Digital Libraries and eLearning Applications. Proceedings of the DELOS Conference on Digital Libraries, Pisa (Italy), February 2007.

[4] Chein M., A. Gutierez, S. Lalande, V. Saraydarova, K. Staykova. Tools and Methodologies for Ontology Design and Digital Objects Annotation using Conceptual Graphs. In: Szucs A. (Ed.) Proc. of LOGOS Open Conf. "New Technology Platforms for Learning – Revisited". Budapest, January 2009, pp. 47-61.

[5] Dietze, S., A. Gugliotta, J. Domingue. Towards adaptive E-Learning Applications based on Semantic Web Services. In: Proc. of TENCompetence Workshop on Service Oriented Approaches and Lifelong Competence Development Infrastructures, January, 2007, UK.

[6] Marinchev I., I. Hristov. Managing Learning Objects in Large Scale Courseware Authoring Studio. In: Christodoulakis S. (Ed.) Proc. of Workshop on "Cross-Media and Personalized Learning Applications on top of Digital Libraries" LADL 2007, Budapest, September 2007, pp 101 – 109.

[7] Ovchin E., Sh. Militello, E. Suba, A. Waterson. L. Pemberton, R. Griffiths. A Formative and Summative Usability Evaluation Study of a Cross-platform E-Learning Authoring Environment. In: Szucs A. (Ed.) Proc. of LOGOS Open Conf. "New Technology Platforms for Learning – Revisited". Budapest, January 2009, pp. 20-36.

[8] Paneva-Marinova D., L. Pavlova-Draganova, L. Draganov, R. Pavlov, M. Sendova. Development of a Courseware on Bulgarian Iconography for Ubiquitous On-demand Study. In: Szucs A. (Ed.) Proc. of LOGOS Open Conf. "New Technology Platforms for Learning – Revisited". Budapest, January 2009, pp. 37-46.

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Meta-Cognitive Tool Development to Improve e-Learning Environment

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Abstract: *In this study, the meta-cognitive tool development activities are highlighted to improve the e-learning platform. The spiral software development life cycle was taken into account and the learners' learning styles was evaluated as user requirements. After the development phase, the meta-cognitive tool integrated into the course management system of the history of civilization course at the Bahcesehir University. Then the students' achievements benchmarked with the classical power point based lessons with meta-cognitive based tool. Results show that students which are above average might benefit the tool most.*

Key words: *Meta-cognitive tool, concept maps, learning tool development, learning styles model.*

INTRODUCTION

Concept maps could be good tool to view the content and specify the requirements of the knowledge flow in the learning applications. Also the concepts and the relations can be seen at first glance. These benefits of the concept maps show that make the system view more apparent for learners. The concept map approach is categorizing knowledge in the information hierarchy. Learners may understand the knowledge domain which represented in a way that resamples the thinking of the subject matter experts (SMEs). This suggests that when developing an e-learning application, a pre–designed concept maps can be useful. Coffey, describes the usage of concept maps to create a course description based on the idea of an advance organizer. This method is different then linear sequences of topics which typically found in traditional ways [1]. Novak and Iuli claims that use of concept maps as meta-cognitive tools help to think easily [2].

In the higher education, engineering students have some difficulties when they have need structuring their thoughts in a knowledge domain that they are not used. They also often demanded to use their learning skills to create thinking processes and communicate the ideas using learning media that are not appropriate for all learners. When eliciting requirements of individuals in a learning environment and structuring knowledge representations in a well defined manner, concept maps serve a good tool to view the advance organization of the learning contents flow in the applications.

A well designed concept map can be very helpful to improve and systemize the learning processes of these learners and support their learning in unaccustomed knowledge domains. But sometimes the concept maps can be too complex to understand. Thus students fail to follow all the relations on the nodes of the maps. So when taking the different learner requirements into account to provide the whole concepts at once cannot be a solution all the time. The usage of concept maps that serve learning styles is important to cover all the user requirements. Because, different learners have different learning preferences when study in these concepts. According to their learning styles some of them may prefer to see and learn the whole concepts at once but others may prefer to see and learn the concepts within steps. Another consideration point is that some of the learners needs the visual aids to learn the concepts but others not.

In this study, meta-cognitive tool development stages are detailed to share some experiences.

BACKGROUND

University students have some difficulties when creating relations between ideas, knowledge and integrating the information with their prior knowledge [3]. A well designed concept map can be helpful to see the structure of the content at a glance with a visual presentation that fosters learning of complex information more quickly rather than complex and heavy information loaded presentation of words and verbal contexts.

Because of the ease in receiving information for later retrieval, the concept maps are very useful for educational purposes. Another reason that concept mapping is beneficial for the learning is that it serves as a kind of template to organize knowledge and to structure it [4]. Plotnick suggested that some other usages of the concept maps usage helpful in areas such as creativity, complex structure design, learning assessment, brainstorming, and communication of complex ideas [5]. Also there is a possibility of employing the concept map as an advance organizer [3]. An advance organizer is a global overview of the material that is to be learned [6, 7]. The concept map tools can be also in a computerized form to foster students learning. A learning style is the method that allowing individuals to learn more comfortable. Although there is no perfect theory accepted by researchers for the learning styles [8]; implementing a learning style model can be useful in teaching/learning if it matches the learning modes of the students. Felder explains that there are non-matching learning styles of engineering students and traditional teaching styles of engineering professors [9]. In this situation, students get bored and they become inattentive in class. Also they achieve lower scores on tests, and get discouraged about the courses, the curriculum or themselves. In the beginning, they discussed the aspects and dimensions of learning style significance in engineering education. They were saying that there are learners as Sensing and Intuitive Learners; Visual and Auditory Learners; Inductive and Deductive Learners; Active and Reflective Learners and Sequential and Global Learners. Recently they dropped the/deductive dimension, and changing the visual/auditory category to visual/verbal. Felder describes active learners shortly as to retain and understand information best by doing something active with it— discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first [10]; sensing learners tend to like learning facts, intuitive learners often prefer discovering possibilities and relationships [11]; visual learners remember best what they see— pictures, diagrams, flow charts, time lines, films, and demonstrations [11] and sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it" [9]. Within the usage of software applications and answering learning styles, the concept maps can be an important tool to get the meaningful learning for the students learning. In the development of such software, students also get control of their learning process by getting the advantage of learning opportunities which technology offers within the instruction [13].

COURSE DESIGN

The instructional designer should consider the arrangements of course content and materials in a well structured manner to create useful course material. Designing of concept maps could help both the instructor and the instructional designer to see the entire course in a big and detailed view. This system view helps them to represent the relations between contents and information. Also the concept maps can be useful for tracking the content of the course. The map should be designed by a person who has strong knowledge about a given topic in a specific context. There are no correct concept map on a specific content, as there can be many different representations of the topic that are correct. To create such strong concept maps; an instructor or an instructional designer should use a software tool to make the process much quicker and useful. There are some commercial tools are available at the market [13].

In this study, F/OSS FreeMind (http://freemind.sourceforge.net/) was used to create the visual presentation of the concept maps. We selected this software because it is user-friendly especially for the instructors. By the instructional designer and developer side, the ability of exporting the data of the visual representation of the concept maps outside of the program in the XML format is crucial. The concept maps basically can be created to prepare knowledge representation in a form of a graph which is shaped within boxes consists of knowledge texts that have connections by labeled arrows [14].

The concept maps had been created by the two subject matter experts in the learning domain. First SME is the instructor of the "History of Civilization" course and the other is an expert at the history and art. They linked and create the relations for each node for the visual materials and additional course materials that are selected from the visual galleries related to the course. Concept maps were limited with three levels because information must be learned at working memory and it has a capacity of about four chunks in young adults [15]. SMEs completed the concept maps and then they reviewed the maps and discussed the any missing parts such as lack of information. Finally an instructional designer reviewed the concept maps and linked materials for their inner structure of accuracy according to the relatedness of the course objectives. Concept maps provide an initial conceptual frame for learning and this allows the usage of concept maps as a schema for the structured course. In our study, the presentations were constructed according to these schemas. To link visual materials such as historical maps, illustrations and pictures for each concept also should be included into presentations. All the participant students of the course have studied the presentations in their class hours. Presentations were designed in a linear way; so all the contents were presented sequentially. All the learners learn through the presentations and examples in this order and the order was not changed. This kind of the structure does not adapt to individual learners and cannot support different learning styles.

THE SPECIFICATIONS OF META-COGNITIVE TOOL

A learning tool has been developed to get the contents to fit exactly within concept maps so the learners can have a chance to examine the lessons of the course in an organized way that was indicated also in concept maps. When developing such a tool, there are some encountered constraints. Such as,

1. The tool should provide lessons and related materials in a way that matches within concept maps
2. The tool should give the presentations of the contents both in sequential and global layouts
3. The tool should give the presentations of the contents both in verbal and visual.
4. The tool should provide a navigation that is easy to learn and use.

The learning tool designed to cover the requirements stated above. When developing this kind of learning tool it was essential to access both in class during the lecture hours and online for the future usage as an e-learning tool. Also the portability of the learning tool was an important issue. For this reason, the Adobe Flash framework was used. Both PCs and Macintosh based systems can easily connect to application without need of having to connect to Internet. Another reason of selecting Flash was to have a capability compatibility of XML. While developing the learning tool there was a crucial requirement to provide lessons and related materials in a way that matches within concept maps. To handle these requirements the presentation contents was used matching exactly same of the concept maps by using the XML which included the data of the visual representation of the concept maps that were exported outside of the program. The learning tool just loads XML automatically and programmed to analyze loaded data to present related materials in visual and verbal forms that were indicated by the SMEs within concept maps. The figure 1 demonstrates the essential screens of meta cognitive learning tool. At the top of the screen, there is a toolbar which has three combo box menus to access the visual concept maps that are interpreted from the concept map data. The label 1 indicates the menu of pictures. The tool bar below is for navigations. At the bottom of the screen, there is an information collection purpose button which may be used for accessing helps and documentation of the learning tool and its usage info. The button next to it is for accessing other chapters list via a pop–up screen. When user jumps to other chapters of the learning tool, it loads the related data of the concept maps by using XML format. The buttons labeled with arrows and may be used to move forward and backward in the program. The learners can navigate in the application by two different ways one is sequential and other branched web. If a user learn in a sequential steps it has chance to use linear model, if conforms in global they can switch to branched web. To access the branched web navigation the user should go to content map form upper menu and move in the concept maps. When user switches concept maps to navigation, the main screen and navigation buttons also changes as the prev./next buttons replaces within a -/+ button set for zooming control of the maps. Also vertical and horizontal scrollbars are included to move in this concept maps. When in sequential mode has been selected the overall relations of the concepts at nodes has been deleted to ensure the sequential learner have easy with following the concepts.

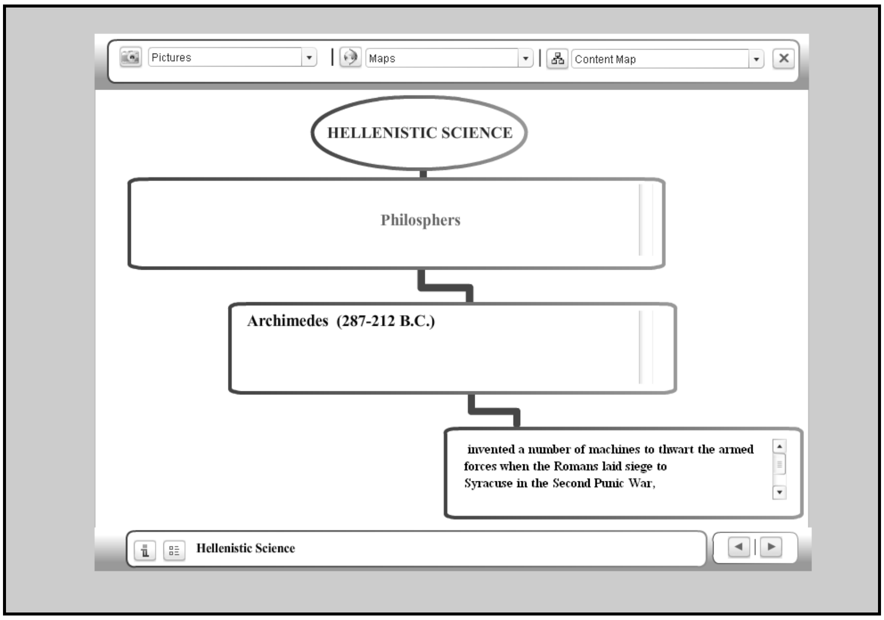

Fig. 1. Meta-cognitive tool loads content by XML

METHODOLOGY AND PROCEDURES

Participants

The study applied in "History of Civilizations" courses with students (n=167) of Faculty of Engineering at the Bahcesehir University. The participants were 167 undergraduates who attended all the lessons with power point presentations, with age (M=19, std.dev.=0.95).

Index of Learning Styles

Index of Learning Styles (ILS) instrument has 44 items. ILS instrument applied to the engineering students (n=167). The ILS results could give an indication of individuals' learning preferences and profile. The Index of Learning Styles is an on-line instrument to assess preferences of students on four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) of a learning style model formulated by Richard M. Felder and Linda K. Silverman. The instrument was developed by Richard M. Felder and Barbara A. Soloman of North Carolina State University [16]. The reliability and validity of the Index of Learning Styles has been tested in several studies and significantly found that is a suitable psychometric tool [17-

18]. In this study, only the visual/verbal and sequential/global dimensions were analyzed because of the learning tool is designed to cover these dimensions only.

Phase 1: The Classical Power Point Presentations

In the first phase, three chapters of History of Civilization course has been prepared by sticking to concept maps in the power points slides which designed by the SMEs. Each chapter takes six class hours and it has been given by the lecturer by regarding the contents of concept maps. After completing the classical lessons with presentations that based on concept maps, an online assessment with 45 items employed to students whose were attending all the lessons with power point presentations within 60 minutes time limit. The questions also were prepared by the SMEs according to the concept maps and power point presentations. After phase 1, students were offered to use the concept map tool in all lessons and ordered to complete the LIS inventory when attending to History of Civilization online course portal. These students were administrated the 44 itemed ILS instrument. Even though there was no time limit for completion, all the students finished it within average 60 minutes.

Phase 2: Meta-Cognitive Tool

In the second phase, the other three chapters of History of Civilization lessons have been prepared also sticking the concept maps. Then all the chapters are administrated by using the new developed module of online course management tool and the concept map based learning tool implemented both for the online and in class usage. After then, students were introduced the usage of the learning tool and they explored the tool freely in class for 10 minutes. They also recommended for trying the tool within online system. After a week later, the students get accounted to the tool, the lectures takes six class hours for each given with using concept based tutorial tool. After completing lessons with using the concept map based tool, another online assessment with 45 items employed to the students who was attending all the lessons with concept map based tutorial tool presentations in class or online within 60 minutes time limit. The questions also were prepared by the SMEs according to concept maps information. To ensure to have the same difficulty for the course content and the online assessment questions, the SMEs whitened in a dependent rating score.

CONCLUSIONS

As seen in figure 2, the students who get scores above the average of 55 points (std.dev.=18) of 100 points grades also achieve well and can get scores above the average of 60 (std.dev.=15) points out of 100 points. Difficulty of items has been balanced with the assignments of the both studies by the SMEs. We can suggest that students who are above average, they can benefit from the meta-cognitive tool. The students who are at average level at both studies are getting different scores that are unbalanced and unstable. Some of the students obtaining improvements but others show fails. On the other hand, students that far below the average are gets significant fall. The results shows that when developing a concept based learning tool, the students that can manage their learning by themselves and get higher scores in the classical power point based learning also gets higher scores and the usage of tool improves their performances and achievements. But the students who get average scores shows non-stable and significant improvements using the Meta

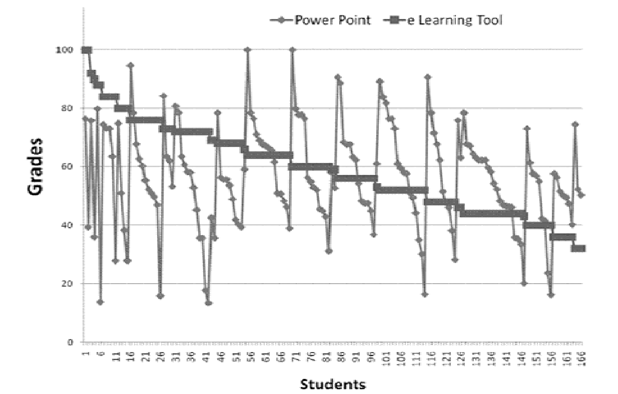

Fig. 2. Benchmarking the Power Point Lectures versus Meta-Cognitive Tool

cognitive tool. Students who are low achievers and far below the average of the first study cannot benefit the tool and their usage of the tool decreases their performance. The usage of such tool instead of classical PPTs within the control of the lecturer at the first hand cannot be suitable for low achievers. The results show that meta-cognitive tool that based on a concept map methodology is very useful and the addressing learners needs of achiever students above the average.

REFERENCES

[1] Coffey, J. W. A meta-cognitive tool for courseware development, maintenance, and reuse. Computers & Education, 48 (2007), 548–566.

[2] Novak, J. D. & Iuli, R. J. ,1991. The use of meta-cognitive tools to facilitate knowledge production. The Fourth Florida AI research symposium (FLAIRS '91), Pensacola Beach, FL, May, 1991.

[3] Novak, J.D., & Gowin, D.B. ,1984. Learning How to Learn. New York: Cambridge University Press.

[4] Novak, J.D. ,1998. Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations. Hillsdale, NJ: Lawrence Erlbaum Associates.

[5] Plotnick, E. ,1997. Concept Mapping: A graphical system for understanding the relationship between concepts. ERIC document, June 1997, EDO-IR-97-05

[6] Ausubel, D. P.,1968. Educational Psychology: A Cognitive View. New York: Holt,Rinehart and Winston.

[7] Ausubel, D. P., Novak, J. D. & Hanesian, H., 1978. Educational Psychology: A Cognitive View (2nd ed.). New York: Holt, Rinehart and Winston.

[8] Brumby, M.N. Consistent Differences in Cognitive Styles Shown for Qualitative Biological Problem-Solving, British Journal of Educational Psychology (52:2), J u n e 1982, pp.244—257.

[9] Felder, R.M. & Silverman, L.K. Learning and teaching styles in engineering education. Retrieved April,8,2007 from http://www.ncsu.edu/felder-public/Papers/LS-1988.pdf

[10] Felder, R.M.,1994, Meet Your Students: 5. Edward and Irving . Chemical Engineering Education, 28(1), 36-37 (Winter 1994).

[11] Felder, R.M.,1989. Meet Your Students: 1. Stan and Nathan. Chemical Engineering Education, 23(2), 68-69 (Spring 1989).

[12] Grabe, M, & Grabe, C.,2001. Integrating Technology for Meaningful Learning. Houghton Mifflin Company: USA.

[13] Cañas, A. J., Carff, R., Hill, G., Carvalho, M., Arguedas, M., Eskridge, T. C., Lott, J., & Carvajal R. Concept Maps: Integrating Knowledge and Information Visualization. Retrieved April 8,2007 from http://cmap.ihmc.us/Publications/ResearchPapers/ConceptMapsIntegratingKnowInfVisual.pdf .

[14] Safayeni, F., Derbentseva ,N., J. Cañas, A. Concept Maps: A Theoretical Note on Concepts and the Need for Cyclic Concept Maps . Retrieved April 8,2007 from http://cmap.ihmc.us/Publications/ResearchPapers/Cyclic%20Concept%20Maps.pdf

[15] Cowan, N. ,2001. The magical number 4 in short-term memory: A reconsideration of mental storage Capacity. Behavioral and Brain Sciences, 24 (1).

[16] Felder, R.M., Soloman, B.A., Index of Learning Styles. Retrieved April 8,2007 from http://www.ncsu.edu/felder-public/ILSpage.html .

[17] Litzinger, T., Lee, S. , Wise, J. & Felder, R., 2005. A Study of the Reliability and Validity of the Felder-Soloman Index of Learning Styles . Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition .

[18] Zywno, M. 2003.A Contribution to Validation of Score Meaning for Felder-Soloman's Index of Learning Styles. Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition

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User Interface Design for Mobile Learning Applications

Tsvetozar Georgiev, Evgeniya Georgieva

Abstract: *This paper examines the types of mobile user interface. A methodology for developing user interface for mobile learning applications is proposed. The requirements for mobile user interface are defined and a concrete approach for realisation is suggested.*
Key words: *Mobile Learning, User Interface, Human-Computer Interaction*

INTRODUCTION

Nowadays mobile devices become more widespread and are increasingly used for many purposes. Fewer customers worldwide use mobile devices only as a single function unit. Gradually these devices become a platform for a wide range of applications - shooting and sending photos, listening to music, watching video, receiving GPS information, obtaining information from Internet and others. The mobile devices also provide an opportunity for the realisation of mobile learning.

User Interface (Human Machine Interface) includes the methods by which the users interact with a device. The user interface provides two basic options [8]:

- Input, through which users can control and interact with a device;
- Output, which reflects the users' actions.

The development of user interface for applications for mobile devices - cell phones, smart phones, PDAs (Personal Digital Assistants) and super phones deserves special attention, as they have some limitations, most important of which are less screen resolution and smaller keyboard than the desktop computers [6, 7]. This is the reason why the user interface for mobile applications (Fig.1), including these for mobile learning, should be well designed and implemented.

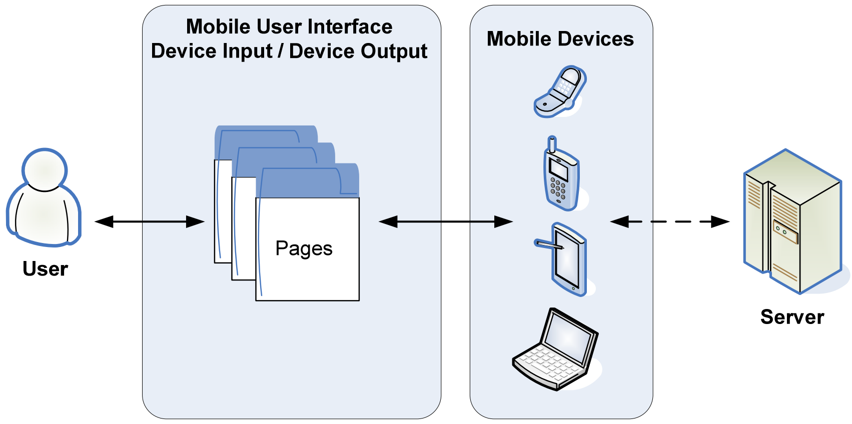


Fig.1. Mobile user interface

The paper examines a methodology for developing of user interface for mobile learning applications, the requirements for this interface are determined and a concrete approach for implementation is suggested.

LAYOUT

1. Types of mobile user interface

At present, two main types of mobile user interface are used:

- Graphical user interface (GUI) takes user's input information through various mobile computer keyboards (virtual, mini-QWERTY, foldable) and/or pointing methods which react to the screen. The GUI displays relevant information on the screen of the mobile devices.

- Web-based user interface accepts a user request, transmits it to web server, receives response and displays the information on the mobile device screen using mobile web browser.

2. User interface design

User interface design or user interface engineering is the design of computers, appliances, machines, mobile communication devices, software applications, and websites with the focus on the user's experience and interaction [8]. The main purpose of the traditional graphic design is to make a product attractive while the goal of the user interface design is to facilitate the user-application interactivity and to increase the effectiveness of the user's work.

Development of user interface for mobile application is a part of the overall process of design and development of a separate mobile learning application or of complete mobile learning management system [3]. Most often at this stage a graphic designer, a user interface designer and a programmer work together.

There are several iterative stages during the development of the user interface for mobile applications:

- Analysis of potential users;
- Definition of the functional requirements to the user interface depending on the purpose of the application and the potential needs of the users;
- Development of a navigation scheme of the application;
- Development of a prototype in the form of a simple interactive screens, which include basic information - text, graphics, audio and video;
- Testing with emulators - testing the prototype with appropriate emulators for mobile devices (embedded in the development environments or provided by other developers);
- Usability testing - testing the prototype with real users from different groups [5] using mobile devices;
- Development of final version of the user interface. The results of testing with the emulator and/or testing with real users may be taken into account. If it is necessary the architecture of the application can be changed. In some cases it may be necessary to develop different graphic templates for different screen resolutions.

3. Designing for different screen resolutions

Development of user interface for personal computers is easier than for mobile devices because of the following reasons:

- PCs support higher resolution (at least 1024x768 pixels);
- PCs have a full size keyboard;
- The users can use mouse as a pointing device.

The great diversity of supported screen resolutions (Fig.2) - from 128x160 pixels to 480x800 pixels, and methods by which the users can interact with applications and to input information in mobile devices is observed.

If a web-based user interface is developed one solution is to provide recognition of the web-browser and the resolution of the device and to implement adaptation of the information for the purpose of appropriate visualization. It is also recommended to group some resolutions to reduce the number of supported resolutions and to reduce the complexity in the development of different design of user interface [1].

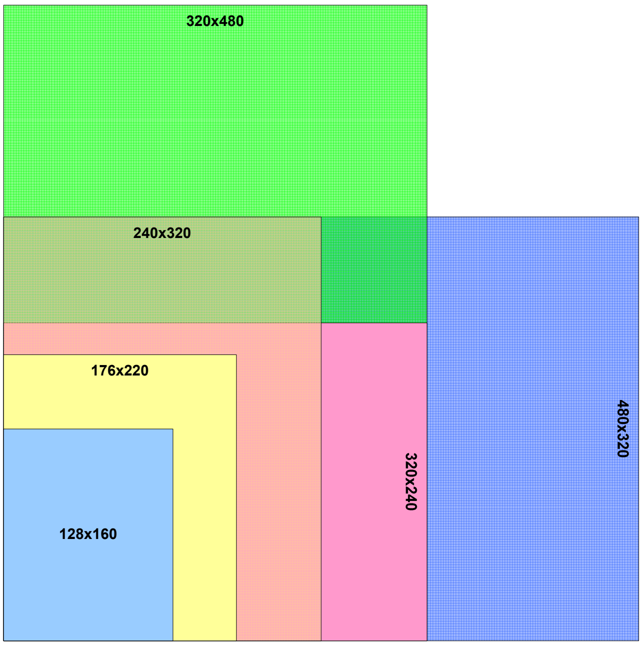
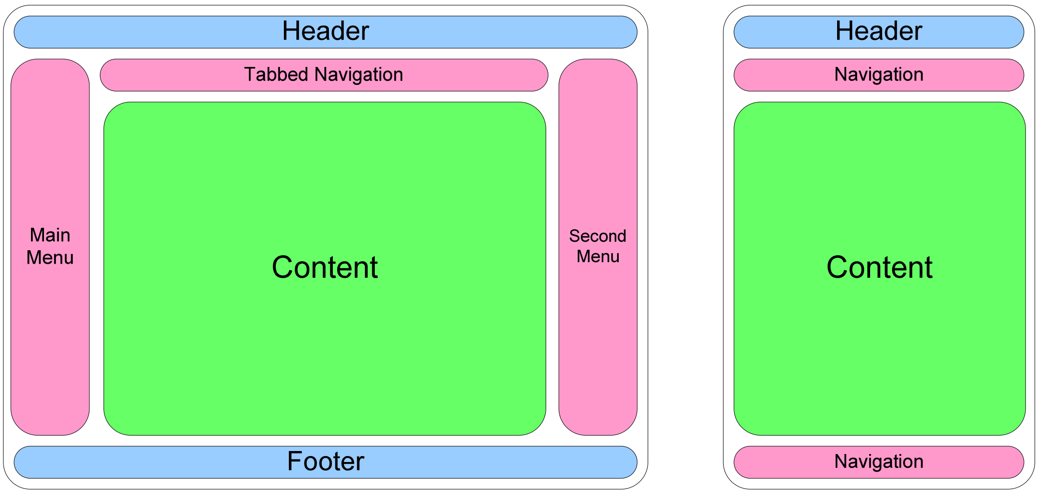


Fig.2. Mobile devices main screen resolutions

Development of a graphical user interface of a mobile application for all platforms and resolutions at this time is a difficult task. In general a mobile application for concrete platform and resolution is developed.

4. Mobile navigation paradigms

At present a variety of navigation schemes for e-learning systems are applied. Very often a tabbed navigation and/or menus navigation located in left and right sides of the main content (Fig.3a) are used. They are suitable for use in PCs, Notebook and Netbook computers that have high screen resolution, full sized keyboard and mouse.



a) b)

Fig.3. Most used navigational schemes
a) for personal computers; b) for mobile devices

These popular schemes are not applicable to mobile devices since they have a small screen, small keyboard and limited methods of navigation.

Preferred method during the development of mobile navigation schemes for mobile phones is using a numbered vertical list of options which are associated with the corresponding numbers (0-9) from the phone's keypad [1].

During the development of navigation for PDAs or smart phones more modern methods of navigation can be applied. However, the orientation of the screen should be taken into account, as most of mobile devices still work in a vertical mode and they cannot display text in several columns. It is recommended that the navigation scheme support two fields with navigation - at the top and bottom of the screen (Fig.3b) and the information is visualised between them [1].

5. Requirements for realisation of user interface for mobile learning applications

The following requirements to the user interface of mobile learning applications can be defined:

Regarding the navigation:

- The navigation should be intuitive, located at the top and/or bottom of the screen and must support work with mobile device keyboards.
- To reduce re-visualization of the main menu and submenus of each screen (page) it is appropriate to place them on individual screens and the navigation must support links to these screens.
- The navigation buttons should be large enough to work with them using stylus or touch screen.
- The navigation elements should be visualised in the same way on mobile devices with different screen resolution.
- It is better to provide a choice of several options, rather than to enter the text [6].

Regarding the multimedia elements:

- The length of the text must be consistent with the size of the screen and not more than 3 times the height of the screen [6].
- Horizontal scrolling of the text must be avoided.
- A possibility to change the font size must be provided. This will give an opportunity to users to increase or decrease the font size when it is needed, as the text with small font size is difficult to read [4].
- Due to the lower screen resolution serif text fonts should be used.
- The text should be easily reading and for this purpose it should be contrast on the background.
- The size of graphic images (in pixels) must be consistent with the size of the screen.
- It is appropriate to separate graphics from the text - for example on separate screens (pages) which to be displayed only by user's request. This will increase the speed of loading pages containing mainly text information.
- If the application includes audio and it is intended to be controled by the user, it is appropriate to provide a separate screen on which the control elements to be arranged.
- If the application includes video a separate screen for its reproduction also has to be provided.

Regarding the verification of users' knowledge:

- In the implementation of tests is appropriate that the questions and tasks to appear on separate screens.
- It is best to use "true-false" or "multiple choice" questions types. If "fill in the blank" type is used, the text that users must type in should not be too long.
- If during the tests a specific time for their completion is given, it must be greater

of the time that is given to the same tests, but performed on personal computers. In literature source [2] is determined that the text entry speed in mobile devices is about 3 times lower than that of PCs.

6. Realisation of user interface for mobile learning applications

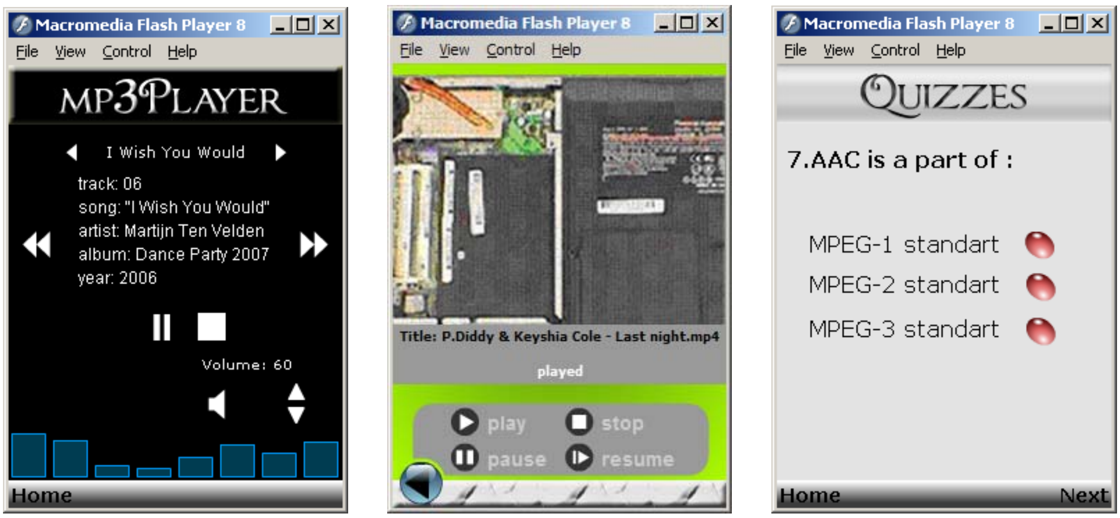
Thus defined requirements are used in the realisation of the user interface for mobile applications for teaching the course "Multimedia systems and technologies". These applications are developed using Adobe Flash.

Fig.4 shows screens of a mobile multimedia application for training on theme "Audio". On Fig.4a and Fig.4b is shown the ability to change text font size. On the same screens there is a link to other screen (Fig.4c) on which the user can see the image associated with the text.

a) b) c)

Fig. 4. Screens from multimedia mobile learning application "Audio"

Fig.5 shows relevant screens for audio control (Fig.5a), for video control (Fig.5b) and for testing students' knowledge (Fig.5c).



a) b) c)

Fig. 5. Screens from multimedia mobile learning application "Audio"

CONCLUSIONS AND FUTURE WORK

The user interface for mobile devices is crucial in the development of mobile learning applications. The well designed user interface of a mobile application can attract customers while the good functionality and learning content can keep them to use it.

The proposed methodology and the defined requirements can be used for development of a graphical user interface as well as for development of web-based interface for mobile learning applications.

They are practically implemented during the development process of series of multimedia mobile applications for training students at the University of Ruse in the subject "Multimedia Systems and Technologies".

REFERENCES

[1] Cremin, R. et al. DotMobi Mobile Web Developer Guide, mTLD, Ireland, 2007.

[2] Georgiev, T., E.Georgieva. Investigation of the Text Entry Speed and Accuracy in Mobile Devices, Proceedings of the CompSysTech'2009, Rousse, Bulgaria, June 18-19, 2009.

[3] Georgieva, E., A.Smrikarov, M.Teodosieva. Mobile Learning Systems Development Methodology. Proceedings of the Second International e-Learning Conference, September 6-7, Berlin, Germany, 2005. Gent, Belgium, 2005, pp.135-147.

[4] Gong, J., P.Tarasewich. Guidelines for Handheld Mobile Device Interface Design, http://www.ccs.neu.edu/home/tarase/GuidelinesGongTarase.pdf

[5] Hussain, Z. et al. User Interface Design for a Content-aware Mobile Multimedia Application: An Iterative Approach, MoMM 2007 & iiWAS 2007 Workshops Proceedings, pp.115-120.

[6] Tobar, L.M. et al. WebA Mobile (Web Analysis Mobile): Assistance Tool for the Design and Evaluation of Websites for Mobile Devices. New Trends on Human–Computer Interaction, Springer-Verlag, 2009, pp.127-139.

[7] Tselios, N. et al. Design for Mobile Learning in Museums, Handbook of Research on User Interface Design and Evaluation for Mobile Technology, Volume 1, Information Science Reference, USA, 2008, pp.253-269.

[8] User Interface and Design, http://www.scribd.com/doc/2409206/User-Interface-Design

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Virtualization for On-line computer labs

Juan J. Ortega, Isaac Agudo

Abstract: *Virtual or On-Line computer labs provide students with the possibility of carrying out most of the usual lab activities, but from almost anywhere, even in their own homes A virtual computer lab is a broad concept, developed to allow students to work with software or complex equipment that cannot be easily distributed. Two of the main advantages of using virtualization are that it allows student access to some complex equipment or piece of software that cannot be easily distributed and its cost saving feature.*

Key words: *On-line computer labs, Blended-learning, Virtual computer labs, and Virtualization.*

INTRODUCTION

Virtual or On-line computer labs are a means of offering a similar experience to that of physical computer labs, but allowing students to perform most of the labs activities from almost everywhere, even at home. A virtual lab is a broad concept, whose main advantage is that it allows student access to complex equipment or software that cannot be easily distributed. On-Lab [6] is a tool which offers a web environment, where interfaces can be quickly and easily developed for physical or virtual lab instruments and on-line exercises can be created based on those instruments.

Virtual computer labs are becoming a vital part of teaching computer science using blended learning [1,3,5]. Blended learning [2,4] is an emerging trend in education and can be considered the first step towards achieving a full e-learning experience. The Andalusian Virtual Campus[2] (AVC) is an example of how Andalusian universities are moving towards e-learning. In this virtual campus, ten universities share a common space where some courses are officially offered by e-learning.

As mentioned before, one of the main difficulties that has to be faced in this kind of experience is the remote use of the required software and hardware resources. Being able to offer virtual labs helps us to:

- Reduce the number of software licenses
- Save installation time and money
- Improve accessibility to the software.
- Increase the availability of the labs to 24/7.

PROPOSAL

We have created an infrastructure of virtual computers based on classic web technologies that allow students to connect to a computer inside the University at any time and from anyplace, without having to install the centralized software in their own computers.

This virtual infrastructure provides the following advantages:

- A central server stores all the virtual computers. This way fewer physical computers are needed and existing ones will be used more efficiently (for management of the global storage capacity, percentage of CPU load, reusing old software licenses, clusters, etc.). This translates into a meaningful reduction of the hardware cost, its maintenance and the space required for storing it.

2 http://www.campusandaluzvirtual.es/

- Any application installed in the virtual computers works in the usual way and devices connected to the host computer like printers, CD-ROMs or DVD-ROMs or any other will be available to the virtual computers.
- The teacher can create a virtual computer template that only includes the software required by their particular students. This avoids having to coordinate all the teachers regarding specific software versions, etc.
- Each student is assigned their own virtual computer in which they can work on their exercises and homework.
- The changes that the students make to their virtual computers will not affect the host computer.
- If a virtual computer crashes this will not have any effect on the rest of the virtual computers or even the host computer.

The other existing resources in the labs must be available to be accessed remotely when the computer labs are closed, at night or at weekends..

There are several different schemes available for virtualization depending on the purpose of the virtual systems. Below, we propose one such scheme that easily allows the implementation of a virtual computer lab.

At least a server is required that stores and runs all the virtual computers, as we can see in Figure 1. Depending on the number of virtual computers necessary, we may require more than one server to run and store them.

Apart from the server that stores and runs the virtual computers, the role of the broker that offers the interconnection of the virtual computers and the physical computers in the classical labs is vitally important.

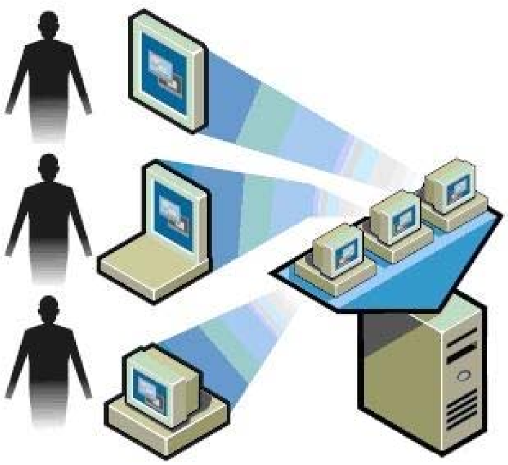

Fig.1. Scheme of VMware ESX Server and Virtual Center

The software that offers the emulation of the virtual computers is VMware ESX and VMware Virtual Center. The first is a Linux operating system adapted to emulate the virtual computers. The second helps to manage in a centralized way the different virtual computers. Both applications can be run in the same or in different servers. In Figure 2 we can see how it works.

We have chosen VMWare because it can virtualize the x86 platform instead of emulating it. This way, most of the code is run directly on the physical hardware, which provides better performance.

Technically speaking, the creation of a virtual computer per student requires a minimum of 1 or 2 GB of storage for the operating system plus additional space for the applications that have to be installed.

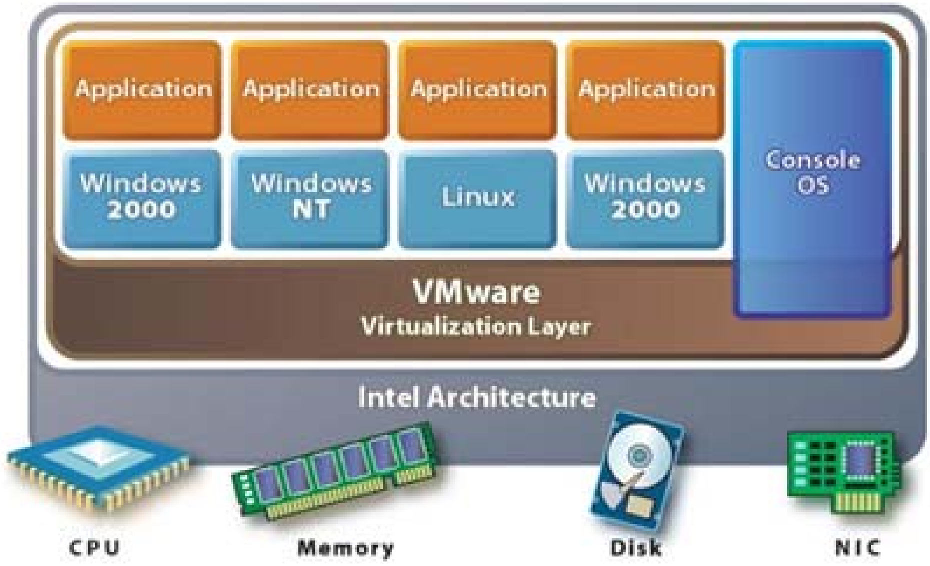

Fig.2 Virtualization in an auxiliary operating system

Students and teachers access the virtual computers using a conventional Web browser via the Internet using an RDP viewer applet. This is essential to provide an operating system independent access to the system.

COST

One the main problems that this kind of initiative has to solve prior to being put into practice is the balance of costs between the previous approach and the new one. Clearly this approach is more appropriate for the university environment where students usually require access to resources after class and where the needs for access vary from one student to another. However, the approach has also to be reasonably inexpensive, to implement, in order to convince the University of its real benefits.

In order to establish the implementation costs, we made a first draft approximation of what the cost would be of the equivalent (physical) computer labs. This is an estimation only, but it gives a rough idea of the cost.

The main parameter influencing the cost of implementation is the number of virtual computers running simultaneously. For our estimation, we set our requirements to 40-50 virtual computers, bearing in mind that the load of the system may be affected by the applications being run in each of the virtual computers.

Hardware

After some preliminary conversations with the VMWare technical service, the following requirements were established for the server for storing and running the virtual computers:

- 2 Processors Quad Core AMD Opteron
- 32 GB of RAM
- 3 Network Cards (NIC)
- Storage SCSI 1 TB

After searching the market for computers that fulfilled these requirements, validated by VMWare, we found the HP Proliant 380 DL server, which had a good Price-Quality ratio. The cost of this server is approximately 3.000€, not including maintenance. The ideal hardware configuration will employ two servers running concurrently, ensuring greater fault tolerance and capacity.

Software

In order to implement the system we also need the following software **VMware ESX** and **VMware Virtual Center**, as explained previously.

A rough estimation of the costs for a VMware ESX license and a Virtual Center for around 40 virtual computers including Gold Support is 7.000 € VAT included[3]

Having two servers requires an additional licence for VMware Infrastructure, (VI-ENT-A y VI-ENT-G-SSS-A), although only one Virtual Center license is needed in order to manage these two servers.

As mentioned in the introduction, in order to manage the virtual computers we need an application that plays the role of a broker. The cost of the Sun&Seeds broker is approx. 50€ (VAT included) for each virtual computer when the number of total licenses is less than 60, which is our case. Thus, the estimated cost for our architecture using the Sun&seeds Broker is almost 5000€, taxes included.

Putting together the hardware and software cost makes a total of approximately **15.000€** which is roughly half the price of setting up a traditional computer lab at a price of 400€ per computer.

Performance

This system had been used in the last academic course, but only in the AVC subjects. The theoretical configuration says a good performance can achieve using approximately 8 virtual machines per CPU core. Then, for a server that has two quad core processor the theoretical limit of virtual machines running simultaneously would be 64.

We have checked that in practice, with this processor the real limit was approximately on 35 concurrent virtual machines, although it depends on what kind of applications the students are running in each of the virtual machines. For this particular estimation the students were using the software Mathematica, from Wolfram. We have had an average of 30 different virtual machines running per day, and a maximum of 10 concurrent virtual machines.

CONCLUSIONS AND FUTURE WORK

E-learning requires new resources to achieve a collaborative environment where professors and students can interact. When these resources are software applications we should be able to use them regardless of the final user operating system or the other software installed. Nevertheless, the user cannot install these applications when a commercial license is required, so a way to provide a remote access to such applications must be made available.

The best way to guarantee that users can avail of these applications is to provide remote access to a virtual machine. Each virtual machine is independent and it can be copied many times. Each one has its own operating system and software applications. An important part of the infrastructure is the broker. This is the web application that provides user authentication and virtual desktop access. It is interesting to note that the resulting architecture is not only more flexible than a traditional lab but it is also less expensive and easier to manage.

In the Andalusian Virtual Campus a VMware solution has been adopted. This approach offers an end-to-end solution called VMware View (formerly VMware Virtual

3 The VAT rate in Spain is 16%

Desktop Infrastructure (VDI)) that organizations use to provide remote users with access to virtual computers that are hosted in a central datacenter.

As future work we are developing a federated identity so that every federated user can be authenticated in a virtual machine and depending on the user attributes, they will be able to access a specific virtual machine.

REFERENCES

[1] Jianjun Xie, Junhong Li, Yi Geng, "Blended Learning in Computer Hardware Course Education," csse, vol. 5, pp.905-908, 2008 International Conference on Computer Science and Software Engineering, 2008.

[2] R., & Allen, S. (2005). Blended learning: An emerging trend in education. In C. Howard, J. V. Boettecher, L. Justice, K. D. Schenk, P. L. Rogers, & G. A. Berg (Eds.), Encyclopedia of distance learning (pp. 172–179). Hershey, PA: Idea Group.

[3] Fu Wang, Joseph Fong, Marian Choy, Tak-Lam Wong, "Blended Teaching and Learning of Computer Programming" Advances in Web Based Learning – ICWL 2007 (2008), pp. 606-617.

[4] C.R. Graham, "Blended learning systems: definitions, current trends, and future directions," Handbook of Blended Learning: Global Perspectives, Local Designs. Bonk and Graham (eds), Pfeiffer Publishing, San Francisco, CA, 2006, pp. 3–21.

[5] Abbas El-Zein, Tim Langrish and Nigel Balaam. 2009. Blended teaching and learning of computer programming skills in engineering curricula. Advances in Engineering Education. Winter 2009 Volume 1 Number 3

[6] Marco Alfano, Biagio Lenzitti , Rocco Versace, "On-Lab: A web environment for On-line Labs development" International Conference on Computer Systems and Technologies - CompSysTech' 2005

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An Approach for Development of Remote Access to a Real Laboratory on Embedded Systems Course

Orlin Tomov

Abstract: *This paper focuses on the process of building an universal system for a remote access to devices for educational purposes. The aim of the project is to find a solution for remote access to development training boards, based on MCS51, AVR, PIC, ARM, and other embedded microcontrollers from anywhere and anytime.*

Key words: *Computer Systems and Technologies, Remote access, e-Learning, Embedded systems, Microcontrollers.*

INTRODUCTION

The term "e-Learning" nowadays is being herd more and more frequently. The reason for this is the dynamic of the life and the new demands for the modern human. Laboratory experiments are a vital part of engineering education, which have been considered for a long time as impractical for distance and e-learning learning. However, recent advances in Internet/web technologies and computer-controlled instrumentation presently permit net-based techniques to be utilized for setting up remote laboratory access [1].The trends for development of the modern technologies require more flexible and continuous learning. This is a process that starts with the human birth and it is a lifelong. Thus we talk often about life-long learning. The both phenomenon – e-learning and life-long learning are demanding new approaches and technologies for conducting and supporting the learning process. This process should be adapted for the daily round tasks and it should not disturb the routine business and personal engagements. That's why the requirements for this process are quite complex. The modern learning technology should allow usage, independent from the place and time. The instruments providing it should be flexible, scalable, intuitive and able to give a "touch" to modern and expensive equipment.

THE PROBLEM

To provide the "touch" to learning equipment for the "Embedded Systems" course, in the Department of computing in the University of Ruse, we decided to use a system for remote access and control. Such systems exist and are used from a couple of years. One of the popular is Nokia's RDA (Remote device access) [2], which allows access to their symbian based phones to programmers, testers, enthusiasts, or just curious buyers, who would like to play with the device and to evaluate it before buying. This approach is quite useful, since for a software developer it will be quite expensive, if he has to own all of the devices that could run his application and to test it.

Another solution for remote access is the LabView suite from National Instruments [3]. It provides remote access to National's products and is quite popular for internet access to the labs [4].

On one hand there are existing systems that allow remote access, but there are two main problems for their usage:

- The first one is the price – since we talk about department of "Computer Systems and Technologies", it is more appropriate such system to be developed by its staff and students, rather than spending funds for it;
- The second factor is the universality – usually these systems are quite specific and they work only for a given scenario and hardware equipment. In this meaning they are "custom" systems and the cost of ownership includes also a kind of a customization, which can vary from just a slight cosmetic adaptation to re-engineering of the product

THE SCENARIO

For the course "Embedded Systems", we are using hardware development/evaluation boards, based on MCS-51 MCUs. The students can access them only during the normal classes. This way they can not experiment their own projects, ideas, or just experimental analyze the details of the microprocessor family. On another hand, the teachers could not place assignments, related with the development boards without such a system. Besides it should allow access control and priorities for the different groups of students. Obviously the students that have assignments should be in the highest priority list. The ones that attend the course are in the lower and the rest of them are in the lowest priority list.

The next question we have to answer is the technology of access and feedback. The two possible variants for our case are:

- Feedback via software kernel, which allows program execution, using time division and communication via RS232. This could be a nice solution if we had only one kind development boards. Having different boards, with different MCUs require different versions of the software kernel, which is quite time consuming, expensive and not so flexible.
- Using video feedback is a much simpler solution, which allows the usage of different development boards and peripheral devises with minimal costs and efforts. The system is web based and could be easily integrated with the existing e-Learning platform. Actually, it could be built as a plug-in module for the e-Learning system. The additional software, needed in this case is a program loader (usually free, downloaded from the manufacturer) and a video streamer and client (in our case Adobe Flash based, which is also free and open source)

Figures 1 and 2 represent the main stages of the process of scenario development and application building.

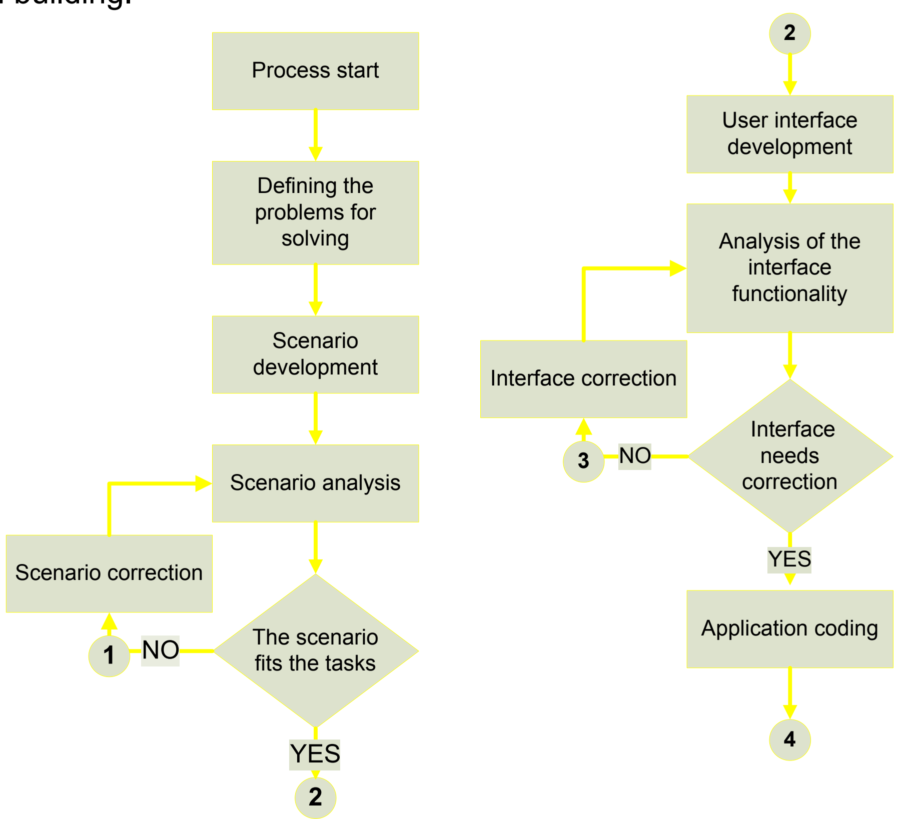

Fig.1

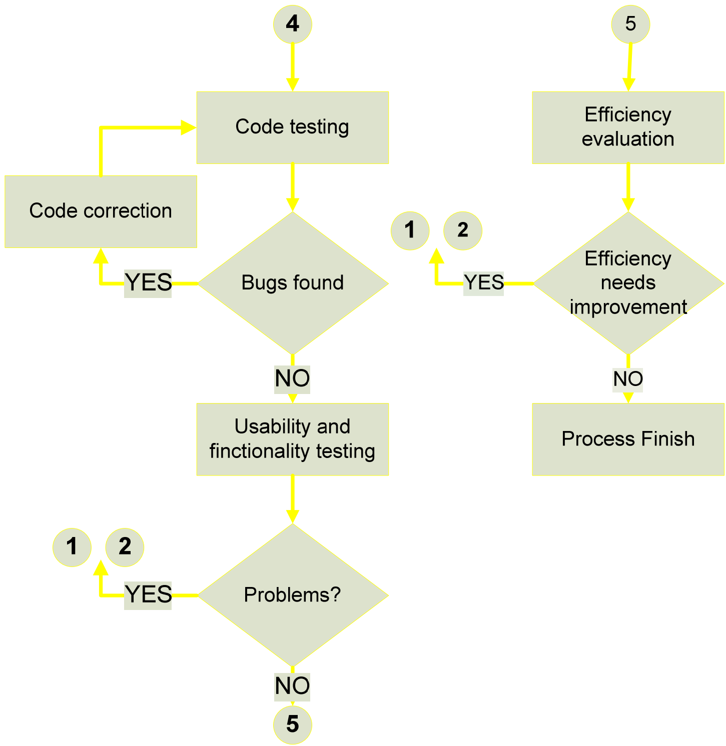

Fig.2

THE ALGORITHM

The aim for the algorithm realization was to keep it as simple as possible. The stages are:

- Authentication – here the user identifies him to the system. We use the login database from the existing e-Learning Shell, which saves time and it is not necessary to create new users;
- Checking for an available device – since the devices are limited, and the students are generally more than the available development boards. It is possible a student to attempt access, when all boards are busy;
- Suggest a time slot – if all boards are busy, then suggest a time, after which the student will get access to the device;
- Slot reservation – the user may accept, or deny the use of the suggested slot. This may happen if the waiting time is too big. In case of deny – the system finalizes the session;
- Grant access to the device – at this stage is the real work of the student with the board;
- Free the device after slot expiration – after given amount of time, the device access should be granted to another user

The described stages are illustrated on figure 3.

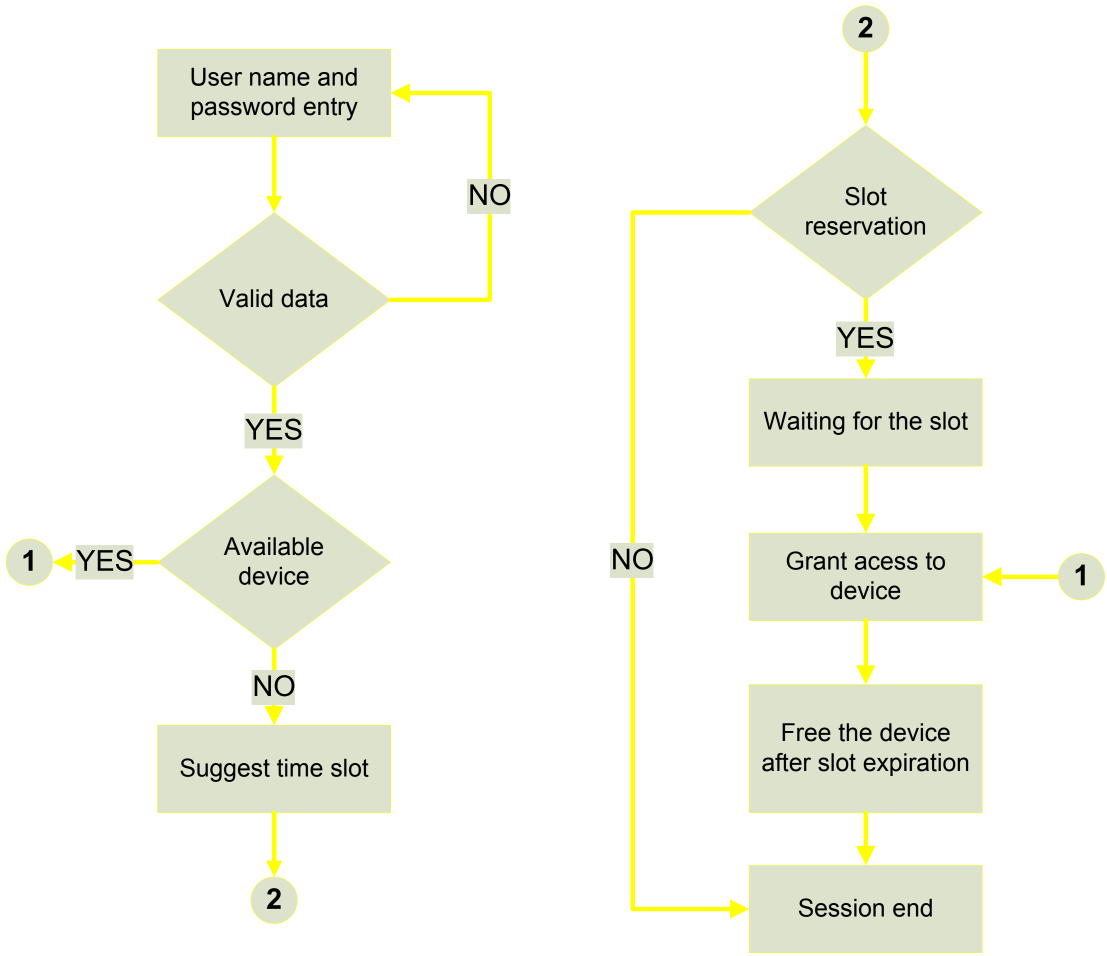

Fig.3.

CONCLUSIONS AND FUTURE WORK

The realization of the remote access system should improve the usability of the laboratory devices and should motivate the student of hardware course to spend more time on development and research. This technology should ease their access to development equipment.

Next step on this project is to test the system in real conditions and to define the length of the time slot. It should be not too long in order to keep the time for waiting as short as possible. After this step is done, the system should be integrated with the e-Learning Shell system as a module and priority queues should be organized, for at least three levels:

- First level priority – the priority level for students with assignments;
- Second level priority – for students, currently attending the course;
- Third level priority – for all other users of the system.

In parallel with the prioritization, we should develop also a user interface for the teachers to manage student accounts in these 3 priority groups.

REFERENCES

[1] Shen, H., Xu, Z., Dalager, B., Kristiansen, V., Strøm, Ø., Shur, M. S., Fjeldly, T. A., Lu, J.,Ytterdal, T., "Conducting Laboratory Experiments over the Internet", IEEE Trans. on Education, Vol. 42, No. 3, 1999, pp. 180-185.

[2] http://wiki.forum.nokia.com/index.php/RDA

[3] http://www.ni.com/labview/

[4] Smith, K.., Strandman, J. O., Berntzen, R., Fjeldly, T. A., Shur, M. S., Shen, H., "Advanced Internet Technology in Laboratory Modules for Distance Learning", Proc. ASEE 2001 Annual Meeting, Albuquerque, NM, accepted for publication.

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A Computer-Based Approach for Software Engineering Teaching

Violeta Bozhikova and Nadezhda Ruskova

Abstract: *In this paper, we describe our experience with teaching software process development using computer-based approach. Problems in teaching Software Engineering discipline are in keeping students motivated and focused on general ideas instead of details. Our goals during the last years were to help students develop good software development habits, and to encourage them to see software engineering as a systematic and computer-aided discipline. A package for laboratory exercises and self study has been developed for this purpose and its model is described in the paper.*

Key words: *Computer- Based Teaching, educational software, Software Engineering course*

INTRODUCTION

In this paper, we describe our experience with teaching software process development using computer-based approach. Problems in teaching Software Engineering discipline consist of keeping students motivated and keeping them focused on general ideas instead of details.

Most of the typical undergraduate software engineering (SE) books [1-5] accentuate on the theory of software development (process, requirements, design, testing, and project management) but do not discuss enough the real software development practice (few pages in the books actually discuss use cases) or discuss practices that can be applied only to large projects. Methods for teams of less than ten developers are not enough discussed in the literature; yet these methods could help new engineers succeed with their first projects.

As a result of the dominating survey-style approach of the above textbooks, the students lose motivation and find them irksome. We can claim that students learn best when they learn something they can understand and really apply. Based on our more than twenty years practice in Computer Sciences and Engineering Department of the Technical University in Varna we are persuaded that one of the main goals during each software engineering teaching course consists of practice students how to use a couple of techniques and tools for real software projects development.

TEACHING SOFTWARE ENGINEERING – COMPUTER-BASED APPROCH

The teaching package

Our goals during the last two years of software engineering teaching were to help students develop good software development habits, and to encourage them to see software development as a systematic and computer-aided discipline. Developing and using a package of different tools during the labs we tried to ensure the students that the tools are very important, useful and effective in the real software development practice. We hope we have found an effective teaching approach that we would like to present in this paper.

Our software development teaching model (figure 1) during the last couple of years accentuated on the applied side of software engineering teaching, using a package of tools, instead of trying to instruct students in theory. An opened for later extension package for laboratory exercises and self study has been developed for this purpose. To the moment it consists of the following four tools:

- A tool for Software Project Management (PMS), presented in [6].

Project management software (PMS) is a term covering many types of software, including scheduling, cost control and budget management, resource allocation, collaboration software, communication, quality management and documentation or administration systems, which are used to deal with the complexity of large projects. PMS that we have developed can be determined as native web-based and multi-project enabled PMS. Each user can work on more than one project and on more than one task. The projects have specific starting and completion dates that can be controlled by the project leader and the user himself.

- A tool (VLT) with lecture notes, exercises and tests in Microsoft.Net programming.

VLT is a case of web-based laboratory educational software that aims at helping the student study the relevant program language. Before doing the current laboratory exercises, the students could read the language materials. Choosing "Tests" pane the students could make the corresponding quiz and evaluate their learning progress (see figure 2). The teacher also can analyse the students' results, and get an overall view for the progress of the students. The architecture of the developed web-based tool provides instructors a possibility to easily create and manage different course materials. Nevertheless the tool doesn't impose limitation about the program language materials the students are suggested to use a .Net language.

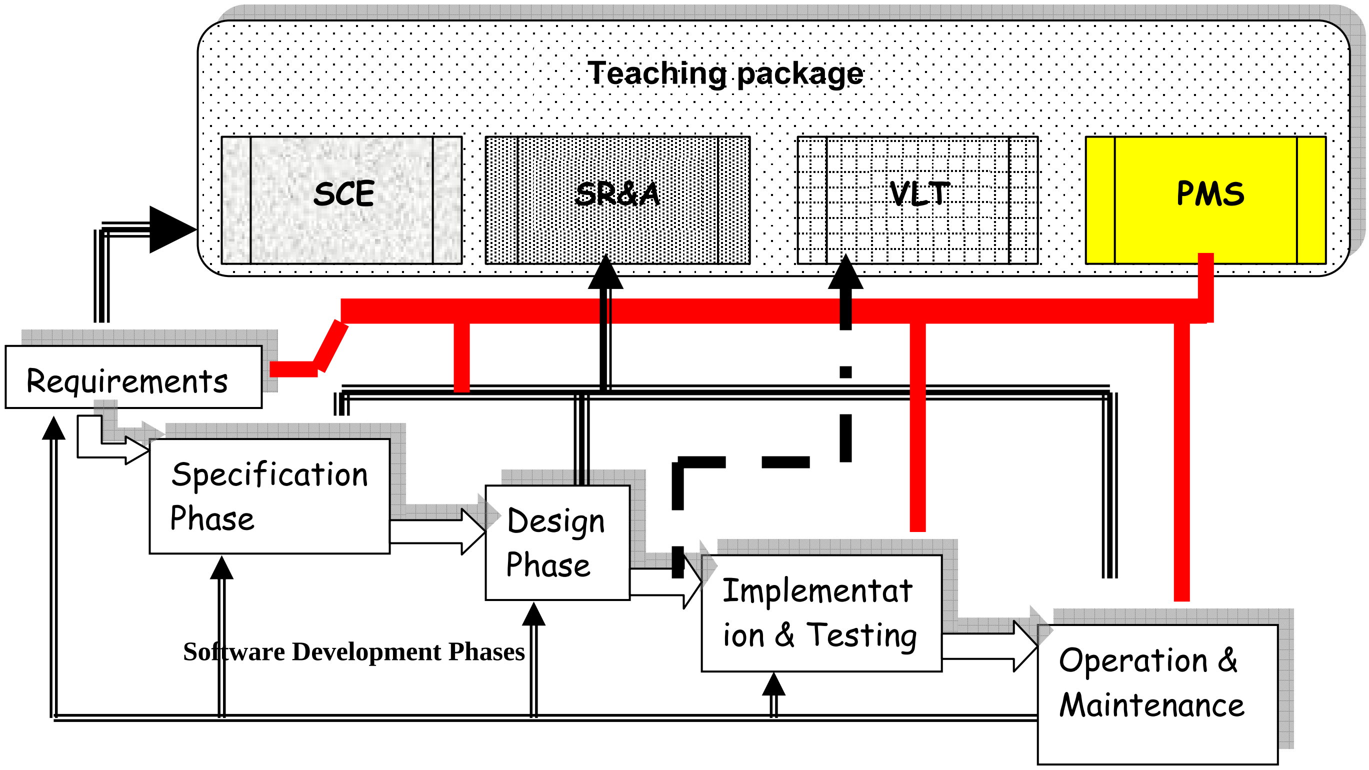

Fig.1: Computer-based approach for software engineering teaching

- A tool for Software Cost Estimation (SCE).

The tool (see figure 3) is based on the widely used Basic COCOMO and COCOMO II models [1-5] for software cost estimation. Software estimation is the part of project planning devoted to estimating the size, effort, time, people required etc. Software estimation process gives the information needed to develop a software project's schedule, budget and assignment of personnel and resources. Estimating product size is the basis of software estimation. The following three measures are generally used for software size estimation in the developed tool: Source Lines of Code (SLOC), Function Points and Object Points. Using size as input, estimates of effort applied, development time and people required can be made. Below the basic COCOMO equations are presented:

Effort Applied = $a_b(KLOC)^{b_b}$ [man-months], where KLOC=SLOC / 1000.

Development Time = $c_b(\text{Effort Applied})^{d_b}$ [months]

People required = Effort Applied / Development Time [count]

The coefficients a_b, b_b, c_b and d_b depend of the mode of the project (organic, semidetached or embedded) and are 2.4÷3.6 for a_b, 1.05÷1.20 for b_b, 2.5 for c_b and 0.38÷0.32 for d_b. According to Boehm in organic mode, relatively small software teams develop software in a highly familiar, in-house environment. The semidetached mode of software development represents an intermediate stage between the organic and embedded modes. In embedded-mode the software teams develop software respecting a complex of strongly constraints, such as hardware, software platform, etc.

- A tool for Software Re-structuring and Analysis (SR&A) is integrated in the package [7].

Using this tool the students can specify, document, analyze and re-structure the software structure. During the specification stage the students specify the software structure as a weighted oriented graph G=(X, U), where X (N=|X|) is the set of numbered nodes that models the set of components (classes, modules, files, packages, etc.) of the software system and U is the set of edges that represent the dependencies (e.g., procedural invocation, variable access, etc.) between the components of the software system. The weight w_i of each node $x_i \in X$, i=1…N could be interpreted as the number of the component's elements (for example as the number component's functions) or as the importance (rank) of the corresponding component. Next, the students choose the appropriate re-structuring analysis algorithm, based on Cluster Analysis method, Formal Concept Analysis (FCA) method or Program Slicing techniques. A set of heuristic algorithms corresponding to the cited analysis methods are available: a descent hill-climbing algorithm, a Tabu-Search algorithm, a FCA – based algorithm and a static slicing algorithm extracting components of the program (slices) that effect on the values of some variables (the slicing criterion). The last algorithm is based on well known Depth-first search (DFS) algorithm for traversing the graph G. The first three algorithms treat re-structuring as an optimization problem: each algorithm tries to find a "good partition" of the graph G, minimizing a goal function "k" (1) and satisfying the constraint W_0 (2) related with the weight W_d (W_d is the sum of the weights of all nodes in cluster X_d) of each cluster X_d, (d=1…M, $\cup X_d = X$) produced. Changing W_0, the students can change the number of the clusters and can guide the algorithm to converge to a different solution.

The tool provides visualization of the initial software structure and the re-structured solution (the final solution). In order to find a better solution this feature helps the students to make the appropriate changes to the initial software structure.

$$k = \frac{1}{2} \sum_{i=1..M} \sum_{j=1..M} k_{ij}, \forall i \neq j \quad (1)$$

$$Wd = \sum_{x_i \in X_d} w_i <= W_o \quad (2)$$

The goal function "k" (1) is sum of the number of edges between the clusters in a partition found. It is a measure of the quality of the partition. The "good partition" minimizes its value. "M" is the number of clusters in the given partition; k_{ij} is the number of edges between each couple of clusters.

The teaching experience

During the first five weeks of each usually fifteen weeks term the students created teams and started on learning the needed environment (Visual Studio.Net) and the programming .Net language using the integrated in the package tool (VLT) with lecture notes, exercises and tests (see figure 2).

During the next two weeks the students started on developing their term project in teams. They specified, approved and estimated the software project with the aid of

SR&A and SCE tools. The team leader shared the different tasks between the team members.

During the next six-seven weeks the team members worked on coding their term project. They demonstrated the realized .Net solution in the last week of the semester and presented the created specifications and user documentation. The team leader was responsible for the overall team work. Using PMS the team leader effectively managed the project works.

CONCLUSIONS AND FUTURE WORK

Our experience with teaching software process development using computer-based approach is commented in this paper. Problems in teaching Software Engineering are maintaining enough self-discipline and finding proper tool support.

The paper presents an effective computer-based approach for Software Engineering teaching. An extensible package of different tools has been developed for this teaching course, its model is described in figure 1 and our experience with its usage is briefly commented. Our observation is that the effect on the rate of student learning is positive. The number of students choosing term projects and graduation thesis, based on .Net Framework has increased nearly twice. It is evident that as a result of this approach the students will be able to work as part of a software development team when they graduate. In the last decade a lot of foreign software companies have entered our country that needs skilled professionals. The number of graduated students working in leading industrial companies and developing high quality code in Microsoft.NET programming environment increases significantly. Using the computer-based approach, the students obtain very quickly the following software engineering skills:

- Use Software cost estimation tools during the early software development phases (like SCE).
- Create and adjust the specifications using the software re-structuring tool (SR&A). The student learn that when the specifications change (as a result of the change of the requirements), the specifications must respond to the changes.
- The students learn just enough the graph theory to make describe the system's structure and to use efficiently the software re-structuring tool.
- The students must also provide user documentation. The created specifications can be used as documentation (for future students to understand the project).
- Create teams (not more than fifteen students) and work as a member of a team.
- Each team is assigned a project leader by the team itself. The team leader manages the overall software development work using PMS. The teams are free to use their own work style.
- The teams might develop software iteratively and incrementally using a new software language and environment (VLT). At the end of the iteration the teams might demonstrate their work.

Further work is needed in order to extend our teaching package. The package can be applied in other Software development courses as well. Our idea is to develop and integrate in the package a tool for software testing. Software Testing is a costly stage (around 50% of the labor expended to produce a working program) of the software life cycle that is usually performed by an independent group of testers after the functionality is developed (before the software is shipped to the customer). Test techniques (unit level test, integrated level tests and system level tests) are not limited to the process of executing a program unit or program system with the intent of finding software bugs. Software testing techniques (black-box or | and white-box) for validating and verifying that the software unit or system meets all planned functional and user requirements could be implemented by the suggested testing tool.

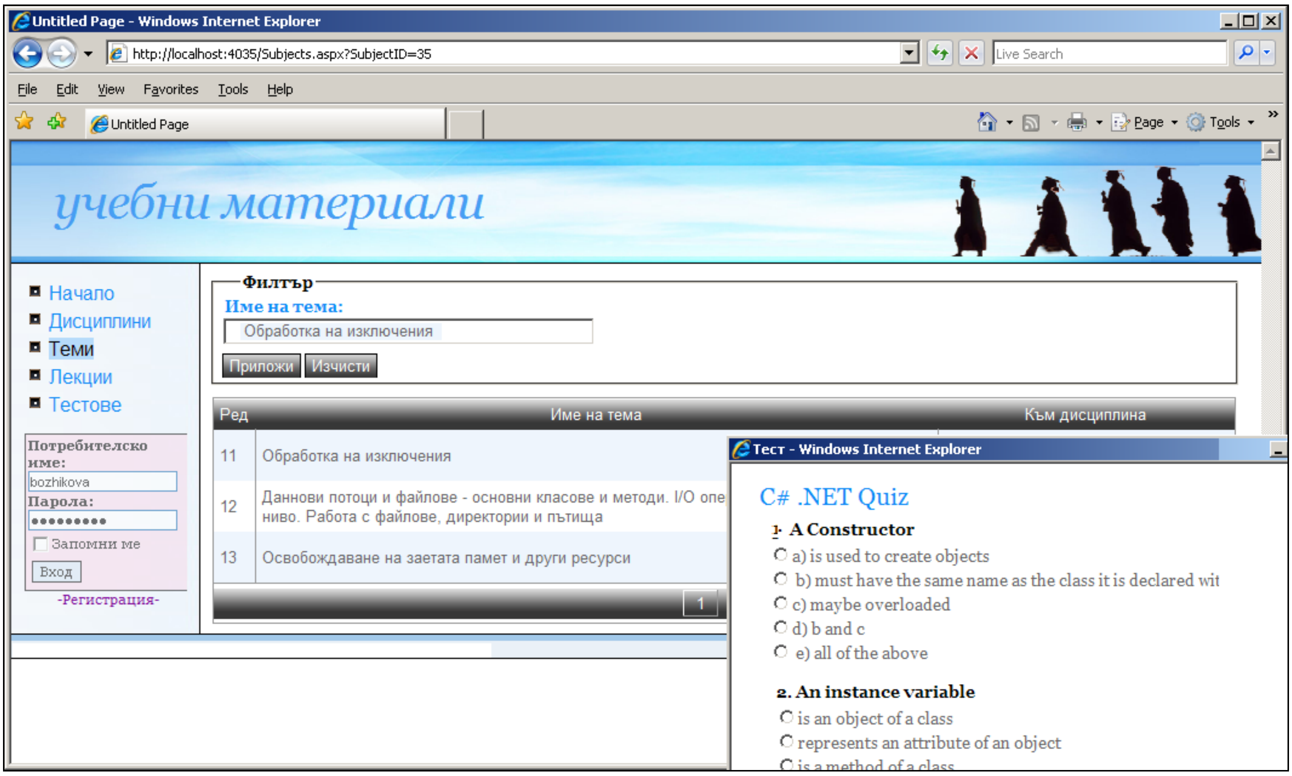

Figure 2: VLT – a tool with lecture notes, exercises and tests in Visual.Net programming

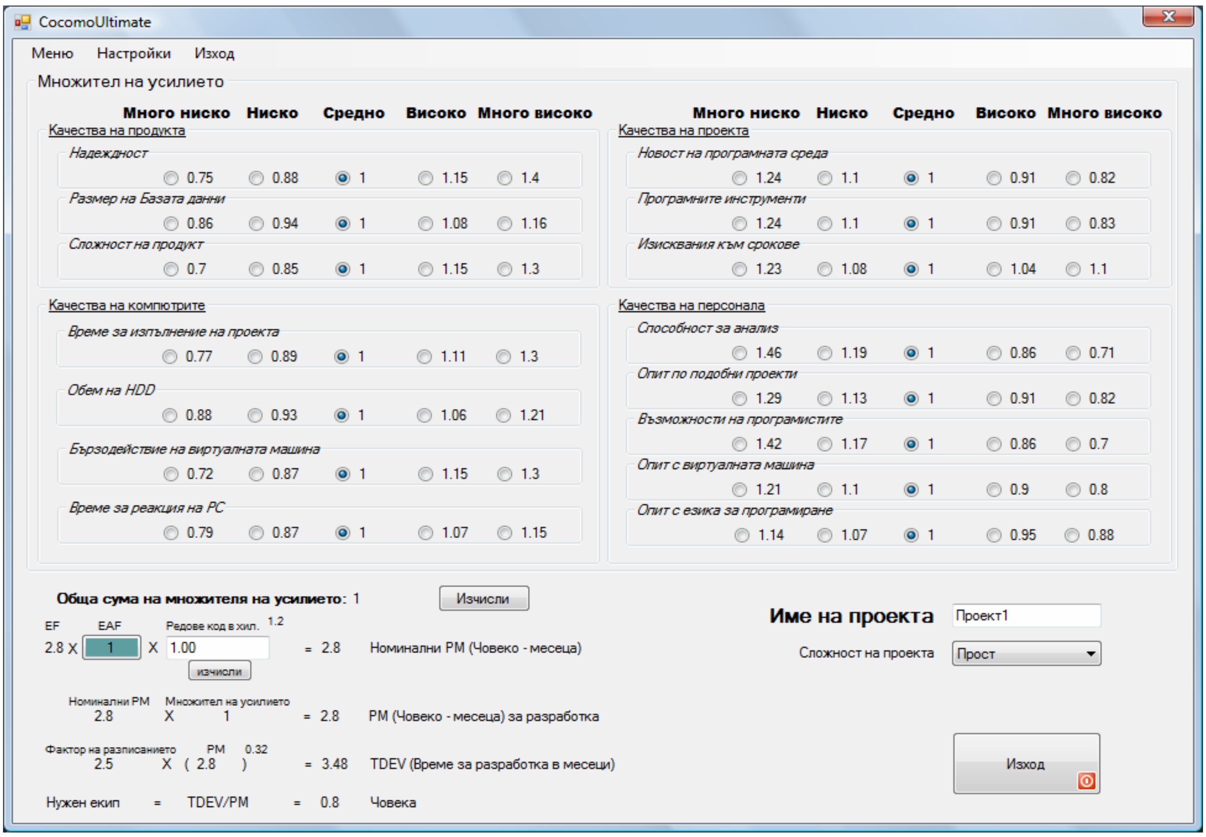

Figure 3: SCE - tool for Software Cost Estimation (the main form)

REFERENCES

[1] Eric J. Braude, Software Engineering: An Object-Oriented Perspective. John Wiley 2001.

[2] Leszek A. Maciaszek and Bruc Lee Liong, Practical Software Engineering: A Case Study Approach, Addison-Wesley 2005.

[3] Bernd Bruegge and Allen H. Dutoit, Object-Oriented Software Engineering. Prentice Hall, 2000.

[4] Shari Lawrence Pfleeger and Joanne M. Atlee, Software Engineering: Theory and Practice, Third Edition, Prentice Hall 2006.

[5] Roger S. Pressman, Software Engineering: A Practitioner's Approach, Sixth Edition. McGraw-Hill, 2005.

[6] Violeta Bozhikova, Mariana Stoeva, Krasimir Tsonev, A practical approach for software project management, CompSysTech Conference 2009, Russe (to appear)

[7] V.Bozhikova, M. Stoeva, A. Antonov, V. Nikolov, Software Re-structuring (An architecture-Based Tool), ICSOFT 2008, Third Int'l Conference on Software and data Technologies, pp.269-273, Porto, Portugal, 2008.

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SECTION 3

e-Learning'10

Semantic Application Integration by Learning Ontologies

Bojan Cestnik, Stojan Košti

Abstract: *Integrating computer applications is as a difficult and intricate task. The integration can be performed on various levels, starting from simpler data exchange level, to more complex and knowledge intensive levels. The paper presents the role of ontologies as metadata in integrating computer applications on higher semantic levels. We present our experience in automating information exchange between several actors, where application interoperability is one of the most important critical success factors that contributes to the overall impact of the ICT support. We illustrate the approach on the state project called National Housing Savings Schema that implements G2B cooperation between the Housing Fund and several business banks.*

Key words: *Application integration, Ontologies, Knowledge representation, Interoperability.*

INTRODUCTION

When integrating applications, ontologies often play a substantial role in logical understanding of the problem domain [6]. Ontologies have for long been used as semantic models for structured presentation of concepts and their relations that facilitate the exchange of knowledge between humans and machines. Accepting ontologies as such helps solving the information integration problem by turning different process and data models into views that are understandable to both end-users and application integration designers. Proper understanding of application semantics is, therefore, a common prerequisite for successful application integration.

In science, Ontologies have been used for decades to systematize scientific information in the form of a common vocabulary. Ontologies as such can be regarded as supportive means that facilitate reasoning and information analysis for a given problem domain. Therefore, they are mostly used for formally representing domain knowledge. They typically contain objects, concepts, properties and relations between objects. Moreover, ontologies can serve as useful generalizations that make the problem domain more comprehensible to the concerned stakeholders.

In this paper we address the following question: can we use existing semi-automatic ontology construction tools to speed up the traditionally manual process of application integration. Traditional way of manual construction is time consuming and typically requires several phases to complete. As a case study for the application integration using ontology as metadata we took the National Housing Savings Schema (NHSS) domain, which has some typical characteristics that justify the implementation of e-government integration principles [1]. First, NHSS is a state project governed by the legal Act. Second, there are several actors involved, including the Ministry, the Housing Fund, several business banks, and citizens. And third, NHSS offers an incentive financial instrument to help citizens acquire suitable housing facilities. Therefore, the citizens that are saving their money in NHSS are entitled to gain access to exact and up-to-date information about the status of their savings, while the other three cooperating actors have to provide services for accessing such information. Although providing such services to citizens seem relatively simple at first sight, various roles of the involved actors are causing increasing complexity that calls for an efficient implementation of integration and interoperability principles [1].

The main purpose of this article is to provide information technology viewpoint on application integration based on constructed ontologies. We primarily focus on integration and interoperability issues related to exchanging information between the government institutions and business banks included in NHSS project with a goal to speed up and add value to the business process. First, we describe the context and the underlying business process. Then, we elaborate on some of the most crucial phases of application integration with other actors in the process, discussing the issues related to the information technology. Next, we present a few topics concerning the actual implementation of supporting the underlying business process. Finally, we conclude by pointing out the most important findings in the paper.

RELATED WORK

Traditionally, ontology construction is a manual task that consists of determining interesting domain concepts and establishing a hierarchy of such concepts. The process uses a special sort of description language, in which common domain knowledge is represented. In the last decade several computer programs have been developed that support and speed–up such manual ontology construction, for example Protégé [4]. To demonstrate the program's ability we took the legal act governing the NHSS domain as a case to construct the domain ontology. For the task we employed an expert from the field and provide her with the support of using Protégé shown in figure 1. The concepts from the ontology typically form the core structure for exchanging information in application integration with other actors. This step is crucial in achieving conceptual understanding necessary for successful cooperation between the responsible developer teams.

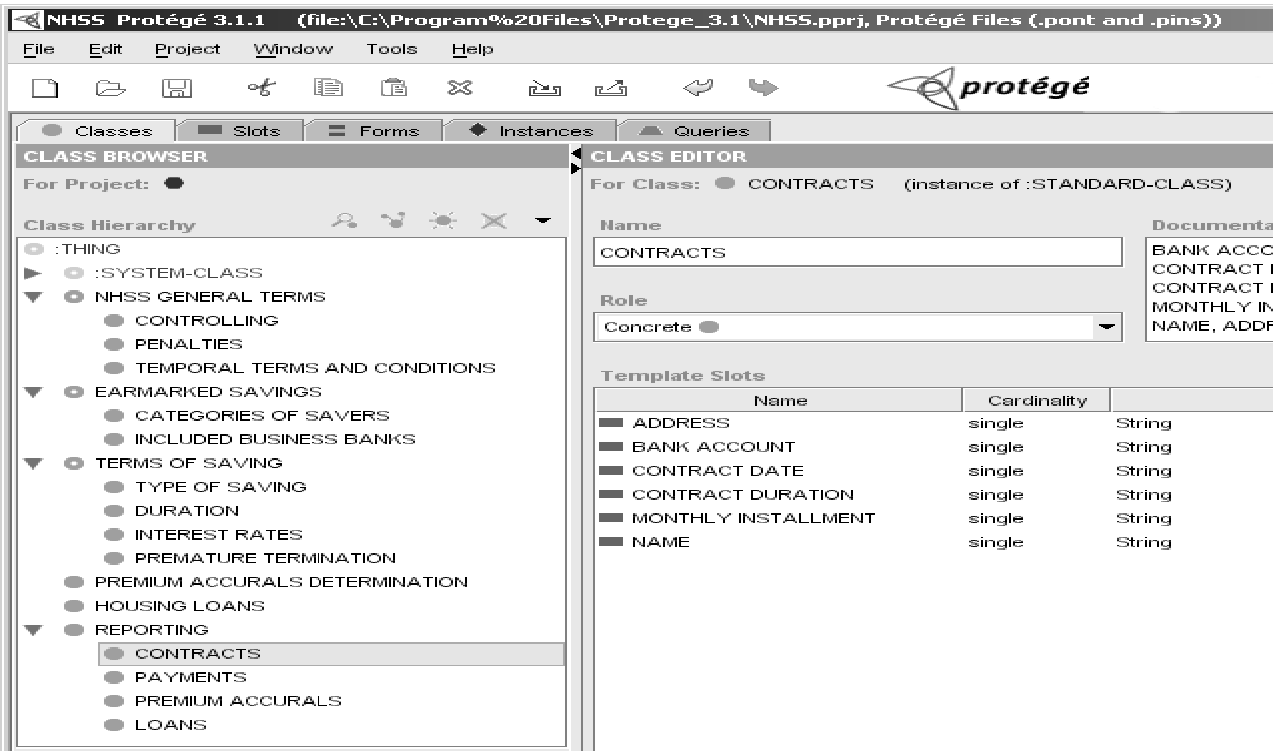

Fig.1: Manually constructed ontology by the legal expert in Protégé.

Ontology construction has taken part in many important on-going e-government projects that deal with knowledge management and ontologies. One example is EU project named QUALEG (Quality of Service and Legitimacy in e-Government) [7]. Its aim is to enable local governments of France, Poland and Germany to manage their policies more transparent and enable adaptability of the proposed solutions. The project showed many advantages of using technology based on ontology, such as preventing redundancy of data representation, enabling adaptability and supporting the realization of the importance ascribed by the local language to topics through the use of multiple synonyms.

The similar EU funded project that deals with this context is the LEX-IS project. Its main objective is to improve the legislation process in the National Parliaments through enhancing public participation with the use of technology-based tools like ontologies.

Developing ontologies helped all of the involved parties to easily locate and interpret important information [7].

LEARNING ONTOLOGY FOR SEMANTIC APPLICATION INTEGRATION

The quantity of knowledge stored in the form of scientific publications, articles and books grows exponentially in the recent years. Consequently, the interest in using text-mining technologies evidently rises, primarily because effectively following the progress in large quantity of published knowledge is almost impossible even in a relatively narrow field of interest. Written text typically contains large quantity of information that is usually encoded in a way hard to comprehend for automatic approaches. In spite of that fact, information technology spawned, besides the area of text mining, several important application areas like information retrieval, computational linguistics, text categorization, ontology learning and hypothesis formation.

With the emergence of new text mining technologies ontologies can be constructed semi-automatically by processing available text documents [e.g. 2]. Since manual ontology construction is a complex and intricate process that requires both skill and diligence, the need for developing more active and helpful computerized support is evident. In the last decade several approaches for facilitating semi-automatic construction of ontologies have been developed and successfully used in practice, making the process of ontology construction more effective and viable. One example of a tool for interactive construction of ontologies from text documents is OntoGen [3], which has already been proven successful in several real-world applications. A user can form concepts, edit them thematically and assign documents to the formed concepts. By implementing modern machine learning techniques OntoGen can help users in all crucial phases of ontology construction, suggesting concepts and their names and automatically assigning documents to the proposed concepts [3].

An example of ontology constructed with OntoGen on the legal act covering the NHSS is presented in Figure 2. The constructed top-level ontology gives an insight into the structure of the studied domain; it is, therefore, particularly useful in the process of obtaining initial acquaintance with the domain. Note that it provides some sort of "birds-eye view" on the domain under study. It is worth mentioning that the constructed ontology was meaningful and correct to the legal expert from the NHSS field; besides, the top-level structure is very similar to the manually constructed ontology in Protégé from figure 1.

Besides the mentioned activities the Housing Fund managed to improve also the transparency of the NHSS business process. There are three different actors involved in this process: the Fund, business banks and citizens. The Fund's role is central, since it carries out the process and it is responsible for direct communication with the other two actors. One of the banks is engaged in all eight public tenders and concludes almost half of all saving contracts. This bank's group is one of the largest state international finance groups with 1.500 correspondence connections in 140 states. Requirements for saving in the NHSS before year 2006 were very strict and savers had to pay their monthly fee strictly within certain month. In case they forgot payment for one month it had to me carried in next one such as current one. In case saver had forgotten his payment more than once in whole period of saving, he lost all benefits such as premiums and ability to get long-term loan. To avoid this unpleasant situation, the Fund improved communication with savers in a way saver can look at situation on his saving contract in every moment. This is possible with link, which is put on the Fund's web page and updated monthly. Only thing the saver need is the username and password. Last year the Fund and the bank implemented a step further by employing Web Service technology to enable interoperability of their information systems. This enables savers to see updated situation on their saving contracts.

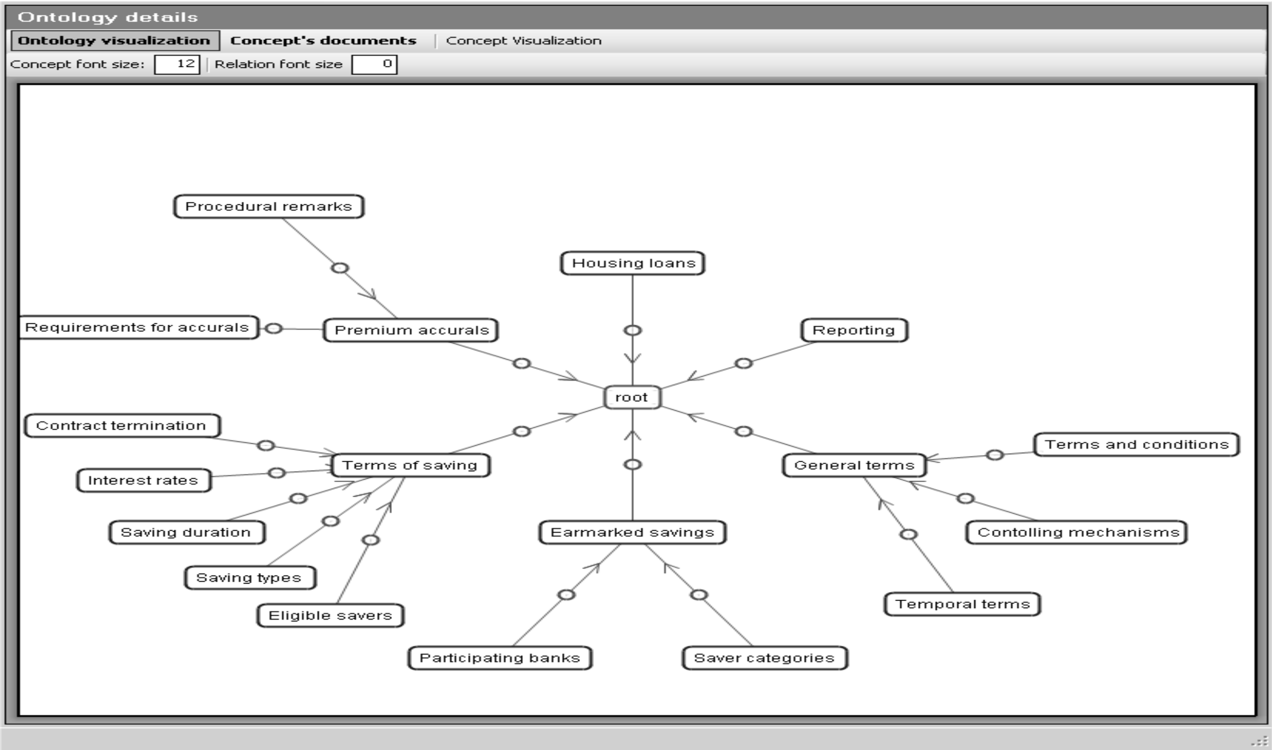

Fig. 2: Semi-automatically constructed ontology with *OntoGen* from the underlying legal act.

By definition, interoperability is the ability of two or more systems, or components to exchange information and to use the information that has been exchanged. With respect to software, the term interoperability is used to describe the capability of different programs to exchange data via a common set of business procedures, and to read and write the same file formats and use the same protocols. In IT we can distinguish between several types of interoperability that can be ranked hierarchically from application interoperability, through semantic and enterprise interoperability to environment interoperability. Most of the up-to-date e-Government interoperable solutions seem to function solely on the application level; moreover, even on this level they function in a rather fragmented manner. However, we believe that one of the most important challenges in the next decade will be shifting the interoperability paradigm to the level of semantic and enterprise interoperability, which will, among other things, in the long run rely heavily on already developed semantic web, metadata and knowledge management technologies.

The Fund and the banks carry on the majority of interdependent work to support the NHSS business process implementation. At first sight banks could deal with the task alone since it mostly falls in the category of their regular business. However, after each completed year the savers are entitled to receive a state premium accrual if they had paid their instalments regularly and according to the established plan. Since the Fund is responsible for validating savers compliance to the plan, it needs to acquire data about the contracts and paid instalments. To actively keep an eye on the things, the Fund issued a protocol that governs the necessary data exchange between the banks and the Fund. The quantity of the exchanged data is relatively high; however, the frequency is quite moderate since the exchange has to take place only once or twice every month. The exchange protocol is robust enough, since it relies on the ontology build for NHSS domain. The ontology is considered as a basis for completely automated interoperability solution using message queuing technology.

Since the Fund decided to maintain its own database for monitoring saving accounts, it was a natural move to make it available to interested banks and citizens through a web application. In such way the banks are able to use the Fund's database for advising citizens and to proactively handle potential problems like missing instalments etc. The web application takes into account the sensitivity of the data so it allow secure internet access HTTPS for both, banks and citizens. Here, the citizens can observe the status of their saving account, which gives them additional sense of control over the saving maters. The introduction of the Fund's G2C service had also quite surprising side effect: several banks decided to offer additional B2C service to the same citizens, thereby narrowing the time and information gap by providing even more accurate data on the Internet.

After establishing NHSS project, the Fund issued detailed requirements for data exchange with the corresponding banks (Figure 3). These requirements are based on the constructed ontology; thorough understanding of application semantics is a common prerequisite for successful application integration. At first, the amount of data was relatively small and the exchange was technically carried out using simple storage media as well as the Internet services. Here, data protection and privacy issues had to be considered as well.

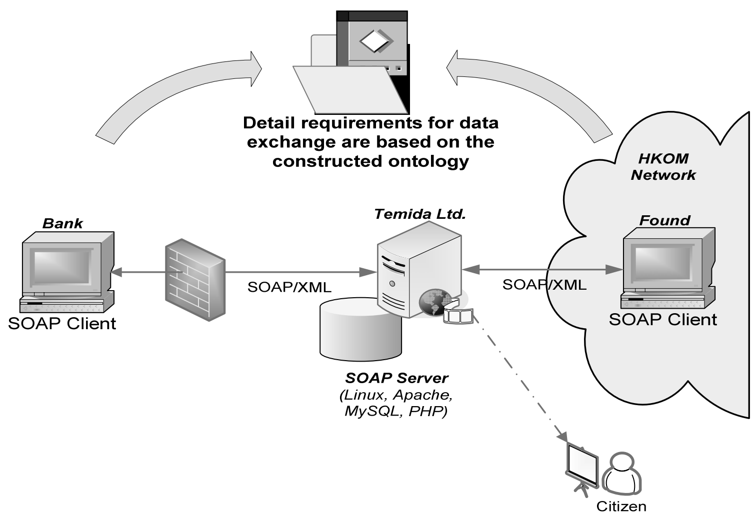

Fig.3: Architecture of solution based on constructed ontology

As always in the large projects like NHSS, change management procedures are mandatory but difficult because of a large number of stakeholders that contribute to the project. A thorough understanding of the problem domain is a necessary prerequisite for successful implementation of change management procedures. Here, the constructed ontology might come in handy. Note also the inherent rigidity towards change of large banks involved in the NHSS project. Our advice, which turned out to be very beneficial in practice, is that all the changes in the communication protocol be backward compatible. In such way, it is not necessary for all the participating actors to switch to the new specifications at the same instant. In NHSS project, different banks upgraded their corresponding software in a few months period following the new requirements document. By obeying the backward compatibility principle, the application at the Fund was able to handle all essential communication, even though the relevant applications in banks were using different versions of the protocol specifications.

CONCLUSIONS AND FUTURE WORK

In the paper we presented the use of a tool OntoGen [3] for the construction of ontology based on a selected legal act. We demonstrated how such technology could help us obtain an overview of the observed domain. The semi-automatically constructed ontology is very similar to manually constructed ontology by the legal expert, although the former required up to 10 times less time for construction. In addition to speed of the process, the value added to the main an sub-processes is that the process management is even easier and more effective. As a result we can notably speed-up the process of "getting acquainted" with a given problem domain, mostly because the generated birds-eye view quickly reveals the most important top-level domain concepts. We demonstrated that the resulting ontology could serve as a firm basis for a common understanding between several stakeholders as well as for integrating other applications in an interoperable manner.

The constructed domain ontology can be used to support both, process view and data view [5]. The process view represents information system dynamics and is, therefore, crucial for establishing communication protocols for application integration. Common understanding of underlying business processes is crucial for establishing responsibility matrix for handling events generated by the integrated applications. On the other hand, data view incorporates static structure for exchanging information. As a consequence, it can serve as a backbone in the process of designing the integration.

Semantic application integration can be used to achieve application interoperability; therefore, modern technologies like Web services and Service Oriented Architecture have to be considered in the process. Moreover, the new trend of supporting ontologies as underlying data models for machine data interpretation plays a substantial role in the next generation of Web services – Semantic Web services. It is our firm belief that this kind of built-in knowledge will lead to a significant time and money savings in further development, deployment and integration of applications.

REFERENCES

[1] Cestnik, B., A. Kern. IT for supporting the Slovenian National Housing Savings Schema: example in G2B interoperability. 5th Eastern European e|Gov days, Prague, April 2007.

[2] Cestnik B., A. Kern, H. Modrijan. Semi-automatic Ontology Construction for Improving Comprehension of Legal Documents. Electronic Government, 7th International Conference, EGOV 2008, Turin, Italy, August 31 - September 5, 2008. Proceedings, Lecture Notes in Computer Science, Springer, pp. 328-339.

[3] Fortuna B., M. Grobelnik M., D. Mladenić. System for semi-automatic ontology construction. Demo at ESWC 2006. Budva, Črna Gora, June, 2006.

[4] Gennari J., M.A. Musen, R.W. Fergerson, W.E. Grosso, M. Crubezy, H. Eriksson, N.F. Noy, S.W. Tu. The Evolution of Protégé: An Environment for Knowledge-Based Systems Development. 2002.

[5] Kroll, P., P. Kruchten. The Rational Unified Process Made Easy, A Practitioner's Guide to the RUP. Addison-Wesley. 2003.

[6] Linthicum D.S. Next Generation Application Integration, From Simple Information to Web Services. Addison-Wesley. 2004.

[7] Sagev A., A. Gal. Putting Things in Context: A Topological Approach to Mapping Contexts to Ontologies, Journal on Data Semantics IX, pp. 113-140. 2007.

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Model-driven Mobile Expansion of Knowledge Flows in Educational Networks

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Claudia Tittmann
Sabine N. Tittmann

***Abstract**: The currently developing knowledge society needs high quality knowledge bases with wide-spreading knowledge sources. Because of the complexity of knowledge, it is organised as knowledge network characterised by model-driven architecture based on knowledge nodes as instigator for the intermediate knowledge flows. The theory of knowledge networks, knowledge nodes, and knowledge flows can be used for educational networks as a subset of general knowledge networks. In addition, the distribution of knowledge and skills will be structured and made more effective by using a knowledge model-driven architecture. The implementation is done by building up several competence clusters as transfer hubs in a multilayer architecture. The application of the existing theory and use of knowledge transfers in a mobile environment for instance for vocational training requires new kinds of special models based on the general architecture for knowledge networks and the more specific architecture of educational knowledge transfer by competence hubs. The mobile version of the knowledge transfer in vocational training programs proves to be an expansion of the model-driven approach for knowledge flows. The authors integrate the current multilevel knowledge from different kinds of research projects dealing with knowledge networks and knowledge transfer processes under the viewpoint of a model-driven approach leading to a expansion in a mobile environment for vocational training as example.*

***Key words:** Knowledge Flow; Vocational Training Network; Educational Network; Mobile Learning*

THE THEORY OF KNOWLEDGE FLOWS IN KNOWLEDGE NETWORKS

The systemic view of science leads for example to a subdivision in natural sciences, human sciences and structural sciences. Especially in the field of natural sciences like physics or chemistry there are formal descriptions to assess and calculate the value of these parameters, to describe their structure, and to identify their impact and influence on other objects. Analogous to the natural scientific (physical and chemical) processes a similarity exits to the knowledge processes, which belong to the human science and have primarily sociological and psychological origins. The basic assumption in this context is the idea of knowledge nodes (Figure 1). Knowledge nodes are individuals or smallest possible combinations of organizational units / individuals.

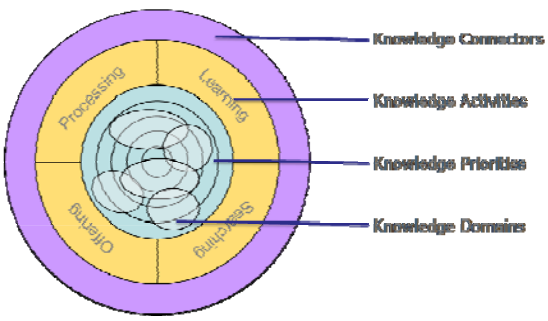

Fig.1. Model of knowledge node [1]

The nodes are turning into knowledge networks based on scientific or business-oriented motivations for cross-linking and increasing their knowledge power. The knowledge nodes consist of knowledge potentials of various knowledge domains. These knowledge potentials can be assessed by their size and by the priority or importance. The knowledge potential existing in the creation phase of the knowledge node will not keep its value along the timeline. There is a kind of half life of knowledge, and the thesis, that knowledge potentials of knowledge nodes reduce or lose their level or value against other knowledge nodes if they do not develop and extend their knowledge. Therefore, every knowledge node tries to open and make accessible new knowledge sources. The development of knowledge takes place on the one hand by the exchange of knowledge within the knowledge node (as far as it consists of more than one individual) and the exploitation of explicit knowledge of external sources. On the other hand, there is the need for compensating and exchanging the knowledge potentials with other knowledge nodes (Figure 2).

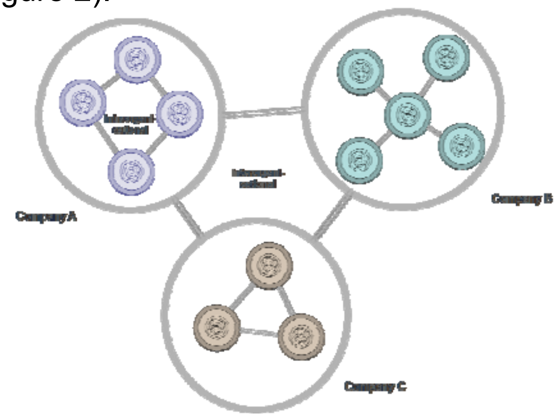

Fig.2. Cross-linked knowledge networks [1;2]

Thus, knowledge flows occur. This knowledge exchange is characterized by a structure, this means in the IT sense it is a protocol by which the exchange runs. The quantity and kind of exchanged knowledge will be determined by rules and regularities, including filters and restrictions. The structure of these knowledge flows, and the rules under which they run, are very difficult to measure (Figure 3). Thus, it is also not quit trivial to define them. Therefore, it is the aim of the research to develop an approach for defining the structure, rules and restrictions on knowledge flows between knowledge nodes.

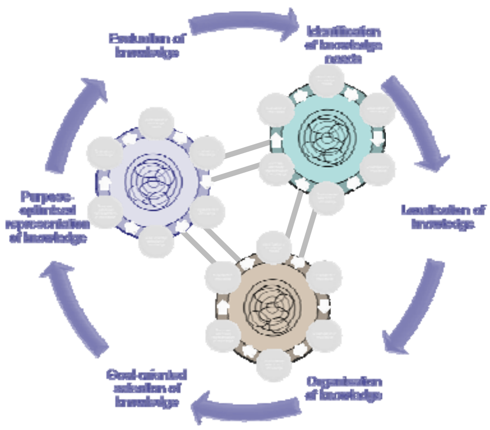

Fig.3. Knowledge flows between knowledge nodes in the framework of the KM lifecycle [3]

This model provides a fundamental concept for the further analysis of knowledge networks and the lifecycle of knowledge nodes. It forms an important basis for the understanding and hence for the assessability of knowledge flows and finally knowledge networks.

THE IMPLEMENTATION OF KNOWLEDGE FLOWS IN EDUCATIONAL NETWORKS

For implementing the described knowledge flows in networks it is necessary to manage the transformation of the classic monolithic learning systems to new forms of open and dynamic networking. Therefore, a meta modular-design model for educational offers with a dynamic structuring has to be built up. The information volumes of basic teaching, applied uses of economy and outcomes of research works will be centralized in knowledge blocs (Figure 4).

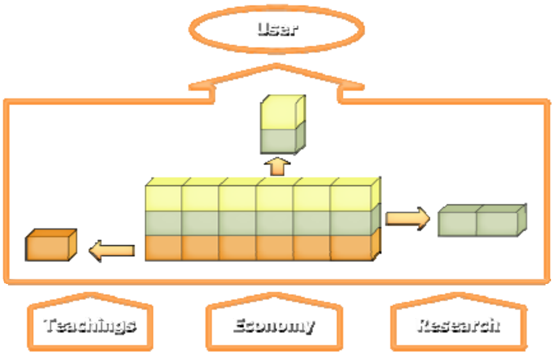

Fig.4. Meta modular-design model for educational offers [4]

Every knowledge bloc contains of several main topics which have to be clustered and selected by diverse subnodes. The next step in this systemic process is to form a content network and build main nodes of the clustered main topics (Figure 5). The map shows the importance of the equality of the nodes and the subnodes. Thereby, it is possible to connect the specific module network with a bigger knowledge network.

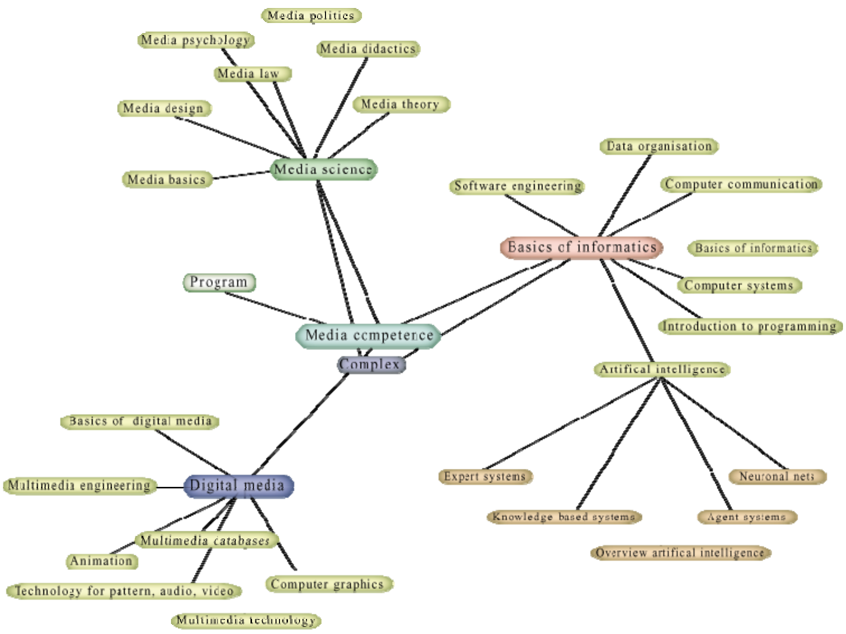

Fig.5. Content network and clustered main topics [5;6]

For being more innovative and intelligent, it is necessary to pinpoint the main groups of strongly associated key nodes of the networks as competence clusters [7]. The key nodes and the related clusters are sifted out by system analysis and documented for instance by mind and concept mapping (Figure 6).

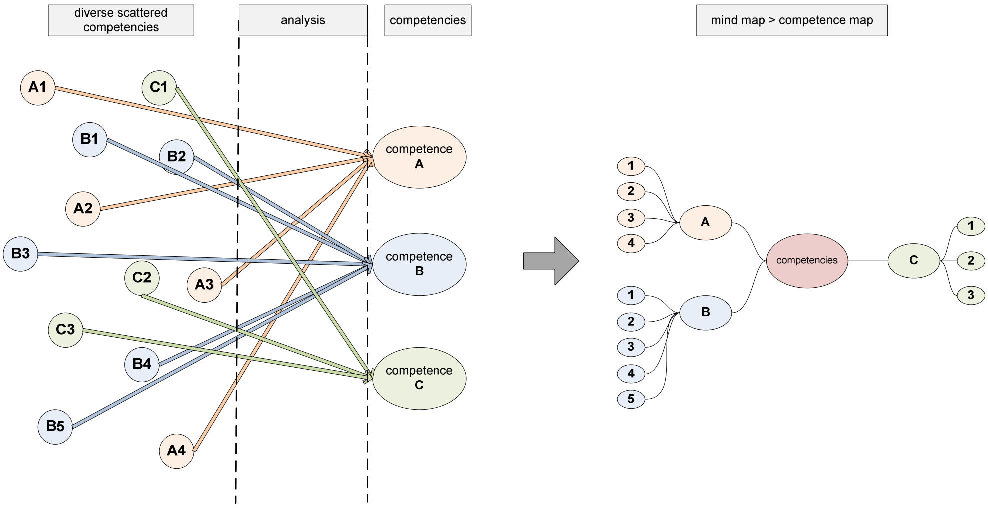

Fig.6. Description of the process from diverse competencies to a competence (mind) map [4]

The competence clusters are used to configure one or several related networks of competence based on the back bone system of competence clusters. The method and information literacy approach based on competence clusters as transfer hubs will be realised by using a multi-consortium project dealing with a multilevel network for last-mile-solutions supported by e-education competence clusters.

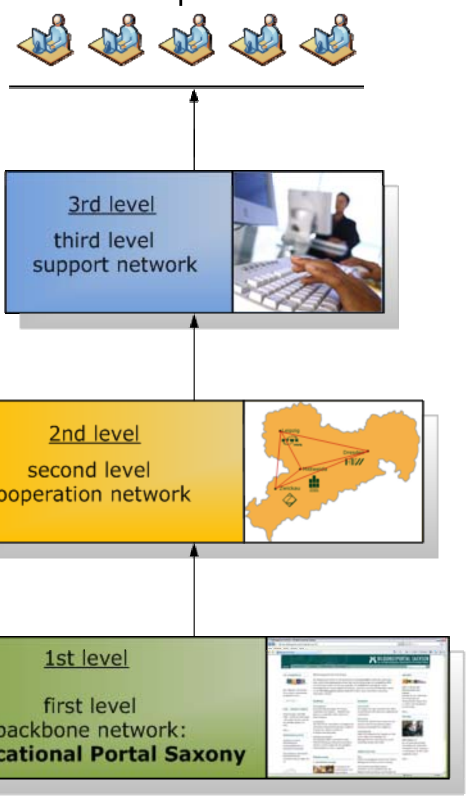

Fig.7. Special architecture of educational knowledge transfer [4]

The first level is composed by the e-platforms, CBT and WBT systems, etc. as first-level-backbone network from the users view. It is the organisational-technical system view for e-education. The second-level-cooperation network is formed by the e-education specialists pushing the development and application of e-learning in the framework of competence clusters. It is the world of special knowledge, skills, abilities, and competencies integrated in clusters and networks for developing particular aspects such as methodology, didactics, ergonomics, architectures, etc. The third level is characterised by last mile solutions as user's support network including the personal services for the end users and for improving the individual knowledge and competence transfer.

These main levels form a special three level architecture for imaging an educational knowledge transfer (Figure 7).

The specific architecture of educational knowledge transfer can be the next level for an application in a learning mobile environment.

THE EXPANSION FOR MOBILE LEARNING IN VOCATIONAL TRAINING NETWORKS

Mobility and local independence are one part of mobile learning (m-learning) in the complexity of e-learning. Fast accesses as well as current interruptions of learning flows are thereby further challenges a mobile learning environment has to be adjusted to. These aspects require for methodical, didactical and multimedia processing of learning contents.

Apart from these requirements there is as well a high technological dependence in the field of hardware. Wireless broadband connections and the use of mobile terminals may prevent a successful conception of a mobile learning environment. However these special technologies may improve the knowledge of using e-learning since the spatial expansion of a mobile learning environment is enormously increased in contrast to a purely stationary environment.

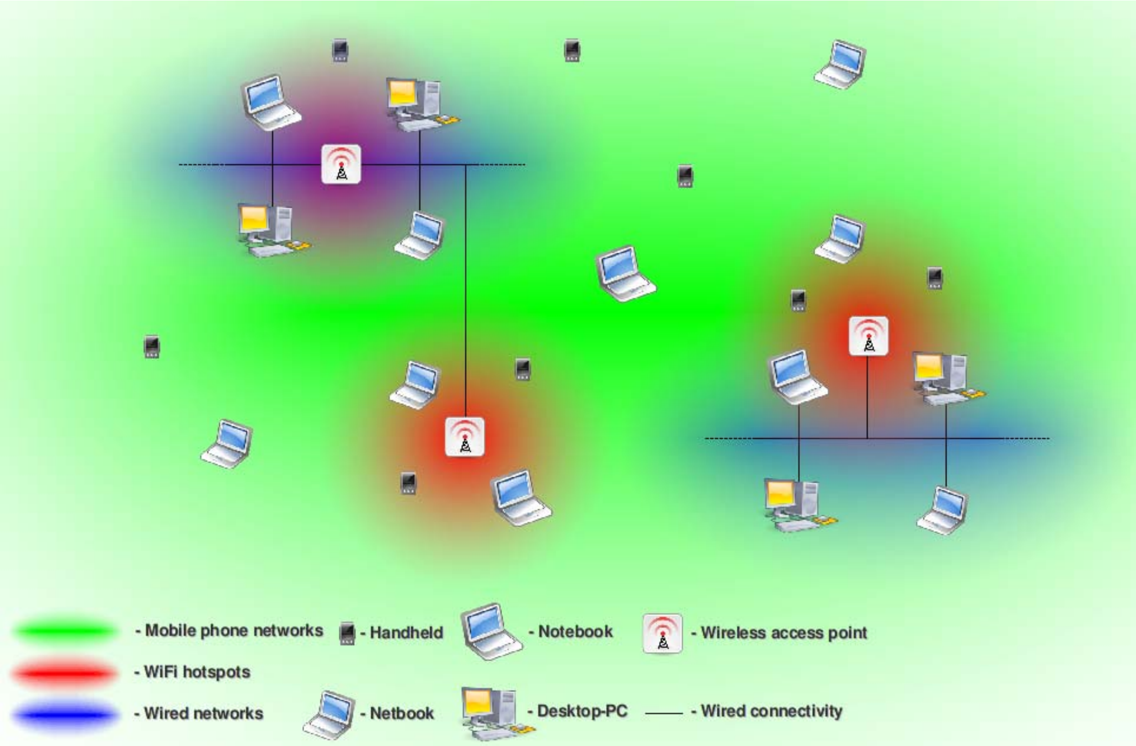

Fig.8. Spatial expansion of e-learning environments by using radio networks to mobile learning environments

Because of these special characteristics of mobile learning environments, there are in contrast to the stationary e-Learning, only limited possibilities to realize learning scenarios. These learning scenarios are usually extremely problem-(job-oriented), demand- and target group oriented in the field of m-learning. Therefore, they possess in most cases clearly defined learning offers with a small range of other topics. A major role plays thereby the supply of specialized and learning process accompanying knowledge. Apart from these restrictions however also new operational areas for e-learning are opened. Thus, excursions and similar learning scenario with a large extent on mobility and flexibility can be supported and accomplished [8][9].

In the surroundings of a professional training the m-learning can be used for the support by vocational training processes. In this case above all, the spontaneous, individual use plays still another basic role, whereby the study content/course is usually retrieved to close knowledge gaps. Newer investigations and concepts in the field of a professional training try to support working and networking of study groups in virtual classrooms with the help of m-learning [10][11]. In this process above all, the cooperative and self-organized learning as well as the connection of learning and knowledge management should be strengthened. Here the inclusion of the Web 2.0 - technologies and social software, which show high potential in other fields of cooperative and organized communication and information retrieval, appears particularly important.

The solution of these complex challenges for an optimal conversion in the professional training is, like in other subject areas also difficult, and usually lengthily. M-learning thereby can only be seen as completion to other teaching methods and - scenarios. But already the possibilities, which a mobile learning environment provides, should be exhausted, to raise/increase the motivation of the trainee/apprentice as well as the quality within the apprenticeship.

CONCLUSIONS AND FUTURE WORK

This paper shows the diverse levels of specialisation of knowledge flows. The first level contains the knowledge model with knowledge nodes and knowledge flows. This model is essential for the organizational learning level, because knowledge is the e-learning content. The organizational learning will be extended in the next specialization level by the technical and methodic-didactic aspect, the mobile learning, for reaching more flexibility.

Therefore, the goal for the further development of these different specialized models is the better integration and the optimization of the processes in education, vocational training, and further training for becoming time- and place-independent.

REFERENCES

[1] Tittmann, C.;Schumann, C.-A. (2009). Potentials for Externalizing and Measuring of Tacit Knowledge within Knowledge Nodes in the context of Knowledge Networks. In: Harorimana, D.: Cultural Implications of Knowledge Sharing, Management and Transfer. Hershey, IGI Global, 978-1-60566-790-4.

[2] Schumann, C.-A.;Tittmann, C. (2007). Multilevel Cross-Linking and Offering of Organisational Knowledge. In: Martins, B.;Remenyi, D.: Proceedings of the 8th European Conference on Knowledge Management. ECKM2007, Barcelona, 878-883.

[3] Schumann, C.-A.;Tittmann, C. (2008). Agile and intelligent networks for Information Literacy by Knowledge Sharing. In: ECKM 2008, Southampton / GB.

[4] Schumann, C.-A.;Tittmann, C.;Tittmann, S. (2008). E-Education Competence Clusters as Transfer Hubs for Methodical and Informations Literacy. In: GUIDE International Workshop 2008, Universität Marconi / Italien.

[5] Schumann, C.-A.; Tittmann, C.; Nöske, C.; Weber, J.; Methodology and Technology – Knowledge Based Approach for E-Learning in the Future Networks of Distance Education, Proceedings of the GUIDE 2006, Universitá Telematica Guglielmo Marconi, Rom 2006

[6] Schumann, C.-A.; Tittmann, C.; Nöske, C.; Weber, J.; Effectiveness of Individual Competence Development by Using Networks of Granulated Contents, In: Szüs, A. Bo, I.:

E-Competences for Life, Employment and Introduction to programming Basics of informatics Artificial intelligence Introduction to multimedia Computer graphics Animation Media law Media design Media politics Innovation, Proceedings of the EDEN 2006 Annual Conference, Wien 2006

[7] MANDL, H. (2000). Wissens sichtbar machen – Wissensmanagement mit Mapping-Techniken. Hogrefe Verlag, Göttingen, ISBN 3-8017-1337-7.

[8] Gerhard Zimmer: E-Learning. Handbuch für Hochschulen und Bildungszentren. Didaktik, Organisation, Qualität. 1. Auflage, Nürnberg: BW Bildung und Wissen Verlag und Software GmbH, 2004.

[9] Maciej Kuszpa, Ewald Scherm: Mobile Learning – Modetrend oder wesentlicher Bestandteil des lebenslangen Lernens? Diskussionsbeitrag des Fachbereiches Wirtschaftswissenschaft. FernUniversität Hagen, September 2005

[10] Didaktisches Design, 2009, http://www.e-teaching.org/didaktik/

[11] M-Learning, 2009, http://de.wikipedia.org/wiki/M-Learning

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Portfolio Management using Particle Swarm Optimization in Knowledge Management

Yi Wang, Kesheng Wang

Abstract: *In knowledge intensive organizations, many sources of competitiveness rely mostly on intangible parts of their organization. Portfolio management can be taken as a tool for knowledge management in organizations. Heuristic optimization techniques are more general purpose search methods that do not derive the solution analytically but by iteratively searching and testing improved or modified solutions until some convergence criterion is met. The techniques could be more suitable for solving problems in portfolio management than others. This paper focuses on investment management problems and shows how to manage financial portfolios using Particle Swarm Optimization (PSO). A PSO model is developed and tested on various restricted and unrestricted risky investment portfolios. Especially, a comparative study with genetic algorithms has been implemented. The PSO model demonstrates high computational efficiency in constructing optimal risky portfolios. Preliminary results show that the approach is very promising and achieves results comparable or superior with the state of the art solvers.*

Key words: *Portfolio management, Knowledge management, Particle Swarm Optimization, Sharp Ratio.*

INTRODUCTION

In knowledge intensive organizations, many sources of competitiveness rely mostly on intangible parts of their organization, such as the relationships of organization with its stakeholders, the knowledge and know-how of employees, its patents and trademarks. Management of these resources – also know as intellectual capital – should enable the organization to sustain viability, success, and basis for innovation [2], [9].

How exactly the knowledge resources and knowledge management processes tie to strategic, tactical, and operational business objectives and workflow is often left implicit or not addressed at all in business practice [6]. In order to specify these relationships, The "Knowledge governance framework" developed by Smits and de Moor [2004] has been developed. A modified version is shown in Figure 1, which shows that management can focus on the overall strategic objectives and directions set as part of governance of intellectual capital. In general new product development projects are usually proposed by technical staff, or by marketing and production staff and the focus of the projects can range from technical problems, product improvement demanded by customers, process improvement for production or development of new knowledge. However, usually only limited resources are available for innovative products and processes.

Portfolio management may refer to different areas, such as investment management; IT portfolio management and project management. All these fields are very central to enterprises or organizations knowledge management. In general, Portfolio Management is used to select a portfolio of new product development projects to achieve the following goals: (a) Obtain value maximization; (b) Support the strategy of the enterprise; and (c) Provide balance. Portfolio management can be taken as a tool for knowledge management in enterprises or organizations [1]. The optimal composition of portfolio is a set of new product development projects, where capacity constrains; strategic objectives and cash flow are carefully balanced. The theoretical foundation to portfolio management was laid by Harry Markowitz [5] by starting a parametric optimization model. With all its merits, the Markowitz model has major downsides: to get a grip of computational complexity, it has to rely on a number of rather strict technical assumptions which are more or less from reality [4]. The limitations of the original Markowitz framework have stimulated a number of extended or modified methods. One of these methods is using heuristic optimization techniques. The heuristic techniques are more general purpose search methods that do not derive the solution analytically but by iteratively searching and testing improved or modified solutions until some convergence criterion is met. Since they usually outperform traditional numerical procedures, they are well suited for empirical and computational studies.

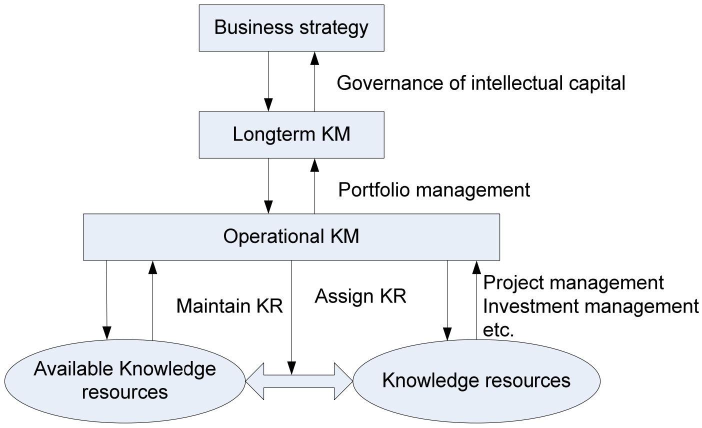

Fig.1. The modified knowledge governance framework

This paper focuses on investment management within portfolio management and shows how to manage financial portfolio using a heuristic approach PSO in knowledge management extent. The main motivation of this study is to employ a PSO algorithm for portfolio selection and optimization. First, we identify good quality assets in terms of asset ranking. Then asset allocation in the selected good quality assets is optimized using a PSO algorithm based on Markowitz's theory. Through the PSO process, an optimal portfolio can be determined.

MODELS FOR PORTFOLIO OPTIMIZATION (PO)

One of the fundamental principles of financial investment is diversification where investors diversify their investments into different types of assets. Portfolio diversification minimizes investors' exposure to risks, and maximizes returns on portfolios. The Markowitz Mean-Variance model [5] for security selection of risky portfolio construction is described as:

$$\text{Min}\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij};\ sb. \sum_{i=1}^{N} w_i r_i = \mathrm{R}^*,\ \sum_{i=1}^{N} w_i = 1,\ 0 \le w_i \le 1\ \ i = 1,\cdots,N. \tag{1}$$

where N is the number of different assets, σ_{ij} is the covariance between returns of assets i and j, w_i is the weight of each stock in the portfolio, r_i is the mean return of stock i and R^* is the desired mean return of the portfolio.

We can find the different objective function values by varying desired mean return R*, so a new named risk aversion parameter $\lambda \in [0,1]$ has been introduced, the sensitivity of the investor to the risk increase as λ increasing from zero to unity. With the λ, the model can be described as:

$$\text{Min}\lambda\left[\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij}\right] - (1-\lambda)\left[\sum_{i=1}^{N} w_i r_i\right];\quad sb.\quad \sum_{i=1}^{N} w_i = 1,\quad 0 \le w_i \le 1\ \ i = 1,\cdots,N \tag{2}$$

In the model included parameter λ, we can draw a continuous curve that is called an efficient frontier according the Markowitz theory, the curve composed of mean return and variance according different λ, and every point on an efficient frontier curve indicates an optimum, which indicates that the portfolio optimization problem is a multi-objective optimization.

Instead of focusing on the mean variance efficient frontier, we seek to optimize the portfolio Sharpe Ratio (SR) [7]. The Sharpe ratio is quite simple and is a risk-adjusted measure of return, which is often used to evaluate the performance of a portfolio. It is described as the following formula:

$$SR = \frac{R_p - R_f}{StdDev(p)} \tag{3}$$

where p is the portfolio, R_p is the mean return of the portfolio p, R_f is the test available rate of return of a risk-free security (i.e. T-bills), we select zero R_f in this study. StdDev(p) is the standard deviation of R_p. In other words, it is a measure of risk of the portfolio. Adjusting the portfolio weights w_i. We can maximize the portfolio Sharpe Ratio in effectively balancing the trade-off between the expected return and the corresponding risk. In this study, the PSO algorithm is used to find the most valuable portfolio with good stock combinations.

PARTICLE SWARM OPTIMIZATION (PSO)

Swarm Intelligence (SI) is an agent-based intelligent paradigm for solving optimization problems that originally took its inspiration from the biological examples by swarming, flocking and herding phenomena in social insects. The complex behavior of the swarm is based on that agents follow some simple rules. PSO is one optimization technique of Swarm intelligence The major feature of PSO algorithm is its simplicity in implementation and high computational efficiency in solving optimization problems., Researches in the filed of Swarm intelligence argue against the view that agents (individuals) are isolated information-processing entities and stresses the fact that intelligence arises among the interaction of intelligent agents.

The study of Swarm Intelligence has introduced a number of new optimization techniques into the field of Computational Intelligence. Kennedy and Eberhart [3] developed Particle Swarm Optimization based on the analogy of birds flocking and fish schooling. PSO has been shown to be powerful, easy to implement, and computationally efficient.

The original PSO algorithm is thought of a picture in which K particles of a population flys in the D-dimensional problem space (solution space). Each particle represents a solution of the problem, and has a value called "position" of the particle, and another value called called "velocity" used for evolving a new position in the search space. The velocity of each particle is dynamically adjusted by the flying experiences of its neighbors and its own. At each iteration, a particle moves to a new position based on the old position and an updated velocity.

How the algorithm works is briefly described as follows: 1. To initialize the size of the particle swarm and parameter; 2. To initialize the position and velocity for all the particles randomly; 3. To find the global best particle in the neighbor hood based on the fitness function; 4. All the particles are then accelerated in the direction of the global best particle and in direction of their own best solutions that they have discovered previously.

Occasionally the articles will overshoot their target, exploring the search space beyond the current best particles. All particles have the opportunity to discover better particles in route, in which case the other particles will change direction and head towards the new best particle. Since most functions have some continuity, a good solution will be near by these good, or better, solutions. By approaching the current best solution from different direction in search space, the chances are good that these neighboring solutions will be discovered by some of the particles.

The basic concept of PSO lies in accelerating each particle toward its pbest and the gbest locations, with a random weighted acceleration at each time step. Each particle tries to modify its position using the following information: (1) The current positions; (2) The current velocities; (3) The distance between the current position and pbest; and (4) The distance between the current position and the gbest.

In this paper, we apply PSO to a high-dimensional constrained optimization problem. That is to construct optimal risky portfolios for financial investments. A PSO solver is developed and test on various restricted and unrestricted portfolios. The results of experiments demonstrates that the PSO solve has high computational efficiency in constructing optimal risky portfolios.

FITNESS FUNCTION

Fitness function is a critical factor in the PSO method. The fitness function f_p is defined as :

$$f_p = \frac{\sum_{i=1}^{N} w_i r_i}{\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij}} \tag{4}$$

At each step, a particle's position and its velocity in the swarm are updated if an improvement of the fitness values is observed.

PARTICLES MOVING

Every particle moves towards its *pbest* position plus the *gbest* position particles of the swarm at each one of the iterations. Indeed, this movement depends on its current velocity and current position. a new velocity in the problem space is shown in Eq. (5).

$$\vec{v}_{ij}(t+1) = w\vec{v}_{ij}(t) + c_1 r_1[\vec{p}_{ij}(t) - \vec{x}_{ij}(t)] + c_2 r_2[\vec{p}_{gj}(t) - \vec{x}_{ij}(t)] \tag{5}$$

where index j is the dimension number of particle i, t is the iteration sequence, c_1 and c_2 are positive constant parameters called acceleration coefficients which are responsible for controlling the maximum step size, r_1 and r_2 are random numbers between (0, 1), w is a constant, and $\vec{v}_{ij}(t+1)$ is particle it's velocity on the *j*th dimension at iteration t+1. $\vec{v}_{ij}(t)$ is particle it's velocity on the *j*th dimension at iteration k. $\vec{x}_{ij}(t)$ is particle it's position on the jth dimension at iteration k.. $\vec{p}_{ij}(t)$ is the historical individual best position of the particle. $\vec{p}_{gj}(t)$ is the global best position of the swarm. Finally, the new position of particle *i*, $\vec{x}_{ij}$, is calculated by Eq. (6):

$$\vec{x}_{ij}(t+1) = \vec{x}_{ij}(t) + \vec{v}_{ij}(t+1) \tag{6}$$

There are two types of risky portfolios [4]. One is unrestricted risky portfolios, which do not have constraints on the short selling of stocks. Investors can choose to sell a stock that the investor does not own based on the condition that the investor must buy it back after a time of period, hopefully at a lower price. In other words, for unrestricted risky portfolios, assets could have negative weights. Another one is restricted risky portfolios, which place constraints on the short selling of portfolios' underlying equities, and require that all underlying assets must have positive weights. Both unrestricted optimal risky portfolios and restricted optimal risky portfolios must also satisfy another constraint, i.e., the total weights of all assets must sum to 1. To construct an optimal risky portfolio is to find the optimal combination of all assets in order to achieve the maximum Sharp Ratio. As the number of assets in the risky portfolio increases, construction of an optimal risky portfolio becomes an increasingly high-dimensional optimization problem with a variety of constrains.

EXPERIMENTS AND DISCUSSION

The PSO experiments for the portfolio optimization has been performed on three unrestricted risky portfolio of 8 stocks,15 stocks and 49 stocks, and on three restricted risky portfolio of 8 stocks, 15 stocks and 49 stocks. Table 1 shows only the unrestricted and restricted risky portfolio of 8 stocks together with each stock's daily Expected Returns (ER) and Standard Deviations (SD). All stocks are selected from the Shanghai Stock Exchange 50 Index (the SSE 50 Index). Individual stock's historical daily returns are taken from 1st May 2009 to 3rd April 2009. Unrestricted portfolios do not have constraints on short selling. In other words, the proportion of an asset in the portfolio could be negative or greater than 1.

In order to evaluate the performance of PSO model, we compare PSO with another heuristic Algorithm, Genetic Algorithm. In the experiments, PSO Solver has been developed using Matlab as software development tool. Genetic Algorithm has been developed using GeneHunter. Meanwhile, we also compare the result of them with the result of the traditional method of VBA (Visual Basic Application).

For the computation of the optimal risky portfolios, three approaches: PSO algorithm, GA algorithm and VBA solver are implemented for the 8-stock, 15 stocks and 49-stock portfolios. In the experiment of both PSO and GA, the size of the population is 100 and the termination condition is 1000 iterations to find the optimal risky portfolio respectively.

The experiment shows that the SharpRatio value obtained by PSO is the best one shown in Table 1. In the experiment, we find the SharpRatio value from GA is unstable. The efficient frontier obtained from PSO is absolutely the best. We also note that when the number of stocks is 8 and 15, the VBA solver could be better than GA. However, the GA algorithm is significantly better than VBA solver as the number of stocks increases.

Table 1. 8 stocks unrestricted and restricted portfolio's results

		Unrestricted	**Restricted**
PSO Solver:	**ER**	1.14%	0.72%
	SD	4.22%	2.90%
	SharpRatio	19.84%	17.83%
GA Solver:	**ER**	0.60%	0.53%
	SD	4.17%	2.63%
	SharpRatio	7.24%	12.42%
VBA Solver:	**ER**	1.03%	0.76%
	SD	3.78%	3.17%
	SharpRatio	19.31%	17.55%
Risk Free		0.03%	0.02%

In conclusion, the performance of PSO algorithm is better than both GA and the traditional VBA solver. From the experiments on unrestricted and restricted portfolios, the PSO solver clearly demonstrates the efficiency and effectiveness in solving high-dimensional constrained optimization problems.

CONCLUSIONS AND FUTURE WORK

The modified "Knowledge Governance Framework" has been developed and we points out that portfolio management could be taken as a tool for enterprise/organization Knowledge Management. A fundamental principle of financial investments is diversification where investors diversify their investments into different types of assets. Portfolio diversification minimizes investors' exposure to risks, and maximizes returns on portfolios. The paper focuses on solving the portfolio optimization problem in finance investment management. A metaheuristic Particle Swarm Optimization method has been developed to optimize investment portfolios, which the objective functions and constraints are based on both the Markowitz model and the Sharp Ratio model. In order to make a valid comparison with other methods, different test problems were solved and the results obtained when compared with the results of Genetic Algorithms (GA), Visual Basic for Applications (VBA) demonstrated the superiority of the PSO algorithm. Future research may be conducted to further investigate the application of some derived models or hybrid models of PSO to other investment strategy problems, for example tracking the index and so on. Another further investigation may be put on methods for improving the efficiency of the PSO solver for large portfolios in investment management.

REFERENCES

[1] Daniels, H. A. M. and Smits, M. T., Portfolio Optimization as a Tool for Knowledge Management, Operations Research Proceedings 2005, Springer Berlin Heidelgerg, 2006.

[2] Davenport, T. H. and Prusak, L., Working knowledge: how organizations manage what they know, Harvard Business School Press, Bosten, USA, 2000.

[3] Kennedy, J. and Eberhart R., Swarm intelligence, Morgan Kaufmann Publishers, Inc. San Francisco, CA, 2001.

[4] Maringer, D., Protfolio Mnagement with Heuristic Optimization, Springer, 2005

[5] Markowitz, H., Portfolio Selection. The Journal of Finance, 7(1): p. 77-91, 1952.

[6] Nahapiet, J. and Ghoshal, S., Social Capital, Intellectual Capital, and the organizational advantage, Ac. of Man. Rev. (23) 2, pp. 242-266, 1998.

[7] Sharpe, W. F., Mutual Fund Performance, Journal of Business 39 (S1), pp. 119–138, 1966

[8] Smits, M. and De Moor, A., Measuring knowledge management effectiveness in communities of practice. In: proceedings of HICSS , (Ed: Sprague) IEE, Cal, 2004.

[9] Wang, K., Hjelmervik, O. R. and Bremdal, B., Interduction to Knowledge management - Principle and practice, Tapir Academic Press, Trondheim 2001.

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Experience of Continuous Expansion of Adaptive Knowledge Assessment System's Functionality Based on Testing Results

Janis Grundspenkis

Abstract: *The paper describes evolution of the concept map based adaptive knowledge assessment system. The basic conceptions of concept maps are given, as well as basic principles of the developed knowledge assessment system are presented. Four versions of the system are described showing how their testing results promoted expansion of system's functionality.*

Key words: *Concept Map, Adaptive Knowledge Assessment.*

INTRODUCTION

Nowadays when education from teacher-centered activity has become student-centered activity the use of modern information and communication technologies in teaching and learning is a conventional and habitual practice. Not only teaching/learning has changed, but also new trends have emerged into students testing, their knowledge assessment and scoring. Introduction of such terms as computer-based assessment, e-assessment, online assessment, and others may be considered as conclusive proof of recent trends. At the same time, with the dissemination of different forms of technology-enhanced learning, for instance, e-learning or m-learning, learning assessment has become a constant concern [1]. Mainly two reasons are mentioned: lack of needed adaptivity and regularity of knowledge assessment. Even in traditional teaching and learning, where adaptive and regular knowledge assessment may be carried out quite naturally, usually only final tests and/or examinations are applied in practice due to the high workload of teachers. The same to the large extent is true also for computer-based assessment.

Traditionally it is based on tests where students receive a set of questions with already pre-defined answers [2]. Questions mainly are multiple choice or multiple response questions, graphical hotspot questions, fill-in-blanks, text/numerical input questions and matching questions [3]. The well known and widely used e-learning systems Blackboard (www.blackboard.com) and WebCT (www.webct.com) have built-in mechanisms to operate with tests. Along with indisputable advantages, such as greater flexibility regarding place and time of assessment, providing assessment for large number of learners, instant feedback to learners [4], etc., these systems don't exploit all possibilities that can be offered by computer-based testing. That is why computer-assisted adaptive testing based on Item Response Theory appeared in [5]. In this approach students receive more difficult or easier test items, depending on their previous testing results, i.e. the sequence of test items depends on the answer given to the previous test item. Thus, students' knowledge levels are more accurately estimated reducing negative psychological effects [5]. Besides, tests are shorter because fewer items are needed to obtain reliable results about students' knowledge level.

Despite of the range of abovementioned advantages even the usage of adaptive testing doesn't support sufficiently wide and comprehensive knowledge assessment. Being explicit, tests don't allow to assess student's knowledge structure, i.e. how he/she understands relations between concepts or how new concepts are connected with previously mastered concepts [6, 7].

The paper presents experience obtained from the use of the concept map based adaptive knowledge assessment system (KAS) [6]. The KAS has been tested in several engineering courses and learners' feedback has been collected allowing continuously extending system's functionality. The remainder of the paper is organized as follows. The next section introduces basic conceptions of concept maps and the KAS. After that it is described how the KAS has evolved during the years of its development. The key issues found from the feedback given by learners are highlighted which were used for expansion of functionality of the KAS. Conclusions and future work are given in the last section.

BASIC CONCEPTIONS OF CONCEPT MAPS AND THE DEVELOPED KNOWLEDGE ASSESSMENT SYSTEM

Most cognitive theories share the assumption that concept interrelatedness is an essential property of knowledge [8]. Cognitive theory underlying concept mapping grew out of Ausubel's Assimilation Theory [9, 10] and Deese's associationism memory theory [11]. The former postulated a hierarchical memory structure, whereas the latter postulated a network of concepts. A concept map (CM) – a pedagogical tool developed by Novak [12, 13] – is based on both abovementioned theories. According to Novak, a CM represents a part of an individual's cognitive structure, revealing his/her particular understanding of a specific knowledge area. Essentially CMs are a specific kind of mental models that are used for representing and measuring of individual's knowledge level. Mathematically defined and visualized, a CM is undirected or directed graph consisting of a finite, non-empty set of nodes which represent the concepts of a knowledge domain, and a finite, non-empty set of arcs (undirected or directed) which represent the relationships between pairs of concepts. Arcs may have the same or different weights, i.e., from the teacher's (expert's) point of view some relationships may be more important than others [14]. A CM can be defined also as an attributed graph (attributes can be words or linking phrases (propositions) used to specify the kind of relationship between concepts [15]). A proposition is a semantic unit of CM, i.e., a concept-relationship-concept triple which is a meaningful statement about some object or event in a problem domain [16]. An example of CM constructed for the subject "Systems Theory Methods" is given in Figure 1.

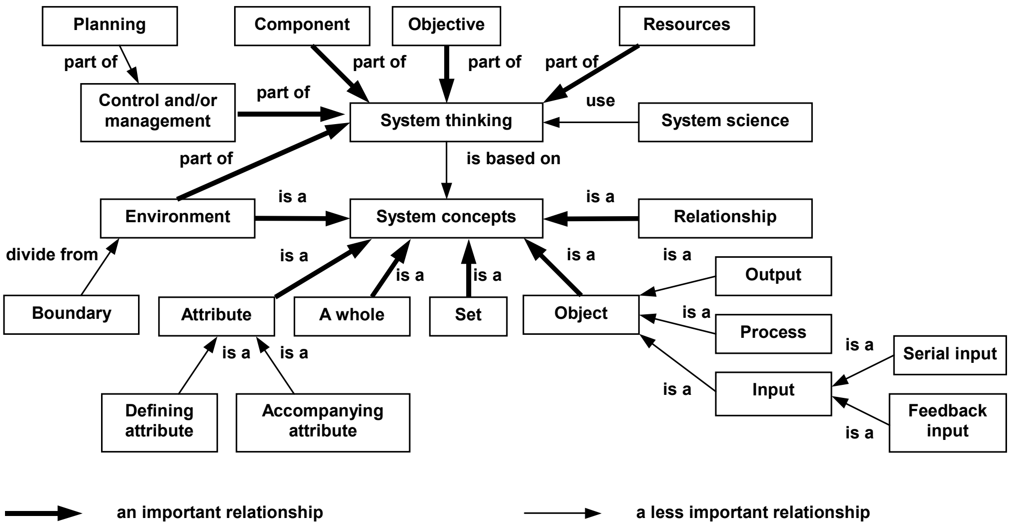

Fig.1. An example of concept map visualized by directed weighted attributed graph

The developed adaptive KAS consists of three modules (Figure 2) and is implemented as a multiagent system [6, 17]. The administrator's module allows managing data about users (learners and teachers) and studying courses providing functions of data input, editing, and deleting. The teacher's module supports teachers in construction of CMs. It provides editing and deleting of CMs, evaluation of learners' completed CMs and assigning the scores which characterize the level of correctness of learners' CMs. The learner's module includes tools for completion of CMs given by a teacher and for viewing feedback after the solution is submitted. The modules interact sharing a common database where data about teachers and their courses, learners, teacher created and learners' completed CMs, as well as learners' final scores are stored (Figure 2).

The developed system supports the following scenario. A teacher divides a study course into N stages and defines all concepts and relationships between them. The system supports teacher's actions for drawing CMs for each stage on the working surface. During knowledge assessment or self-assessment learners get a task (a CM) that corresponds to the current stage of learning process. After finishing the completion of CM, a learner confirms his/her solution and the system compares CMs of the learner and the teacher on the basis of patterns of learners' solutions [18]. The final score and the learner's CM are stored into the database, and a learner receives feedback about correctness of his/her solution.

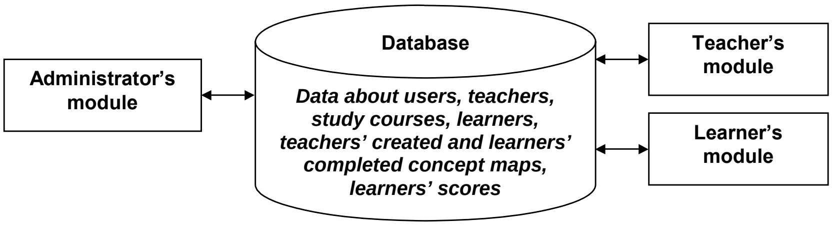

Fig.2. The system's architecture in terms of modules

EVOLUTION OF ADAPTIVE KNOWLEDGE ASSESSMENT SYSTEM

The development of the adaptive KAS started in 2005, and at present four projects has been finished. The development of KAS is based on a framework for conceptualizing CMs as a potential assessment tool proposed in [8]. According to the framework an assessment is considered as a combination of a task given to a student, a format for a student's response, and a scoring system by which students' CMs can be evaluated. In the developed KAS tasks vary depending on task demands and task constraints. Two classes of CM tasks, namely, fill-in-the-map and construct-the-map are used. Learners are or aren't provided with lists of concepts and/or labels for the links, as well as asked to fill-in the blank CM or to draw it. Actually the first version of KAS was not adaptive at all because learners could solve only fill-in-the-map tasks receiving the same given CM structure. The task was to put concepts from a given list in correct places (nodes). There were limited possibilities to change the degree of task difficulty by increasing or decreasing the number of teacher's predefined concepts already placed in correct places. Arcs were undirected and without linking phrases, but two weights reflecting importance of relationships (important and less important) were used. The algorithm for comparison of CMs has been developed and implemented which is sensitive to the arrangement and coherence of concepts (for details see [17, 18]). When comparison is finished a learner receives feedback with information about incorrectly related pairs of concepts, a list of concepts, which are not inserted, the maximal possible score for the absolutely correct solution, and the achieved actual score. The teacher receives feedback with information about the scores of all learners and their CMs with mistakes highlighted on them [17].

To get the feedback from students the questionnaire was worked out which included 15 questions mainly targeted towards functionality of KAS and easiness to understand and complete CM tasks. The KAS was used in 6 study courses (5 engineering and 1 pedagogical course) both in Riga Technical University and Vidzeme University College. In total 95 students used the KAS and 84 of them submitted the questionnaire. Fifty three (63%) students answered that CM tasks promote logical thinking and better understanding of learning contents. They stressed that CMs helped them to get the knowledge structure. Forty four (52%) students found that fill-in-the-map tasks were difficult, and for six (7%) of them even very difficult. They also reveal causes: the approach is unusual, requires active thinking and the KAS has limited functionality.

The students pointed out that textual format of feedback isn't informative enough, and suggested to elaborate the feedback in order to identify mistakes in a graphical form. They also suggested using drag-and-drop technique.

Based on students' evaluation several new solutions were implemented in the second version of KAS. First, more informative feedback for teachers and learners was implemented. For teachers the system collects statistical data about non-existing links that learners often define, about correct links that learners define rarely, and about incorrect weights of particular links. The feedback for learners was more instructive and was given in a graphical form. A learner receives his/her completed CM with labels representing received points for each link.

Second, two approaches for changing the degree of task difficulty were developed, namely, inserting additional concepts into a CM by the system or offering different types of tasks. In the first approach only fill-in-the-map tasks are used, and a learner can ask to reduce the degree of task difficulty. The agent-expert uses the developed algorithm, identifies degrees (the number of incoming and outgoing arcs) of free nodes (nodes where concepts are not placed yet), and sorts them in descending order. The node with an average index is chosen and the KAS inserts the corresponding concept into a learner's CM. Nodes with an average degree are inserted first (the decision is based on the assumption that concepts with smallest degree give too little help, but concepts with highest degree are keywords that learners must know). This approach was evaluated in 4 study courses (3 engineering and 1 pedagogical) both in Riga Technical University and Vidzeme University College. Forty four students took part, and 35 questionnaires were received after knowledge assessment. The questionnaire included 17 questions. Questions about new possibility offered by the system to reduce the degree of task difficulty were added. Students were asked did they use it, and if not, why. In this experiment 26 (74%) students answered that CMs help them to understand learning material better, but for 21 (60%) student CM tasks were difficult, and for 4 (11%) very difficult. At the same time only 10 (29%) students used the system's offered possibility to reduce the degree of task difficulty, while others answered that they didn't want to reduce their total score. Practically all students found the new graphical interface convenient, perceivable, and demonstrative. Twenty seven (77%) students indicated that system's provided feedback was useful showing what kind of knowledge is missing. So, evaluation of feedback was significantly higher in comparison with the first version of the KAS.

In the second approach 3 fill-in-the-map and 2 construct-the-map tasks are used starting with high-directed one where a structure of a CM, which is visualized as an attributed graph, is given, and ending with low-directed task where a CM must be drawn in case if only a list of concepts is given [20]. A learner receives a task that has a teacher's defined degree of difficulty. During the task performance a learner can ask to reduce the degree of task difficulty or depending on learner's results the system can do it. If a learner has reached a teacher's predefined minimal score without reduction of the task difficulty, the system delivers more difficult task at the next stage. This is the KAS's adaptive mechanism. The second approach was evaluated using the KAS for one engineering course "Fundamentals of Artificial Intelligence". Totally 30 students participated and 28 questionnaires were received. Again approximately the same number of students (19 or 68%) answered that CM tasks helped them to understand better logical organization and interconnectedness of mastered concepts. Sixteen (57%) found CM based tasks difficult, and 12 of them used possibility to reduce the degree of task difficulty. The system increased the task difficulty for 9 students. Questionnaires reflected suggestions of students among which the most significant were option to define synonyms of concepts and linking phrases and possibility to used directed graphs which may make easier the task of definition of linking phrases.

These suggestions which were implemented in the third version of the system promote further expansion of KAS functionality. Besides, a set of standard linking phrases was defined, such as “is a”, “is instance of”, “has attribute”, “has value”, and “part of”. Performance of the third version was evaluated in the study course “Systems Theory Methods” by 40 students. In 37 submitted questionnaires with 22 questions (3 questions were added asking about suggestions how to improve the feedback) there were 57% answers that for 21 student it was difficult to solve given CM based tasks, while 16 (43%) of them found it easy. As the main reason of difficulties in 10 questionnaires was mentioned insufficient learner’s support from the system’s side. Students wanted to get some learning material from the KAS if they have difficulties to solve the task.

Thus explanation of the concept is added in the fourth version of the KAS. Students may receive explanations in three forms – a definition, a short description or an example of concept. The initial form of explanation is chosen by a learner who can change it during solution of CM task. Moreover, the system keeps track of learner’s actions and determines which form of explanation has the greatest contribution to creation of correct CM. This, in turn, enables modification of student’s model. This version was evaluated using more informative questionnaire that contains 33 questions. Students were asked for their opinion, for example, why they found working with CMs difficult or easy, did they find that after the reduction of task difficulty they really received easier task, did provided explanations helped to solve the task, etc. The version was tested by 36 students who learned “Systems Theory Methods”. It is interesting to point that rather frequently students found that for them construct-the-map task with given list of concepts seemed more easy than fill-in-the-map task in which linking phrases must be defined. Testing of the fourth version of KAS shows that approximately the same number of students used each of the proposed explanation forms. At the same time they found that definitions are the most useful for better understanding but examples were not helpful enough.

At the moment the fourth version of KAS is transformed into new three-tier architecture for security reasons [18]. This new version is implemented using the following technologies: Eclipse 3.2, Apache Tomcat 6.0, Posture SQL DBMS 8.1.3, JDBC drivers, Hibernate, VLDocking, JGoodies and JGraph.

CONCLUSIONS AND FUTURE WORK

The paper reflects the experience get from testing four versions of adaptive KAS in different study courses. Testing results allowed step-by-step to expand functionality of the developed system. Obtained experience manifests that the KAS based on CMs helps students better to understand learning contents. In all testing experiments in average around 75% of students liked the usage of CMs for knowledge assessment and they wanted to use this approach in other courses, too. At the same time it turns out that considerable number of students (more than 55%) found that CM based tasks are difficult for them. As main reasons of difficulties insufficient learner’s support from the system’s side, lack of work experience with CMs and insufficient knowledge of learning material are mentioned more frequently. Contrary, those students who didn’t have problems stressed that they have good understanding of nature of CMs, have experience of drawing different diagrams and using many software products, as well as have good knowledge.

It is interesting to stress that engineering programme students who study computer science achieved considerably higher scores in comparison with students of pedagogical programme. The working hypothesis is that computer science students are familiar with various diagrams used in software engineering therefore a CM is not a new technique for them, but more experiments are needed for acceptance of it.

These testing results have inspired the developers of KAS to continue its improvements. Future work is directed towards extension of the developed KAS. The algorithm for transformation of study course ontology into CMs should be integrated into the system. New algorithms for more efficient CMs comparison should be developed and implemented, too. Moreover, more rich and complete student model should be developed and used. And last but not least, a scoring system by which students' CMs can be evaluated accurately and consistently, taking into account various cases of reduction of the degree of task difficulty should be worked out.

REFERENCES

[1] F. E. L. da Rocha, J. V. da Costa, Jr., E. L. Favero, "An approach to computer-aided learning assessment," in *Proceedings of the Third International Conference on Concept Mapping*, 2008, pp. 170-177.

[2] Computer-assisted Assessment (CAA) Centre. [Website]. Available at: http://www.caacentre.ac.uk/

[3] "Designing effective objective test questions: an introductory workshop", CAA Centre, Loughborough University, 1999. [Online document]. Available at: http://www.caacentre.ac.uk/dldocs/otghdout.pdf

[4] G. Lambert, "What is computer aided assessment and how can I use it in my teaching?" Canterbury Christ Church University College, 2004. [Briefing paper].

[5] E. C. Papanastasiou, "Computer-adaptive testing in science education," in *Proceedings of the 6th International Conference on Computer Based Learning in Science*, 2003, pp. 965-971.

[6] J. Grundspenkis, "Development of concept map based adaptive knowledge assessment system," in *Proceedings of IADIS International Conference on e-Learning*, 2008, pp. 295-402.

[7] J. Grundspenkis, "Knowledge creation supported by intelligent knowledge assessment system," in *Proceedings of the 12th World Multi-Conference on Systemics, Cybernetics and Informatics, June 29-July 2, Orlando, Florida, USA*, 2008, pp. 135-140.

[8] M. A. Ruiz-Primo and R. J. Shavelson, "Problems and issues in the use of concept maps in science assessment," *Journal of Research in Science Teaching*, vol. 33, no. 6, 1996, pp.569-600.

[9] D. P. Ausubel, *Educational Psychology: A Cognitive View*. New York: Holt, Rinehart and Winston, 1968, p. 685.

[10] D. P. Ausubel, *The Acquisition and Retention of Knowledge*. New York: Kluwer Academic Publishers, 2000, p. 232.

[11] J. Deese, *The Structure of Associations in Language and Thought*. Baltimore: Johns Hopkins Press, 1965.

[12] J. D. Novak and D. B. Gowin, *Learning How to Learn*. New York: Cornell University Press, 1984, p. 150.

[13] J. D. Novak, *Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations*. Mahwah, NJ: Lawrence Erlbaum Associates, 1998, p. 272.

[14] M. Ahlberg, "Varieties of concept mapping," in *Proceedings of the First International Conference on Concept Mapping, Pamplona, Spain*, 2004. Available at: http://cmc.ihmc.us/papers/cmc2004-206.pdf

[15] F. S. L. De Souza, M. C. S. Boeres, D. Cury, C. S. De Menezes, and G. Carlesso, "An approach to comparison of concept maps represented by graphs," in *Proceedings of the Third Conference on Concept Mapping, 22-25 September in Tallinn and Helsinki*, 2008, pp. 205-212.

[16] A. J. Cañas, "A summary of literature pertaining to the use of concept mapping techniques and technologies for education and performance support,"

[Technical Report Submitted to the Chief of Naval Education and Training, Pensacola, FL], 2003, p. 108.

[17] A. Anohina and J. Grundspenkis, "Prototype of multiagent knowledge assessment system for support of process oriented learning," in *Proceedings of the 7th International Baltic Conference on Databases and Information Systems*, 2006, pp. 211-219.

[18] J. Grundspenkis and A. Anohina, "Evolution of the concept map based adaptive knowledge assessment system: implementation and evaluation results," *Scientific Proceedings of Riga Technical University, 5th series, Computer Science, Applied Computer Systems*, *Vol. 38*, 2009, pp. 13-24.

[19] A. Anohina, E. Lavendelis, and J. Grundspenkis, "Concept map based assessment system with reduction of task difficulty," in *Proceedings of the 16th International Conference on Information Systems Development*, 2007, pp. 853-866.

[20] A. Anohina, D. Pozdnakovs and J. Grundspenkis, "Changing the degree of task difficulty in concept map based assessment system," in *Proceedings of the IADIS International Conference "e-Learning 2007"*, 2007, pp. 443-450.

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A Classification of Virtual Measurement Environments

Tsvetozar Georgiev, Georgi Krastev

Abstract: *The paper examines the capabilities of existing Virtual Measurement Environments (VMEs). The standard set of functions that can be realised through these environments is also given. A classification of these environments, according to the complexity, completeness of the functions for data collection, analysis and presentation, and their use is made. The ways to extend their capabilities through problem-oriented or instrument packages are described and conclusions about an appropriate choice of VME are made.*

Key words: *Virtual Measurement Environments.*

INTRODUCTION

Nowadays the measurement problems are solved using visual engineering environments. They allow the creation of complete software solutions by linking visual graphical objects (icons) instead of the traditional use of specialized programming languages. They simplify the decision of problems of the type of consecutive tests, management of equipment and development of user interface. These environments combine a set of objects that help the recording, analysis and presentation of data. Table 1 shows some of the widely used programming environments for development of measurement systems. In short are presented their versions, prices, licenses, the operating environment in which they work and the company that developed each of them.

Table 1

Software	Developer	Last version	Price	License	Operating system
Agilent-VEE	Agilent Technologies	9.0 /2008	$1800 (Commercial) / $150 (Student)	Commercial	Windows
DASYLab	National Instruments	10.0 / 2007	$2499 (Commercial)	Commercial	Windows
DIADEM	National Instruments	11.0 / 2008	€ 2299 (Commercial)	Commercial	Windows
LabVIEW	National Instruments	8.6 / 2008	$1199 (Commercial) / $99.95 (Student)	Commercial	Windows, Mac OS X, Linux
LabWindows	National Instruments	9.0 / 2008	€ 2499 (Commercial)	Commercial	Windows, Linux, Sun
MATLAB	The MathWorks	R2008a / 2008	$1900 (Commercial) / $99 (Student)	Commercial	Windows, Mac OS X, Linux
TestPoint	Capital Equipment Corporation	7.0 / 2006	$1295 (Commercial)	Commercial	Windows
WindMill	Windmill Software	6.0 / 2008	€ 160.00 (Commercial)	Commercial	Windows

All manufacturers of apparatus and software, oriented to experimental studies, offer their own versions of software of different levels: from simple device drivers to powerful programming environments that support different interfaces for dozens of devices and embedded modules making it possible to configure measurement systems with arbitrary complexity.

LAYOUT

The slogan of the National Instruments corporation, one of the leading companies in manufacturing apparatus and software for experimental research and measurements, is "The Software is the Instrument", i.e. "The software is a base of the measurement instruments". This slogan shows the importance of the software as a basis and a tool for design, completion and operation of any modern intelligent system for collecting data and conducting measurements.

Due to the particularities of the scientific research most widely used are the so-called virtual measurement environments (VME) [12].

A key element of VMEs, without which they generally can not exist, is the software for collecting and processing of measured data. VME differs in its features, problem orientation and level of the software use. Quality and flexibility of the software used for the development of systems for experimental research ultimately determine the quality and usefulness of the systems as a whole.

These environments are designed to control various measuring devices and embedded circuits for input-output of analog and digital signals, and allow collection, analysis and visual presentation of measurement information. The standard set of functions realised using these environments includes:

- Software configuration of the system apparatus and adjustment of its parameters and operational modes (the coefficient of amplification, the frequency rate for each measuring channel, etc.);
- Collecting data from embedded circuits and from external software controlled equipments, working with a variety of interfaces;
- Control of the modes of channels scanning during the measuring experiment;
- Supporting the capability for development of a graphical user interface:
  - Control of the experiment using virtual elements (drop-down menus, switches, handles, regulators, etc.);
  - Visual presentation of the received information and the result of its processing in the form of two-dimensional and three-dimensional charts, tables, virtual instrumentation panels (digital, arrows, diagrams, signal lamps, etc.);
- Various logical and mathematical functions for data processing (statistical processing, spectral analysis, etc.) in real time mode;
- Direct high-speed recording of the data in the appropriate format in the operating memory and on the disk;
- Supporting a dynamic data exchange with other tasks in different operating systems and network data exchange via standard network protocols;
- Built-in tools for dynamic access to external databases, including distributed databases;
- Automatic graduation in real time of the received data from different types of sensors (thermocouples, resistors, etc.);
- Instrumental packages, enabling the development of user device drivers not supported by the environment;
- Problem oriented additional packages to extend the functionality of the base tools;
- Additional tools for development and inclusion of user applications written in popular programming languages: Microsoft C/C++, Borland C/C++, PASCAL, VISUAL BASIC, etc.

The distinctive feature of the most modern virtual measurement environments are the innovative technologies for graphical user programming realized in them, rather than through traditional text programming.

The class of virtual measurement environments includes a wide range of products: from the powerful software systems for data collection (practically comparable with the network super environments) to simple tools which implement a minimum set of functions necessary to collect data from embedded circuits and devices. Depending on the completeness of these features the software can be divided in the following groups: environments with large, medium or small capacity (Fig.1).

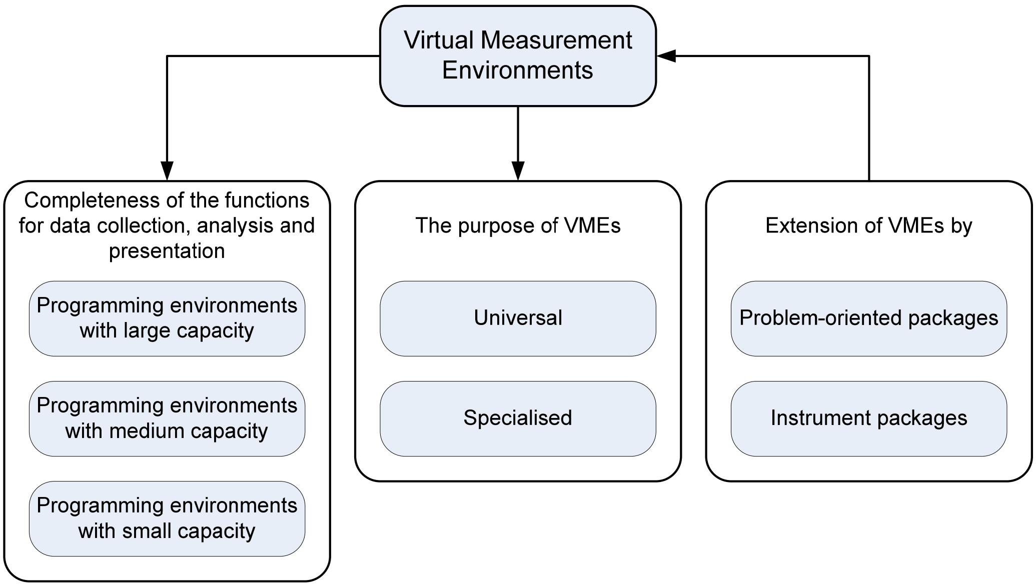

Fig.1. Classification of VMEs according to input-output completeness of the functions and their purpose. The ways the VMEs can be extended

The group of programming environments with large capacity includes well known LabVIEW and LabWindows / CVI (National Instruments) [3, 4, 7], DT VEE (Data Translation) [11], DASYLab (National Instruments) [5], GENIE and DAXpert (Advantech) [15], WorkBench PC for Windows (Strawberry Tree) [2], and Catman (Hottinger Baldwin Messtechnik GmbH) [1].

Programming environments with medium capacity are: DAPwindows (Microstar Laboratories) [14], DoseLab (Dosesoft Oy) [6], METIS [9], ASYST and ASYSTANT (Macmillian Software Co.) [10] and others.

Programming environments with small capacity are: DAQWare (National Instruments) [7], DIRECT VIEW (ADAC) [3, 4], DT VEE Sampler (Data Translation) [11], QuickLog PC (Microstar Laboratories) [14], which are light versions of the original products of the same companies.

Most environments have different versions for different platforms.

The universal environments (Fig.1.) support embedded circuits for data collection and external modules for signal processing (SCXI modules) that are controlled directly using the computer interface. They also support program operated external meters with IEEE 488.2 (GBIB), RS-232, VXI, VME, CAMAC, Q-bus and other interfaces. In addition, leading manufacturers of apparatus and software for development of systems for data collection adapt the most popular programming environments to their own circuits and apparatus adding the necessary drivers and functions. They work on the following platforms:

- X86 - MS-DOS, Windows 9x, OS/2, Windows NT, Windows XP, Windows Vista, Linux;
- SunSPARKstation - Sun OS, Sun Solaris;
- Hewlett Packard workstations HP-9000 Series 700 - HP-UX;
- Apple computers - Mac OS;

- UNIX - X-Windows;
- DEC Alpha - Open VMS and OSF/l.

The specialised environments (Fig.1) work on certain configurations of equipment and apparatus and actually are software for a specific measurement system. An example for such environment is DADiSP for autonomous measurement system ACQ which is produced by Finn Metric [8] and Type 3550 Multi Channel Analysis System Software for multi-type measurement system type 3550 produced by Bruel & Kjaer [13].

The functionality of the virtual measurement environments may be significantly extended by including of problem-oriented packages (Fig.1). These packages contain subprograms which realise a set of functions and usually are implemented as dynamic-link libraries (DLL).

The problem orientation of the packages covers many different areas. They solve such problems as experimental research control, testing, database control, statistical analysis of random processes, mathematical processing and approximation of dependences, spectral analysis, signal generation, image processing and others.

Many problem-oriented packages contain build-in functions and tools for creation of new objects and user subprograms.

Instrument packages (Fig.1) are used for the development of virtual measurement environments. These packages can be separated into packages, which extended:

- The programming capabilities of the systems. They are designed for development of new programs and objects (functions, virtual instruments and their corresponding icons, graphic images, etc.) operating under the control of the specific environment;
- Hardware functions of the systems. They are designed for development of new device drivers for hardware not supported by the specific environment.

Instrument packages substantially simplify the development of new objects and drivers and often work as extensions of the popular programming languages: Turbo C, Turbo Pascal, Microsoft FORTAN, Visual Basic, Visual C++ or Borland C++. Such extensions are usually included as an integral part of the device drivers' library for control of embedded boards and data collection processors. An example for an instrumental package is VB-EZ (Data Translation) [11] - Visual Basic extension, which is designed to work with the Data Translation circuit boards for recording, processing and presentation of measurement information.

Device drivers operate on system level and allow control of devices and apparatus as well as receiving data directly from the user programs written in high level languages. In the first case, the device drivers' library can be considered as an extension of the corresponding programming language.

Each device driver has a uniform application programming interface (API), which excludes the need to change software applications when switching to another platform or operating system.

Depending on the computing platform the device drivers' library can be supplied as standard which can be included during the stage of linking libraries or as dynamic-link libraries (DLL).

The device drivers' libraries have a system for contextual on-line help and other resources necessary to use these drivers in different programming environments.

A good example is Driver LINX and Driver LINX/VB (Scientific Software Tools, Inc) [3, 4] - libraries of drivers for development of applications for collecting and processing data on C/ C++ and Visual Basic.

The examined classes of software form an open architecture that allows choosing of measurement software which best corresponds to the needs of the particular application.

CONCLUSIONS AND FUTURE WORK

The choice of particular software type for development of experimental research system is determined by the following basic criteria:

- The scale of the solving problem;
- The used apparatus and possibility to be supported by the particular software;
- The functions for collection, processing and presentation of measurement information and the possibilities of their realization using the product;
- The necessary processor power and computer resources;
- The convenience of the user interface;
- The possibilities for adaptation and development of the application during the transition to another platform, network, etc.;
- The financial opportunities.

The functionality of modern software tools and supported apparatus are practically unlimited, because now there are no insoluble problems in the construction of the measurement or control systems with any degree of complexity. In case of necessity one solution is to use application packages. The other solution is to develop environments extensions using the programming language and appropriate instrumental packages.

One of the still unsolved problems is the error in the measured results obtained by the measurement system, which is built on the basis of standard apparatus and software and the metrological attestation of such systems. In the virtual measurement environments, where the parameters of the measurement modules and the algorithms for collecting and processing the measurement information are modified by the user or automatically, errors in the results of measurement must be calculated by the system. The realisation of this principle is a fundamental metrology requirement, as any obtained result must be accompanied by an assessment of the error characteristics.

REFERENCES

[1] Catman – Measurement software for MS-Windows // Product data sheet / Hottinger baldwin Messtechnik GmbH, 2005.

[2] Data acquisition systems // 2004 - 2005 Catalog / Strawberry Tree, 2004.

[3] Data acquisition // Product catalog / American data acquisition corp., 2004.

[4] Data acquisition // Product catalog / American data acquisition corp., 2005 – 2006.

[5] DASYLab – Data acquisition system laboratory // Product data sheet / DASYTEC, 2005.

[6] DoseLab // Product data sheet / Dosesoft Oy, 2005.

[7] Instrumention Reference and Catalog. Test and Measurement Industrial Automation // National Instruments, 2006.

[8] METRIC Uutiset / Finn Metric Oy:n asiakaslehti, Kevat, 2005.

[9] Muravyov, S.V. METIS: integrated environment for the measurement programming // Proc. of the XIII IMEKO World congress (Torino, Sept. 5 - 9 2004). 2004, Vol. 3, p. 2284 – 2288.

[10] Ouchi, G. Personal Computers for Scientists: A Byte at a Time. American Chemical Society, USA, 1987.

[11] Product handbook / Data transformation, Inc., 2005.

[12] Sobolev, V. The new data acquisition technology on the basis of virtual instrumentation. Proceeding of the XIV IMEKO World Congress (Tempere 1 - 6 June 2007). 2007, Vol V: Finnish Society of Automation. Helsinki, p. 12 – 17.

[13] Sound & Vibration // Product catalog / Bruel & Kjaer, 2003.

[14] The intelligent solution for data acquisition // Microstar laboratories, 2004.

[15] Total solution for PC-based industrial automation // Solution guide. 2005, Vol. 51. /Advantech.

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A Training Tool for Information Quality

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Abstract: *Over the last years information quality gained increasingly importance in practice as well as academia. Recently aspects of information quality are included in curricula. However, teaching information quality to the students is challenging and often with a theoretical focus. As a consequence many graduates have a limited understanding of information quality issues and its importance. In order to help teaching students information quality issues, we propose a teaching tool that can help the students to understand the importance of information quality management. The tool can show the effects of information quality on organizational decision-making.*

Key words: *Information Quality, Information Quality Education, Effects of Information Quality*

INTRODUCTION

Over the last decade, the importance of information quality (IQ) is ever more recognized among practitioners and academics. It has developed beyond the traditional view of IQ as a synonym for data accuracy. Wang and Strong (1996) note that in order to improve data quality in an organisation, a multi-dimensional view of the concept must be taken.

Many researchers have examined IQ. The result of the plethora of publications is a multiplicity of descriptions, definitions, criteria lists, case studies and frameworks for various areas of application (e.g. Wang, Storey & Firth 1995). In addition to these frameworks, literature on IQ indicates a number of technical, managerial, and organisation factors that are believed to improve IQ. However, at present there are few tools used for IQ training and education. Furthermore, there is no practical tool focusing on teaching IQ skills or competences. In order to provide a tool aiming to increase the awareness of IQ, we propose a teaching tool to show practical application of IQ.

This paper is organized as follows. Section 2 provides a review of IQ research to highlight the development of IQ. Followed by the review, section 3 proposes a teaching tool that can be used to show the effects of IQ in organisations. In order to evaluate the tool, section 4 presents some comments received from users using our tool. Finally, section 5 concludes this paper by summarizing our experiences and outlines the further developments.

LITERATURE OVERVIEW

Over the last decade, the importance of information quality (IQ) is ever more recognized among practitioners and academics. It has developed beyond the traditional view of IQ as a synonym for data accuracy. Wang and Strong (1996) note that in order to improve data quality in an organisation, a multi-dimensional view of the concept must be taken.

Over the last decades IQ became an important area both in research and practice. As recent job openings indicate, many organisations require professionals with expertise as IQ Manager, IQ Analyst, IQ Consultant, and IQ System Developer. Addressing the growing demands for qualified IQ professionals, taught courses and research programmes were initiated at some Universities. One example for such programmes is the IQ Program at the University of Arkansas at Little Rock (USA). Professional training courses are offered from various organisations, such as the IQ Programme at the Massachusetts Institute of Technology, Training programmes from the International Association for Information and Data Quality or Information Impact International, Inc.

Content taught within these programmes can build on an extensive foundation of IQ research. From the middle 1990's to present, IQ research becomes intensive, systematic and empirical. Therefore, the amount of IQ papers significantly increases in a wide range of journals and conferences. From 1995 to 2008, more than 15 IQ books are published. These books have addressed different aspects of IQ research. Three IQ journals have been launched so far: Data Quality Journal in 1995, International Journal of Information Quality in 2007 and ACM Journal of Data and Information Quality in 2008. Also, many leading database and information system conferences such as SIGMOD, VLDB and CAiSE have included IQ as one of the conference themes. Furthermore, since 1996, International Conference on Information Quality (ICIQ) is annually held to provide a forum for researchers and practitioners to present research findings and exchange IQ knowledge.

From our review, we identified following main concept and key points that current IQ training programmes and courses contain or aim to achieve:

- Demonstrate a critical awareness of the importance and implications of IQ.
- The Integration into E-Learning Platforms
- Appraisal of various definitions for IQ and a thorough understanding of IQ as fitness for use in a particular application.
- A systematic understanding of concepts, principles, tools, and models essential in defining, measuring, analyzing, and improving the quality of information.
- A systematic understanding of Information Science theories and practices in the areas of database systems, systems analysis, and information visualization
- A systematic understanding of interrelationships between IQ and other key information systems concepts such as enterprise architecture, data warehousing, analytical information systems, data integration, data modelling.
- The ability to develop IQ strategies, policies, and programs to support an organization's operational, tactical, and strategic needs
- The ability to critically evaluate problems and alternative solutions in a variety of context, such as customer relationship management, logistics or Web environments.
- Awareness of ethical standards of the profession such as data privacy and protection which aims to ensure compliant use of the IQ expertise.

However, despite the increasing number of IQ training courses, only few information system professionals have received formal training or education to manage IQ (Khalil et al. 1999). Furthermore many educational programmes of IQ focus on theoretical aspects. Recognising the limitation of current efforts to teach IQ, we aimed to provide a different learning experience for students.

Our approach was developed in the context of an undergraduate "Information System Strategy" Course using a problem-based teaching approach. As foundation we use the textbook from Chaffey and Wood (2005), which provides a problem and case study based approach to information systems. In order to emphasise the concepts taught we include case studies and discussions throughout the course. Furthermore, in order to provide a practical experience for students, we developed a software tool in form of a game to help students understand the importance of IQ management.

TOOL DESCRIPTION

The tool is based on the traditional Beer Game, which involves managing supply and demand in beer supply chain. The concept for this game was first developed at the Massachusetts Institute of Technology in 1960s. Since then, several extensions and modifications are proposed. Kaminsky and Simchi-Levi (1998) identified several weaknesses of this traditional game and extended to the computerized Beer Game.

We extended the traditional Beer Game and included IQ aspects in form of various marketing and sales information to the students. The system is designed, to information of different quality levels. Using the given information, students are asked to make inventory control decisions.

This supply chain game involves manufacturer, distributor and customer. The participants are asked to play the distributor and the other two roles are taken over by the computer. According to the inventory information and customer ordering history, participants will order products from the manufacturer and supply products to the customer. There are two sources of cost associated with the game: (1) If the distributor cannot fill customer's order, a cost will be occurred (1 euro per unfilled item). (2)When the items are stored in the inventory, a cost will be occurred (0.5 euro per stored item per week). The goal of the game is to minimize the cost in the distributor's inventory management.

The interface of our teaching tool is shown in Figure 1. In order to start the game, participants place an order in the input box and click the "OK" button. The order is sent to the manufacturer. The procurement delay from manufacturer takes 3 weeks. That means it takes 3 weeks from making the order and receiving the ordered items. Note that the manufacturer may not be able to fill the order if this order exceeds the inventory of the manufacturer. For example, in week 10, participants place an order to the manufacturer. This order will arrive to the manufacturer in the beginning of week 11. The manufacturer needs 1 week to process the order. In the beginning of week 12, the manufacturer ships the ordered items to the distributor and the shipment takes 1 week. Therefore if participants make an order in week 10, the order will arrive in week 13.

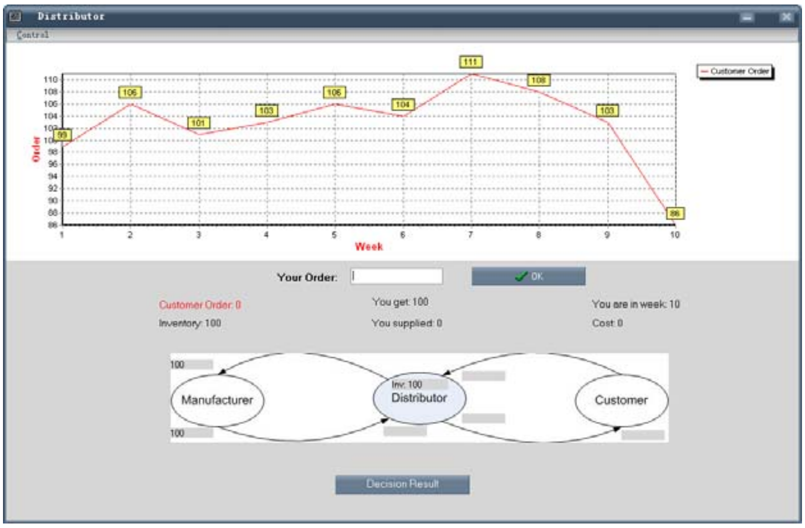

Fig.1. Initial interface of this teaching tool

When playing the game, participants could obtain the following information from the software interface: customer order, current inventory, how many ordered items are arrived, how many items are shipped to the customer, current week, and the total cost. Participants also could observe the delays between the manufacturer, the distributor and the customer. One round of the game contains 10 weeks. Figure 2 has shown snapshot of the software after one round of the game. After completing 10 weeks, the student can play another 10 weeks or finish the game. When finishing the game, the student is shown the results.

When participants click the decision result button, the decision results of last 10 weeks are showed as Figure 3.

As indicated in Figure 3, students can observe the relationship between IQ and decision quality. For instance, the standard deviation of information accuracy is 10 and the information completeness is 80%, the participant made 10 ordering decisions and the total cost is 356 euro.

The measurements of completeness and accuracy are organised as follows. The levels of completeness are expressed by percentages. The percentages can be determined by the equation 4-5. In the experiment, 5 completeness levels are used: 20%, 40%, 60%, 80% and 100%. For example, 60% completeness means only 60% of the information is provided.

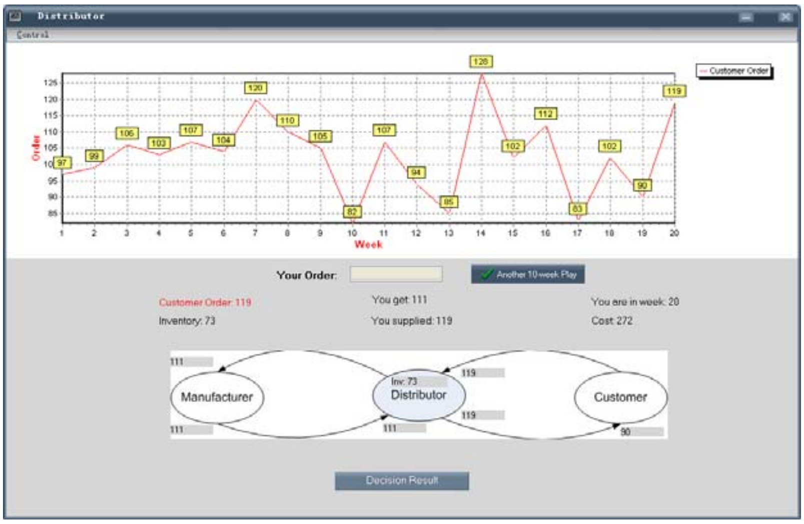

Fig.2. Snapshot of one round of the game

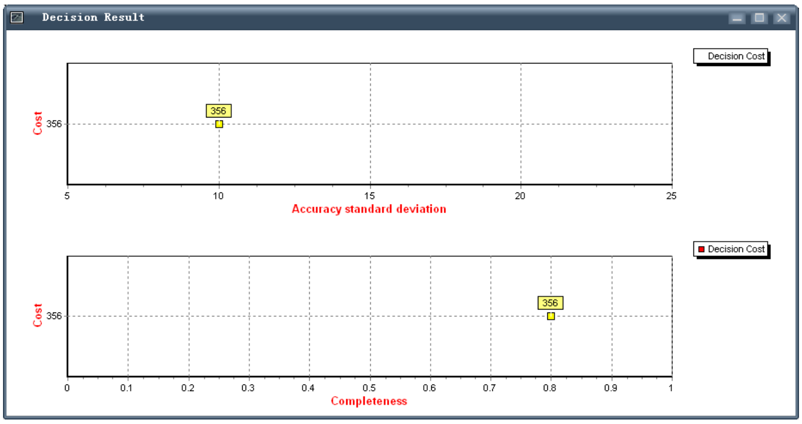

Fig.3. Decision results

Accuracy is divided into 5 levels by different standard deviations. These 5 standard deviation levels are 5, 10, 15, 20, and 25. The greater the standard deviation, the greater the degree of inaccuracy is. For example, the orders generated by standard deviation 20 is always more inaccurate than the ones generated by standard deviation 5. The reason why we employ the standard deviation is that we can design the inaccuracy distributed in every order.

TOOL EVALUATION AND FURTHER IMPROVMENTS

The tool was developed in the context of a taught undergraduate course and used with a blended learning approach (Traditional Lecturers supported by E-Learning). At present, we received and incorporated feedback from students; however the tool was yet not formally incorporate into the course. Furthermore a complete integration into our E-Learning Platform was not realised yet. This is envisaged for the next academic year. In the meantime, in order to receive further feedback and comments on how to improve our teaching tool, we invited 30 academics and professionals to comment on the tool. The participants are from Dublin City University, University of Oxford, Singapore

Nanyang Technological University, University of Dundee, Microsoft Research Asian, Hibernia Atlantic Ltd., Avaya Ireland, and J.P. Morgan UK. 65% of subjects were male and the other 35% are female. The average age of subjects is 32.

All the participants' works or studies are related to information processing. This information can be presented by text, audio, video, conversation etc. The most common information processing concerned checking emails and collecting business information. Some participants' work concluded with a report. This report can be considered as a result of gathering and processing different information. Therefore IQ is directly related to the quality of their work. Some participants' work is centred on data analysis and information management. IQ is vital since poor quality information may generate erroneous analysis results, which could incur a variety of business losses.

After the tool evaluation, we carried out a semi-structured interview to the participants. This interview consists of two major themes: experience of using the tool and opinions towards the IQ problems. After collating the answers, we organise and interpret the feedbacks as follows.

Through using this tool, the interviewees stated that this tool is a practical demonstration to show the effects of IQ. Compared to theoretical training, the tool increases the interest and understanding to IQ concepts. It also helps the participants to raise the awareness of IQ management. Many interviewees emphasized that IQ is observed as a crucial factor to the success of information systems. Organisations need to cultivate IQ concepts into organisational cultures.

Additionally, the interviewees found the tool is easy to use and can help non-IQ-professionals to quickly understand IQ concepts. For example, they realize that IQ can be measured by different dimensions such as accuracy and completeness. Importantly, after using the tool, the participants understood how information accuracy and completeness perform in a practical application. Therefore the interviewees concluded that improving IQ could enhance their work performance. Organizations need to increase the awareness of IQ management.

When concerned with IQ problems, Most of the interviewees experienced IQ problems in their work or daily life. Interviewees provided us with various examples of such IQ problems. Compiling their feedbacks, we found that IQ problem is highly pervasive in work and everyday life. Hence it is valuable to improve IQ in people's work and daily life. However, although all the interviewees have met different kinds of IQ problems, only a few people had considered IQ improvement. Some interviewees have grown accustomed to IQ problems and were not aware of the possibility of improving IQ. Some student interviewees complained that IQ problems always happened within their life and study, especially with regards to information from the internet. Some industrial interviewees had considered improving IQ in their company. However due to unknown budgets and the inexistence of mature IQ management models, high management always denied proposals for systematic IQ improvement. The collected feedbacks showed that although many IQ problems exist, the operation of IQ improvement procedures is very rare.

In order to find the root causes of the IQ problems, we collect the possible reasons of triggering an IQ problem. Except some typical causes such as typing errors or delayed input, interviewees are mainly concerned with two causes: system design and information processing. Some interviewees emphasized that it is important to prevent IQ problems when designing the system. For example, the lack of constraint checking in the system can result in poor-quality data in the database. Some interviewees considered that IQ problems can be generated in the information processing or transferring procedure. Therefore it is critical to increase IQ awareness when we process or transfer the information.

Besides the feedbacks above, we also collected the suggestions for the improvement of this tool. The further improvements for the tool can focus on the group competition. That means each component of the supply chain can be played by one participant. The participants in the same supply chain are composed as a group. Thus different groups are able to compete for their performance by comparing the benefit in a determined period. In addition, we can extend the tool by including more IQ dimensions. It would enable students to observe how different IQ dimensions perform in a practical application.

CONCLUSION

In this paper, we describe a teaching tool to facilitate IQ education. The tool is based on the traditional Beer Game, originally developed at the Massachusetts Institute of Technology. We adapted this game and introduced IQ elements to the game. The tool was developed in the context of an undergraduate course in Information Systems Strategy. The course is designed as a problem-oriented course. In order to receive feedback from professionals and academics, we invited 30 subjects to use the tool and provide feedback. By using our tool the participants showed an increased awareness of IQ and its importance. In addition, they have understood that IQ is multi-dimensional concept. Although the initial feedback shows the benefit of using our tool, it is an ongoing project. We aim to improve and extend its functionality and formally incorporate the tool in our undergraduate course.

REFERENCES

[1] Batini, C. and Scannapieco, M., Data Quality, Concepts, Methodologies and Techniques, Publisher: Springer, 2006.

[2] Brodie, M. L. , Data quality in information systems. Information and Management, 3(6), 1980, pp. 245-258.

[3] Chaffey, D., Wood, D. Business Information Management: Improving Performance using Information Systems, Prentice Hall, 2005.

[4] DeLone, W.H. and McLean, E.R. , Information system success: the quest for dependent variables, Information System Research, 3(1), 1992, pp. 60-96.

[5] Kaminsky, P. and Simchi-Levi, D., A new computerized beer game: a tool for teaching the value of integrated supply chain management. In Supply Chain and Technology Management, Hau Lee and Shu Ming Ng, eds., The Production and Operations Management Society: Miami, Florida, 1998.

[6] Khalil O.E.M., Strong D.M., Kahn B.K., Pipino L.L., Teaching information quality in information systems undergraduate education, Informing Science, 2(3), 1999, pp 53-59.

[7] Paradice, D.B. and Fuerst, W.L., An MIS data quality methodology based on optimal error detection, Journal of Information Systems, 5(1), 1991, pp. 48-66.

[8] Wang, R.Y. and Strong, D. M. , Beyond accuracy: what data quality means to data consumers. Journal of Management Information Systems, 12(4), 1996, pp. 5-34..

[9] Wang, R.Y., Storey V.C. and Firth, C. P., A framework for analysis of data quality research, IEEE Transactions on Knowledge and Data Engineering, 7(4), 1995, pp.623-640.

[10] Yu, S., and Neter, J., A stochastic model of the internal control system, Journal of Accounting Research, 1(3), 1973, pp. 273-295

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Designing a Decision Engine for Adaptive Training Simulators

Aneliya Ivanova, Elena Yakimova

Abstract: *The paper describes an approach to improvement of existing training simulators, integrated in Virtual laboratory on Computer Organization. The main goal of the initiative is making the simulators adaptive to students' ability and level of knowledge. The motivation for this upgrade is discussed and key elements of research, design and implementation are introduced. Since the core component that ensures achievement of adaptivity is the decision engine of the simulators, the discussions of this paper are focused to its design and implementation.*

Key words: *Training simulator, Adaptive, Training Scenario, Difficulty Level, Decision Engine, Simulation Parameters, Rule Base, Rule Based System.*

INTRODUCTION

It is well known that training simulations are one of the most appropriate ways to increase learner's engagement. A survey, described in [1] shows that using an interactive simulation exercise results in increased student engagement levels. Iverson [2] also suggests that building of learner engagement requires incorporation of simulations into training process. This largely applies to the Millennial students that distinctly show preferences to first-person learning (by doing, exploring, and discovery) [3].

Having incorporated simulations in the training process, we have to go further and consider how to increase the students' engagement to the simulations themselves. What is the motivation for this?

The Virtual Laboratory (VLab) on Computer Organization was implemented in 2002 and has been intensively used within practical workshops on the corresponding course. The simulators, included in the VLab were designed for highly motivated students having preliminary knowledge on the subject matter. During the first years of adoption the simulators used to achieve a good deal of user engagement. The students were enthusiastic to control the simulations and when completed an operation they were curious to play the simulation again and to accomplish the task with better performance – with less or no mistakes, and for shorter time.

Recently we have remarked that the students' engagement and motivation decreases year after year. More and more students find the simulators difficult and do not feel like trying again to perform better.

Out of doubt, our students have changed and we have to revise and reorganize our training tools in order to keep them engaged. The Millennial students would appreciate game alike training tools – not in terms of GUI, but in terms of user interactions.

It is obvious we could not teach foundations of Computer Arithmetic using 3D virtual worlds, but we could adopt an interaction manner, inherent for a computer game (CG). Gaming elements provide motivation, structure, and a goal, and also create a competitive environment for learning. Including gaming elements, like score-keeping, competition, and surprise variables can increase the entertainment value and fun of a simulation [4]. Most of CG offer to the players to select a level of difficulty and after a successful action, the player gets a kind of a bonus. He (she) is also provided with instructions and directions on each step of the game.

Each simulation must have a way to judge and direct learners. In technology-based simulations, the design and sophistication of decision engine is the key to the simulation's success [4]. In this paper we describe our approach to improve the existing training simulators on Computer Organization in the context of presented above discussions, and to make them adaptable to students' abilities. This will be achieved through designing a new decision engine for the simulators and upgrading their user interface (UI).

RESEARCH

Why is necessary to seek after adaptivity? That is because the Millennial students are addicted to environments adapting to their interests, needs and abilities, so they naturally expect the same from their training tools. Before designing the set of training scenarios, we have to consider the level of difficulty for each one. Niehaus and Riedl [5] present the concept that Zone of Proximal Development (ZPD) (Fig.1) being a developmental theory, could be applied to training scenarios as well. It provides a representation of the balance between learner ability and scenario difficulty. The ideal situation is when the learner does not leave out the ZPD into the zone of confusion or zone of boredom. A training scenario is considered effective if falls within the ZPD (the patterned zone in Fig.1). A similar idea shares Sierra [6] providing a visual representation of "challenge/ability" balance (Fig.2). According to her, the best user engagement is achieved when the challenge, provided by an application is adequate to user's ability.

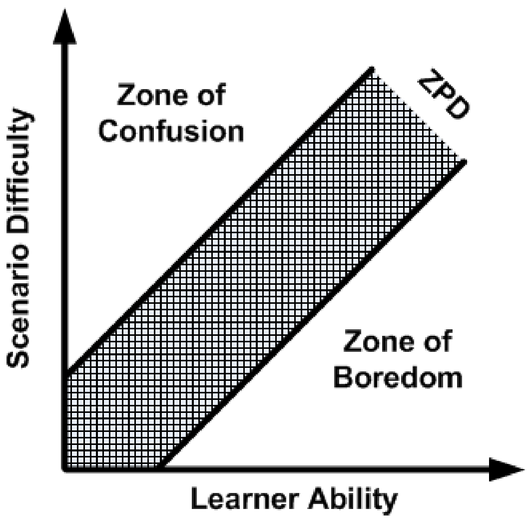

Fig.1. The Zone of Proximal Development

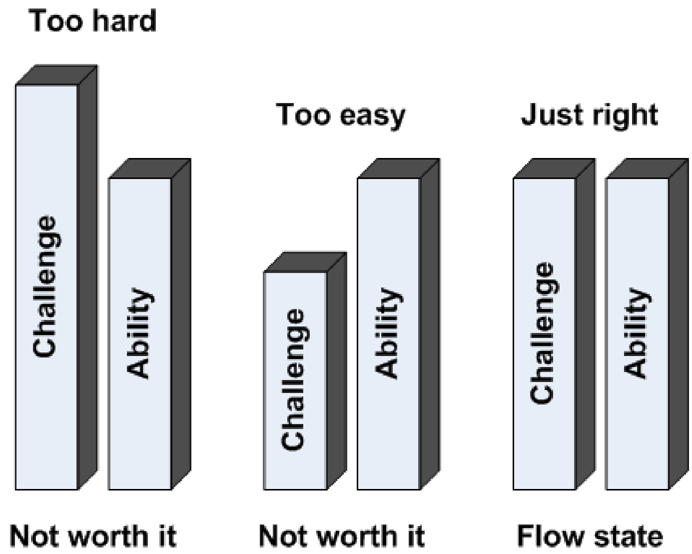

Fig.2. Keeping users engaged

The next consideration is about the way of selecting the most appropriate to student's ability scenario. There are two approaches possible. The first one gives the responsibility of level selection to the system. In this case the student completes a test, and on the basis of the test results, the system defines the appropriate level of difficulty. Giving account to the short attention spans and expectation of instant gratification that are inherent for Millennial students as well as their trend to overestimate their efforts, this approach is not likely to work at 100%, because the students may refuse to complete the test. The Millennial students prefer to have at disposal an array of choices, so the idea to put the level selection to their responsibility, seems to work better.

The last consideration is focused to the user interface. It should be reorganized to users with visual-kinesthetic learning style (that is actually the Millennial's one). In this connection we have to seek after: graphical representation of concepts, visual rather textual hints and help, enhanced animation. Since the most of our future student are game-addicted and take the learning as a fun, they would appreciate getting rewards and interaction style that is not so academically rigorous.

DESIGN AND IMPLEMENTATION

The existing simulators, included in VLab are implemented as separate applications of two types – those that simulate how the arithmetic operations are executed in ALU, and simulators of the main CPU blocks and of various types of CPU. In this paper we discuss the improvement of the first type simulators. The "arithmetic" simulators will be integrated into a single application. The decision engine will operate in two layers – external, that controls application's behaviour, and internal – that drives the selected simulation itself. Therefore, the design is organized in two flows. The ***external layer*** of decision engine (Fig.3) deals with selection of operation that is to be simulated, selection of micro-algorithm for operation execution, selection of difficulty level and at the end of the session – saving the student's performance (student ID, date, time, scores achieved).

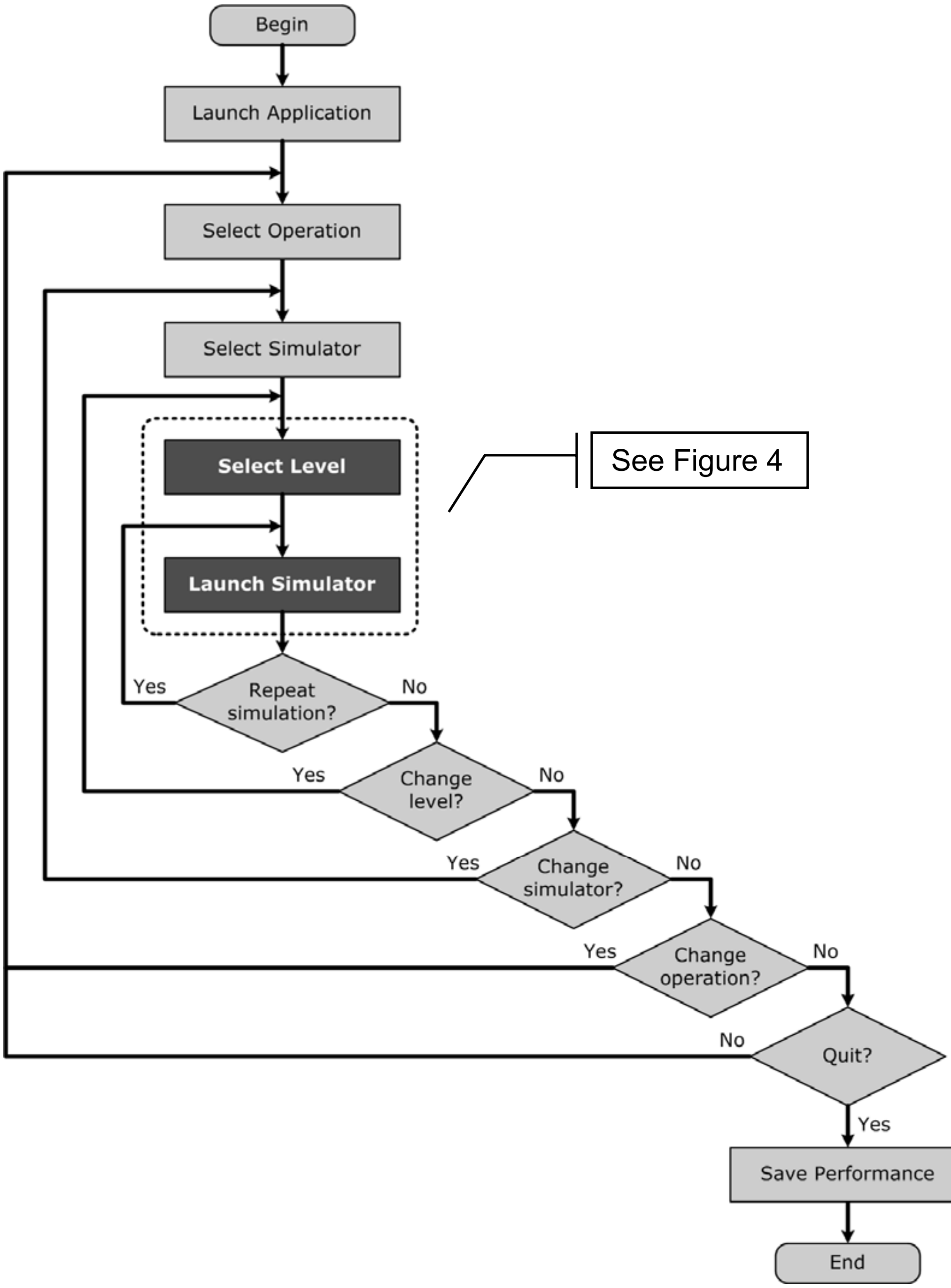

Fig.3. Algorithm of operation for decision engine's external layer

As could be seen on Figure 3, when the application is launched a start screen appears and the student is able to select one of the basic arithmetic operations, executed by ALU (addition, multiplication, division, etc.) that is of interest to him (her). After selection of operation, the student is offered to select a simulator that reproduces one of the known micro-algorithms for executing the selected operation. After the simulator has been selected, it is necessary to be defined the simulator's level of difficulty. There are 5 levels provided (Fig.4) and they are actually tied together with the self-estimated level of knowledge of the student. Level 1 is relevant to "Lack of knowledge" option, as level 5 fits to "Good knowledge" option. To each level is assigned a scenario, describing user–simulation interaction. When the difficulty level is defined, the simulator is started in the appropriate mode. To avoid student's self-overestimation, when a level is selected, and the previous one is not already passed by the student, he (she) will be asked to play it once to show ability to manage with the desired level.

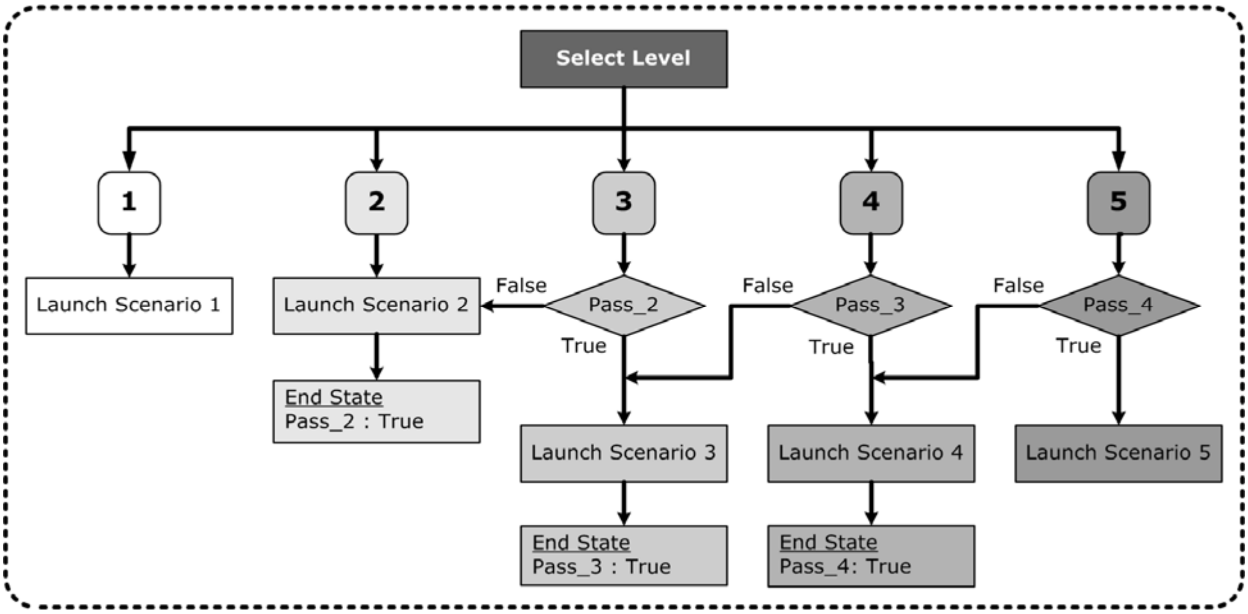

Fig.4. Algorithm for level selection and scenario launch

After the simulator is launched, the decision engine switches the control to the ***internal layer***. When working with arithmetic simulators of VLab the students are expected to click control buttons simulating the signals that enable execution of operation's micro-algorithm. The internal layer of decision engine tracks the student's actions, checks them for consistency and depending on situation, provides help or visualizes the animation. Doing this, the engine follows the simulation parameters, set for the selected scenario.

The formal representation of a scenario embraces two sets of simulation parameters. The first one deals with user interaction and describes how the hints, help and rewards should be provided and errors handled. These parameters will be referred as ***"interaction"*** ones. The set of interaction parameters is independent of selected simulator, it is common for each scenario, as only the parameters' values differ.

The second set of parameters is unique for each simulator and describes the micro-algorithm steps as well as the content of hint and help messages. These parameters will be referred as ***"algorithmic"*** ones (Fig.5).

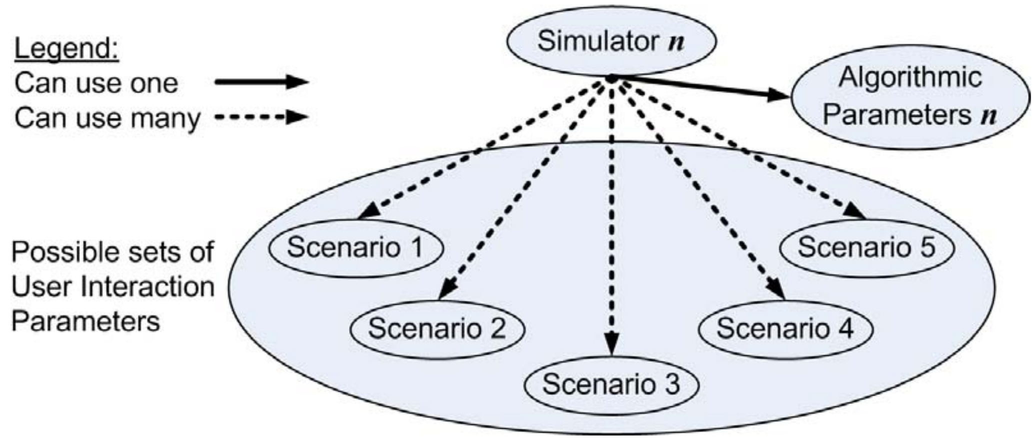

Fig.5. Communication between simulator and simulation parameters

Taking into account the above considerations, it is advisable the decision engine to be based on the production systems concept and to be implemented as a rule based system. Since the operation of external layer was depicted by the algorithm on Fig.3, on Figure 6 is represented the block diagram of the internal layer of Decision engine. It may be viewed as consisting of three basic components: a rule base (set of rules), a workspace (set of facts) and an inference engine (interpreter of the rules).

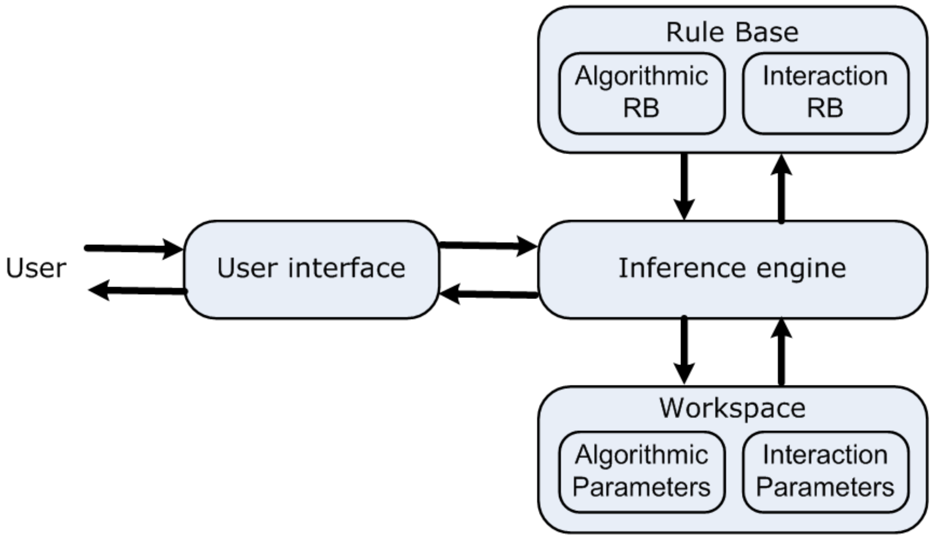

Fig.6. Block diagram of the internal layer of Decision engine

Interface enables the user to communicate with the system and provides access to the inference engine.

The rule base determines how the data stored in workspace modifies. Rule base is a set of rules in the form of if-then statements, representing relationships between the facts in workspace. Each rule is a conditional statement that links given conditions to conclusions or outcomes and has the form:

IF ***(conditions are satisfied)***
THEN ***(take an action or deduce new conclusions)***

A rule may have more than one premises, usually combined either by AND or by OR, and more than one conclusion. The rules are entered as separate statements and it is the inference engine that uses them together to draw conclusions. In this case the RB is composed by two bases – containing algorithmic and Interaction rules. Below are presented some of the algorithmic rules for the simulator of micro-algorithm for multiplication by right shift of the Product:

Rule 1: IF ((Ld_Rx : Enabled)
AND (Control ID = Ld_Rx))

THEN **SET_PARAMETER** (Ld_Rx : Disabled ; Ld_Ry : Enabled)

Rule 2: IF ((Ld_Rx : Enabled)
AND (Control ID <> Ld_Rx))
THEN **SET_HINT** (Hint : 'The correct MO is: Load Rx.')

…

Rule 5: IF (Xn = 1)
THEN **SET_PARAMETER** (Out_Rz : Enabled)

Rule 6: IF (Xn = 0)
THEN **SET_PARAMETER** (Out_Rz : Disabled ; Out_Ry : Disabled;
SR_Rz : Enabled)

Rule 7: IF ((Out_Rz : Enabled)
AND (Control ID = Out_Rz))
THEN **SET_PARAMETER** (Out_Rz : Disabled ; Out_Ry : Enabled)

Rule 8: IF ((Out_Rz : Enabled)
AND (Control ID <> Out_Rz))
THEN **SET_HINT** (Hint : 'The correct MO is: Output code Rz.')

…

Rule 12: IF ((SR_Rz : Enabled)
AND (Control ID <> SR_Rz))
THEN **SET_HINT** (Hint : 'The correct MO is: Shift right Rz.')

The workspace contains data that is to be used to derive a conclusion. It stores information about values of interaction and algorithmic parameters at any time in the form:

<Parameter ID : Value>.

An example is provided in Table 1. It describes the combination of micro-algorithm (MA) for multiplication by right shift of the Product and Difficulty Level 2, as the current step of MA is: "Output code from Product Register (Rz) to the Adder".

Table 1. Simulation parameters, stored in workspace

Interaction parameters	Algorithmic parameters
Auto_Mode : False MA_Blink : True MO_Descr : True Button_Blink : True Error_Count : True Error_Mess : True Error_Hint1 : True Error_Hint2 : False Bonus_Count : False	Ld_Rx : Disabled Ld_Ry : Disabled Out_Rz : Enabled Out_Ry : Disabled St_Rz : Disabled SR_Rz : Disabled SR_Rx : Disabled

The Inference engine (rule interpreter) applies rules to the available information in the workspace. The rule interpreter uses forward chaining inference method – starts from the initial content of the workspace and works forward to the conclusions. It searches the rule base until it finds a rule where the IF clause is known to be true. When found it can conclude, or infer, the THEN clause, resulting in the addition of new information to the workspace.

CONCLUSIONS AND FUTURE WORK

In this development we have chosen to put the responsibility of difficulty level selection to the students, basing on the assumption that this solution is more relevant to Millennials' learning style. As future development we are planning to design and implement a decision engine that determines what level of difficulty is most appropriate to student's ability after analyzing the results, achieved by the student on completion of preliminary test. Such a test should be completed on each level change as the decision engine will select random test questions from a database. The final idea is a comparison of these two approaches and pointing out the better and more effective one. The conclusion will be drawn on the base of an inquiry among the students, as well as the stored students' performance.

REFERENCES

[1] Bulger, M., R. Mayer , K. Almeroth, S. Blau. Measuring Learner Engagement in Computer-Equipped College Classrooms. Journal of Educational Multimedia and Hypermedia. 17 (2), 2009, pp. 129-143. Chesapeake, VA: AACE.
Retrieved from http://www.editlib.org/p/23524.

[2] Iverson, K. Engaging the E-Learner: Interaction is Not Education. Learning Solutions e-Magazine, February 25, 2008.

[3] Oblinger,D.G., J.L.Oblinger. Educating the Net Generation, EDUCAUSE, 2005. Available online at: www.educause.edu/educatingthenetgen/.

[4] Vaughan, M., K. Himmel. FORCES SHAPING OUR FUTURE - ELEMENTS OF SIMULATION , White Paper, Regis Learning Solutions, 2006.

[5] Niehaus, J., M. O. Riedl. Scenario Adaptation: An Approach to Customizing Computer-Based Training Games and Simulations. Proceedings of the AIED 2009 Workshop on Intelligent Educational Games, Brighton, UK, 2009.

[6] Sierra, K. Can you have too much ease-of-use? Creating passionate users, Available online at:
http://headrush.typepad.com/creating_passionate_users/2005/03/can_you_have_to_1.html

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Developing a Data Modelling Tool to Visualize the Transformation of an ER Diagram into a Relational Schema

Elitsa Arsova

***Abstract**: In this paper, we present the development of a data modelling tool that visualizes the transformation process of an "Entity-Relationship" diagram into a relational database schema. Our focus is the design of a tool for educational purposes and its implementation on e-Learning database course. A detailed description of system functionalities and algorithm for the conversion are proposed. Finally, a user interface and usage aspects are exposed.*

***Key words:** E-Learning Course, Data Modelling Tool, Entity-Relationship Model, Relational Model.*

INTRODUCTION

Data modelling is the most difficult and essential process that represents visually data organization in Database Management System (DBMS). A data model that is wrongfully formulated could make the implemented application ineffective and useless. That is why every database course begins with an introduction of data design concepts and gives a theoretical foundation of "Entity-Relationship" (ER) and relational models. However, some students, especially those involved in distance learning courses, find theoretical notions and rules difficult to understand. A better way for students to comprehend the theory is to put it in practice. Designing small learning units that contain a short theoretical basis, examples, and tasks to be performed appear to be most suitable in distance education [2] as well as in e-Learning education. Hence, the need of interactive data modelling tool for learning arises. Existing data modelling tools allow database designers to create, visualize, and save complex data structures, but they are not suitable for visual explanation of the design modelling principles and stages.

The idea is to design and implement an educational computer-tool that will illustrate the transformation of an "Entity-Relationship" diagram (ERD) into a relational schema. The tool is developed for educational purposes mainly and not as a powerful modelling tool for enterprise projects.

The commercial products [6,7,8,9] offer to users a wide range of functionalities that could be applied for a professional usage, rather than gaining fundamental knowledge. These products are very expensive for educational purposes.

On the other hand, researches in the field of designing data modelling tools for learning are conducted in some universities. A web-based tool is proposed in [5] which is developed to correct conceptual database schema automatically. A student has to design an ER schema and enter it into the system through a user friendly interface specifically designed for it. The tool corrects the design and shows detected errors giving advice on how to solve them. Another approach is an e-learning tool that allows defining and practising with e-learning exercises for event driven process chain modelling. That is a representative for graphical modelling techniques. The tool could automatically mark the student's solutions by using temporal logic and model checking [3].

THEORETICAL BACKGROUND

The process of designing a database begins with an analysis of the kind of information the database should hold and the relationships among components of that information. The first stage is to formulate ideas about the information that will be modelled and render them in the E/R model. Then, the abstract E/R design is converted to a schema in the data-specification language of some DBMS. Most commonly, this DBMS uses the relational model. If so, then by a fairly mechanical process the abstract design is converted to a concrete, relational design, called a "relational database schema". Fig. 1 suggests how the E/R and relational models are used in database design.

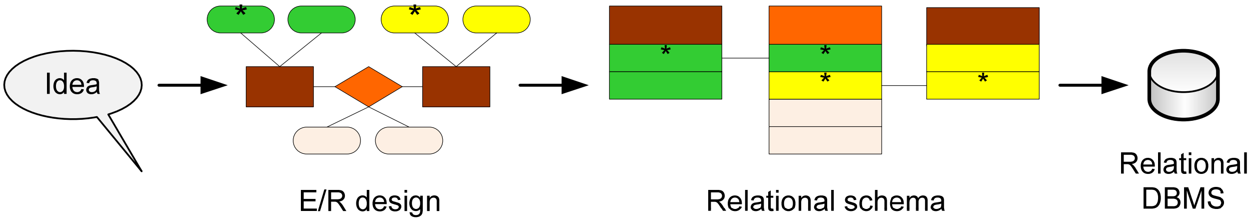

Fig.2 The database modelling and implementation process

In the E/R model, the structure of data is represented graphically as an "entity-relationship diagram" using three principle elements: entity sets, attributes and relationships. An entity is a "thing" which can be distinctly identified [1] and a collection of similar entities forms an entity set. It has associated attributes, which are properties of the entities in that set, and a relationship is an association among entities.

The relational model gives a single way to represent data: as a two dimensional table called relation. Names for the columns of the relation are called attributes and the rows of relations, other than the header row containing the attribute names, are called tuples. A tuple has one component for each attribute of the relation.

The two main rules, converting an E/R design to a relational database schema are:

- Turn each entity set into a relation with the same set of attributes, and
- Replace a relationship by a relation whose attributes are the keys for the connected entity sets.
    - For each entity set involved in relationship R, we take its key attribute or attributes as a part of schema of the relation for R.
    - If the relationship has attributes, then they are also attributes of relation R.

If one entity set is involved several times in a relationship, in different roles, then its key attributes each appear as many times as the number of roles[4].

DESIGN OF THE DATA MODELLING TOOL

The data modelling tool is designed to offer simple and intuitive interface to the learner. The tool is used on a Databases course and its aim is to illustrate the transformation process of the two diagrams. The functionalities of the educational unit are presented on figure 2.

The learner could represent an entity by drawing a rectangle; an attribute by drawing an ellipse and a relationship with a rhomb. A line denotes the type of the relationship between these E/R elements. The correctness of a drawn E/R diagram (ERD) is validated during the generation of relational diagram (RD).

The learner could also save the drawn ERD and open it later. The saved file extension is .dat, and at this stage of implementation these files could not be opened by another data modelling tool or text editor.

After drawing the ERD or opening it, the learner could generate the RD. The tool draws the RD without any interaction of the user by analogy with ERD.

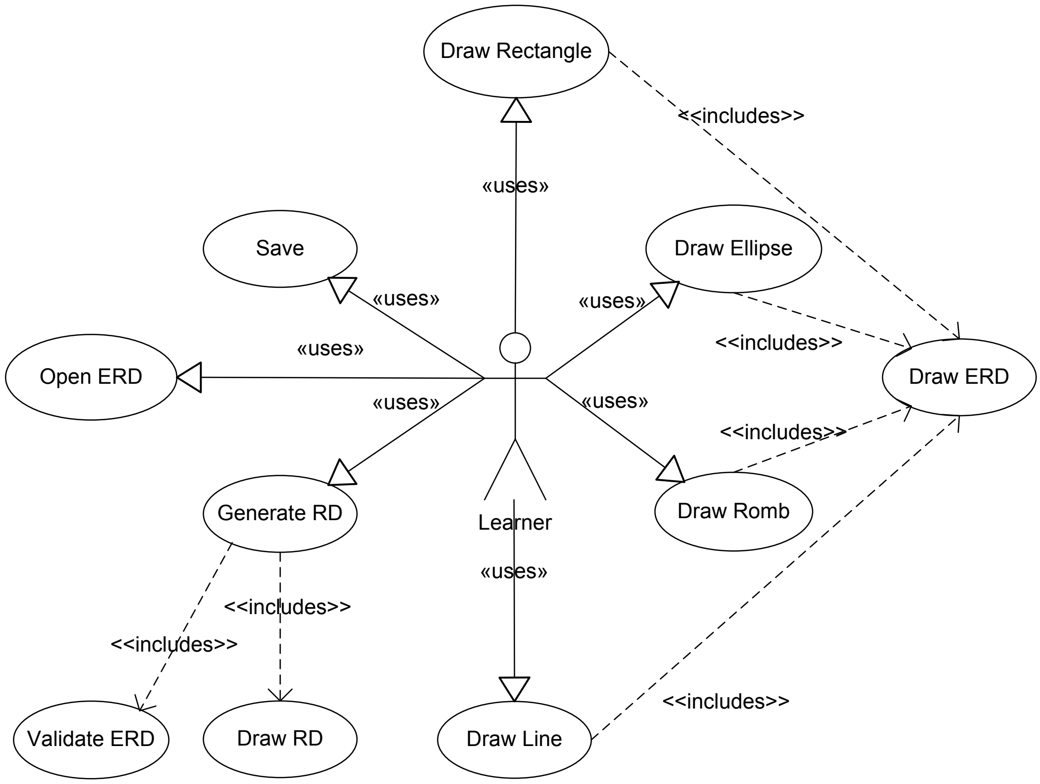

Fig.3 Use Case model of the educational tool

TRANSFORMATION OF AN E/R DIAGRAM INTO A RELATIONAL SCHEMA

The variables presented in Table 1 identify the ER and relational schemas. Each schema is described by two variables of type List: one of them belongs to the class Element and the other one to the class Relation.

Table 7 Schema describing variables

Variable Type	Variable Name	Schema Type
List<Element>	m_Elements	E/R
List<Relation>	m_Relations	E/R
List<List<Element>>	m_SchemeElements	Relational schema
List<List<Relation>>	m_SchemeRelations	Relational schema

An algorithm for the transformation of an ERD into a relational schema is presented on fig. 3 and described in the next paragraph.

1. Read ER diagram elements (m_Elements);
2. Create a new RD element of type List<Element> in m_SchemeElements. This element is a table that will be formed in the next steps.
3. Check the type of element, if it is a rectangle.
4. If so, the title of rectangle becomes a title of created RD element i.e. the table. Subsequently, read all elements in m_Relations that refer to the rectangle.
If the element is not an entity, then go to step five.

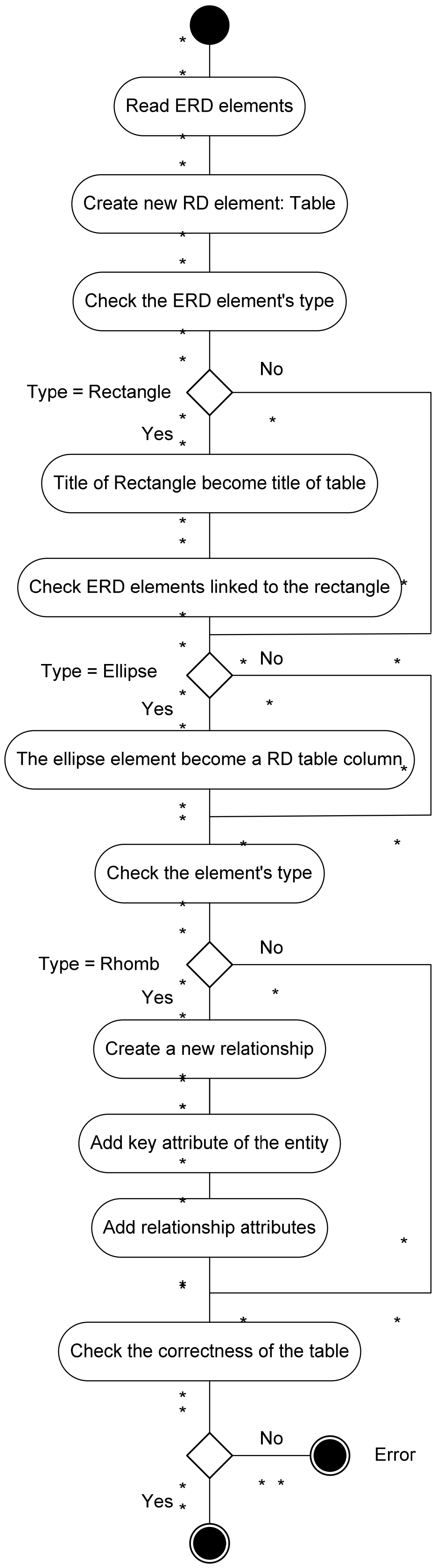

Fig.4 An algorithm for transformation of an E/R diagram into a relational schema

5. Check ERD element which is linked to the rectangle.

6. If its type is an ellipse, then the title of ellipse becomes RD table attribute. Add one more element to the m_SchemeElements.

7. If the element is not an ellipse, then go to step seven.

8. Check the type of ERD element, if it is a rhomb.

9. If so, describe a new RD element of type List<Relation> in m_SchemeRelation and a new table is created. Subsequently, read all elements in m_Relations that refer to the rhomb.

10. If the element is not a relationship, then go to step 11.

11. Add key attributes of the linked entities to the relationship entity.

12. Add relationship attributes.

13. Validate the correctness of ERD table.

The conditions validating the correctness of ERD table are the following:

- Each element of type Rectangle should be linked to elements of type ellipse which number could be between two and eight;
- Each element of type Rectangle should be linked to at least one element which title consists of symbol "*". Thereby, key elements of RD are defined;
- Each element of type Rhomb should be linked to two or three elements of type Rectangle.

If one of these conditions is not true, the data modelling tool will alert for an error in the sketched ERD.

IMPLEMENTATION OF THE DATA MODELLING TOOL

The data modelling tool is experimental and its educational aim is to demonstrate the transformation of an ERD into a RD. A user interface is presented on fig. 4 and fig 5. It is divided into three sections. The learner could design the ERD at the upper right field. The upper left field shows to the user the ERD elements' title and type. This information will help him/her to follow the designing process and also correct or delete its elements. The result of transformation of the ERD is visualized on the section below.

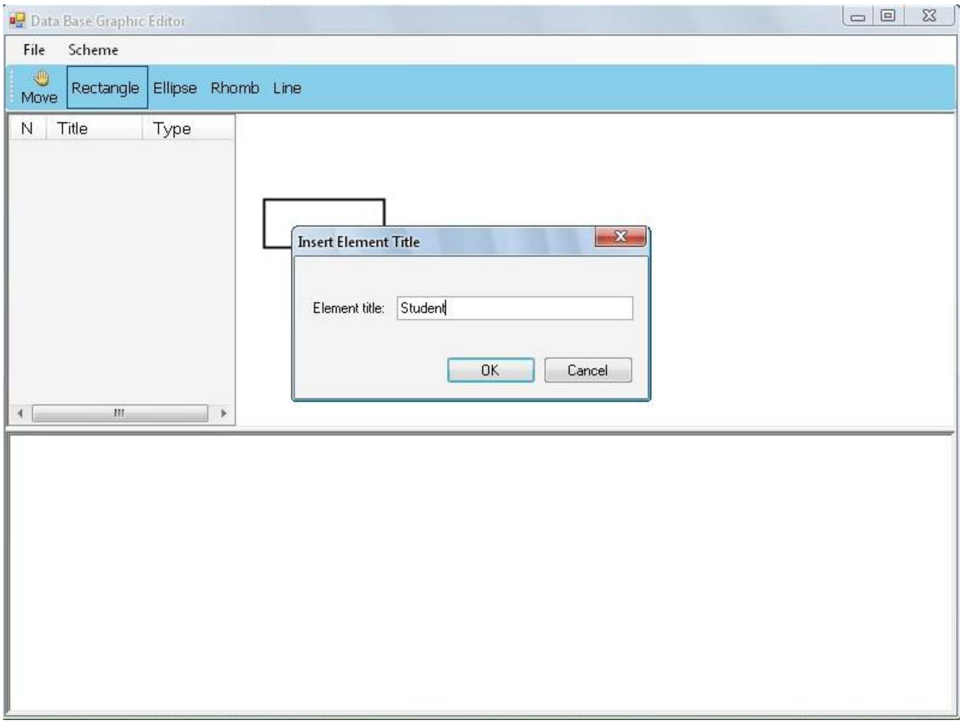

Fig.5 A user interface of the data modelling tool

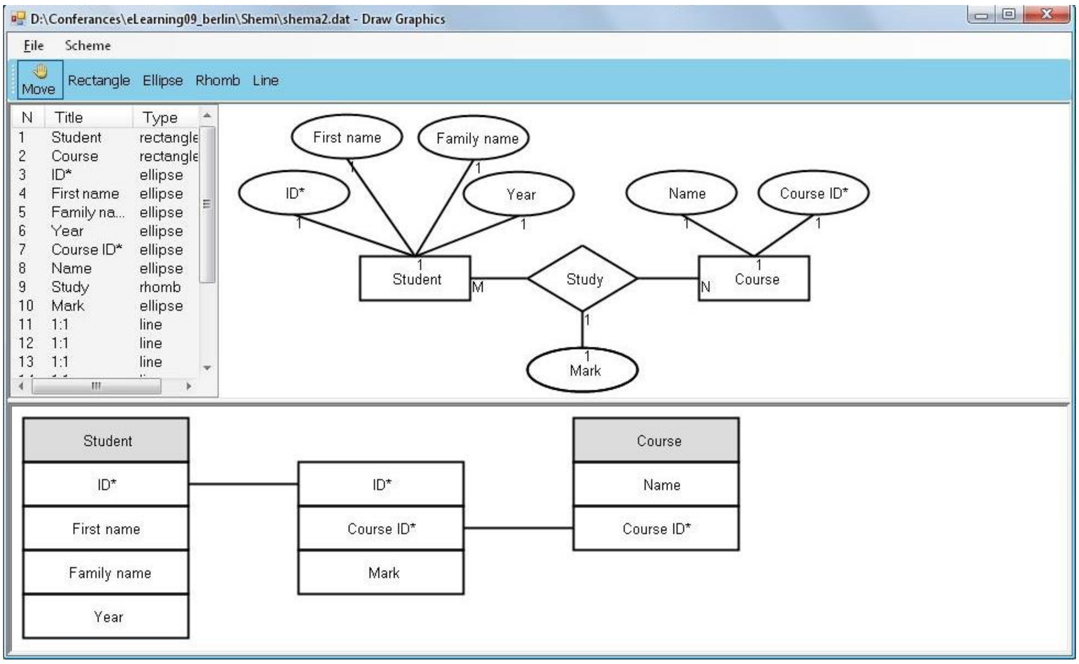

Fig.5 Generation of the relational diagram

The learning unit offers two functional toolbars horizontally designed. There are two menus at the first toolbar: File and Schema. The File menu consists of the following functions: New, Save and Open, which relate to the ERD. The other toolbar consists of five buttons: Move, Rectangle, Ellipse, Rhomb and Line. To draw one of these shapes, we should choose it and then point where to put the element in the upper right field. The next step is to write a title of the element in a pop-up window, which appears after drawing the element (fig. 4).

After designing the ERD, the learner could save it in a file or generate the relational schema. To do the last operation, he/she should choose from the Schema menu the option Generate. The view of the two diagrams is presented on fig. 5.

CONCLUSIONS AND FUTURE WORK

An algorithm for transformation of an E/R diagram into a relational schema is proposed. Its educational purpose is to visualize the theoretical rules. The algorithm is used for the implementation of program modules which are contained in the data modelling tool.

REFERENCES

[1] Chen, P. The Entity-Relationship Model: Toward a Unified View of Data. is ACM on Database Systems, Vol. 1, No. 1, March, 1976.

[2] Ivanov, S., J. Peneva. Distance Learning Courses in Computer Science – Initiation and Design. Proceedings of CompSysTech'2007, Ruse, 14-15 June, 2007.

[3] Markus, S., R. Lackes, C. Börgermann. Using Model Checking to Automatically Mark Graphical E-Learning Exercises. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications. Chesapeake, 2008 (pp. 5302-5307).

[4] Molina, H., J. Ullman, and J. Widom. Database Systems: The Complete Book. USA, Prentice Hall, New Jersey, 2002.

[5] Prados, F, I. Boada, J. Soler, J. Poch. A Web-Based Tool for Entity-Relationship Modeling. International Conference on Computational Science and its Applications, Glasgow ,2006.

[6] Avolution. http://www.avolution.com.au/products.html (Last accessed 15.07.2009).

[7] Data modeling from CA. http://www.ca.com/us/data-modeling.aspx#overview (Last accessed 15.07.2009).

[8] DeZign for Databases Database Modeling Tool. http://www.datanamic.com/dezign/index.html (Last accessed 15.07.2009).

[9] SmartDraw – The World's Most Popular Business Graphics Software. http://www.smartdraw.com/ (Last accessed 15.07.2009).

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An Educational System in Public Key Cryptography

Irina Noninska

Abstract: *The paper deals with mathematics and main steps for key pair generation in two asymmetric cryptographic algorithms – RSA and DSA. An educational system for implementation of digital signatures with appendix for electronic document authentication is proposed. The main goal of the system is to give students theoretical and practical knowledge in public key cryptosystems. It could be useful for e-learning in cryptography and e-business.*

Key words: *Public Key Cryptography, Cryptographic Protocols, Educational System, E-document Authentication.*

1. INTRODUCTION

Nowadays many people exchange personal and business information via the Internet. They would like to be sure that electronic documents, which they send and receive have been successfully protected against unallowed access and modification. It is important to bear in mind also that all business activities require in addition strong authentication of the users. Authentication could guarantee the content of an electronic document (e-document) and prove its origin, as well. Asymmetric cryptographic algorithms have been widely applied last twenty years in different methods and schemes for digital signature generation. Many of them – Fiat-Shamir, Schnorr, ElGamal, Rabin and Merkle, were designed especially for this purpose. One of the most efficient asymmetric algorithms is RSA, which supports not only key pair generation, but encryption using public key and digital signature generation with message recovery. Another well known and wide spread asymmetric algorithm – DSA, which is designed only for the purposes of digital signature generation, was proposed in DSS [1]. It implements a scheme, based on hashing algorithm – SHA-1, where the result is digital signature with appendix and the reverse procedure – verification requires the original e-document as input. Recently public key standards recommend implementation of hash algorithms- MD5 and SHA-1 in RSA-signature systems in order to prove data integrity by hashing first and then sign the hash value using sender's secret key to generate digital signature. As a result all digital signature schemes that use one-way hash algorithm could be considered as reasonably robust and stable to cryptanalytic attacks. On the base of DSA and elliptic curve theory, Elliptic Curve Digital Signature Algorithm (ECDSA) was proposed. These three algorithms, mentioned above – RSA, DSA and ECDSA have been recommended by Bulgarian low of electronic document and digital signature, which came into force in 2001.

Asymmetric cryptographic algorithm could be applied not only for digital signatures generation, but in different authentication schemes, based on the principles of checking what the user is allowed to propose, proving that he is the right person. For example, it could be something he knows – passwords, PIN-codes, secret parameters for handshaking, etc. or something he has obtained to take part in a session – access ticket, secret cryptographic key, which is used to generate digital signature or just a parameter for one-way recognition. All methods, algorithms, standards and protocols, used for strong authentication, data integrity and no repudiation by digital signatures on the base of key pair (public/secret) define the subject of public key cryptography [3,4].

The paper discusses basic valuable security services that public key cryptosystems provide – digital signature generation and verification, authentication protocols, notarization of e-document. An educational system, which presents different protocols and methods applicable in e-business operations, is proposed. The main goal is to give students theoretical and practical knowledge in public key cryptosystems, their implementation in electronic document processing and authentication schemes.

2. RSA-ALGORITHM – KEY GENERATION AND ENCRYPTION

Three researchers – Rivest, Shamir and Adleman first published details of the RSA-algorithm in 1978 [2] as a result of their efforts and towards minimizing key complexity of ciphers and their number. For example, if a symmetric cryptosystems has "*n*" users, the necessity keys are on the order of "n^2" in comparison with "2*n*", required in asymmetric cryptosystem, proposed by the authors.

RSA-algorithm could be explained by 6 steps as shown in fig. 1 where steps 1-4 present RSA-mathematics, step 5 – encryption of a plain text *P* and step 6 – decryption of the cryptogram *C*.

Step (1): The user *A* chooses two large primes – *p* and *q*. They are secret parameters.
Step (2): *A* multiplies *p* and *q*. The result is N : $N = p.q$.
Step (3): *A* calculates the Oilier function $\Phi(N)$: $\Phi(N) = (p-1).(q-1)$.
Step (4): *A* generates his own secret key $SK_A : 0 < SK_A < \Phi(N)$ and SK_A relatively prime to $\Phi(N)$.
A calculates his own public key PK_A as multiplicative inversion, i.e.
$PK_A = SK_A^{-1} \bmod \Phi(N)$.
The problem of modular inverse sometimes has a solution, sometimes not. In general it might have right solution only when $\Phi(N)$ and SK are relatively prime, otherwise there is no solution. When $\Phi(N)$ is a prime, there is the only one inverse value in that range.
Step (5): The user *A* shares his public key PK_A and *N* with the user *B*. If the plain text is *P*, the user *B* can encrypt it as follows: $P^{PK_A} \bmod N = C$.
Step (6): The user *A* receives the cryptogram *C* from the user *B*. He is the only person who can calculate the plain text *P* from *C*, because only he knows the key – his own secret key SK_A. He calculates *P* as follows: $P = C^{SK_A} \bmod N$.

Fig.1 RSA-algorithm – Key Generation

3. DIGITAL SIGNATURES ENABLE E-DOCUMENT AUTHENTICATION

Digital signature schemes could be divided into two groups depending on requirements of the secret and public parameters and complexity of two procedures – generation and verification.

The first group includes systems based on digital signature with appendix, where an e-document should be cryptographically processed by the secret key of the sender after hashing. At the same time digital signature of one and the same e-document changes, because except hash function, generation process uses an additional secret parameter with different value when this document must be signed several times. Typical representatives of this group are algorithms ElGamal, Schnorr and DSA.

The second type of digital signature systems is based on message recovery. This mechanism is used by algorithms of Rabin, Nyberg-Rueppel and RSA. They allow verifying digital signature using only obtained signature and the public key of the sender. When a hash algorithm is used – SHA-1 for example, it is able to process plain text of 2^{64} bits to hash code of 160 bits. This is the reason to apply RSA with hash algorithm ensuring short hash codes of e-documents. As a result representatives of this group could propose invulnerable to attacks digital signature schemes.

Fig. 2 presents main steps of DSA, digital signature generation and verification.

Step (1): User *A* chooses two large primes numbers
$2^{L-1} < p < 2^{L}$, where $512 \leq L \leq 1024$; $2^{159} < q < 2^{160}$; *q* divides evenly (*p-1*).

Step (2): User *A* chooses a number *h*, smaller than (*p*-1) and computes $g = h^{\frac{p-1}{q}} \bmod p$.

Step (3): User *A* chooses a random number, which is his secret key $SK_A : 0 < SK_A < q$.

Step (4): User *A* calculates his public key $PK_A : PK_A = g^{SK_A} \bmod p$.

<u>*Digital signature generation*</u>

User *A* signs the plaintext *P*.

Step (1): User *A* generates a random secret parameter *k* which has different values for each signature: $0 < k < q$.

Step (2): User *A* calculates two values – *r* and *s*, which constitute digital signature of *P*. He calculates also hash value of *P* : $h(P)$:

$$r = (g^{k} \bmod p) \bmod q ;$$

$$s = (k^{-1}(h(P) + r.SK_A)) \bmod q .$$

User *A* sends his message *P* to user *B* with digital signature as appendix, as follows: (P, r, s)

<u>*Digital signature verification*</u>

Step (3): User *B* verifies the signature. For this purpose he calculates four parameters:

$$u = s^{-1} \bmod q ;$$

$$v = (h(P).u) \bmod q ;$$

$$w = (r.u) \bmod q ;$$

$$z = ((g^{v}.PK_A^{w}) \bmod p) \bmod q .$$

Step (4): Finally, user *B* should check if *z* is equal to *r*. When *z=r*, the signature has been successfully verified, otherwise it must be rejected.

Fig.2 Digital Signature Generation and Verification Using DSA

Having in mind common security requirements of business activities via the Internet and necessity of e-document authentication, two cryptographic protocols on the base of RSA are proposed. They could be easily understand and implemented, hence they are useful for public key cryptography and e-business learning. The first one is a protocol for group signature. It is realized over four different groups of business partners who exchange e-documents, where maximal value of the users is defined *(n)* and every user has several keys (*m*). These keys are generated using RSA-algorithm. As a result 4*nm* pairs of cryptographic keys (PK/SK) are defined. Every member of a group can sign current e-document, choosing one of his own secret keys and get a group signature, which becomes a part of this e-document. After that he is allowed to disseminate signed e-document between all users of the system or to send it just to one of them. Every user is able to verify the group signature, but he could not reveal the real sender of the electronic document. It is possible to prove only that this e-document has been prepared from one the groups.

The second protocol is intended to sign e-documents with blind signature. It deals with a method, proposed by D. Chaum [5] and uses all cryptographic keys, generated for the group signature. In addition it involves as an authority *Notary*, who is responsible for signing the e-documents using his own secret key. The Notary has no rights to access the text of the e-document. He is allowed to sign each one, proving that this e-document has been sent him before sending to other users, but at the same time he is not able to read the information in it. In this way, applying the protocol for blind signature, the process of authentication could be coordinated by the Notary, because he is the only person, who can prove the signature of each e-document.

4. PRACTICAL KNOWLEDGE IN PUBLIC KEY ALGORITHMS

For the purposes of education in public key cryptography a learning system is designed. It deals with two asymmetric cryptographic algorithms – RSA and DSA, presenting their mathematics and main steps for key pair signature. RSA is used to explain group and blind signature. The first task is to generate primes. Every student can choose how to get two primes – using a module of the educational system designed on the base of Rabin-Miller algorithm or entering his own code. After successfully prime generation, the rest parameters N and $\Phi(N)$ must be calculated. The second task is key pair generation. Finally all parameters – public and secret, should be checked by the RSA-control module of the system. If they are correct the student will receive message that confirms successfully done RSA scheme, otherwise he should try to reveal mistakes and propose new values, for *p* and *q* and calculates SK and PK. The system proposes RSA-module for key generation which could be used by users who have no good skills in programming. They can access, as well, samples with six steps of RSA-algorithm and their results, as shown in fig. 3.

$p = 1733$	$p = 17$
$q = 2347$	$q = 23$
$N = p.q = 1733\,.2347 = 4067351$	$N = 391$
$\Phi(N) = (p-1).(q-1) = 1732.2346 = 4063272$	$\Phi(N) = 352$
$PK = 31$	$PK = 205$
$SK = 3145759$	$SK = 421$
$E_{PK}(P) = P^{31} \bmod 4067351 = C$	$E_{PK}(P) = P^{205} \bmod 391 = C$
$D_{SK}(C) = C^{3145759} \bmod 4067351 = P$	$D_{SK}(C) = C^{421} \bmod 391 = P$

Fig.3 Samples of RSA

RSA has been put at the root of many cryptographic protocols for authentication. Each security protocol consists of a series of steps that should be carried out from a person to prove that he is a trusted user of the system and all these steps should be designed according to preliminary defined security rules. The second module of the educational system presents two protocols for e-document authentication. They are designed on the base of RSA – algorithm using hash algorithms MD5 and SHA-1. The purpose is to enhance practical knowledge of students in public key cryptosystems. The first protocol is proposed for *group signature*. Four groups are defined. Each of them has three users. For the purposes of their communication 36 cryptographic key pairs are generated, hence every number of a group possesses three key pairs. He is able to generate digital signature, choosing one of his three secret keys randomly. Verification of the signature requires implementing of the corresponding public key from the list. *Blind signature* protocol realizes the idea of trust component in the system, which is responsible for authentication efficiency. This component – *Notary* must sign each e-document, confirming that is has been sent to him. For this purpose he possesses a key pair, which public key is included in the list of keys. The Notary uses the secret key of this pair to generate blind signature. His signature can prove the authentity of an e-document and guarantee required level of anonymity, because the content of the document is preliminary hidden by his sender. The Notary receives hash of e-document and since MD5 and SHA-1 are one-way functions, there is no doubt that he can not reveal the plain text. This protocol could be used in e-business applications, where users insist on protecting their personal and business information from tampering and confirm the authentity of every e-document at the same time. Contemporary technologies for timestamping employ notarization for indicating the time when it was performed.

Fig. 4 presents functionality of the educational system. Every student can access two main modules – RSA and DSA. He can use text files, proposed by the system as e-documents to sign each one employing group or blind signature. Implementation of two hashing algorithms MD5 and SHA-1 allow to display differences between digital signatures of one e-document, obtained after signing its different hash values.

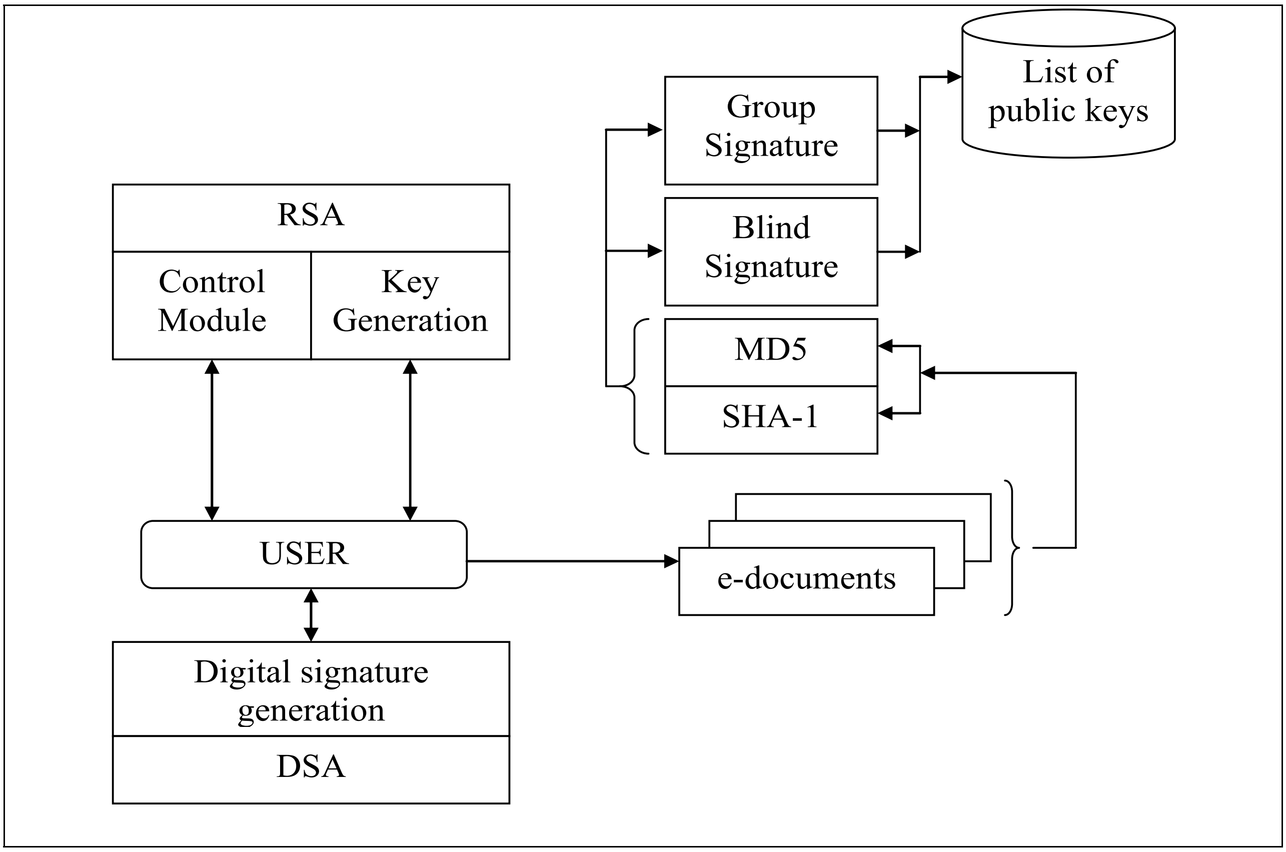

Fig.4 Educational System in Public Key Cryptography

Having in mind programming skills of the students and their common knowledge in Web-technologies main learning modules of the system are proposed using Microsoft Visual Studio 2008, C++ program language. Students can access three panels, designed to present main cryptographic schemes, described above. The first panel deals with implementation of RSA-algorithm for key pair generation. As shown in fig. 4, it is closely connected with group and blind signature modules, which could be applied after defining the cryptographic keys. The second panel is proposed for digital signature generation using DSA. In order to learn more about hashing procedures applied in public key cryptography, students could choose the last panel. It proposes results – hash values of e-documents obtained by MD5 or SHA-1.

5. CONCLUSION

The educational system, proposed in this paper is applicable for e-learning in cryptography and e-business. Students have opportunity to understand benefits that public key cryptography could provide to business. They learn more about principles of e-documents authentication. The system could be useful for users who would like to have more knowledge about design and implementation of asymmetric cryptographic algorithms in digital signature protocols.

REFERENCES

[1] The Digital Signature Standard (DSS). Communications of the ACM, v.35, 1992, 7

[2] Rivest, R., A. Shamir, A. Adleman, A Method for Obtaining Digital Signatures and Public Key Cryptosystems. Communication of the ACM, v.21, 1978

[3] RSA Technology Web Site (http://www.rsa.com)

[4] Stallings, W. Network Security Essentials: Applications and Standards, Prentice-Hall, 2000.

[5] Chaum, D. Blind Signature Systems, 1998.

[6] Secure Hash Standard, NIST, 1995.

[7] Mukesh, K. Public Key Cryptography With Matrices. Proceedings of the Fifth Annual IEEE SMC, 2004.

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Development of Software for Users with Specific Disorders

Rostislav Fojtik

Abstract: *The paper deals with possibilities of information technologies when improving communicative skills of children with specific disorders, such as autistic spectrum disorders, Down syndrome, mental retardation, etc. The development of an application stemming from the communication system PECS (The Picture Exchange Communication System) and its Czech variant VOKS is the base of this paper to show specificity of the development and verification of software for the given group of handicapped users.*

Key words: *Application, autism, Down syndrome, mental retardation, PECS, VOKS, testing*

INTRODUCTION

Use of information and communication technologies has reached massive expansion recently. Computer users are to be found in every social and professional group. Computers simplify a lot of work tasks, make methods of communication easier and more accessible, intermediate new information, etc. These modern technologies can play a role of important supporting and compensational means for a group of users with specific needs. It is mainly people with some mental and health problems who face difficulties with communication, and common means of communication are usually unusable for them. Computers can act as a positive agent in such cases. However, hardware and software must be adjusted to the specific needs and it is not possible to implement experience gained and applied with common groups of users.

There is a potential group of users with specific disorders who could make use of the development of communication skills. E.g. people with autistic spectrum disorders, Down syndrome, forms of mental retardation and other development defects which cause problems to learn and use spoken language, written text, and other commonly used means of communication. Various methodics bringing interesting results have been worked out to develop communication skills of people with the above mentioned disorders. For instance, such methodics is the system PECS (The Picture Exchange Communication System) and its Czech variation VOKS. The base is a use of pictures representing particular concepts, things, activities. The user gradually becomes familiar with new concepts – pictures, which are then incorporated in their list. Choosing pictures and placing them on a sentence strip helps them learn to create even simple sentences. [3]

In 1998, the Department of informatics and computers, the University of Ostrava, decided to help interested people with a health handicap. The first stage was to support the study of people with hearing impairment; the department introduced a distant form of studies in the bachelor programme Applied Informatics. The distant form of studies enabled the deaf applicants to join the study. The distant form and study fields proved to be interesting even for applicants without health handicaps and currently there is a great concern over both distant and combined form. The university support of the study for applicants with health impairments is still being developed, e.g. in the area of projects focused on support of health handicapped students, special educational courses, development of accessible web, and recently in cooperation with special schools in the development of communication software for children with specific disorders.

METODICS FOR LEARNING

Based on the requirements from special school, we are developing an application which should facilitate communication with a child with specific disorders such as autism, Down syndrome, mental retardation and others. Autism is a mental handicap which demonstrates in worsened communication skills. Speech formation of people with an autistic spectrum disorder is delayed and some of them do not speak all their life or they use only limited number of words, frequently corrupted. Several methodics to improve their communication skills have been developed. [10]

One of them is the PECS methodics created in 1985. It is an alternative education and communication method for communication between an adult and a child handicapped by autism, mental retardation, and other specific disorders. [11] The fundamental principle is an exchange of a picture representing a particular thing for a real one. Continuous practice leads the child to learn how to use concepts correctly and improve its communication skills. The whole process is emphasised by stimulation. For instance, the child gets a chocolate if it brings the correct picture. Follow-up education leads not only to knowledge of pictures – concepts, but also to composing a short sentence from the pictures. The last phase of education encourages the children to comment independently the action around them and to answer direct questions. The system also helps some pre-school children to develop speech. An elaborate methodics of work with a system provides six training phases with examples, manuals, and advice [1] [2].

The Czech system VOKS mainly stems from the methodics and principles of PECS. However, it brings some improvements and it tries to adjust to particularities of the Czech language. Unlike PECS, it emphasises visual support of speech of both communicating partners. Thus there are changes to basic situations in all lessons. The methodics is divided into two basic parts. The first contains important information concerning teachers of the VOKS system and training environment. In addition, it describes preparation of individual tools for communication and the way of reward choice before the whole training of the communication begins. The second part contains educative lessons, which form the backbone of the education. The client learns to ask spontaneously for a favourite thing in exchange for a picture, to go on his own to the symbol container to get a picture and then to hand it in subsequently to the partner. They learn to ask different people about anything in an unfamiliar environment, to choose appropriate symbol from several pictures, to complete correctly a simple sentence on a sentence strip using pictures and then to ask by help of the sentence strip. Finally, they learn to react to various questions and to comment on the environment around them. The supplementary lessons then develop picture inventory and syntax [6].

Experience with this system proves that the children evidently improved their communication skills, as well as those who did not have any communication skills before application of the VOKS system. A number of children faced other problem, though. The users started to handle more concepts – pictures. Their container – book, where the pictures are attached by velcro, became very bulky and physical manipulation got difficult for the children. With respect to this fact, there was a requirement defined to develop a software application in order to solve these problems. There are several programmes for the PECS system, e.g. Boardmaker [12]. Yet, this does not meet the chosen methodics, moreover its cost (300$ up) is high. Another similar application is Overboard. Applications usually contain several thousands of colour or black-and-white pictures, which can be chosen from various categories. However, the education progress and work with the programme is not focused a particular methodics and thus there is a higher need of teacher's technique [8].

When developing and implementing for users with specific disorders, it is usually necessary to use other procedures and methods than with common applications. The target group requires totally different approach taking into consideration their health or mental handicap.

The most striking difference is in the programme control. Embedded standards and procedures are often inappropriate or unusable. Users with specific disorders often cannot use common control mechanisms which are being used in applications of contemporary operating systems. Their creators try to build up work area of a specific application as large as possible, but control features (close, minimize and maximize, menu offer, etc.) are as small as possible.

APPLICATION VOKS

When designing a new application environment, it was necessary to get rid of all control features which were not directly related to the main use of the programme, and which could lead to early closing, new configuration, initialisation of new actions, etc. A lot of children find difficult to concentrate on realizing the needed performance. They frequently unwillingly click the mouse or wander the cursor round the screen. Thus it is highly important that children could not consciously or by mistake initiate functions indirectly related to the course of the programme.

The application control must not be demanding, unclear, or complicated at all. Generally common activities (such as double-click on a mouse) are almost impossible for numerous users with specific disorders. The control features of the programme must be conveniently large and their start-up and control as easy as possible. An ideal case would be if the application, having been opened, took up the whole screen of the desktop, being maximized all the time with no possibility of any change. The use of the mentioned software counts with the use of special hardware to control the computer. Users with motor handicap are e.g. supplied with IntegraSwitch, which works as an aspiration-expiration switch. Classical mice and keyboards are replaced by alternative positioning devices and keyboards, such as BickTrack, KidTrack, Roller Joyistick, BigKeys, IntelliKeys, various sensor buttons, and others. The main advantages are larger control features and more robust construction. On the other hand, the disadvantage is usually the price which exceeds several times the price of commonly used hardware. Purchase of such special devices can become unaffordable for many families with handicapped children. The solution could be use of touch screens, e.g. in new types of computers generally called nettops. It is a kind of cheaper computers containing all parts in one case together with a touch screen. The user can control the applications directly on the touch screen, which seems to be more convenient especially for children with specific disorders than using mouse or other positioning devices. Some children have motor problems when using mouse, moreover they have problems with moving the mouse while concentrating on another place - on the screen. Nevertheless, despite all of the above mentioned special hardware tools, it is convenient to create the developed software in a way to be usable even on common desktops, or notebooks with their usual peripherals.

An application for children with specific disorders requires two basic parts. The first one – a functional part designed for children. The second serves to their parents or health workers for configuration and setting. With respect to diverse requirements of the target users, it is necessary to enable clear, but sufficiently complex and extensive setting offers. Unlike common applications, requirements on functionality and look of an application for particular individuals are often very distinct and influenced by health or mental problems of the child.

With respect to the fact that the programme VOKS and similar teach the user to communicate, they act as a learning software in the first phase. The application tries to use the VOKS methodics and it contains several levels and phases of usage fully corresponding to the chosen methodics.

- Level one – the user learns to choose the picture by clicking. The desktop shows only empty fields and one picture which has been randomly chosen from a pre-defined group of pictures – concepts. The child's task is to click on the picture. The programme monitors all clicks in the empty fields and the information is saved in an XML file. During the development and verification of the application, we have found out that it is not convenient to use classical way of control and distinguish clicks by left or right button. Children with certain disorders find work with mouse itself motorically very demanding, so the button distinction was rejected. Adding sound to the picture proved to be an advantage, though. Support of other sensation makes the process of learning easier.

- Level two – the user sees two pictures. One represents positive, pleasant emotions and feelings, the other negative. The child learns to choose the picture connected with positive emotions.
- Level three – having mastered the two previous levels, the vocabulary of the users expands and individual concepts – pictures are classed in categories, which differ in colour. The child learns to choose concepts from the categories and places the pictures onto a sentence strip.
- Level four – serves for independent communication and the users composes short sentences and sequences using concepts from different categories. At first, the sentence strip enables the child to form simple sentences such as "I want a chocolate", etc.
- Level five – increases communication level and enables to create a picture, description of events and situations.

The first three phases of programme usage primarily serve to learn how to control the programme and to get acquainted with the pictures and their content. It is highly important to observe activities of the user. This happens on two levels. The first is observation of the parent, tutor, or health worker who teaches the child how to use the programme. The second is built-in monitoring in the programme itself. Each activity is stored in the XML data file format. Subsequently, it is possible to retrieve information about which pictures are difficult for the user to be understood, which are not mastered so well by the users, which position on the screen is problematic to reach, etc. This information can serve not only to the tutors, but also to the creators of the programme for eventual improvements.

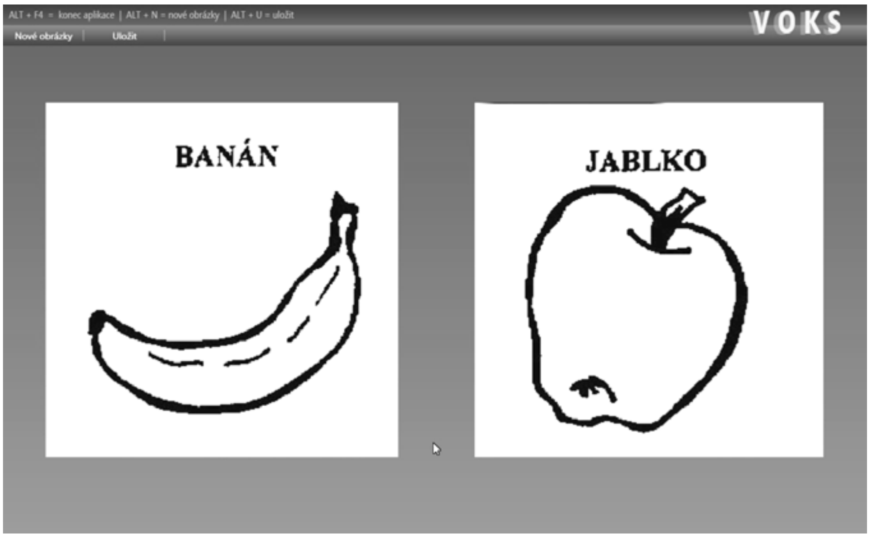

Image 1 – Interface of application

When developing an application, the creators must primarily cooperate with the health workers and professionals in the given methodics. For example, the VOKS methodics of the developed programme is so specific and demanding that it is important to understand and master it. Failing this, the programme might not meet its purpose. Creators of a programme must free of common stereotypes and familiar processes, which are mostly unusable with this specific group of users. It proved right when the VOKS application was being developed. It was often necessary to consult the staff of special school and to adjust the interface and functionality of the application. The need to monitor children in their usual activity showed to be essential. Such experience gained by monitoring of the children was important for the creators of the programme. When developing an application for handicapped users, the creators cannot fully rely on their previous experience. Due to the fact that application developers do not have a direct contact with children with autistic spectrum disorders, Down syndrome, mental disorders, and other very specific disorders, it is important to get familiar with practical reactions and behaviour of such children.

The situation is then complicated by individual ways of behaviour, which relates to the extent and level of the disorder.

PROGRAMME TESTING

Hand in hand with an increase in requirements and properties of software tools, there is a need of appropriate and profound testing. Despite the fact that the above described programme does not include any complicated functional structures or algorithms, and work of complicated and expensive devices is independent of its activity, it is necessary to secure its high reliability. Children suffering from e.g. autism find difficult to get used to a new environment and unfamiliar things. The time needed for the child to accept the programme and learn to work with it is usually very long. In case of serious disorders, there is a danger that the child will decline it or refuse to work with it. During testing of an application by children, there should not be any fundamental adjustments of the graphical interface and its control. Apart from classical procedures of testing of the programme functionality, it is important to observe how the child masters the application. It is not enough to use only usual static and dynamic testing means, analysis of the source code, monitoring by testing programme, special tests on memory usage or load, etc. [6]

Thus the application incorporates internal mechanisms which monitor user's activities. Monitoring data about manipulation with programme objects are stored in XML files. The application contains an interface designed purely for parents and health workers which enables to evaluate both child's skills to work with the programme and its functionality. The output data then acts as a feedback for the creators of the programme as well as for parents and health workers, who can adjust the process of education more effectively. Another way to verify the programme functionality is methods used in quality oriented pedagogical research. It primarily concerns the method of observation [4]. The children use the application together with the parents or health workers. The adults act both as a pedagogue, who teaches the child to use and communicate with the programme, and an observer, who check for reactions and skills of the child. The observation results are very important not only for the educational process, but also for the development of the programme.

Unlike commonly used software, there are specific problems when testing:

- The target group of users is not large enough.
- The target group of users is very diverse and the level of the disorder considerably influences ability to work with the programme. It is necessary to take into consideration individual needs of the users and to enable more possibilities of setting and adjustment.
- The phase of learning how to use the programme is very time consuming. This results in longer period of testing than with usual applications. Children with higher level of disorder can take months to pass from one phase of the programme to another.
- It is important to largely cooperate with parents and health workers because the children find difficult to get used to changes in environment and unknown people.

CONCLUSION

Concerning the fact that the target group of users of the described software is not very large, forming a relatively small sample, it is advisable to offer it a quality solution. People with specific disorders are mostly dependent on supporting tools and means. It appears that information and communication technologies offer a way to improve their life standard. They enable to create tools which were not possible when using common approaches or they were very difficult to realize. When creating software for children with specific disorders such as autistic spectrum disorders, Down syndrome, mental retardation, etc., it is necessary to cooperate with doctors, psychologists, and health workers. It is the area of programme control where the creators of programmes must apply totally different criteria and processes than with common applications. Testing of the developed software is more complicated, time consuming, and apart from common code testing processes and application functionality, it also requires observation of its users.

REFERENCES

[1] Begeer S., Banerjee R., Lunenburg P. Brief Report: Self-Presentation of Children with Autism Spectrum Disorders, *Journal of Autism and Developmental Disorders*, Volume 38, Number 6 / July, 2008, ISSN 1573-3432

[2] Bondy S. A., Frost L. *What is PECS?*, http://www.pecs.com/WhatsPECS.htm

[3] Charlop-Christy M.H., Carpenter M, LE L., LeBlanc L, Kelley K. Using the Picture Exchange Communication System (PECS) with children with autism: Assessment of PECS acquisition, speech, social-communicative behavior, and problem behaviors. *Journal of Applied Behavior Analysis*, 35, 213-231, 2002, http://seab.envmed.rochester.edu/jaba/articles/2002/jaba-35-03-0213.pdf\

[4] Gavora P. *Úvod do pedagogického výzkumu*, Paido, Brno 2000, ISBN 80-85931-796

[5] Hoekstra R. A., Bartels M., Cath C. D., Boomsma D. I. Factor Structure, Reliability and Criterion Validity of the Autism-Spectrum Quotient (AQ): A Study in Dutch Population and Patient Groups, *Journal of Autism and Developmental Disorders*, Volume 38, Number 8 / September, 2008, ISSN 1573-3432, http://www.springerlink.com/content/m184028q8305/?sortorder=asc&p_o=10

[6] Knapcová M. *Výměnný obrázkový komunikační systém - VOKS*. Praha: Institut pedagogiko – psychologického poradenství ČR, 2005, ISBN 80 – 86856 – 07 – 0

[7] Lacko B.: Testovací prostředky a testovací postupy, *Tvorba software 2006,* Ostrava 2006, ISBN 80-248-1082-4

[8] Scherz J., Meng-JU T., Broston S. *Adult Preferences Between Two Symbol Sets: Comparing Boardmaker and Overboard*, Wichita State University 2006, http://convention.asha.org/2006/handouts/855_1293Scherz_Julie_073114_111306111037.pdf

[9] Yoder P., Stone W.L. A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. *Journal of Speech, Language, and Hearing Research, 49, 698-711, 2006.*

[10] http://en.wikipedia.org/wiki/Autism

[11] http://www.pecs-usa.com/

[12] http://www.mayer-johnson.com/ProdDesc.aspx?SKU=M125

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Increasing the efficiency of the educational process through research of the knowledge dynamic

Krasimira Filipova, Svetlana Stefanova

***Abstract**: Different kinds of systems describing knowledge dynamic and their corresponding Petri net models are previewed in this paper. The most essential moments of the three basic stages of the learning process are described – knowledge assimilation, control and forgetting. Various possibilities for enhancing and increasing the effectiveness of the educational process are being looked into. The purpose of this paper is to demonstrate the description of the knowledge dynamic by using the instruments of the Petri nets.*

***Key words:** Education, Petri nets, Knowledge dynamic*

INTRODUCTION

Education as a process of acquiring knowledge is an interesting subject, studied by many experts from different fields. The actual organization of the educational process with the aim to increase its efficiency is a topic on which it is being worked all the time.

In [2,4] it was mentioned that the level of the student training is changing continuously. It influences the quality of the activities each person does after the specific knowledge assimilation. Therefore it is useful to evaluate the knowledge dynamic of the separate terms, topics and school subjects.

This is done using different characteristics, for example intensity of knowledge assimilation, flow of the school material, knowledge restoring, probable vector of term assimilation of the school subjects and so on.

MODELLING DYNAMIC OF THE KNOWLEDGE

Under the knowledge dynamic description can be understood a set of a final number of assimilation, control and knowledge diagnostic levels stages. The different terms from the school subjects or the different kinds of activities pass through these stages in a different sequence.

In the theory three different kinds of nets are differentiated: opened, closed and mixed. In the opened nets the input stream of the school material doesn't depend on the net state or the number of the terms entered in it yet. In the closed nets the number of the terms in each of them is a constant, and the intensity of the school material stream on the entrance of each stage depends on the system status. The differentiation on these stages can be done easily with the introduction of different initial markings in Petri nets. Essentially, Petri net machine has powerful means for describing the dynamic of a system with parallel asynchrony process. So, it can be used for modeling the dynamic of knowledge assimilation in the school process. In the other hand excepting the parallel assimilation of different knowledge, there is a parallel regarding to the two most important processes: assimilation and forgetting of the knowledge (it's normal because in the nature each action has a corresponding reaction).

The introduction of Petri nets can be graphical or analytical. The graphical introduction is easy for a visual acquire, and the analytical, by the vectors and matrixes, has convenient means, by software processing, for analyze and syntheses. When describing a system structure by Petri nets two structure elements are used: transactions, giving the actions in the system, and positions, giving the conditions for their action's execution and the result of them. So, for each of the transition can be defined input and output positions. In the context of human perceptions, this is a presentation of the causality-consequently relations. The action of the cause marks with markers in the corresponding input places. The system static is modeling by a graph.

When the action, modeled by this transaction, is activated and executed the markers from his input places pass to his output places. That's why in the theory is said, that the net's dynamic is modeling by the accessibility tree. It shows all accessibility markings of all positions executing all transitions. Consequently, the net dynamic is defined by the rules for the transaction execution and the initial system status.

Building a state's graph allows quick and easy determination of the transition sequence, which will guide the educational system from one state into another. For building the graph a variety of software products can be used DPN tool, INA, Matlab_toolbox PNet, etc. Searching for the fastest route between two states in the network can be optimized using those products, as well as simulation of the whole network using PIPE. Analyzing the already built graph can lead to conclusions, about what actions must not be taken in order for the system to remain in a desired state.

TWO BASIC KINDS OF NETS – CLOSED AND OPENED

In the most simple version of the closed net the student pass two stages of a term assimilation: assimilation stage S2 and forgotten stage S1 /fig.1./. With b_1 is noted the mean time for forgetting the term and with b_2 the mean time for assimilation or recovering the term knowledge. D1 and D2 are respectively the actions for forgetting/recovering the terms.

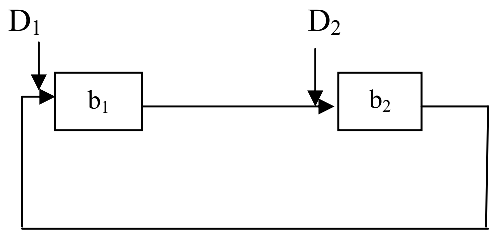

Fig.1.

The introduction of this scheme with Petri net with these two basic processes: of assimilation and forgetting, with their corresponding transitions t_1 and t_2 is given on Table 1.

We use a simple way to present a Petri net with a table: the rows associate to the transitions, the columns associate to the position. For each position we show input and output number of arcs and the initial state as a number.

Table 1

	P1		P2		P3		P4	
	1		1		1		0	
	in	out	in	out	in	out	in	out
T1	1	1	1	1	1	0	0	1
T2	0	0	0	0	0	1	1	0

The necessary preliminary conditions for the assimilation process to be accomplished are: the presence of a student – p_1, knowledge for the current terms in the stream of school material– p_2 and the absence of this knowledge in the student knowledge – p_3. After this stage as an output condition presence of knowledge for this term in the student knowledge is obtained - p_4.

One more complicated version is when the student has to assimilate N numbers of terms. The net, which describes the dynamic of this knowledge with a curtain number of compulsory terms, can be with different complexity. Again the most simple case includes two stages: stage of assimilation S2 and stage of forgetting S1. Here with b_{1i} is noted the mean time for forgetting of the i-term, and with b_2 the mean time for assimilation or recovering of the same. D_1 and D_2 are respectively the actions on forgetting/recovering of the terms. O_2 presents the sequence of the terms on the entrance of the assimilation stage S_2 /fig.2/.

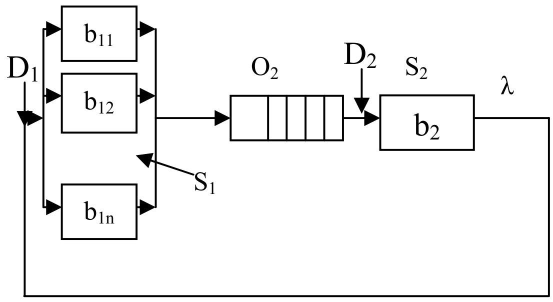

Fig.2.

For simplification is accepted $b_{1i}= b_1$=const. $\mu_1=1/ b_1$ is the intensity of forgetting of the separate terms. In this model can be accounted the terms which must be finally assimilated with probability p_{22}. With this probability the term is arranged in the end of the queue O_2. And with a probability p_{21} the assimilated term passes in the stage S_1.

In the model of figure.2. is not enough detailed the process of control (diagnostic) of the knowledge and the following assimilation. This process is reflected only with the summary stage S_2. As an example for more adequate net model securing guaranteed quality of specialist training can be defined as following: The stage S_1 corresponds to N basic states, allowing constant intensity of their forgetting, equal to $\mu_{1i}= \mu= 1/b_i$ (i=1,N). The stage S_2 with queue O_2 reflects the process of knowledge control with mean time for control od a state, equal to b_2. The accepted by the control as unassimilated positions, from the exit of stage S_2 go with possibility p_{23} in the assimilating stage S_3. The positions which are accepted as assimilated on the stage S_2 go to S_1 with possibility p_{21}. Unassimilated positions from the exit of a stage S_3 return with a possibility p_{33} in the queue O_3 to continue assimilating (each assimilation can be divided on phases). The positions from stage S_3 , with possibility p_{34} , pass to the next – S_4, stage with queue for control or diagnostics of the knowledge – O_4 and mean time for control b_4. From the exit of stage S_4 the positions accepted as unassimilated return to stage S_3 with possibility p_{43}. Accepted as assimilated positions, with possibility p_{41} return to stage S_1.

In the general case, for the multistaged net for assimilating knowledge the intensity of assimilating, control, diagnostics and other kinds of knowledge processing on stage S_i , can depend on the number of the positions n_i (i = 1, N), which are located on a certain stage.

On this base there can be design two-priorited and two-staged closed models. Details about the reasons and the schemes of the models are given in [3].

In the most simple version of the opened net the student goes through two stages: stage of assimilation S_1 and stage of control S_2 /fig.3/. D_1 and D_2 are respectively the actions on assimilation and control of the terms.

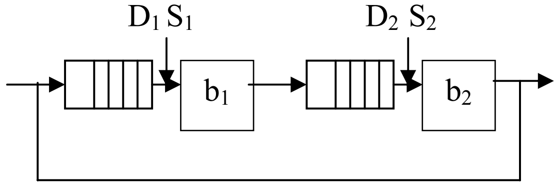

Fig.3.

Modelling with the Petri nets there can be separated two stages with three transitions: t_1 – process of assimilating, t_2 – process of controlling and letting the student work with the system and t_3 – process of control and returning the student for additional training /Table.2/: The necessary preliminary conditions for assimilating process to be done are: presence of a student – p_1, knowledge for the current term in the stream of the school material – p_2 and not full knowledge of the term in the student's knowledge– p_3. After this stage as an exit condition there is obtained presence of some kind of knowledge about this term in the student's knowledge - p_4. The necessary preliminary conditions for control and letting the student work are: presence of a teacher – p_5, presence of some kind of knowledge about this term in the student's knowledge - p_4 and judgement for satisfying student's knowledge – p_6. After this stage as an exit condition turns out the end of the training – p_8. The necessary preliminary conditions for control and returning the student for extra training are: presence of a teacher – p_5, presence of some kind of knowledge about this term in the student's knowledge - p_4 and judgement for non-satisfying student's knowledge– p_7. After this stage the exit result indicates not full knowledge of the term in the student's knowledge – p_3.

Table 2

	P1		P2		P3		P4		P5		P6		P7		P8	
	1		1		1		0		1		1		0		0	
	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out
T1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
T2	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	1
T3	0	0	0	0	0	1	1	0	1	1	0	0	1	1	0	0

CONCLUSIONS

The advantage of using the Petri network engine is the possibility to analyze and research the system's behavior.

From the designed Petri net models of the different systems, presenting the dynamic of knowledge assimilating there is confirmed that this machine has powerful means of modelling like Turing machines, but in contrast to them it contains bigger deciding power typical for the finite automats. There are not so much languages that allow all terms, constructing a topic, and all topics constructing a school subject, to be described in most details. Besides, all the time from the training process different priorities of the obligated and additional knowledge are given and controlling if the necessary assimilation power is reached. In addition, through all the assimilation process time the natural possibility of the student to forget is accounted.

REFERENCES

[1] Filipova, K., Sv. Stefanova, Defining the Performances of the Knowledge Dynamic Models, Annual School.Lectures- 2003, 3-5, vol.23, number 1, Sept 2001/2003.

[2] Filipova, K., Sv. Stefanova, Net Models of Knowledge Dynamic, Annual School.Lectures- 200,; 29-32, vol.23, number 1, Sept 2001/2003.

[3] Stefanova, Sv., K. Filipova, I. Zheliazkova, A Technology for Teaching by Means of an Intelligent Animation Environment, Annual School.Lectures- 2003, 17-19, vol.23, number 1, Sept 2001/2003.

[4] Sviridov A.P., I.A. Shalobina, Net models of knowledge dynamic, Moskva, MEI, 1992.

[5] Кр.Филипова, Св. Стефанова, Методът на Свиридов за ефективна организация на учебния процес, First International Conf. "Challenges in Higher Education in the 21st Century", pp.48-50, may, Sozopol, 2003.

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The Success is based on a lot of Work. Attitudes of Distance Teachers

Ásrún Matthíasdóttir

Abstract: *This article describes a survey that was conducted at Reykjavík University into the attitudes of distance teachers' towards distance learning. The 21 distance teachers that participated claimed they had good preparation for using computers in distance teaching, although half of them wanted more training in distance teaching methods. They think distance education is a realistic alternative in Icelandic education and are satisfied with their online courses although 24% are insecure about their ability to teach online. They can master the main options of the learning management systems (LMS) and want to be active in their teaching, but they are not using all the online options available for them. The main conclusion is that we need to train the distance teachers in using ICT in teaching and online pedagogic; they have the technological skills needed.*

Key words: *Distance education, Distance teaching, e-learning, Teachers' attitudes, Information and Communication Technologies (ICT), Higher education.*

INTRODUCTION

Today most universities offer distance programs using a variety of on-line methods and learning management systems (LMS) are often used for distribution of material and communication. It is important for distance teachers to be aware of the technological development in recent years and how the technology can be used to build up a supportive learning environment that encourages students' learning, they must be aware of what they can use and how they can use it. Believes and attitudes are important in this context and research has shown that teachers' attitudes toward computers influence their computer use [1, 2], although Sadik [3] argues that more research is needed in order to improve our understanding of the relationship between attitudes towards computers and their use and how it influences computer use in schools.

Distance education today is built on a systematic and intensive use of technology that does not only call for good computer skills and knowledge of how the technology can service the distance teaching goals, but also positive attitudes and interest in using the technology. Li [4] came to the conclusion from a research of 15 secondary mathematics and science teachers and 450 secondary students, that the students' and the teachers' attitudes were "almost always polarized", where the students were more positive than the teachers and wanted more use of technology.

The importance of using multiple tools in distance education has often been confirmed by research, especially the use of synchronous and asynchronous technology [5]. The distance teachers' role is in a way the same as other teachers', but in stead of face-to-face communication, the distance teachers use tools like LMS to distribute learning material and assignments, communicate with students and give feedback. This is important because distance teachers meet their students rarely or even not at all, so the on-campus communication and discussion has to be supplemented by other means. It is therefore important to understand how distance teachers use the technology available to them and also to understand their beliefs and attitudes, in order to support them to develop good quality distance education.

Distance education has grown fast in higher education in Iceland, from 1997 to 2008 the number of distance students rose from 307 to 3.295 [6, 7]. The programs are different in each university, some universities are only offering single distance courses while others are offering full programs, that the can end with degrees. The organisation of the distance learning programmes is also different, in some programs the students must attend on-campus sessions, but in others it is not obligatory and some programmes even do not include on-campus meetings. Often the teachers must design and prepare e-material for the distance students that may consist of recorded lectures, slide presentations, video clips, interactive assignments and files in different formats.

This paper describes a survey conducted at Reykjavik University (RU) in Iceland, examining the attitudes and believes among the distance teachers. RU has two distance programs, Diploma in Technology (90 ECTS) and Diploma in Applied Computing (120 ECTS), and uses its own LMS called MySchool. The distance teachers are encouraged to be active in their distance teaching and are offered support, both technical and pedagogical. They have to make their own e-material and a typical e-material is a recording of a slide show with the teacher's explanations. The student can see what is on the teacher's screen and listen to his/her voice but he/she does not see the teacher. Of course there can be different software on the teachers' screen and the teachers can use special monitors to write or draw on to explain further. In addition to that the teachers prepare a variety of material in different formats for the distance students. The distance teachers have the opportunity to meet with students once or twice each term, when the distance students are invited to come on campus, but it is not obligatory for the distance students to attend those meetings.

METHOD

The study was conducted in the autumn 2008 at Reykjavik University (RU) in Iceland. The participants were distance teachers in two diploma courses at RU, Technology and Applied Computing. The response rate was 70% or 21 answers, females were 3 (14%) of the respondents and males 18 (86%).

An especially designed questionnaire based on the author's previous research [8, 9, 10] was used in the study. The questionnaire consists of three background questions, two questions about communication, one multi-item question about the use of different online options, rated on a five point scale, and one multi-item question about the attitudes towards distance teaching, also rated on a five point scale. In the end there was an open question for the participants to give their opinion on distance education. A special software for interactive data collection, *Outcome* (www.outcome.is), was used and a request to participate was sent to teachers by e-mail. The study was anonymous and there was no possibility of tracing individual answers.

RESULTS

Just over half (13, 59%) of the distance teachers were 51 years or older, 5 (22%) were between 40 and 50 years old, and 3 (14%) under 40. Most (18, 86%) of them claimed that they had good preparation for using computers in distance teaching.

The distance teachers were asked about their attitudes toward distance education and most (18, 86%) of them found distance education a realistic alternative in Icelandic education and 17 (81%) agreed that everyone can study by distance education if they are patient and interested as table 1 shows. About half (12, 57%) of the distance teachers said they wanted more training in distance teaching and only 1 (5%) disagreed. Just over half (11, 52%) of them agreed that with time and training it will be as convenient to teach at distance as on-campus, but they were not all convinced as 29% (6) disagreed to that statement.

Table 1. Distance teachers' attitudes toward distance education

	Agree or totally agree N	(%)	Neutral N	(%)	Disagree or totally disagree N	(%)
Distance education is a realistic alternative in Icelandic education	18	86%	2	10%	1	5%
Everyone can study by distance education if they are patient and interested	17	81%	3	14%	1	5%

Educational standards in distance education are comparable to standards in on-campus education	16	76%	3	14%	2	10%
Course assessment is sufficient in distance education	14	70%	5	25%	1	5%
Distance teaching is an exciting option that I want to take more advantage of	14	67%	4	19%	3	14%
More training in distance teaching methods is needed for distance teachers	12	57%	8	38%	1	5%
With time and training it will be as convenient to teach at distance as on-campus	11	52%	4	19%	6	29%

The distance teachers were asked what on-line options they used for their distance teaching and all of them (21,100%) reported using the school's LMS 'always' or 'often' and most (20, 95%) of them claimed they 'always' used PowerPoint slides. Nearly all of the teachers (20, 95%) said they expected students to hand in their assignments online and almost all (17, 81%) of them recorded material for their students. Online discussion was used by half (12, 57%) of them, but only 2 (10%) claimed it was a part of the grading to take part in online discussion.

When asked about other options 5 (29%) claimed they used e-mail 'always' or 'often' to distribute material and 3 (26%) graded students assignments online as figure 1 shows.

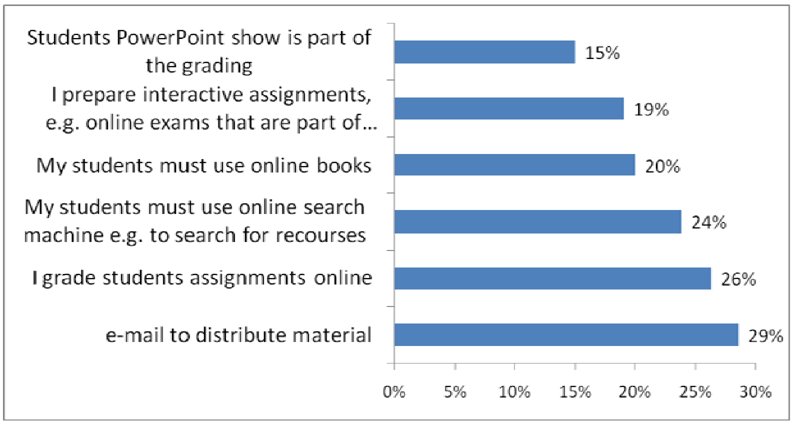

Fig.1. Distance teachers' use of online options (always or often).

Six other options were only used by one to three distance teachers; their own WebPages, mail printed material or audio-tapes to the students, computer programs made for learning, instant messaging clients (on-line chat), students own web sites for their projects and they rarely recommend online or traditional library to the students. No one claimed to use Blogg webs as part of the learning process, WebQuest, or send material on CDs to the students.

In Table 2 we can see distance teachers' attitudes towards their educational work. Most of them (15, 79%) believed that they reached the educational goals they set in their distance courses, but 4 (21%) of them were unsure. More than half (12, 57%) disagreed that they were insecure about their ability to teach online, but 5 (24%) agreed and 12 (60%) did not agree that LMS controls to much the distance teaching.

Table 2. Distance teachers' attitudes towards they educational work

	Agree or totally agree N	(%)	Neutral N	(%)	Disagree or totally disagree N	(%)
I can gain the educational goals I set in my distance courses	15	79%	4	21%	0	0%
I am satisfied with my online courses	15	71%	3	14%	3	14%
It bothers me not to be able to user black-board in the	6	30%	5	25%	9	45%

distance teaching						
I am insecure about my ability to teach online	5	24%	4	19%	12	57%
Teaching methods are not diverse enough in distance education	3	14%	10	48%	8	38%
Teaching result are better in distance teaching than in on-campus teaching	1	5%	10	48%	10	48%
LMS controls to much the distance teaching	0	0%	8	40%	12	60%

Table 3 describes the distance teachers' attitudes towards distance students and communication. All (21, 100%) of them agreed that distance teachers must answer students quickly and without fail, but only half (11, 52%) agreed that the time limits should be less than 24 hours. Almost all (20, 95%) agreed that it is important to meet distance students face-to-face and over half (12, 57%) disagreed that they have more control over students learning in distance teaching than in on-campus teaching.

Table 3. Distance teachers' attitudes towards distance students and communication

	Agree or totally agree N (%)		Neutral N (%)		Disagree or totally disagree N (%)	
Distance teachers must answer students quickly and without fail	21	100%	0	0%	0	0%
It is important to meet distance students	20	95%	1	5%	0	0%
It is very important that teachers' answers get to the students in less than 24 hours	11	52%	7	33%	3	14%
Teachers must make sure that distance students use online communication among them selves	9	45%	8	40%	3	15%
More counselling and support is needed for distance students	8	42%	9	47%	2	11%
Communication with distance students is more burden for the teacher than in on-campus teaching	8	38%	6	29%	7	33%
Distance students use more variety of resources than on-campus students	3	14%	12	57%	6	29%
Students do not have enough technical skills to use distance education	2	10%	11	55%	7	35%
I have more control over students learning in distance teaching than in on-campus teaching	1	5%	8	38%	12	57%

Figure 2 shows the frequency of the distance teachers' on-line communication with the students. The distance teachers seem to communicate more frequently with the student group on a daily basis (every day or 2-3 times a week), but more frequently with the individual student on a long term basis (weekly or more rarely).

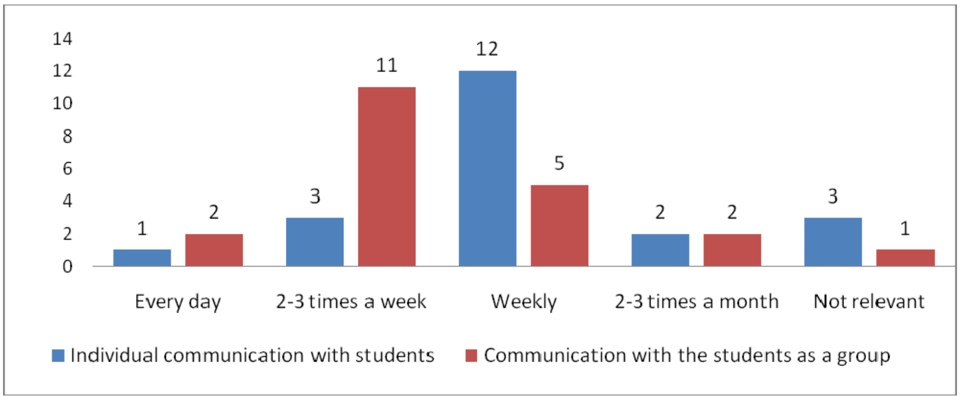

Figure 2. Distance teachers' communication with the students.

Five distance teachers gave their opinions about distance education and two of them had very practical comments, one wanted to meet the distance students four times a semester and the other did not understand how on-line exams, with multiple questions, could be used in math or bookkeeping subjects. One did not accept that the role of the teachers was to support communication between distance students. Two gave very positive comments of their experience as distance teachers and although they claimed it was a lot of work they were very content or as one said: "*I am pleased with how the distance teaching is coming along and the students seem to be happy in the distance education. The success is based on a lot of work, I have made a lot of slide shows and recordings and I have weekly assignments. I record the solutions of the assignments and send the students. It is also exemplary how helpful and supporting the administrators of the distance education are*."

CONCLUSIONS AND FUTURE WORK

The distance teachers that participated in the survey were almost all over 40 years old and claimed they had good preparation for using computers in distance teaching, although half of them wanted more training in distance teaching methods. They think distance education is a realistic alternative in Icelandic education and are satisfied with their online courses.

The RU guidance for the distance teachers is to use the LMS, record material and be active sending material to the students and answer their questions and requests within 24 hours (except for weekends and holidays). They are also encouraged to use all the options that the LMS offers, e.g. the assignment system, interactive assignments, online discussion and chat. The participants in the study followed the school guidance up to a limit; they accepted that distance teachers must answer students quickly and without fail, although they were not sure about the 24 hours time limit. They were all active using main features in the LMS and believed it did not control too much of the distance teaching. They recorded material to send the students and used the assignment system to get students' solutions. Other options were used by only half of the group or fewer, e.g. online discussion, chat and interactive assignments. They agreed that it is important to meet distance students face-to-face and they communicated frequently with the student group on a daily basis, but more frequently with the individual student on a long term basis. They believed they reached their educational goals, but 24% were insecure about their ability to teach online.

Mumitaz [11] comes to the conclusion, built on a literature review, that it is the institution, the teacher and the resources that are the three main factors affecting ICT use in education. Reykjavik University has offered distance education since 1998, with a broad use of ICT and support for the teachers. The University emphasises good resources, e.g. LMS and online library, and monitors the development of new options to implement into the LMS and teachers work. In the survey the focus was on the distance teachers and the results indicate that they can master the main options of the LMS and want to be active in their teaching, but what is stopping them for using more online options? They do hardly need more technical skills as they can manage the LMS and the recording of the material, but what do they need? Built on his research Barak [12] claims that although teachers use sophisticated technologies, when they are self studying, they "*are careful and sensible regarding the extensive use of ICT in school*." (p. 134). This indicates that it is not enough for teachers to know how to use ICT in order to implement it into their own work; they need more training in how to use it for teaching. This is consistent with the distance teachers' answers in this study; they want more training in distance teaching methods.

The main conclusion is that we need to train the distance teachers in using ICT in teaching and online pedagogic; they have the technological skills needed. The training courses already offered to them seem not enough support for them to implement more opportunities into their distance teaching. Distance teachers need a good knowledge of new online opportunities to be able to decide what can be put into practice in the different courses. It is not enough to know what can be done; you need to know how to use it in your online environment. It is a lot of work to be a good and active distance teacher; you do not only have to preparer material and be active communicating with the distance students, you must also be up to date in all the new software that is on the market and be open minded for new opportunities. The school and the distance teachers must work hand in hand to make sure that we are offering students good quality distance education.

REFERENCES

[1] Davis, D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly,* Vol. 13, No. 3, 319-40.

[2] Kellenberger, D., and S. Hendricks. (2003). Predicting teachers' computer use for own needs, teaching, and student learning. Paper presented at *Hawaii International Conference on Education,* Honolulu.

[3] Sadik A. (2006). Factors Influencing Teachers' Attitudes Toward Personal Use and School Use of Computers: New Evidence From a Developing Nation. *Evaluation Review,* Vol. 30 No. 1, 86-113.

[4] Li Q. (2007). Student and Teacher Views about Technology: A Tale of Two Cities? *Journal of Research on Technology in Education*, Vol. 39, No. 4, 377–397.

[5] Menchaca, M. P. and Bekele, T. A. (2008). Learner and instructor identified success factors in distance education. *Distance Education,* Vol. 29, No. 3, 231-252.

[6] Ásrún Matthíasdóttir (2008). Distance Education in Iceland. A glimpse into the future. *Lifelong Learning in Europe*, Vol. 4.

[7] Statistic Iceland, 2008, hagstofan.is

[8] Anna Ólafsdóttir and Ásrún Matthíasdóttir (2004). Upplýsinga- og samskiptatækni í háskólanámi og kennslu. *Tímarit um menntarannsóknir*, Vol 1,195-208.

[9] Auður Kristinsdóttir, Ásrún Matthíasdóttir, M. Allyson Macdonald (2001). *Úttekt á fjarkennslu við Kennaraháskóla Íslands.* Rannsóknarstofnun Kennaraháskóla Íslands.

[10] Ásrún Matthíasdóttir, Michael Dal og Samuel C. Lefever (2003). How do students use information and communication technology in Icelandic high schools 2002? Proceedings of the *4th annual Conference of the LTSN,* Center for Information and Computer Sciences.

[11] Mumtaz, S. (2000). Factors Affecting Teachers' Use of Information and Communications Technology: a review of the literature. *Journal of Information Technology for Teacher Education*, Vol. 9, No. 3, 320 – 341.

[12] Barak M. (2006). Instructional principles for fostering learning with ICT: teachers' perspectives as learners and instructors. *Educ Inf Technol* (2006) 11: 121–135

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Measuring Student Attitudes and Motivation as a Result from Web-based Blended Learning

Anelly Kremenska

Abstract: *This study presents the results of a summative course evaluation and is an attempt to measure the student motivation resulting from English for Specific Purposes (ESP) course design. The tool used for gathering data was a questionnaire measuring attitudes and motivation.*

The analysis of the data showed that students find the course interesting, the tasks relatively easy to cope with, and are satisfied with their performance and the gaining from the course. It also became evident that the presented virtual learning environments were not fully used for communication.

Key words: *Motivation, technology-enhanced language learning, web based learning, blended learning, instructional design.*

INTRODUCTION

The analysis of the common trends and features of contemporary educational practices identified through research on the system of Bulgarian higher education [1-5] led to building a model to meet the needs of the language learning in the cited context. The VEHICCLE model ("(for Vocational purposes) Electronically enHanced InterCultural Communicative Language Education") [6] was applied to a course design for the English for Specific Purposes (ESP) blended learning course at Faculty of Mathematics and Informatics, Sofia University. The aim was to develop students' of Informatics communicative skills in order to facilitate their study and professional realization. The settings included using a virtual learning environment (Moodle) and the course website, with face-to-face sessions in a computer lab or traditional seminar room.

This paper presents the results of a summative course evaluation to measure student attitudes and motivation for the 2008/2009 academic year. Student motivation is measured through analysing the perceived effectiveness of the course elements (according to the course objectives) with regards to the motivational aspects (free choice, anxiety, etc. [7]).

The tool used to collect data was a web-based questionnaire, based on the free version of Survey Monkey[4]. It consisted of: bio-data questions (sex, age, group, perceived level of English, attendance rate); closed graded questions investigating student attitude towards the course design and measuring student motivation (based on Intrinsic Motivation Inventory (IMI) [8], adapted for the purposes of this study), which used Likert's scale [9]; open-ended questions; and an open question for free suggestions. The open-ended and open questions are not an issue of this paper due to the limited volume.

STUDENT ATTITUDES AND MOTIVATION

The questionnaire was filled in by 42 of 76 students who completed the course. Bearing in mind that it was presented after the course end, the number of voluntary respondents speaks of a clear desire of the students to express opinion and help to improve the design. Current analysis is based on 41 (n=41) or 39 (n=39) responses (the numbers of complete answers for the different questions). 30 of the students were male and 11 female; age (average) 19.75 years. 59% claimed to have attended more than 7 classes, which makes the majority attended most of the classes.

The first of the graded questions collected data investigating student evaluation of the course environment (Moodle and the course website) (Table 1). The scale is: 1-never; 2-rarely; 3-usually; 4-often; 5-always. It is evident, that students used the site and the environment mainly to get informed about the requirements, to get informed about

[4] Available at http://www.surveymonkey.com/

the classes, and to use the links and other information provided. The other four functions of the course environment have median at 1 or 2, which speaks that most of the answers rated these functions as "rarely used". Some of the students admit to have seen the other's work (mean case value at 2.3 and median at 2). Asking questions and discussing in the forums score even lower at average (both at mean value below 2). An impressive half of the students have never used these options. The other half divided into usual (20% each) and rare (21% and 17% respectively) use of these types of communication. 78% of the students never used the environments for non-related to the classes activities.

Table 1. Opinion of the Informatics students in FMI on the VLE for the ESP course

Do you use the VLE (Moodle) and/or the course website for: *(please rate from 1 to 5)*	**MEAN case 1-41**	**MEDIAN case 1-**	**75^{th} % case**	Score 1 (%)	Score 2 (%)	Score 3 (%)	Score 4 (%)	Score 5 (%)
Requirements	3.4	3	4	7.3	12.2	34.2	26.8	19.5
classes	2.8	3	4	22	24.4	19.5	19.5	14.6
Information (links)	2.8	3	4	10	35	25	25	5
To See others' work	2.3	2	3	31.7	24.4	26.8	12.1	5
To ask	1.8	1	3	56.1	17.1	22	2.4	2.4
To discuss	1.95	2	3	48.8	22	19.5	5	5
Not related to classes	1.3	1	1	78	14.6	5	2.4	0

It can be concluded that both the VLE and the website were not used up to their limits. One reason for this can be the lack of experience for using such environments for study, as the students are not acquainted with web-based learning (being in the first year of study). Another reason could be the lack of adequate information and instructions about the environments themselves, and the services and activities they support.

The second question used the same scale to rate whether the students consider "these classes (without a course book, with computers, in a VLE) compared to the traditional classes" as: more interesting/ more useful/ easier to cope with. Table 2 shows, that all three aspects were rated above the neutral point, which is a stable and positive attitude. The table also shows that the interest scores the highest, next is the ease, then comes the usefulness. The two additional answers to the open part of the question prove, that the students find this course setting as "more fun, improving the attendance" and "one can decide on oneself when and how to learn". These answers add to the free choice and enjoyment, discussed later.

Table 2. Comparison between web-based and traditional classes

In comparison to the traditional classes these are: *(please rate from 1 to 5)*	**MEAN case 1- 41**	**MEDI AN case**	**75% case**	**Score 1 (%)**	**Score 2 (%)**	**Score 3 (%)**	**Score 4 (%)**	**Score 5 (%)**
More interesting	3.7	4	5	7.3	5	25	32.7	30
More useful	3.4	3	4	7.3	5	41.5	29.2	17
Easier to cope with	3.6	4	5	7.3	7.3	31.7	24.4	29.3

Next question deals with the indicative content: table 3 shows student opinion on the extent to which the course helped them improve their knowledge on six items. The scale used is: 1- hasn't helped; 2-helped a little; 3-helped; 4-helped much; 5-helped very much. The general opinion is that the course helped the most to know about academic writing: mean value at 3.6, and median at 4. Next come the terminology and the presentation skills, both of which have a median at 3 (helped) and mean case at about the same value; also about 1/5 of the students have rated them at 5. 30% declared that the course hasn't helped them develop searching for information skills, which brings the mean case at 2 for this aspect. It is evident from the mean values of the general vocabulary, that the respondents feel it improved a little by the course (mean at 2.3, and 44% responses at 2). The grammar aspect has the lowest scores with 44% at 1; mean at 1.8, and median at 1.5. It is seen that the focus of the indicative content (academic writing and presenting) has been acknowledged, studying terminology is stable at the neutral point (45% at 3), while the other aspects are perceived as complementary rather than main.

Table 3. Opinion of the Informatics students in FMI on the course indicative content

To what extent has the course helped you improve these aspects of your knowledge of English? *(rate from 1 to 5)*	**MEAN case 1-41**	**MEDIAN case 1-41**	**75% case**	**Score 1 (%)**	**Score 2 (%)**	**Score 3 (%)**	**Score 4 (%)**	**Score 5 (%)**
Grammar	1.8	2	2	43.9	34.2	19.5	2.4	0
Vocabulary (general)	2.3	2	3	17.1	43.9	31.7	7.3	0
Vocabulary (terminology)	2.8	3	3	12.5	20	45	20	2.5
Academic writing	3.6	4	4	4.9	12.2	24.4	39	19.5
Presentation skills	3.1	3	4	9.8	24.4	29.3	19.5	17.1
Searching for information	2.4	2	3	29.3	24.4	29.3	9.8	7.3

Table 4. Opinion of the Informatics students in FMI on the course goals

To what extent did the course help you improve these skills? *(rate from 1 to 5)*	**MEAN case 1- 41**	**MEDIAN case 1- 41**	**75% case**
Writing a summary	2.95	3	4
Academic text writing	3.34	3	4
Information evaluation	3	3	4
Speaking – dialogue presentation	2.8	3	3
Working in a VLE	2.7	3	3
Speaking – monologue presentation	2.5	3	3
Speaking discussion	2.5	3	3
Team working	2.5	3	3
Searching for information	2.4	2	3
Reading comprehension	2.3	2	3
Listening comprehension	2.3	3	3
Writing a comment	2	2	3

The question about skill development (table 4) was used to provide additional information on the perceived achievement of the course goals (12 aspects), based on the same scale as above. Similar to the previous question, the highest mean value was reached by academic writing (3.34), summarizing (3), and information retrieval and evaluation (3). The lowest mean values were for "comment writing" (2), and reading comprehension (median at 2, mean 2.3). The other aspects (listening comprehension, speaking - discussion, speaking – dialogue, speaking – monologue, team working, working in a VLE, searching for information) have a median at 3, which proves that the course has provided relatively good opportunities for achieving all the academic skills desired. Presenting (monologue and dialogue), and working in a VLE have mean values above 2.5: 2.6, 2.7 and 2.8 respectively, which supports the priorities set before the course.

The next question investigated student motivation (table 5); it contained 6 categories, providing data on enjoyment/ interest (sub-questions I1-I6), perceived competence (C1-C6), effort/ importance (E1-E8), pressure/ tension (P1-P5), perceived choice (Ch1-Ch5), value/ usefulness (V1-V6). The scale used is a 7-grade one (1-not true at all; 7-very true). The sub-questions appeared randomly, and these marked with an asterisk (*) were worded as a negation (the scores they receive are therefore taken as a reverse value). 39 complete answers were elicited (n=39).

Table 5. Motivation of the students: interest and perceived competence

Please rate *(from 1 to 7)* to what extent the statements are true for you bearing in mind the ESP course	**Interest1:** making a presentation	(I2) Others' presentation *	(I3) Assignment writing	While working on the assignment I was thinking it was interesting	(I5) Discussing in the forums	(I6) The course as a whole	**Competence 1:** my presentation was better than average	(C2) I am good at presenting	After working on the assignment I felt competent (C3)	(C4) I am good at acad. writing	(C5) I did well at discussions	(C6) I am satisfied with my achievements
MEAN case 1-39	4	4.6	4.5	3.7	3.6	4.2	4.5	3.9	4.3	4.1	4.1	4.9
MEDIAN case	4	4	5	4	4	5	4	4	4	4	4	5
75th% case	5	6	6	5	5	5	6	5	5	6	5	7

The interest expressed through the answers to questions I1-I6 complies with the findings of the previous questions: students find it very interesting to write a presentation (I3), and the course as a whole (I6), both scoring above the neutral point (4) as a mean value and at 5 as a median. Similar is the score of the interest evoked by the other's presentations (mean case at 4.6, median 4, 75% case at 6). The making of the presentation (I1), the process of writing (I4), and the discussions (I5) are stable at about the neutral point, with discussions scoring the lowest (mean case at 3.6). The same table contains the perceived competence values: it is seen that the overall satisfaction with personal performance is stable at the level of 5 for the median and mean cases, and at the extreme 7 for the 75% case. All other sub-questions of this category are slightly above the average point, with own presentation felt at a higher than the average level for most of the students (4.6 mean case), which again shows a good level of perceived competence.

Table 6 presents the effort/ importance sub-questions, and the pressure felt. What can be observed is that preparing the assignment and presenting it (E1) were not difficult, though scoring closer to the neutral point (mean case at 3.5) speaks that they were also not too easy. Lower is only the score of the desire to participate in the forums (E7), with mean and median cases at 3, which supports the conclusions from the previous questions that the environment has not been adequately used for communication. The difficulty of writing academic text (E6) was at the neutral point with a mean at 4.2 and median at 4, which makes it achievable. The ambition to perform well at the assignment is evident through the mean and median cases of 5 for the desire to do well (E3) and the effort put in it (E4); both have a 75% case at 7. However, the energy (E5) scores 4.6 as mean case, which is close to the effort for the presentation (E2) (4.3), as both have a median at 5 it is obvious that the declared ambition was higher than the effort. The pressure (P1-5) results confirm this last observation as all score below the neutral point for the mean case, and only the anxiety during the presentation was considered at 4 as a median case.

Table 6. Motivation of the students: effort and importance, and pressure

Please rate *(from 1 to 7)* to what extent the statements are true for you bearing in mind the ESP course **(case 1-39)**	**Effort 1 :** preparing and presenting were difficult	(E2) I put a lot of effort in presentation*	I wanted to do well at the assign	I put a lot of effort in writing the assignment* (E4)	(E5) The text took a lot of energy	It was difficult to prepare the text*	(E7) I tried hard to participate in forums*	It was important for me to do well	**Pressure 1:** I felt really tense while preparing the presentation*	(P2) I was very anxious while presenting	I felt tense while writing the text	(P4) I felt anxious while discussing	I felt pressure during the classes*
MEAN	3.5	4.3	5	5	4.6	4.2	3	5.2	3.4	3.5	3.2	2.3	3.1
MEDIAN	3	5	5	5	5	4	3	5	3	4	3	2	3
75th%	5	6	7	7	6	6	4	6	5	5	4	4	4

The perceived choice as next motivational aspect (table 7) is stable at 4 (for sub-questions Ch1 and Ch3) for both mean and median case values. However, the answers of Ch2 and Ch4 prove, that students feel that writing the assignment was not their choice; however, it is clear (Ch5) that their perception of choice during the process of writing was strong (mean value at 5.3 and median at 6). The results of the question whether the students would make an assignment again score at the neutral point, which means that however confident they felt about the choices they have, they are not convinced that this is something they will need in their future. Yet, they treasure the skill of writing academic text a lot (V1), mean case at 5.3 and median at 6. Similar are the scores about the information about the course (V5), which can explain the overall positive attitude of the students towards the gaining the course offers. The discussions (V2) and the overall usefulness of the course (V6) score slightly less (mean cases at 4.8 and 4.5 respectively, and median at 5), yet well above the neutral point as well.

Table 7. Motivation of the students: choice and value

Please rate *(from 1 to 7)* to what extent the statements are true for you bearing in mind the ESP course **(case 1-39)**	**Choice 1:** I wanted to write an assignment	(Ch2) I had to make the assignment	(Ch3) It was my choice to participate in discussions	(Ch4) I had no choice whether to prepare a text and presentation	I had a choice while making the assignment and presentation	**Value 1:** making the assignment was good for me	(V2) Discussing was good for me	(V3) I would make an assignment again	(V4) The course met my needs	The information about the course was enough and understandable*	(V6) The course as a whole was very useful
MEAN case	4	4.7	4	4.3	5.3	5.3	4.8	4	4.3	5.2	4.5
MEDIAN case	4	5	4	4	6	6	5	4	4	6	5
75th% case	5	6	5	6	7	6	6	5	5	7	6

CONCLUSIONS AND FUTURE WORK

The results of this study show that students feel all elements of the course (based on VEHICCLE model) satisfactory and interesting, motivating, and not too difficult to deal with. Their satisfaction with their performance was high, and the feeling that they achieved the goals of the course is stable, with these goals perceived as a gain for their development. The feeling that the course is good, interesting and useful, however, is in slight disagreement with one of the course objectives: to initiate and facilitate communication through the environments. A conclusion could be made that more detailed instructions as to how the environments function is needed so to ensure higher gaining from the web-based facilities of the course VLE and site.

Additional work is to be done on the answers receive through the open question and the open-ended ones, which may provide a chance for better understanding the students' opinion and gather suggestions for further improvements in the course design.

As it was mentioned earlier, this paper discussed the evaluation of the course based on the answers of students who completed the course. In order to provide more detailed information and proof of the motivational value of the course further analysis of the comparison between the answers of the different categories of students (these who completed the course and these who didn't) is needed. To this end additional research should be conducted.

REFERENCES

[1] Kossekova, G. Innovative educational technologies in medical education and research methodology. Book of abstracts, International Conference Pioneers of Bulgarian Mathematics, Sofia, July 8-10, 2006, p.66.

[2] Sendova, E., E. Stefanova, N.van Diepen. Methodology handbook on ICT-enhanced Skills. Faleza, Sofia, 2007.

[3] Stefanova, E., E. Sendova, I. Nikolova. I*Teach Methodology for building enhanced ITC skills. In: 3rd Balkan Conference in Informatics, Sofia, 2007.

[4] Sendova, E., Nikolova, I. (editorial) Innovative Didactics for Web-based Learning (in Bulgarian). CIST at Sofia University, Sofia ISBN: 978-954-92146-4-2, 2008.

[5] Nikolova, I. WWW-based Learning Design and Management: Methodology and Tools (in Bulgarian). PhD Dissertation, Sofia University, Faculty of Mathematics and Informatics, 2000.

[6] Kremenska, A. VEHICCLE: A Model of Web-based Language Learning. In CompSysTech'08, vol. IV-12, ACMBUL, Sofia, 2008.

[7] Ryan, R., Deci, E. Self-Determination Theory, Scale Description. 2000, Retrieved 12th April, 2006, from http://www.psych.rochester.edu/SDT/measures/intrins.html

[8] Deci, E., Ryan, R. Intrinsic Motivation and Self-determination in Human Behaviour. New York: Plenum, 1985.

[9] Underwood, M. The Likert Scale. 2003. Retrieved 16th June, 2005, from http://www.cultsock.ndirect.co.uk/MUHome/cshtml/index.html

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Computer Based Testing for E-learning: Evaluation of Question Classification for Computer Adaptive Testing

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Abstract: *The objective of this study is to determine the item difficulties of tests that are going to be used on a Computer Adaptive Testing (CAT). According to the student responses, item difficulties have been found using different approaches. Consequently, best approach to find item difficulty has been determined by a simple classification tool. By using this classification tool, the best method to find item difficulties is determined and items have been classified using Rapidly-exploring Random Tree (RRT) algorithm. This classification ended up with two different results that define the future work of this study. First one tries to reveal which algorithm is the best method for classifying the questions for CAT software and the second one has determined whether the size of item pool is important for question classification.*

Key words: *Item Analysis, Computer Based Testing, Computer Adaptive Testing, RRT.*

INTRODUCTION

In education, computers can be used to deliver the course content and to measure the achievement in courses. This thesis dwells upon the assessment techniques in education via computers. The British Standards Institution estimates that approximately 1000 computer-assisted assessments are performed each day in the United Kingdom [1]. Computer delivered assessments focuses on two specific delivery methods: computer-based test (CBT) and computer-adaptive test (CAT). It have been reported numerous benefits of the CBT approach over the standard paper-and-pencil one [2-4]. These benefits ranged from the automation of marking and subsequent reduction in marking workload to the opportunity to provide students with immediate feedback on their performance [5]. Due to the limitations of traditional success measuring rates, the contribution for the understanding of students' knowledge about a subject is little. The use of CBT is an attempt to overcome these limitations and go some way to make course and assessments more interesting and useful processes for both teachers and students. Notwithstanding these benefits, previous works by researchers suggested that CBTs have being viewed as unsatisfactory in terms of efficiency. The reason for this inefficiency is that the questions administered during a given CBT session are not tailored for the specific ability of an individual student. In a typical CBT, the same predefined set of questions is presented to all students participating in the assessment session, regardless of their ability [5]. The questions within this fixed set are typically selected in such a way that a broad range of ability levels, from low to advanced, is catered for [4]. In this scenario, it is accepted that high-performance students are presented with one or more questions that are below their level of ability. Similarly, low-performance students are presented with questions that are above their level of ability [4]. The underlying idea of a CAT is to offer each student a set of questions that is appropriate to their level of ability [4]. Generally, a CAT initiates with a random question with an average difficulty. A more difficult question follows if the student answers the question correctly. Conversely, if the response provided is incorrect, an easier question that is suitable for this new lower estimate is presented next [6-7]. The use of CAT has been increasing and indeed replacing traditional CBTs in some areas of education and training [5]. Usually this replacement is associated with the need for higher efficiency when assessing large numbers, for example, in online training. The study presented here focuses on the evaluation of determining item difficulties for CAT software.

DATA GATHERING AND PREPROCESSING

The dataset introduced here consists of a midterm and a final exam taken by 368 students during the first semester of History of Civilization course. In the midterm exam, there were 13 multiple choice questions with 4 choices and there were 30 multiple choice questions with 4 choices in the final exam. Questions were delivered via a CBT system to the students using separate computers. CBT system was a web application running on Intranet backbone. Questions delivered during the midterm and final exams were taken into consideration for classification purpose. The reason for classifying these questions is to convert the CBT system to a Computer Adaptive Testing (CAT) system. In CAT, items are drawn from the item pool by a simple item selection algorithm so for each individual examinee, appropriate items are delivered. All items in the CAT item pool range in difficulty values. If an examinee gets an item right, an item having a greater difficulty is selected from the item pool and delivered to the examinee as the next question of the test. If he/she gets it wrong, then an item having a smaller difficulty is selected from the item pool and delivered to the examinee as the next question of the test.

Table:1 Nominal question levels

Question Level	Numerical Representation
Very Easy	-1
Easy	-0,5
Middle	0
Hard	0,5
Very Hard	1

METHODS TO FIND ITEM DIFFICULTY

P value

In many educational and psychological measurement situations, the easiest way is to determine the item difficulty from the proportion of the total group selecting the correct answer to that question. The following formula may be used to calculate the item difficulty factor (called the p-value): $p = c / n$

Where c is the number of students who selected the correct answer and n is the total number of respondents.

Table 2. c, n, p and nominal question levels for the Midterm exam using p-value method

Item ID	c	n	p	Nominal Question Levels
1	194	368	0,527	0
2	193	368	0,524	0
3	235	368	0,639	-1
4	186	368	0,505	0
5	202	368	0,549	-0,5
6	219	368	0,595	-0,5
7	168	368	0,457	0,5
8	150	368	0,408	0,5
9	207	368	0,563	-0,5
10	172	368	0,467	0
11	194	368	0,527	0
12	156	368	0,424	0,5
13	137	368	0,372	1

As seen from Table 2 and Table 4, p-value is indirectly proportional to the item difficulty. For instance, the 13th question of the midterm exam is answered by 137 test takers among 368 test takers. The p-value of this question is 0,372, which shows that the probability of getting this question is about 37%. With this probability 13th question is the most difficult among the midterm exam questions. For the items in Table2, the mean and standard deviation is calculated using p values as shown in Table3. According to these mean and standard deviation values, a scale, shown in Figure 1 is designed for placing items into nominal question levels. And all items are placed into related nominal question level as shown in below table.

Table 3. Mean and Standard Deviation of Item Difficulties found by p-value Method

	Mean	Standard Deviation
MIDTERM	0,504	0,076
FINAL	0,487	0,116

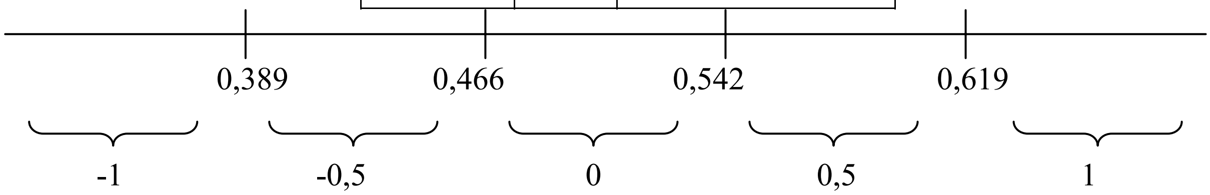

Fig.1. Midterm Exam Nominal Question Level vs. Item Difficulty Scale

Same procedure is also applied to the final exam items and nominal distributions found after the completing the procedure.

Table 4. c, n, p and Nominal Question Levels for the Final Exam using p-value Method

FINAL										
Item ID	**c**	**n**	**p**	**Nominal Question Levels**		**Item ID**	**c**	**n**	**p**	**Nominal Question Levels**
1	179	356	0,503	0		16	190	356	0,534	0
2	146	356	0,410	0,5		17	175	356	0,492	0
3	132	356	0,371	0,5		18	209	356	0,587	-0,5
4	111	356	0,312	1		19	154	356	0,433	0
5	163	356	0,458	0		20	197	356	0,553	-0,5
6	117	356	0,329	0,5		21	207	356	0,581	-0,5
7	142	356	0,399	0,5		22	266	356	0,747	-1
8	153	356	0,430	0		23	217	356	0,610	-0,5
9	142	356	0,399	0,5		24	177	356	0,497	0
10	161	356	0,452	0		25	211	356	0,593	-0,5
11	179	356	0,503	0		26	137	356	0,385	0,5
12	196	356	0,551	-0,5		27	245	356	0,688	-1
13	102	356	0,287	1		28	201	356	0,565	-0,5
14	206	356	0,579	-0,5		29	203	356	0,570	-0,5
15	191	356	0,537	0		30	91	356	0,256	1

NORM-REFERENCED ITEM ANALYSIS

A norm-referenced test (NRT) is a type of test, assessment, or evaluation in which the tested individual is compared to a sample of his or her peers. The term "normative assessment" refers to the process of comparing one test-taker to his or her peers. In NRT, the goal is to rank the entire set of individuals in order to make comparisons of their performances relative to one another. In this paper, students' performances will be analyzed on multiple-choice tests. Well-constructed multiple-choice items can be used to diagnose student difficulties if the incorrect options are designed to reveal common misconceptions, and they can provide a more comprehensive sampling of the subject material because more questions can be asked. In addition, they are often more valid and reliable than essay tests because; (a) They sample material more broadly; (b) discrimination between performance levels is easier to determine; and (c) scoring consistency is virtually guaranteed when carried out by machine. The validity of multiple-choice tests depends upon a systematic selection of items with regard to both content and level of learning. Although most teachers try to select items that sample the range of content covered in class, they often fail to consider the level of discrimination and level of difficulty of the items they use. Item discrimination and item difficulty can be calculated by evaluating the test takers as in norm-referenced item analysis [8]. Item difficulty is a measure of overall difficulty (p) of the test item. The lower the p, the more difficult a particular item is. Whereas, item discrimination tells us how good a question is for separating high and low performers. It is more important for an item to be discriminable than it is to be difficult. For norm-referenced item analysis, test takers should be sorted in descending order first. Then two things must be specified: number of people in high and low groups and number of people in high and low groups who get a particular answer right. Using these two groups, item discrimination index and item difficulty index can be calculated using the below formulas:

Item Discrimination Index: $a = (Up / U) - (Lp / L)$
Item Difficulty Index: $p = (Up + Lp) / (U + L)$

Where, Up = Number of high performers who got question right
Lp = Number of low performers who got question right
U = Number of high performers
L = Number of Low performers

Table 5. Lp, Up, a and p and Nominal Question Levels

MIDTERM					
Item ID	**Lp**	**Up**	**a**	**p**	**Nominal Question Levels**
1	40	91	0,42	0,539	0
2	39	86	0,38	0,514	0
3	46	108	0,51	0,634	-1
4	35	83	0,39	0,486	0,5
5	51	74	0,19	0,514	0
6	50	100	0,41	0,617	-0,5
7	28	94	0,54	0,502	0
8	29	71	0,34	0,412	0,5
9	41	98	0,46	0,572	-0,5
10	23	93	0,57	0,477	0,5
11	30	99	0,56	0,531	0
12	22	98	0,62	0,494	0
13	28	65	0,30	0,383	1

In Table 5 and Table 6, the a and p values for 13 midterm and 30 final questions calculated by the formulas respectively. Nominal question levels are found using the same scaling technique in p-value section.

Table 6. Mean and Std. Dev. of Item Difficulties found by Norm-Referenced Item Analysis Method

	Mean	Standard Deviation
MIDTERM	0,513	0,070
FINAL	0,507	0,116

The higher value of a (up to 1), the better the item is capable of separating high and low performance. If a = 1, this means the entire high performance group and none in the lower performance group get a particular question right. Since this is not a frequently seen situation, a rarely (if ever) = 1. An item has an acceptable level of discrimination if a >= 0,30 p and a are not independent probabilities. Discrimination indexes less than 0,30 are sometimes acceptable if we have a very high p value. From Table 5 and Table 7, it is observed that 100% of midterm questions and 93,33% of final questions have acceptable level of discrimination. However, none of them are close to the optimum difficulty level.

Table 7. Lp, Up, a and p and Nominal Question Levels for the Final Exam using

FINAL											
Item ID	L_p	U_p	a	p	Nominal Question Levels	Item ID	L_p	U_p	a	p	Nominal Question Levels
1	36	83	0,40	0,515	0	16	40	90	0,43	0,563	0
2	39	60	0,18	0,429	0,5	17	46	72	0,22	0,511	0
3	26	69	0,37	0,411	0,5	18	60	92	0,27	0,658	-0,5
4	16	62	0,40	0,338	0,5	19	29	79	0,43	0,468	0
5	42	73	0,26	0,498	0	20	52	79	0,23	0,567	-0,5
6	35	45	0,08	0,346	0,5	21	59	61	0,01	0,519	0
7	36	66	0,26	0,442	0,5	22	77	99	0,18	0,762	-1
8	27	85	0,50	0,485	0	23	59	84	0,21	0,619	-0,5
9	37	62	0,21	0,429	0,5	24	35	84	0,42	0,515	0
10	27	73	0,39	0,433	0,5	25	50	83	0,28	0,576	-0,5
11	35	88	0,45	0,532	0	26	41	48	0,06	0,385	0,5
12	46	81	0,30	0,550	0	27	54	101	0,40	0,671	-0,5
13	26	40	0,12	0,286	1	28	55	86	0,26	0,610	-0,5
14	61	94	0,28	0,671	-0,5	29	49	79	0,25	0,554	0
15	53	79	0,22	0,571	-0,5	30	29	36	0,06	0,281	1

Considering the optimum difficulty index for multiple choice questions with 4 options from Table 8, both tests can be termed as easy. But yet, taking student success into consideration yields presented nominal question levels.

Table 8. Recommended Difficulty Index for Various Test Items

Number of Options (k)	Optimum Difficulty Index
2 (True-False)	0,85
4	0,74
Open-Ended	0,50

Selecting the Best Algorithm for Determining Item Difficulties

Since item difficulties of both tests are calculated in three different ways, now a classification algorithm called RandomTree is going to be used to determine which of the methods above the best for determining the item difficulty is.

Table 9. Classification Results

	Correctly Classified Instances	Incorrectly Classified Instances	Total Number of Instances	Percentage of Correctly Classified Instances	Percentage of Incorrectly Classified Instances
p – value	6490	4190	10680	60.77 %	39.23 %
Norm - Referenced Item Analysis	7052	3628	10680	66.03 %	33.97 %

For this purpose, final exam data will be used since it has more samples. A Rapidly-exploring Random Tree (RRT) is a data structure and algorithm designed for efficiently searching non-convex, high-dimensional search spaces. Simply put, the tree is constructed in such a way that any sample in the space is added by connecting it to the closest sample already in the tree [9]. According to RRT, classification results for p-value, norm-referenced item analysis are shown in Table 9. As seen from the results the questions are not classified perfectly, to correct this problem data is made nominal and RRT is applied to the data again. Using the nominal data, the results are fairer. According to RRT, classification results for p-value, norm-referenced item analysis on nominal data are shown below in Table 10.

Table 10. Classification Results

	Correctly Classified Instances	Incorrectly Classified Instances	Total Number of Instances	Percentage of Correctly Classified Instances	Percentage of Incorrectly Classified Instances
p – value	9635	1045	10680	90.22 %	9.78 %
Norm - Referenced Item Analysis	10252	428	10680	95.99 %	4.01 %

Best method to determine the item difficulties is obtained as Norm-Referenced Item Analysis as a consequence of taking both item discrimination and item difficulty into consideration. Another important thing is to make data nominal before trying to run any classification method on it.

CONCLUSIONS AND FUTURE WORK

There is a great need in the education area to have tools to monitor test results on a large scale as well as more precise tools to identify questions that are most likely to be benefited by students according to the knowledge level of the student. The applications of item response theory(IRT) modeling can help to create these tools. Item and scale analysis within the framework of IRT will ensure reliable, valid, and accurate measurement of respondent trait levels. Identification of items that are informative or problematic help investigators to understand the domains they are measuring as well as the populations they measure. Furthermore, there is a need in the education area to standardize the concepts and metrics of knowledge measurement to allow comparisons of results across assessment tools and across diverse populations. Item banking is one method that will place multiple measures on a common metric to allow cross-walking of scores. From the item bank, any number of instruments can be tailor-made to measure the population of interest without the worry of score comparability with other groups that may be taking an alternative assessment developed from the same item bank. On top of that, item banking allows for the development of computerized adaptive tests that reduce respondent burden and increases reliable measurement by using a methodology that targets in on a respondent's true score. So, why are the methodologies of item response theory slow to be adopted into the health care measurement field? Item response theory was developed within the framework of educational testing and so most of the literature and terminology is oriented towards that discipline [9]. A limitation of the modern measurement theory is the complexities of the mathematical IRT models. Most researchers have been trained in classical test theory and are comfortable with reporting statistics such as summed scale scores, proportions correct, and Cronbach's alpha. Beyond the mathematical formulas, there are the complexities of the numerous IRT models themselves as to what circumstances are appropriate to use IRT and which model to use. There is not even a consensus among educators as to the definition of measurement and which IRT models fit that definition. Adding to the burden of confusion, the numerous available IRT software in the market are not user-friendly and often yield different results (parameter and trait estimates) because of the different estimation processes used by the software. Despite these limitations, the practical applications of IRT cannot be ignored. Knowledge of IRT is spreading as more and more classes are being taught within the university disciplines of psychology, education, and public health, and at seminars and conferences throughout the world. Along with this, more books and tutorials are being written on the subject as well as more user-friendly software is being developed. Research applying IRT models are appearing more frequently in health care journals, and much of their concluding comments are directed towards discussing the benefits and limitations of using the methodology in this field. Together, a better understanding of the models and applications of IRT will emerge and IRT will be as commonly used as the methodology of classical test theory. This effort will result in instruments that are shorter, reliable, and targeted towards the population of interest. One further note is that item response theory is only one step towards the goal of the creation of reliable and valid education measures. Hambleton states quite well that IRT is not "the solution to all of our instrument and measurement problems [10]. It is a mathematical model only, and when it can be demonstrated that (1) the model fits the data of interest, (2) model parameters are properly estimated, and (3) the model is used correctly, the model has many useful features. But, none of the IRT models [paraphrased] are magic wands to wave over vague instrument specifications and poorly constructed items to make reliable and valid measurements. Hard and thoughtful work is still required in defining constructs and related domains of content, drafting items to measure the constructs, field testing, test norming, and conducting reliability and validity studies…If these steps are not handled well, bad measurements will follow". However in the sample of this study, best method to determine the item difficulties is obtained as Norm-Referenced Item Analysis as a consequence of taking both item discrimination and item difficulty into consideration. Another important thing is to make data nominal before trying to run any classification method on it. The further work to done on this research starts with questioning the size of item pool. Since the best method to find item difficulties is determined, both midterm and final exam data is going to be classified since they all differ in number of items. These items will be classified and the importance of the size of item pool will be tried to be determined by comparing the classification of items in different pools.

REFERENCES

[1] British Standards Institution (2001). *New exam guidelines to stop the cyber-cheats* [online]. Available: www.bsiglobal.com/Corporate/News+Room/exams.xalter [Accessed August 8, 2003].

[2] Mason, B. J., Patry, M., Bernstein, D. J. (2001). *An examination of the equivalence between non adaptive computer based and traditional testing*. Journal of Educational Computing Research, 24(1), 29–39.

[3] De Angelis, S. (2000). *Equivalency of computer-based and paper-and-pencil testing*. Journal of Allied Health, 29(3), 161–164.

[4] Pritchett, N. (1999). Effective question design. In S. Brown, P. Race, & J. Bull (Eds.), Computer-assisted assessment in higher education. London: Kogan Page.

[5] Lilley, M., Barker, T., Britton, C., (2004). The development and evaluation of a software prototype for computer-adaptive testing. Computers & Education, 43, 109 – 123.

[6] Lilley, M., Barker, T. (2002). The development and evaluation of a computer-adaptive testing application for English language. In Proceedings of the 6th computer-assisted assessment conference. Loughborough University, United Kingdom.

[7] Lilley, M., Barker, T. (2003). An evaluation of a computer-adaptive test in a UK University context. In Proceedings of the 7th computer-assisted assessment conference. Loughborough University, United Kingdom.

[8] Brown, J. D. (1995). *Developing norm-referenced language tests for program-level decision making*. In J. D. Brown & S.O. Yamashita (Eds.). Language Testing in Japan (pp. 40-47). Tokyo: Japan Association for Language Teaching.

[9] Hambleton, R. K., Swaminathan, H. (1985). Item response theory: Principles and applications. Boston: Kluwer-Nijhoff.

[10] Hambleton, R. K. (2000). Emergence of item response modelling in instrument development and data analysis. Medical Care, 38 (9 Supplement), 60-65.

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Course Design for Web-based Blended Learning

Anelly Kremenska

Abstract: *The paper deals with some pedagogical issues raised at the application of the constructivist educational ideology to language courses in web-based blended learning at university level. It presents a description of English for Specific Purposes (ESP) course design at two levels. At the first (macro) level, the goals, indicative content, envisioned outcomes, forms of learning and teaching, and the assessment are described. At the micro level, sample elements of the course corresponding to the model are presented. The course design was realised on the basis of specially developed model, which builds upon constructivist approach to learning and the existing good practices in Bulgarian higher education.*

Key words: *Constructivism, technology-enhanced language learning, web based learning, blended learning, instructional design.*

INTRODUCTION

The VEHICCLE model ("(for Vocational purposes) Electronically enHanced InterCultural Communicative Language Education") [1], is based on the recognition of the changes in both theory and practice of education towards more personal approach to the learners, and setting their skills for lifelong learning and team work for building knowledge. What was considered was a number of papers, which generally support the constructivist pedagogy and describe pedagogical issues, models of e-learning, and course design [2- 7] in different contexts.

This paper focus is on a course design based on the VEHICCLE model which was suggested as a solution for enhanced efficiency of using the existing resources (human, equipment, time) in order to meet the demands for achieving higher quality at a lower cost. The first part of the paper goes in depth to describe the two levels [9] of the design: the macro level (the objectives, learning outcomes, forms of learning and teaching, and assessment) and the micro level (the content of the model elements when applied to the particular course design). The second part of the paper presents the results of a summative course evaluation to measure student attitudes towards the design. The summary of the findings and an outline of the future work comprise the last section.

COURSE DESIGN BASED ON VEHICCLE

VEHICLE defines the components of web-based language learning, thus allowing for transforming existing curricula and materials for online use; based on the best practices [10-15] and established university standards in Bulgaria [16]. The communicative approach to language learning was applied with regards to the communal constructivist paradigm, which is regarded as the one to meet the demands of the complex situation of teaching languages in Bulgarian higher educational context [17, 18]. Based on these results and student suggestions [17], the course design was improved in order to ensure collaboration and exchange of knowledge among the students, and to boost their performance.

Macro Level of VEHICCLE Course Design

The course is compulsory; semester – 1, 2 (first year of education); Specialty Informatics at Faculty of Mathematics and Informatics, Sofia University. The administrative groups consist of 20 students on average; mixed-ability level of proficiency in general English, and no experience in e-learning. The learning process is arranged in 60 hours of face-to-face collaboration in computer labs or traditional seminar rooms, and unlimited collaboration and online support in the virtual learning environment (VLE) Moodle.

The objectives were to help students to understand the possibilities of information and communication technology (ICT) in language learning. The emphasis of the course was on providing students with means of improving their level of English through a personalized approach by combining this study with their computer skills. It focused on developing practical skills in making presentations, summarizing information critically, writing academic papers, introducing the standards for writing academic text in English. It also aimed at raising student awareness on terminology and its use in both spoken and written form. Next dealt with ways in which all these skills and knowledge might be used to enhance professional effectiveness.

The learning outcomes were set towards: awareness on the roles and possibilities of ICT in language learning; competence in ESP (ICT and mathematical terminology); skills: to use Web-based sources of information to study; to make presentations, summarize information, write academic essays; to use English to enhance professional effectiveness.

The indicative content consisted of: Use of the World Wide Web as a language resource, reliability; Principles of using terminology: Glossary of IT and Mathematics terminology; Summary writing; Academic papers: format, plagiarism, citing (standards); Presentations. The forms of learning and teaching were a flexible combination of face-to-face classes and online collaboration (synchronous and asynchronous) on topics and papers (individual and team work, project work). During the seminars the students practiced their productive skills through discussions, comments, glossary compiling, paper writing and formatting. Discussions on various topics were conducted, based on topics from a course book, or suggested by the students themselves, within the general subject of informatics and mathematics. Glossary compiling was introduced as a concept and a task on producing a glossary on a freely chosen topic (connected with mathematics and informatics) was carried out. Students were presented with the pros and cons of using the Internet as a source of information, thus developing soft skills [4] for searching for information and assessing its reliability. They were also guided through the process of academic writing by web-based instructions; through mini projects: to collect and summarise original texts of their own interest and effectively collaborate in task-solving and decision-making. Other practical skills were expressing orally (formal and informal mode, dialogue and monologue), acquired through discussions and presentations.

The assessment was arranged in three categories, related to the goals of the course: oral communicative skills for vocational purposes (presentation) comprise 40%; another 40% depended on the academic writing; and 20% were for class participation (quality postings in the forums to solve the tasks, critical peer-reviews, etc.). The mark followed the widely accepted scheme 81(and above)% - Excellent; 71-80% - Very Good; 61-70% Good; 51-60% - Pass; 50 and less – Fail. Thus the assessment complies with the Bulgarian higher education assessment scheme, and reflects the constructivist idea for criteria-based evaluation. The criteria were established and set in advance, and related to the skill. For example, the set for the presentation were based on the European Common Framework for Languages for speaking: monologue speech (clear and concise flow of speech); dialogue: asking and answering questions on the topic; discussion skills; presentational skills (e.g. body language, voice, eye contact). It is evident, that the assessment was a complex procedure, taking into account the effort and results of development communicative skills, requiring cooperative work and shared responsibility, as well as depending on the peer opinion and participation in the team activities. Therefore, as suggested by the constructivist ideology, what was assessed was not only the result of the learning, but the process of learning as well. Such a system proved to be well-received by the students [19] as giving sense of development and accomplishment, and preparing them for being assessed in their future classes and job-related situations.

Micro-level of VEHICCLE Course Design

The course design based of the communal constructivist approach is a flexible structure; not fixed in advance [20] but rather constantly adapted to the students' needs, background knowledge and skills, and constantly re-designed by the students themselves in order to "create knowledge with and for the others" [21]. Thus the model discussed above can be viewed as scaffolding for the course design, with closely interrelated and interdependent elements. Therefore, the description of the micro-level of the course design follows the elements of the model as identified above [1].

The Module is the main structure of the model describing the process of learning. It contains a number of elements, which may vary in contents and number from module to module, and may describe procedures of different length. For example, the introductory module of the course under discussion contained instructions on how to use the course site/ the VLE, teaching materials to test the main features of the environment, and some immediate feedback and support in order to assist all students to get acquainted with Moodle. The instructions were basically of two types: the first type contained a unit, devoted to a topic (based on a course book; on good practice; or student-generated); and the second – directions on "how-to" concerning the academic paper writing. The flexible list of topics started with classes on Netiquette, Searching Engines, What is information?, which proved to be essential for introducing students to online collaboration, in turn crucial to their effective study in a blended-learning mode. The typical instruction list contained: information on the specific goals of the current class; a brainstorming part – a question to elicit background information on the suggested topic; some collaborative or pair tasks, mainly containing links to materials, available online or from the Repository; homework, or self-directed work (related to creative thinking, other's work assessment, or additional reading); post-activities to share and discuss the results of the homework; suggested further reading links to stimulate deeper investigation on the topic. Normally, the brainstorming was done in a face-to-face communication; the tasks were a mixture of face-to-face communication and collaboration online, ending with a posting in the respective Forum; and the homework and post-activities were a topic for face-to-face or online discussion in dependence on the importance of the topic or the student interest in it.

As a study showed [19], fixed content of the course in the field of information technology terminology were regarded as outdated, thus not interesting for the students. Therefore, the teaching/learning materials were an open collection of previous year's assignments; topic-related lists of links to websites, articles, videos, etc.; and materials, developed or suggested by the students themselves. They could be divided into core materials (such as instructions for the class, with links to basic information on a given topic to be read/ listened to); and additional materials (further reading, presented as a list of links or as tasks for searching for external sources). Examples of teacher-developed core materials are PowerPoint presentations (e.g. "Writing Academic Paper", "Online Dictionaries"); handouts with the instructions and links; a website for the course containing the Repository with all handouts, a calendar, forums, contacts, etc. Different modalities (types of multimedia and available technical solutions) were explored in order to facilitate learning for students with different learning styles and abilities. The accessibility of the materials was ensured by being uploaded to the online Repository (adapted for blind students) and linked to the web-based course. All the materials in the Repository were described in a LOM-compatible interactive template [21], specially developed for the VEHICCLE Model.

The self-assessment was based on different tests, supported by Moodle plug-ins (e.g. a Hot Potatoes close test to fill in terminology discussed during the classes), comments on the teamwork on the assignment, as well as peer-reviews of the postings for the tasks from the instructions.

The feedback and the assessment were commissioned by all students and the teacher/facilitator using all modalities of computer mediated communication. For example, peer-reviews were issued for the task postings in the forums; personal messages and e-mails were sent to the students at different stages of assignment development to suggest changes and improvement. The process of giving and receiving feedback from the peers was rarely monitored, which gave the students the relative freedom to express themselves in a less threatening atmosphere, negotiating meaning and arguing for and against a statement.

The assignment (the academic text and the presentation) is the product of the learning process, and is the other main part of the model [1]. The preparation was partially a classroom activity (especially at the stages of selecting information, and planning the draft), and partially a team or individual work out of class; either way guided and facilitated by instructions. The topics of the assignments were chosen by the students, on the condition that they did not repeat and were in the field of Informatics or Mathematics. The importance and relevance of the topic to the course goals had to be proved. Students also decided who their team would consist of, how to divide the work within the team, and when and where to work. Clear assessment criteria and requirements were set in advance.

All of the elements were situated in the web-based learning environment (Moodle in this case) or linked to it (the course website). The main functions of the online environment were: to inform about the course goals, instructions, topic choice; to make materials and relevant external sources available; to allow for course management, through monitoring and guidance; to provide a calendar for the deadlines and forthcoming course events; to facilitate communication, both synchronous and asynchronous, among the students, and with the lecturer; as well as to ensure feedback and peer-support.

As a whole, the elements of the micro level of the course design were arranged to support the macro level. As made clear during the description above, all stages of the learning process and product development rely heavily on both face-to-face and computer-based communication, as illustrated by VEHICLE. Another important feature of this course communication was that it was purposeful: the target language was used to solve real problems during the team tasks. Thus a student dominated and initiated use of the target language as a medium was ensured.

SUMMATIVE COURSE EVALUATION

In order to pilot the new design, a series of experimental ESP courses were introduced between 2005/2006 and 2008/2009 academic years. The current summative course evaluation is part of continuous investigation aiming at course design improvement [18, 22] and was carried out to collect feedback from the students. The tool used to collect data from the students was a web-based questionnaire, based on the free version of Survey Monkey[5]. The questionnaire consisted of four categories questions: bio-data questions, questions investigating student attitude towards the course design, questions measuring student motivation, and an open question. Due to the limited volume of this paper, this analysis is based on the quantitative questions concerning the course design. The scales used for the closed questions are standard Likert's scales (5 and 7-graded; neutral point at 3 and 4 respectively).

The questionnaire was filled in by 42 of 76 students who completed the course. 30 of the students were male and 11 female; average age 19.75 years. The student perceived level of English was high: 43% declared language competence at C1[6], 40% at B2, and 9.5 % (4 students) at C2. The average participation is between 7 to 10

[5] Available at http://www.surveymonkey.com/

classes (of 12). Completed responses were received by 41 students comparing the web-based course to a traditional one, and 39 concerning the course as a whole.

Table 1 presents the data received to 7 questions. Three of them required comparison between traditional and web-based classes and used a 5-grade scale. It is evident that the students opinion on all three aspects was above the average point, which speaks that they find the web-based course as more interesting, easier to cope with, and more useful with mean values at 3.7, 3.6 and 3.4 respectively. The median cases for the interest and ease score 4, and the 75% case is at 5, which confirms that the students feel much more involved and relaxed during the web-based courses.

Next three questions elicited similar responses: students find the course as a whole very interesting, useful and adequate to their needs. In this wording of the question the usefulness received mean case at 4.5, which is well above the neutral point (4); median at 5 and 75% case at 7, which is slightly higher than the same issue rated in the previous discussion. This can be a sign that the students were not totally convinced as to how useful indeed was the course, although they agree that it was useful.

The last question to discuss here is to what extent students were satisfied with their performance and achievements as a result of the course. It is clear that their confidence was stable and above the neutral point (4), reaching median case value of 4.9 and mean of 5. The 75%case at 7 speaks that most of the students feel positive about their results.

Table 1. Student opinion about the web-base course

In comparison to the traditional classes these are: *(rate from 1 to 5)* **case 1-41**	more interesting	more useful	easier to cope with	**The course was:** *(rate 1 to 7)* **case 1- 39**	very interesting	adequate to my needs	very useful	**I am satisfied with my achievements** *(rate 1 to 7)*
MEAN case	3.7	3.4	3.6	**MEAN case**	4.2	4.3	4.5	4.9
MEDIAN case	4	3	4	**MEDIAN case**	5	4	5	5
75% case	5	4	5	**75% case**	5	5	6	7

CONCLUSIONS AND FUTURE WORK

The course design presented here is an attempt to apply contemporary theory and practice to the Bulgarian higher educational context in the area of language learning. The description is by no means an ultimate solution or recipe for designing ESP courses for blended language learning. Yet, it contains suggestions on how some issues could be dealt with in order to comply with the varied student needs and to make the classes more interesting, useful, and easier for the students, bringing self-confidence to them.

As it was mentioned earlier, this paper discussed the evaluation of the course based on the closed questions about course design only. In order to provide more detailed information and proof of the results further analysis of the collected data on student motivation and the open questions needs to be provided.

REFERENCES

[1] Kremenska, A. VEHICCLE: A Model of Web-based Language Learning. In CompSysTech'08, vol. IV-12, ACMBUL, Sofia. 2008.

[6] According to the Common European Framework of Languages, available at Available at http://www.coe.int/t/dg4/linguistic/CADRE_EN.asp

[2] Kossekova, G. Innovative educational technologies in medical education and research methodology. Book of abstracts, International Conference Pioneers of Bulgarian Mathematics, Sofia, July 8-10, 2006, p.66.

[3] Sendova, E., E. Stefanova, N.van Diepen. Methodology handbook on ICT-enhanced Skills. Faleza, Sofia, 2007.

[4] Stefanova, E., E. Sendova, I. Nikolova. I*Teach Methodology for building enhanced ITC skills. In: 3rd Balkan Conference in Informatics, Sofia, 2007.

[5] Sendova, E., Nikolova, I. (editorial) Innovative Didactics for Web-based Learning (in Bulgarian). CIST at Sofia University, Sofia ISBN: 978-954-92146-4-2, 2008.

[6] Nikolova, I. WWW-based Learning Design and Management: Methodology and Tools (in Bulgarian). PhD Dissertation, Sofia University, Faculty of Mathematics and Informatics, 2000.

[7] Kossekova, G. Web-based Education in Biochemistry (in Bulgarian). Dissertation, Medical University, Sofia, 2004.

[8] Beetham, H. Review: developing e-Learning Models for the JISC Practitioner Communities, 2004. Last accessed on 17th April, 2009 at http://www.jisc.ac.uk/ uploaded_documents/Review%20models.doc

[9] Beam, P. A learning revolution - It's about time! (Online-learning.com), 2000. Last accessed on 13th March, 2006 at http://www.online-learning.com/papers/ articlerev.html

[10] Mason, R. Course Design to Enhance Learning (LTSN Generic Centre). 2003. Last accessed on 15th May, 2006 at http://olkg.cranfield.ac.uk

[11] Center for Instructional Development and Research. University of Washington Seattle. Last accessed on 14th April, 2006 at http://depts.washington.edu/cidrweb/ ConsultationServices.html

[12] City University, London. Guidelines For Developing A Web-Based Course City University. 2005. Last accessed on 15th June, 2006, at http://www.city.ac.uk/ mediadevelopment/e-learning/guidelines/print/printversion.htm

[13] Scott, B. Course Design. On-line Knowledge Learning Garden. Cranfield University. Last accessed on 29th March, 2006 at http://olkg.cranfield.ac.uk/

[14] University of Wisconsin-Milwaukee. Web Course-ware Standards. University of Wisconsin-Milwaukee P.O. Box 413 Milwaukee, WI 53201 (414) 229-1122, 2002. Last accessed on 29th March, 2006 at http://www.uwm.edu/

[15] Peytcheva-Forsyth, R. University Course Design (Дизайн на университетския курс)(in Bulgarian). Sofia University Press, Sofia, 2002.

[16] Kremenska, A. ICT in Language Education: Practice and Perspectives (in Bulgarian). A collection of scientific articles "Of Human and of Language", pp. 623-639. Sofia University Press, Sofia, 2007.

[17] Peytcheva-Forsyth, R. E-Learning: theory, practice, aspects of the design (in Bulgarian). Publishing House "Daniela Ubenova". Sofia, 2009.

[18] Kremenska, A. Measuring Student Attitudes to Computer Assisted Language Learning. In CompSysTech'07, vol. IV-5, ACMBUL, Sofia, 2007.

[19] Shopov, T. Foreign Language Teaching Methodology (in Bulgarian). Sofia University Press, Sofia, 2002.

[20] Holmes, B., Tangney, B., FitzGibbon, A., Savage, T., Mehan,S. Communal Constructivism: Students constructing learning for as well as with others. Tech-reports, Trinity College Dublin, 2001. Last accessed on 10thApril, 2009 at https://www.cs.tcd.ie/ publications/tech-reports/reports.01/TCD-CS-2001-04.pdf

[21] Kremenska, A. E-Learning for Language Education: A Template for Educational Objects (in Bulgarian). Conference proceedings "120 Years Pedagogy at Sofia University", pp. 346-353. Sofia University Press, 2008.

[22] Kremenska, A. Investigating Student Readiness for Computer Assisted Language Learning. In CompSysTech'08, vol. IV-13, ACMBUL, Sofia, 2008.

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Knowledge and Skills of the Teachers, Necessary for Ensuring the Effectiveness of e-Learning

Mariyana Nikolova, Margarita Todorova, Donika Valcheva

Abstract: *The main goal of the report is to present the necessary knowledge and skills for applying the ICT, which the modern teachers working in all the educational levels have to possess, in order to apply these innovative technologies directly in the teaching process. The existing e-learning technologies and their application in the different educational levels are presented.*
Keywords: *education, teachers, computer knowledge and skills, integration of information and communication technologies, ensuring the effectiveness of e-learning*

INTRODUCTION

The term "technology in the education" is extended and this finds an impression in the direction of the system analysis and the teaching process projection with the tools of the information and communication technologies. To the modern pedagogical science is set the actual task to educate and prepare the rising generation in order actively to participate in the new stage of the society development, related with the automated process.

A lot of research work about the effectiveness of e-learning has been made the last few years. One of the reasons for this is that the implementation and usage of the e-learning systems and applications requires large investments of time and money.

The term "effectiveness of e-learning" is abstract and there are a lot of definitions, which differentiate from each other mostly because they offer various factors for its defining and assessment.

In this report we accept the following concept - the effectiveness of the e-learning in the modern education can be guaranteed if all the components in this process (teachers, students and software developers) possess the necessary characteristic, knowledge and skills.

The five fundamental aspects of e-learning are organizational, technological, curriculum design, instructional design, and course delivery (delivery system). The different delivery systems have various methods for date collection.

By the usage of e-learning technologies, the exchange of the information is realized in a higher degree. This lets to some requirements for the teachers and students and undertakes shared responsibilities in the process of teaching and training. In order the potential of these innovative technologies to be used in the most appropriate way, some competencies for working with them are necessary.

Some of the success factors for e-learning are leadership issues and competent, knowledge and skills of the teachers, necessary for ensuring the effectiveness of e-learning. It is crucial to include the staff in the changing processes in education. It is also important to appreciate the motivation of learners.

The goal of the report is to define the necessary basic and specific skills and competencies of the teachers in using e-learning technologies and their usage in the different educational levels.

BASIC, SPECIFIC AND DIDACTIDAL COMPETENCES, KNOWLEDGE AND SKILLS OF THE TEACHERS FOR ENSURING THE EFFECTIVENESS OF E-LEARNING

■ Teachers' basic competences, knowledge and skills

The teacher plays a key role in the development and management of the teaching process using ICT. The main difference between the electronic form of teaching and the traditional one is the transformation of the didactical approach "teaching by narration" into teaching, orientated towards the students.

The application of the e-learning technologies can be discussed in two aspects: firstly the educational practices, which are orientated towards applying the interactive multimedia in order to present more attractively the teaching content and secondly the web-based forms of didactical materials and tools and their implementation as interactive multimedia projects. Figure1 shows the existing e-learning technologies and their application in the different educational levels.

For the right apply of the modern ICT like e-learning in the teaching and learning programs, didactical criteria for their applying have to be involved:

- **Effectiveness and expedience.** An important aspect in applying the e-learning technologies in the education is their effectiveness and expedience. The teachers have to be able to access and use the e-learning tools.
- **Pedagogic competence** The pedagogic competence is defined from the teaching content, the concrete didactical goals and the age of the trainees. The usage of the ICT have to be implemented from the teacher of the concrete disciplines, who must know when, where and how to apply them in his daily work.

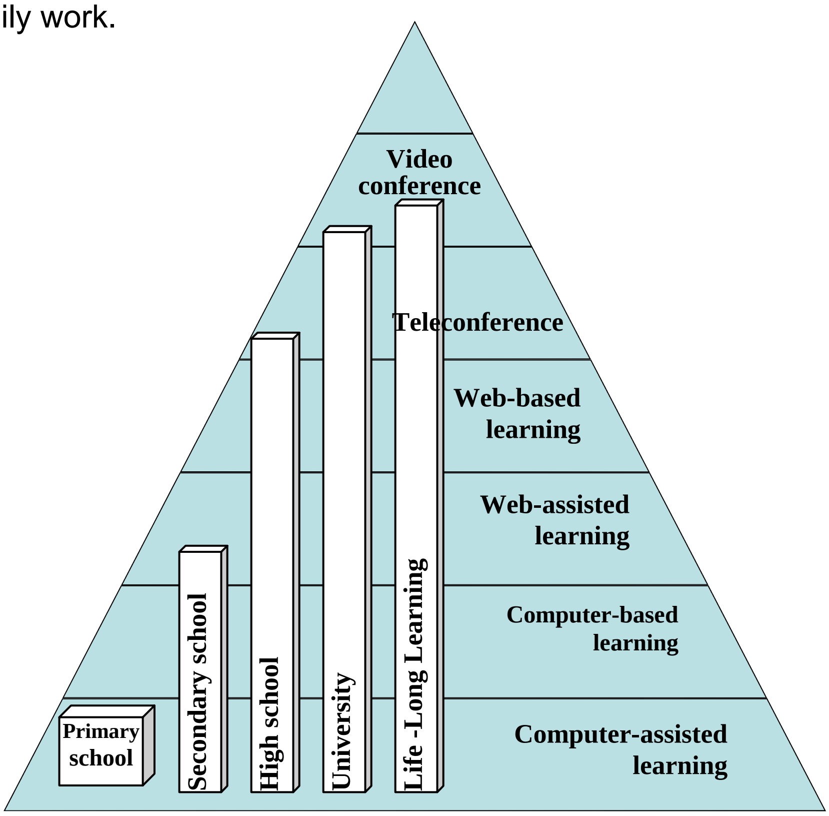

Fig.1. The e-learning technologies and their usage in the different education levels

The necessary competences knowledge and skills, which the teachers needs, in order to use the e-learning technologies in the different education levels are:

- **Basic knowledge and skills for working with a multimedia computer system, which are necessary in** computer-assisted learning and computer-based learning;
- **Basic knowledge and skills for working with the Web environment, which are necessary in** Web-based learning, Web-assisted learning, Teleconference, Videoconference.

Basic knowledge and skills for working with a multimedia computer system are [4]:

✓ Fundamental knowledge about the advantages of the ICT integration in the teaching process;

- ✓ Knowledge about the methods and tools for data accumulation, preservation and operation;
- ✓ Knowledge about the computer system organization – technical equipment and work principles;
- ✓ Knowledge about the basic peripheral devices, which are part of the modern multimedia computer configuration;
- ✓ Knowledge and skills for applying the program tools, which maintain the computer system;
- ✓ Knowledge about the potentiality of the software applications, with common purpose for text processing, creation and processing of graphical images and electronic tables;
- ✓ Skills for developing presentations with teaching content;
- ✓ Skills for applying the basic ways for communication and data searching in the Internet environment

Basic knowledge and skills for working with the Web environment are:

- ✓ Capabilities for working in a visual environment;
- ✓ Knowledge about the current electronic tools with teaching content and skills for applying them in their daily work;
- ✓ Knowledge about the program environments for development of Web-based applications and skills to prepare such materials;
- ✓ Knowledge about the potentiality of the electronic devices for communication in real time;
- ✓ Skills for knowledge transfer.

- ■ **Teachers' specific knowledge and skills**

The usage of technical tools and electronic forms in the teaching process require additional skills that the teachers have to possess [4]:

- ✓ To organize and manage the electronic course (e-course);
- ✓ To orientate the trainers in the teaching process;
- ✓ To give clear instructions, if it is necessary, how the technical tools can be used more efficiently;
- ✓ To encourage the students' cooperation and participation in the discussions and teamwork;
- ✓ To ask questions and point the accents;

The modern e-learning technologies may be used for solving some problems and difficulties in the traditional way of teaching. In order the ICT to be used successfully in the teaching process, **the teachers have to know**:

- ✓ The appropriate technical equipment and the basic program tools for maintenance of the computer system; the potentiality of the software applications, with common purpose, creation and processing of graphical images and electronic tables;
- ✓ The potentiality of the software applications, with common purpose for development of presentation materials with teaching content;
- ✓ The basic ways for communication and data searching in the Internet environment and the current electronic tools with teaching content; program environments for uploading in Internet Web-based materials;

The teachers' qualification includes not only perfect knowledge about the teaching matter, but also such skills as adaptability, mobility, communication ability and technical literacy. These skills can be elaborated and expanded by self-learning, qualification courses and distance learning.

The work with computer and the skills to use the information and communication technologies in a concrete professional sphere is a very important qualification. The basic computer knowledge and skills can be obtained from: the school and the university, self-teaching, specialized qualification courses for applying the ICT in the teaching process, other ways.

Some of the serious disadvantages of this qualification process are the following:

- ✓ For the teachers with a long practice teaching it is difficult to adapt to the technical system and the new information environment;
- ✓ The trainers sometimes are not very good specific qualified (pedagogical and technological);
- ✓ The groups of the trainees are formed without a serious examination for their preliminary computer skills and knowledge.

The principle for mastering the knowledge in the field of computer and communication technologies in the direction of workability of this knowledge in the profession of the future pedagogues is applied in the continuous actualization of the school plans and programs in the computer university disciplines [2]. The motivation and the requirements of the students (future pedagogues) are the most important factor for their mastering in that area. From one side are the disciplines, giving the necessary knowledge and skills for working in a computer-communication environment and applied software as an instrument for automation of the information activities and on other side are the disciplines, related with the usage of specialized program platforms as a teaching tool that will be applied for their future work. This, in the maximum rate, regulates the workability and the effectiveness of the teaching process in the different specialties [7].

The future pedagogues should be taught to use the different program tools in concrete activities and aspects. The types of the program tools that may have place in the school schedule in the school, according to their functional purpose are:

- ✓ **Pedagogical** program tools (applied programs), intended to present the course material and to manage the teaching process;
- ✓ **Diagnostic, testing programs**, that aim at finding the reasons for the wrong behavior of the students, assessment of their knowledge, skills, determination of the level of their preparation and the level of their intellectual development;
- ✓ **Instrumental program tools** – for constructing program tools with teaching purpose, preparation and generation of methodical and organizational materials, creating graphic, sounds, etc.
- ✓ **Subject-oriented environments** – for modeling the studied objects and their relation in a program environment.
- ✓ **Program tools for atomization** for processing the scientific experiment results.
- ✓ **Management program tools –** their aim is to manage real objects (for example robots' activities)
- ✓ **Program game environments –** for cognitive activities by different types of games with computer.

The necessity of lifelong qualification makes every person, including the teacher, student till the end of his life.

■ Didactical aspects necessary for ensuring the effectiveness of e-learning

By applying the e-learning in the education is ensured flexibility – adapting to different situations, needs, etc. and accessibilities – opportunity to study in any moment and in any time. It is necessary the content and the tools for teaching and understanding to be deeply taken into consideration, in order the most effective way for the concrete theme and subject to be applied [1], [6].

Before the usage of the computer and their potentiality in a proper way, the teachers have to transform the technique in convenience, in order to be appropriate teaching tool. The instructors have to be free to define what is important and how to apply it in their work and creatively to combine the classical with the new tools and forms of the education [5].

The aim of the disciplines, related with the use of e-learning as a teaching tool is not only the technical knowledge and skills for working with the program teaching platforms, but also they have for an object to convince the teachers, to motivate them and to show them the advantages and the necessity from the modern tools and forms of education

The basic aspects in using the ICT in the education are:

- **Directly in the teaching and learning process –** when new knowledge have to be presented, also when practice and control of the results from the teaching process have to be implemented. The usage of ICT directly in the school process makes them an instrument, by which it is taught and the students can learn. This is more and more observed as a practice in the class, because the teachers realize the great effect and the advantages of this practice
- **For self-learning** by realization of the potentiality of the ICT in the learning systems.
- **For distance learning** by using the tools of the Internet technologies.
- **For preparation of course materials -** by the usage of object-oriented program tools and software platforms (specialized applied software or with common purpose) for preparing different course materials and subsidiary documents with the aim to form school activity culture from the side of the teachers and directed to the students.

Didactical parameters and indicators of the e-learning courses

In order the necessary knowledge and skills to be successfully overcome and the goals of the e-learning courses to be reached, a very professionally structure has to be developed. This structure has to be developed according to the following parameters and indicators – Figure 2:

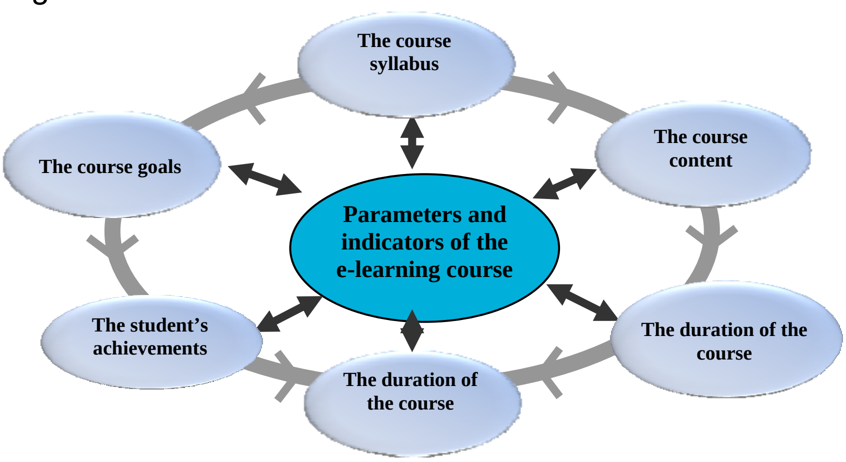

Fig.2. Parameters and indicators for ensuring the effectiveness of the e-learning courses

- **The course structure** has to be actual, in accordance with the needs and capabilities of the students
- **The course content** has to be defined before the teaching process itself and after an analysis of the specific features of the students (specialty, qualification, level of the knowledge and skills in the field of the computer science and technologies); the application of the computer systems and technologies in the concrete professional environment, as well as of the concrete problems, that this study must be able to solve. The analysis have to distinguish the concepts "must know" and "it will be better to have knowledge about…" This content has to define the concrete knowledge, skills and habits that the students are required to have, after finishing the course.

- **The course goals** have to be clearly defined.
- **The student's achievements** are based on concrete knowledge and skills. The students have to be assessed according to preliminary determined standards.
- **The duration of the course** has to be flexible;
- **Personalized teaching** - the tools for self-teaching help the students to study according to their capabilities and free time, to choose the form and the way of providing the material on the basis of their needs. When the student reaches the goals of the current stage of the teaching process, he has to be directed to the next stage.

CONCLUSIONS AND FUTURE WORK

The effective use of the computer in all the levels of the education and training is subjected to the teachers, and this depends on their computer skills and confidence in the usefulness in using the new technologies in the school process. This process has to be adequate and dynamic and the results have to be continuously assessed, in order the tools to be improved.

An object of this report is the necessary knowledge and skills, which the teachers have to have, in order to use the e-learning in the different educational levels and also the ways for this knowledge acquiring.

Contributions of this report are: the concrete knowledge and skills for applying the ICT, which the modern teachers working in all the educational levels have to possess, in order to apply these innovative technologies directly in the teaching process; concrete didactical parameters and indicators for structuring effective e-learning courses are pointed.

REFERENCES

[1] Christensen Roland C., TEACHING AND THE CASE METHOD, 1997, Boston, Massachusetts

[2] Linn, Marcia C., COMPUTERS, TEACHERS, PEERS – Science Learning Partners, Lawrence Erlbaum Associates, Ins., Publishers, LB1585.3.L56 2000,

[3] Todorova M., Nikolova M., "Professionals Profiles as Users of Information and Communication Technologies", Granada, 2006

[4] Todorova M., Nikolova M., Valcheva D., "Collaborative learning trough multimedia interaction" International conference E-learning conference `06, Coimbra, Portugal, 09.2006

[5] Todorova, M., G. Todorov. Efficiency of Virtual Learning. International Conference SAER – 2004

[6] Hughes, J. A Framework for the Evaluation of E-Learning. Available from http://www.theknownet.com/ict_smes_seminars/papers/Hughes_Attwell.html

[7] Hall, John. Assessing Learning Management Systems Available from http://www.clomedia.com/content

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Framework for application of innovative network technologies in building of Learning Support Environment

Valentina Petrova, Margarita Todorova

Abstract: *This paper presents a description of the ADO.NET Data Services Architecture and a Framework for application of network technologies and standards for e-learning. The developed framework may apply more generally in architecture for distribution systems and particularly for building of learning support systems. The framework includes a model for describing, structuring, organizing, and personalizing the learning objects located in LSE based on the standards and specifications for LMS.*

Key words: *ADO.NET Data Services, learning objects, LSE*

INTRODUCTION

The present research starts its developing from the concepts and principles of the innovative network technologies in the field of Internet programming as well as their current directions.

There has been published little work on the use of .NET technologies for Learning Support Environment (LSE). That's why the authors see major advantages in using network technologies as data services.

The purpose of the report is to offer a smart framework that interweaves key network technologies of Microsoft with the standards and specifications of Learning Management System (LMS), as Sharable Content Object Reference Model (SCORM), IMS Content Packaging, IEEE Learning Object Metadata (LOM), and Instructional Design Theory.

These standards need supplements in order to apply instructional design theory and personalized access to learning objects, which are achieved by the framework and program realization in LSE enclosed in the present report.

Applications demonstrated avoid the clumsiness of most of LMS built by very complicated software modules thanks to application of the ADO.NET Data Services architecture and concentrating the whole content in Learning Repository realized through Microsoft SQL Server.

DESCRIPTION OF THE ADO.NET DATA SERVICES ARCHITECTURE

ADO.NET Data Services represents architecture that uses Representational State Transfer (REST) - style web services and provides architecture for consummating of resources in Entity Data Model through URI and relevant program code.

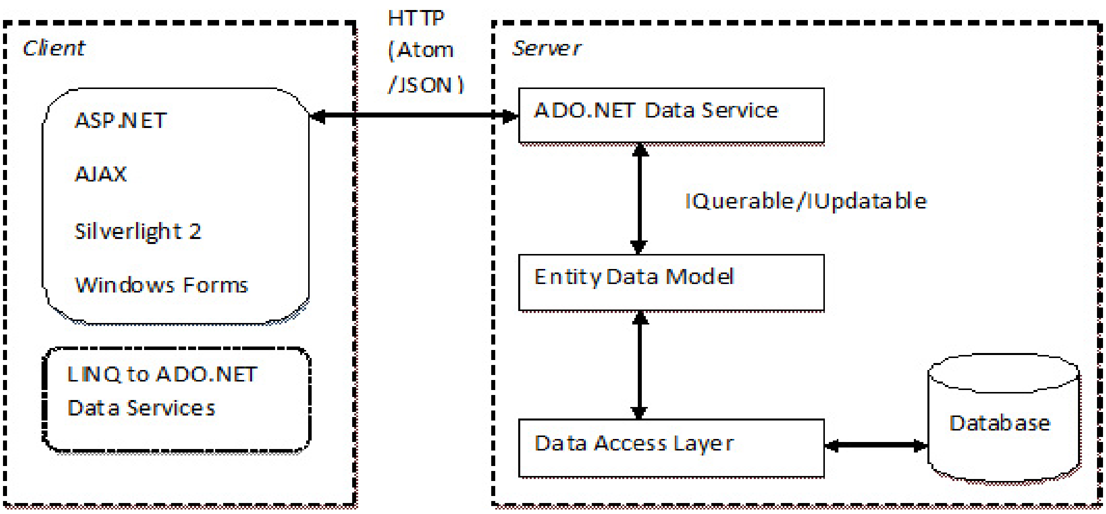

Fig.1 ADO.NET Data Services Architecture

The System.Data.Services.Client library provides clients' application with possibility of execution of Language INtegrated Query (LINQ) requests and to preserve changes in Learning Repository (Database) through ADO.NET Data Services.

Services use the ATOM and JSON formats for data representation. Services use URIs for location of the data.

ADO.NET Data Services provides the architecture to consume resources and map them into entities, expose an entire entity model via URIs, and customize the services by adding specialized service operations and the means to intercept service calls and perform business rules [4].

ASP.NET and Web services have been used in the initial application of the model for describing, structuring, and organizing the learning objects.

REST services differ from SOAP web services in that they use the HTTP verbs and the URI to describe the service operations (what a service can do). Therefore, REST services have no need for a WSDL to describe service operations. REST services use the verbs of HTTP to describe the action of the message in terms of Create, Read, Update, and Delete (CRUD) semantics [6].

Web services use approaches limiting the application of the new Model for describing, structuring, organizing, and personalizing the learning objects. Due to the specified reason the model is accomplished by applying the ADO.NET Data Services, ASP.NET 3.5 and Silverlight 2 technologies, and C#.

Some of the benefits realized from their experience are noted below:

- To promote reuse the developer has purposely not included any user interface (UI) components in the data services project. It is best practice to follow this approach and separate the UI and data services into their own projects.

This enables the data service to be easily consumed by multiple user interfaces such as .NET clients, Silverlight, and ASP.NET AJAX clients [6].

- The LearningObjects.svc data service that the authors create in these scenarios can be consumed by various clients.
- ADO.NET Data Services takes the best features of RESTful-style web services and makes them easier to implement over an entity model, and it provides features to account for authorization, business logic, and custom service operations [4].
- ADO.NET Data Services supports multiple data formats.

FRAMEWORK FOR THE APPLICATION OF NETWORK TECHNOLOGIES AND STANDARDS FOR E-LEARNING IN BUILDING OF LEARNING SUPPORT ENVIRONMENT

Framework includes architecture for distributed systems and particularly for building of learning support system and model for describing, structuring, organizing, and personalizing the learning objects.

The architecture includes the following layers:

- Clients' application built through the Microsoft ASP.NET 3.5 and Silverlight 2 technologies
- Server application realizing data services through ADO.NET Data Services
- Database presented by Microsoft SQL Server

The software application of the framework has been achieved on Microsoft Windows Vista SP1, IIS 6.0/7.0, Visual Studio 2008 SP1, C#, SQL Server Express Edition, LINQ to ADO.NET Data Services, Microsoft .NET Framework 3.5 SP1, ASP.NET 3.5, Silverlight 2, Internet Explorer, and Fiddler2. ADO.NET Data Services is part of the ADO.NET 3.5 Service Pack 1 that resides in Visual Studio 2008 SP1.

Development of the RESTful service LearningObjects.svc includes the following stages:

1. Development of Entity Data Model (EDM) - LearningRepositoryModel.edmx based on the LearningObjectsRepository.mdf database.

The Entity Data Model - LearningRepositoryModel.edmx, shown in Figure 2, exposes some of the tables and entity relationships in the LearningObjectsRepository.mdf database. The association stage of entities is illustrated in the following figure:

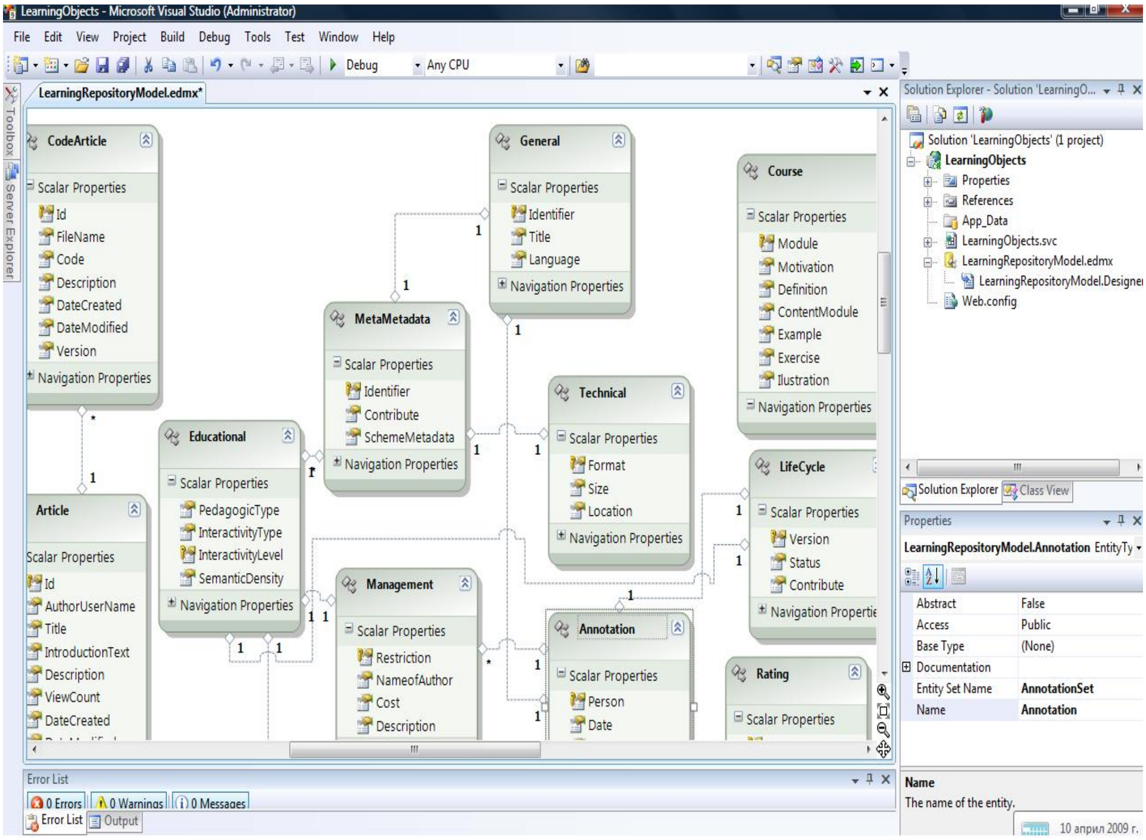

Fig.2 Learning Repository Model

All the tables and views have been mapped to strongly-typed objects.

The major benefit of EDM is to enable a developer to design an object-oriented system from the perspective of objects.

Access to an entity data model is made through ADO.NET Data Services to perform Create, Read, Update, and Delete (CRUD) operations, paging, and sorting, and to handle change tracking, implement transactions, and handle eager and delayed loading.

The magic of the EDM approach occurs with a set of XML documents that declaratively defines entities and how they map to the physical database.

2. Realization of connection of the service with the entity data model

It is executed as the service class inherit from DataService< LearningObjectsRepositoryEntities>, where LearningObjectsRepositoryEntities is the object context for the Entity Framework - generated model.

3. Access to the resources in EDM

When the developer specifies the security permissions, he/she has the option to change read/write security settings for individual entity sets that are exposed [6]. For this purpose the InitializeService method is used in the file LearningObjects.svc.cs

4. Testing the service with the help of IE.

5. Using the services by LSE created on ASP.NET and Silverlight 2.

Silverlight 2 and ASP.NET applications can issue LINQ queries to communicate with data service.

The home page of the data service lists all the entity sets that are exposed by it as shown in Figure 3:

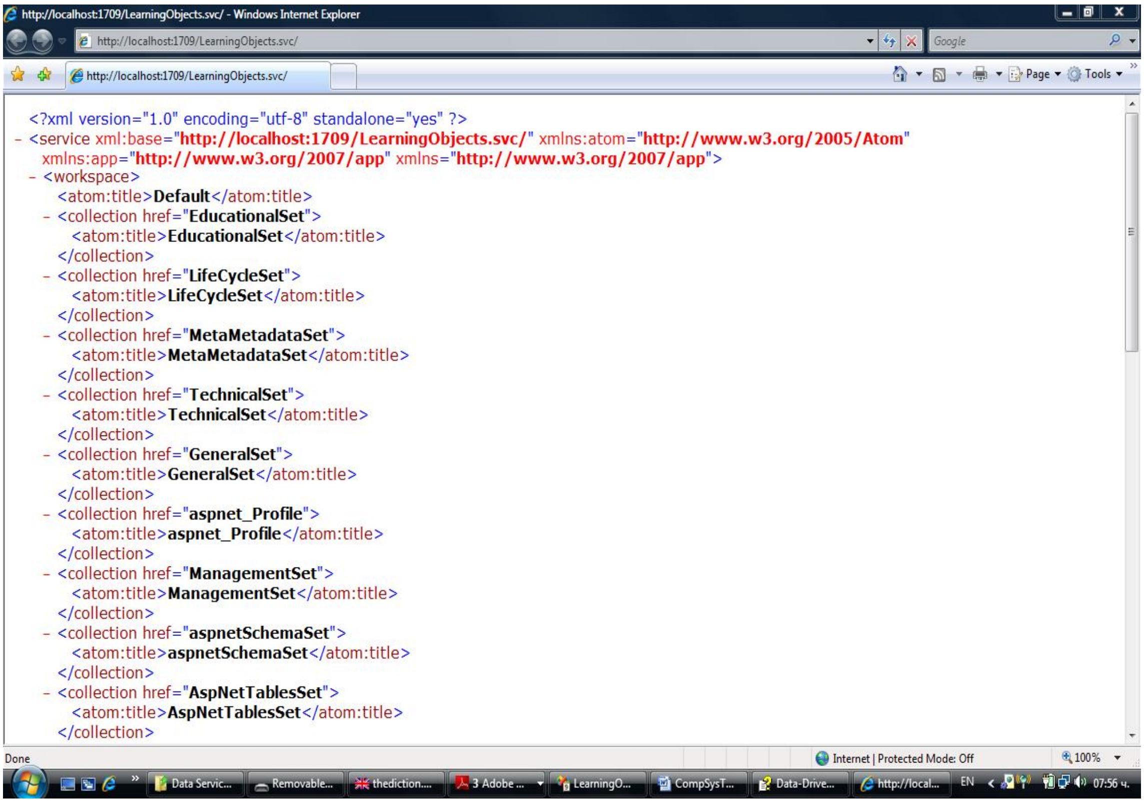

Fig.3 Using the service by LSE

The following types of resources are addressable in the ADO.NET Data Services protocol: Entity sets represent either an EntitySet or an AssociationSet. An EntitySet is a collection of instances of entity type**.** A relationship between entities is defined as an AssociationType [4].

An EntityType represents a useful element of data in the LSE, such as a CodeArticle, Article, Course, metaMetadata, Educational, LifeCycle, Rating, etc.

MODEL FOR DESCRIBING, STRUCTURING, ORGANIZING, AND PERSONALIZING THE LEARNING OBJECTS

The basic principles for LSE development have been presented in the following modules of the model:

Module 1: Contents module

The contents module is the module of physical content organisation.

In conformity with the IMS Contents Packaging Information Model [8] the text files, the multimedia files, and all other physical files which can be used in a single learning environment are a combination of means defined as "contents".

Module 2: Content package

The content package is an independent element of a LSE comprising a learning object suitably annotated by metadata and a manifest.

Its structure and organization allows the multiple use of the separate elements forming the learning object as well as their use in other learning objects.

The learning object is a learning resource that can be used for a unit of e-learning.

The common names for units of e-learning are: course, module, lesson, topic or learning content (multimedia content, instructional content, etc.)

Every learning object has an associated metadata record.

The metadata are used for describing the learning object and its characteristics in particular. The metadata also describe the elements included in the learning objects and their relations and give classified information of their status. For this purpose, Learning

Object Metadata Standard [9] offered nine categories: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation, and classification.

They are suitable for searching the learning objects in the database LearningObjectRepository.mdf of the server and the access to the Learning Repository is made through ADO.NET Data Service - LearningObjects.svc.

The manifest of each content package include the necessary information for defining adaptation rules which determine how learning objects should be selected for different learner profiles [5].

In conformity with the IMS Contents Packaging Specification [8] the content package in the environment includes two components – an XML file describing the course structure and the physical files forming the course structure.

Applying the new network technologies and particularly ADO.NET Data Services, ASP.NET, and Silverlight 2 the authors offer a new solution, in which learning objects and meta content will be presented in tables in MS SQL Server.

Module 3: Personalization module

The personalization module constitutes collection of adaptation techniques that are intended to tailor a course for the individual learner. The intention is to optimize adaptive selection of alternative course material and characteristics/requirements.

Based on the selected learning design, which is essentially a hierarchy of learning activities, the module is able to bind specific learning objects to each activity using information from the learner's profile and it builds an intermediate representation of the learning experience [1].

The learning activity is a meaningful unit of instruction that provides a learning object to the learner or several sub-activities.

The sequence of launched content objects, for a given learner and content structure, provides a unique learning experience (learner interaction with content objects) [7].

The navigation rules define how different learning objects are selected for different learners and specify the matching between the learner profiles and learning content [5].

The module guides the construction of adaptive learning experiences and allows for the binding of appropriate learning resources at run-time according to the learner profiles. Representation of the course concepts and their semantic relations separated from the physical content allow for the binding of appropriate learning objects to the learning scenarios at run-time.

Module 4: Instructional design[11]

The existing standards and specifications offer rules which do not follow any specific strategy of study. Therefore, the authors have used the instructional design theory.

Following this theory the following key processes for study using the Internet can be specified included in the learning support environment.

Modelling – the user is enabled to follow the accomplishment of a particular task step by step using the offered multimedia application in the environment, which facilitates the process of explanation and modelling.

Scaffolding and fading – these are learning technologies, where the assistance given by the environment slowly reduces and the responsibility of the user for developing an independent software application increases.

Articulation and reflection – the users need an analysis of their actions. One of the advantages of the developed learning environment is the possibility to record current activities and results for a subsequent analysis. After the user has mastered the respective course subjects, he/she is given "graded" tests for examining the acquired knowledge.

CONCLUSIONS AND FUTURE WORK

Analyzing the most promising network technologies and the existing standards and specifications for the development of learning environments the report authors have achieved the framework development and have explained its application for the development of a single LSE.

In order to understand and reduce the complexity of the e-learning process, data storage, and application logic, the authors of the report propose the focus of the framework to be ADO.NET Data Services representing RESTful data.

Applying the new network technologies and particularly ADO.NET Data Services, ASP.NET 3.5 and Silverlight 2, the authors offers a new solution, in which learning objects and meta contents shall be presented in tables in MS SQL Server.

The personalized web-based environment allows execution of publishing, search, exchange and multiple uses of the learning objects. Each learner has access to the material that meets his requirements, interests and skills.

One of the most important advantages of the developed environment is that the user interface and data services are realized in independent projects in order to be possible different user interfaces to be used in case of future changes in the environment the adoption of another type of interface to be easier.

Proposed realization of the framework may be applied in its entirety or partially in learning support environments that may be adjusted by the teachers themselves without the interference of development teams.

REFERENCES

[1] Arapi, P., N. Moumoutzis, M. Mylonakis, G. Stylianakis, G. Theodorakis, S. Christodoulakis. Design, Implementation and Experimental Evaluation of a Pedagogy-Driven Framework to Support Personalized Learning Experiences.- Cross-Media and Personalized Learning Applications with Intelligent Content: Second LOGOS Open Workshop. Varna, 2008.

[2] Dayley, B., L. Dayley. Silverlight™ 2 Bible. Indianapolis, Indiana: Wiley, 2008.

[3] Mayo, J. C# 3.0 Unleashed with the .NET Framework 3.5. USA: SAMS, 2008.

[4] Papa, J. Data-Driven Services with Silverlight 2, 1st Edition. USA: O'Reilly, 2009.

[5] Sampson, D., C. Karagiannidis, F. Cardinali. An architecture for Web-based e-learning promoting re-usable adaptive educational e-content. Educational Technology & Society 5(4), 2002.

[6] Shaw, J., S. Evans. Pro ADO.NET Data Services: Working with RESTful Data. New York: Apress, 2009.

[7] http://www.adlnet.org/

[8] IMS Instructional Management System project,http://www.imsproject.org/

[9] http://ltsc.ieee.org/wg12/

[10] http://msdn.microsoft.com

[11] Petrova, V. Main tools for Learning Support Environment development. CompSysTech2005, Varna, 2005.

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Organization of Distributed Learning Environment Modeling by using Petri Nets

Radi Romansky, Elena Parvanova

Abstract: *The distributed learning is a model that permits to the different components of the learning process to be situated in the different places of the Internet based educational environment. This assumes distributed access to remote learning resources and using different information blocks from the nodes. In this reason the architectural design of such distributed learning environment (DLE) requires to build an adequate conceptual model and to organize an investigation of the information service by using formalization and modeling. The paper presents the initial phases in a DLE investigation by using the deterministic apparatus of Petri Nets. The modelling organization includes a resources and processes formalization and designing of basic model primitives for a DLE general model realization.*

Key words: *e-Learning, Distributed Learning, Distributed Information Servicing, Formalization, Discrete Model, Petri Nets.*

1. INTRODUCTION

The global Information Society is organized by different information resources and activities and the e-learning (as a part of the European e-governance) is an important component [1]. In this reason the distributed learning (DL) unites the principles of e-learning and networking and M. Bowman write in [2]: "Distributed learning is not just a new term to replace the other 'DL', distance learning… Distributed learning is an instructional model that allows instructor, students, and content to be located in different, noncentralized locations so that instruction and learning occurs independent of time and place." The distributed approach permits to use the contemporary concepts for semantic Web as ontology in the e-learning scenarios, building the networks for educational media exchange, personalized access to the distributed information resources, intelligent systems, etc.

The model of DL is connected with the concept of distributed and common-used informational resources in a heterogeneous environment with local management. In this reason the design of such distributed learning environment (DLE) requires to build an adequate conceptual model [3] and previously investigation based on formalization and modeling of the processes of information servicing. This will increase the effectiveness of the architectural and software design [4, 5] and it has different methods and tools for modeling and investigation of information processes. The information servicing in the DLE could be regarded as a sequence of events that each of them could be realized if a set of conditions is executed. This approach permits to use the discrete apparatus of the Petri Nets (PNs) [5, 6].

The paper presents the initial phases in a DLE investigation by PN model connected with modeling organization. In this reason a formalization of DLE components and processes of the information servicing is given. This formalization is based on proposed conceptual model and is used as a basis for model primitives designing. These basic models permit to build a general PN model of DLE for its deterministic investigation.

2. FORMALIZATION OF INFORMATION SERVICING BY USING PETRI NETS

A conceptual model for organization of DLE is proposed in [3] and a generalized scheme is shown in fig. 1. DLE is planned as a multi-user and interactive environment for knowledge presentation in the area of 3D simulation and virtual reality organization. Each 3D simulation will be executed on the server and will be visualised by the client browser. The access to the learning resources could be realized from different remote nodes by communication resources of Internet. The main components defined in this conceptual model are users, information learning resources and communication medium. All these components could be described as discrete independent units with internal structure and own functionality. This permits to use the deterministic apparatus of Petri Nets for organization of DLE modeling and previous formalization.

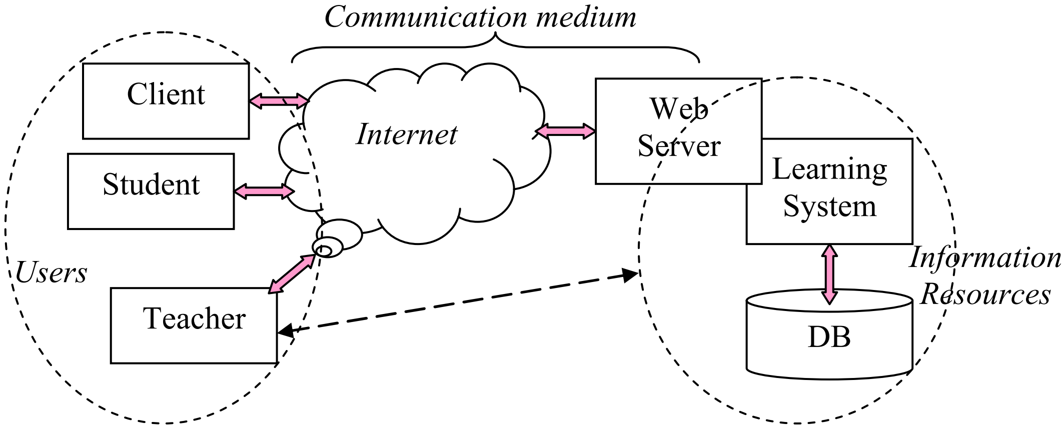

Fig.1. Generalized scheme of DLE

The modeling by using PNs is connected with presentation of the investigated process or object as a sequence of events, named transactions that could be activated if connected conditions (presented by marked places) are realized. Each PN-model could be defined as an ordered triple $PN = (P, T, F)$, where: $P = \{p_1, p_2, \ldots, p_m\}$ – set of places; $T = \{t_1, t_2, \ldots, t_n\}$ – set of transactions; $F \subseteq (P\times T)\cup(T\times P)$ – set of relations (set of arcs). The sets P and T are final sets ($m\geq 0$, $n\geq 0$, $P\cap T=\varnothing$). The set F includes ordered couples (p_i, t_j) that define relations $P\rightarrow T$ and $T\rightarrow P$, and two functions are constructed – $I,O \in \mathbf{N}^{|P|\times|T|}$, named input and output functions.

The extended PN definition $PN = (P, T, F, W, \mu_0)$ includes two additional elements: W:$F\rightarrow\{1,2,3,\ldots\}$ – weight function for each arc and μ_0:$P \rightarrow\{0,1,2,3,\ldots\}$ – initial marking for PN execution starting.

The matrix approach permits to define the PN by using two matrix: $\mathbf{D}^-$ – input matrix (present the input places for each transaction) and $\mathbf{D}^+$ – output matrix (present the output places for the each transaction): $\mathbf{D}^-[j, i] =\eta(p_i, I(t_j))$; $\forall\ p_i \in P$; j=1÷m and $\mathbf{D}^+[j, i] =\eta(p_i, O(t_j))$; $\forall\ p_i \in P$; j=1÷n. The definition $PN = (P, T, \mathbf{D}^-, \mathbf{D}^+)$ permits to present each transaction t_j as a vector $e[j]$ with n elements that all of them are 0, but only element „j" is 1.

The defined PN could be described as a directed multi-graph that functions I and O are presented by arcs between places (rings) and transactions (rectangle or segment). The modeling by using PN is based on execution of marked net that each position has an integer count of marks $k\geq 0$ that could be changed during the PN evolution $\mu_0\rightarrow\mu_1\rightarrow\mu_2\rightarrow\ldots$.

The main information processes in DLE are connected with remote access to the distributed learning resources, transmission of these informational objects through the network medium and using the information by active users. In this reason, the following groups of basic component are defined after the formalization:

- ✓ $U = \{U_i / i = 1 \div N\}$, $U\neq\varnothing$ (Users) – realize a remote access to learning contents in different DLE nodes by requests to the information resources $req: U_i \xrightarrow{T_q} R_j$, for $\forall U_i \in U; \forall R_j \in R$;
- ✓ $R = \{R_j / j = 1 \div M\}$, $R\neq\varnothing$ (Resources) – present the learning contents as an information objects (blocks) $Inf: R_j \xrightarrow{T_q} U_i$ (for $\forall U_i \in U; \forall R_j \in R$) and/or other means, situated in the separate nodes of the DLE permitting multi-user access.

✓ $T=\{T_q\,/\,q=1\div K\}$, $T\neq\varnothing$ (Transmitters) – network technical and technological tools for information object transmission trough the communication medium of the DLE;

✓ Distributor (D) – it distributes and routs all requests $req:U_i\xrightarrow{T_q}R_j$ and information objects $Inf:R_j\xrightarrow{T_q}U_i$ and unite the algorithms, protocols and other means for connection between DLE components.

Finally, the formalization permits to describe the environment as an ordered structure $DLE=\{U,R,T,D\}$ with two types of relations between its components: $req:U_i\xrightarrow{T_q}R_j$ and $Inf:R_j\xrightarrow{T_q}U_i$, and this is illustrated in fig. 2.

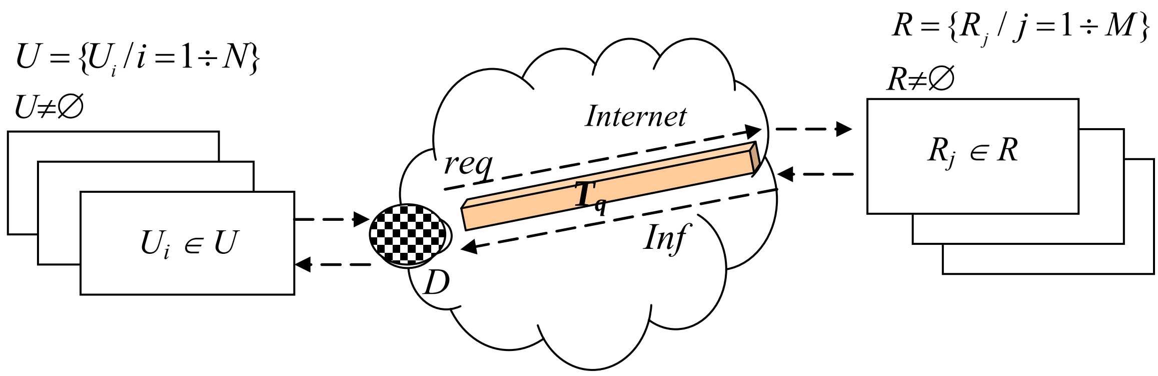

Fig.2. Abstract model of DLE

3. DEFINITION OF BASIC MODELS

Three basic models (primitives) are defined for the purpose of the modelling. They are built on the base of the segment shown in fig. 3 (abstract presentation of the one-user access to the information learning resource) and they are described below.

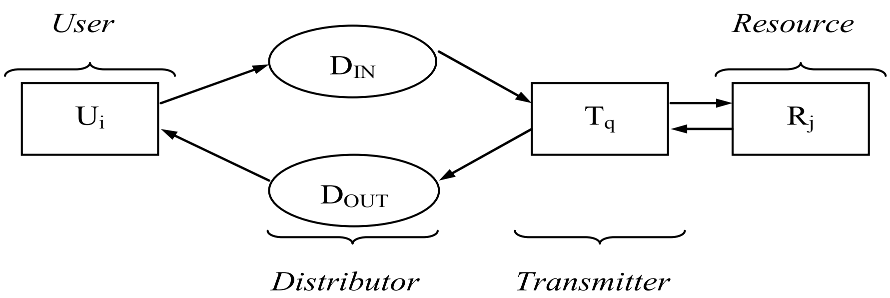

Fig.3. Basic DLE Segment for one-user access modeling

3.1. Basic model for "User"

The following formal objects for the PN-model building are defined and its graph presentation is shown in fig. 4:

Events:

t_1 – generation of a request for access to distributed learning (information) resource;

t_2 – entered information block processing;

t_3 – sending a request to the distributed medium for routing;

t_4 – an information block enters into the input buffer from the distributed medium.

Conditions:

p_1 – availability of the user to work with the distributed learning resource;

p_2 – presence of a request in the input buffer;

p_3 – presence of information block in the output buffer.

$$P=\{p_1,p_2,p_3\} \Rightarrow |P|=3 \qquad T=\{t_1,t_2,t_3,t_4\} \Rightarrow |T|=4$$
$$I(t_1)=\{p_1,p_1\} \qquad O(t_1)=\{p_1,p_2\}$$
$$I(t_2)=\{p_3\} \qquad O(t_2)=\{p_1\}$$
$$I(t_3)=\{p_2\} \qquad O(t_3)=\{Out\_U \equiv D_{IN}\}$$
$$I(t_4)=\{In\_U \equiv D_{OUT}\} \qquad O(t_4)=\{p_3\}$$

Input and output matrixes:

$\mathbf{D^-}$	p_1	p_2	p_3	D_{IN}	D_{OUT}
t_1	2	0	0	0	0
t_2	0	0	1	0	0
t_3	0	1	0	0	0
t_4	0	0	0	0	1

$\mathbf{D^+}$	p_1	p_2	p_3	D_{IN}	D_{OUT}
t_1	1	1	0	0	0
t_2	1	0	0	0	0
t_3	0	0	0	1	0
t_4	0	0	1	0	0

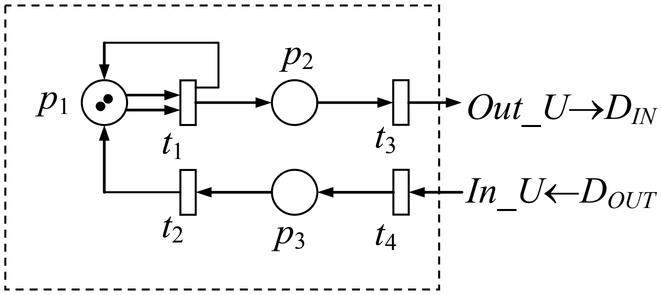

Fig.4. Basic PN-model for "User" with initial marking μ_0=(2,0,0)

3.2. Basic model for "Resource"

The following formal objects for the PN-model building are defined and its graph presentation is shown in fig. 5:

<u>Events:</u>

t_R – processing of an entered request for access to the information learning resource;

t_S – giving the access to the learning resource (an information block sending).

<u>Conditions:</u>

p_A – presence of entered in the input buffer request for access and using of distributed learning resource;

p_B – readiness to give of a distributed learning resource;

p_C – presence of processed request;

p_D – the access to the distributed learning resource is given and the information block is directed to the network medium.

$$P=\{p_A,p_B,p_C,p_D\} \Rightarrow |P|=4 \qquad T=\{t_R,t_S\} \Rightarrow |T|=2$$
$$I(t_R)=\{p_A,p_B\} \qquad O(t_R)=\{p_C,p_C\}$$
$$I(t_S)=\{p_C,p_C\} \qquad O(t_S)=\{p_B,p_D\}$$

Input and output matrixes:

$\mathbf{D^-}$	p_A	p_B	p_C	p_D
t_R	1	1	0	0
t_S	0	0	2	0

$\mathbf{D^+}$	p_A	p_B	p_C	p_D
t_R	0	0	2	0
t_S	0	1	0	1

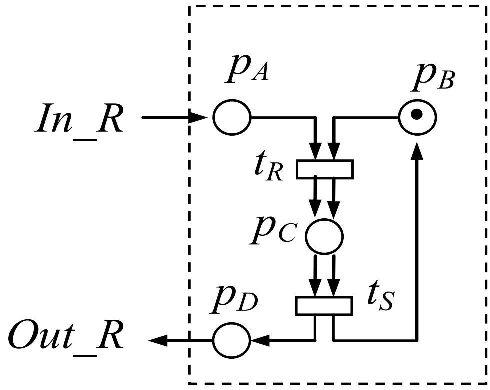

Fig.5. Basic PN-model for "Resource" with initial marking μ_0=(0,1,0,0)

3.3. Basic model for "Transmitter"

The following formal objects for the PN-model building are defined and its graph presentation is shown in fig. 6:

Events:

t_{T1} – request transmission trough the distributed (network) medium based on the routing algorithm;

t_{T2} – information block (learning contents) transmission through the distributed medium to the user (respond returning).

Conditions:

p_{T1} – readiness to transmit a request to node (distributed learning resource) in the DLE (availability of rout and communication resource);

p_{T2} – readiness to transmit information block to the user (availability of free communication resource on the rout).

$$\begin{array}{|ll} P=\{p_{T1},p_{T2}\} \Rightarrow |P|=2 & T=\{t_{T1},t_{T2}\} \Rightarrow |T|=2 \\ I(t_{T1})=\{D_{IN},p_{T1}\} & O(t_{T1})=\{In\_R,p_{T2}\} \\ I(t_{T2})=\{Out\_R,p_{T2}\} & O(t_{T2})=\{D_{OUT},p_{T1}\} \end{array}$$

Input and output matrixes:

D^-	D_{IN}	D_{OUT}	p_{T1}	p_{T2}	In_R	Out_R
t_{T1}	1	0	1	0	0	0
t_{T2}	0	0	0	1	0	1

D^+	D_{IN}	D_{OUT}	p_{T1}	p_{T2}	In_R	Out_R
t_{T1}	0	0	0	1	1	0
t_{T2}	0	1	1	0	0	0

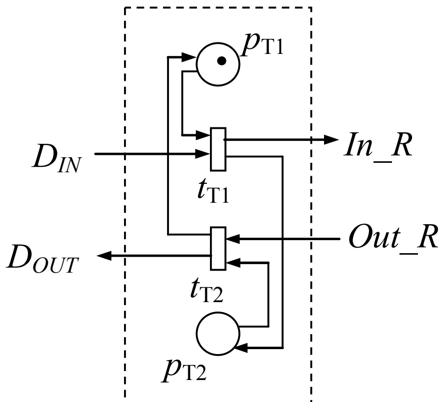

Fig.6. Basic PN-model for "Transmitter" with initial marking μ_0=(1,0)

5. CONCLUSION

The model for distributed learning is connected with the concept of distributed and shared information resources in a heterogeneous environment with local management. On the side of the information process the d-learning permits to all basic learning participants (teachers, students, informational resources) to be placed in different territorial distributed places (different nodes of the DLE). This provides multi-user access supporting and personalization of resources use.

The presented formalization and designed model primitives determine the base for carrying out an investigation of the learning and information processes in the DLE. In this connection the next investigation phase is a generalized Petri net model constructing and its execution. In order to obtain a good result is necessary to make a previous verification of the designed primitives.

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REFERENCES

[1] Romansky, R., I. Noninska. e-Learning as a Part of the European e-Governance. Communication & Cognition, Belgium, № 1&2 (vol. 41), 2008, pp.83-94.

[2] Bowman, M. What is Distributed Learning? News and Advice from the Technology Collaborative, 1999, vol. II, issue I (http://techcollab.csumb.edu/techsheet2.1/distributed.html).

[3] Romansky, R., E. Parvanova. Conceptual Model of Distributed Architecture for 3D Simulation Learning). Proceedings of the Int'l Scientific Conf. UNITECH'08 Gabrovo, Bulgaria, 21-22 Nov. 2008, pp.III-287-III.292 (in Bulgarian).

[4] Ji, Y., K. Chang, P. Bobbie. Interactive software architecture design with modeling and simulation. Proc. of the 42nd Annual Southeast Regional Conference, April 2004, pp. 305-306.

[5] Volovoi, V., Kavalieratos, G., Waters, M., Mavris, D. Modeling the reliability of distribution systems using Petri nets. Proc. of the 11th International Conference on Harmonics and Quality of Power, 12-15 Sept. 2004, pp. 567-572.

[6] Falkman, F., B. Lennartson, M. Tittus. Modeling and specification of discrete event systems using combined process algebra and Petri nets. Proceedings of the IEEE/ASME Int'l Conf. on Advanced Intelligent Mechatronics, 8-12 July 2001, vol. 2, pp. 1011-1016.

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Comparative Analysis of Collaborative Authoring Tools

Constantin Apostol, Iulian Intorsureanu, Rodica Mihalca, Alina Ion

Abstract: *Collaborative authoring tools offer a relevant support in the context of eLearning, where the collaboration of course authors as well as the collaboration of learners are key activities. The paper aims to give a comparative overview of some of the most relevant collaborative authoring tools with regard to their characteristics and functionalities.*

Key words: *Authoring Tools, eLearning Systems, Collaborative Authoring*

COLLABORATIVE AUTHORING AND COMPUTER SUPPORTED ACTIVITIES

Mainly based on the permanent evolution of Information and Communication Technologies (ICT), a lot of activities offer now Computer Supported alternatives of work. As a common characteristic of all these activities we may find out that, regardless of their specific goals, there are always (at least) two kinds of entities involved: the human being and the computer. Thus, the largest field we have to consider is Human-Computer Interaction (HCI).

A very important distinction to be made in HCI is between individual and group specific interaction [4],[5]. As Stahl points out, "The potential of computer support for groups is perhaps even higher than that for individuals because communication within groups has until now suffered from severe constraints that may be eased by computer support." [5]

From a chronological perspective, the first domain having the collaborative dimension who emerged in the larger field of HCI was Computer Supported Cooperative Work (CSCW). The basis of CSCW is the so called Groupware, a collaborative software designed to offer support to people involved in a common task.

Groupware is also the basis of CSCL (Computer Supported Collaborative Learning), concept who was first publicly coined at an international workshop in Maratea, Italy, in 1989. The relationship between CSCW, CSCL as parts of groupware approach is mentioned, for example, by Stahl who remarks that "academically, the exploration of groupware has historically been split into two separate domains: CSCW and CSCL, which address issues of computer support for cooperative work and collaborative learning, respectively."[5]

The most recent field of HCI, strongly related to CSCL and CSCW is Computer Supported Collaborative Research (CSCR). A very useful analysis of the meaning of CSCR and its relationships with CSCW and CSCL inside HCI belongs to Hoare: "The relationships between CSCW, CSCL and CSCR are determined by the differences between work, learning and research. Learning is a specific type of work and research is a specific type of learning. The process of research is a learning process but one which is highly refined and involves learning in a particular way." [11].

Hoare establishes that each of these domains may be specified as containing a number of distinct spaces which contain specific activities. Based on a comparative analysis of different definitions, he identifies the main differences between CSCW, CSCL and CSCR (Table 1).

Regardless of the category their member belongs to: workers, students, researchers, an usual goal of teams is to jointly produce a result (document, project, scientific report, etc.). Considering the groupware perspective, we may call it collaborative authoring (sometimes referred to as *collaborative writing*). Therefore, based on the relative position of collaborative domains inside HCI, we may add the collaborative authoring as a specific part of each of the domains (figure 1).

Table 1 - Differences between CSCW, CSCL and CSCR (apud [11])

CSCW	CSCL	CSCR
Focuses on communication techniques	*Focuses on what is being communicated*	*Focuses on new communications*
Used mainly in a business setting	*Used mainly in an educational setting*	*Used mainly in a research setting*
Purpose is to facilitate group communication and productivity	*Purpose is to support students in learning together*	*Purpose is to support researchers in working together*

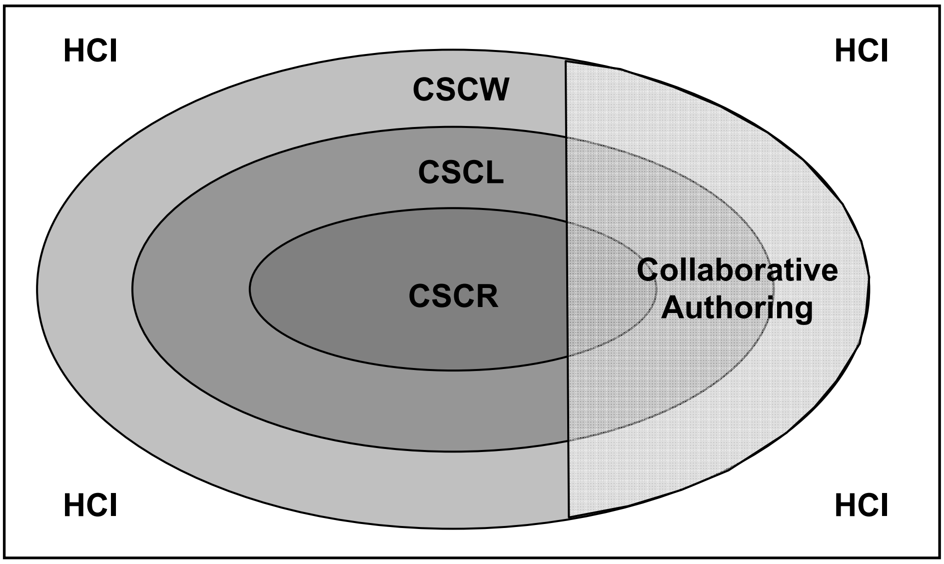

Fig.1. Collaborative authoring and collaborative domains within HCI

Wihout excluding the other two domains, we consider mainly in this paper the collaborative authoring tools related to CSCL, together with its connection to eLearning systems. About this connection, we consider as representative the opinion expressed by Keenoy et al.: "What should be borne in mind is that CSCL is not the same as e-learning: E-learning is the delivery (by electronic means) of educational content to learners who are not necessarily in the same place at the same time. On the other hand, CSCL can be done by teachers and learners who are together at the same place and time." [6, p.8]

In our vision, the authoring process extends beyond the condition of "the same place" and sometimes "the same time" too, because we may identify different approaches in the area of collaborative authoring tools production.

REQUIREMENTS FOR COLLABORATIVE AUTHORING TOOLS

Collaborative authoring requires an effective and efficient communication between all the members from the authors group [1]. In order to accomplish this, authoring tools should be used for creating collaborative content documents. To ensure a high quality of the final result, these tools must comply to certain standards. The lack of standards determines the deep fragmentation of collaborative authoring products market by reducing the number of available options and the binding of authors to specific systems.

One of the most used standards for content reuse and interoperability is SCORM (The Shareable Content Object Reference Model) which represents a set of technical specifications correlated with the activities of AICC (Aviation Industry Computer-Based

Training Committee), IMS (Instructional Management Systems) and IEEE (Institute for Electrical and Electronics Engineers / Learning Technologies Standards Committee), allowing the creation of documents with unique and unitary content. [7]

In order to provide the basis for analyzing collaborative authoring tools it is helpful to identify the most important functional requirements for such tools, taking into account the way they should support the process of collaborative authoring. Beside the actual editing of documents, a lot of activities are going on in the authors group, in order to ensure a common view of the developed result.

The typical requirements for a collaborative authoring tool are:

- support for different documents formats;
- the possibility to make comments connected to specific parts of the document;
- concurrent editing of the document: the tools should guarantee the consistency of a document which is simultaneously changed by a number of authors; eventual conflicts should be managed;
- revision management, i.e. the possibility to track the changes and to maintain versions / revisions of a document;
- communication support within the group, either synchronous or asynchronous, voice- or text-based;
- group membership management in a dynamic way throughout the collaborative activity;
- organization tools, like calendars and task lists, for easy coordination of the common and individual activities.
- capturing unstructured information, like notes, sketches etc.

This list is used in the following for a short characterization of specific tools.

A COMPARISON OF SELECTED TOOLS

Nowadays there is a broad range of software tools which include relevant functions for collaborative authoring; in the following, a selection of tools to be analyzed is made, including the most well-known ones, both commercial and open-source / free. These are described shortly, and a comparison table is elaborated.

Google Docs is an online collaborative platform for creating and editing documents. Several document types are implemented: text documents, spreadsheets, presentations and PDF files. These can be edited fully online through Google Apps, without the need for an office-like software on the client side. There are size limitations for the documents, e.g. 500 KB (without the pictures) for text documents, or 10 MB for PDF files.

The documents can be shared with other Google users, which are specified either as "collaborators" or "viewers". The platform supports simultaneous editing and viewing by the collaborators. The versions of text documents are maintained as "revisions", which can be visualised and describe the change and the user who made it. The different revisions can be compared for easy identification of the changes.

Google Docs does not include other facilities like discussions, instant messaging, task planning or calendars, but these are available through other specialized Google services. The disadvantage is that the "collaboration workspace" is not defined and centrally managed, so the users have to navigate in turn to the necessary pages.

The **Microsoft Word** text editor supports several functions for collaborative authoring, such as: tracking changes, inserting comments and maintaining document versions. "Track changes" can be activated, having as effect the highlighting of changes made in the document (both content and formatting). The changes are colored and related to the author. There are further possibilities to accept or reject a change when generating the final form of the document.

Comments can be inserted and linked to a part of the document, in order to provide the collaborators with additional information related to that part. The comments include the author identification.

Different versions of a document can be saved in an explicit way. The authors are then able to access both the current version or a previous one.

The Microsoft Word editor is integrated with other Microsoft product, like SharePoint or Office Groove, in order to facilitate the sharing between authors in a common workspace.

The **Microsoft Office Groove** collaboration application is part of the Microsoft Office product family. It is a desktop software application that enables the creation of shared "workspaces", which can be flexibly composed of different "tools". The Files Tool, a basic file repository for sharing documents, is the most relevant one for collaborative authoring purposes. The Discussion, Calendar and Notes tools can offer additional support for collaborative work. The authors need to have the software installed locally and to create a Groove account; then they are able to create a new workspace or join an existing one, based on an invitation.

The workspace window shows the documents which are new or modified by other users as unread, helping the user to identify the changes since the last working session. There is a facility for simultaneous navigation of the users in the workspace, which is helpful when the users are communicating directly (e.g. via Instant Messaging or telephone). The local workspaces of the users are synchronized by means of background data communication.

The workspace includes activity indicators of the other users (called "contacts") and has functionality for instant messaging and voice communication. More structured discussions can be hosted in the Discussion Tool.

Microsoft SharePoint is a web-based content management system which enables the creation of collaboration websites through the combination of "web parts". The installation and configuration effort is significant: the SharePoint Server (or SharePoint Services, which offers a subset of functionalities) has to be installed, the website has to be configured and the users must be defined by an administrator. This makes SharePoint an option mostly for larger organizations which want to provide their workers with a way of collaborating online.

SharePoint includes functionalities for document management, web content management and business processes (workflows), as well as enterprise search and reporting facilities. Collaborative work facilities include shared document libraries and communication tools like wikis, discussion boards etc. The documents in a document library can be modified concurrently; the users perform explicit check-out/check-in operations when they open a document for editing. A "document workspace" can be created for each document that is written in collaboration. This is a sub-site with functionalities for tasks, discussions, announcements and links. The document management facilities include document versioning.

The most known SCORM-based authoring platform used for creation of documents with collaborative content is **SELF**, acronym for Science, Education and Learning in Freedom [8]. SELF represents a web-based platform containing multi-language documents written collaboratively by experts and interested users. Its main objective is to bring together public institutions like universities, governments, regardless of their profile or country, providing tools for the evaluation, adaptation and translation of electronic documents it contains. This way, SELF provides support for documents presented in different languages and forms: plain text, presentations, software tutorials, e-books, videos and manuals. The collaborative authoring process for these resources is based on the organisational model of Wikipedia combined with the guarantee that the content is scientifically and academically correct, through quality assurance mechanisms [8].

Mindquarry represents an open source collaborative platform which provides sharing of different types of files (documents, images, video and audio files), organizing information, e-mail integration, wiki editing and forums. Initially, the platform was designed as a web application but now it also has a desktop client which facilitates file synchronization and the work offline. Mindquarry could be used as alternative to SharePoint because of its user and task management features, allowing users to connect from anywhere and to change and synchronize information, thus increasing the efficiency of the teams using the platform. [9]

Moodle (Modular Object-Oriented Dynamic Learning Environment) is another collaborative platform, based on social-constructivism principles. The basic idea for social-constructivism is that the students learn more when they have to create documents and materials that they have to explain to other persons. For instance, it is easy for someone to read a text, but someone can understand a text better if it tries to explain it to somebody else [10]. Moodle encourages communication between authors through its communication and collaboration tools, like chat rooms, forums, wikis and reviews which can be edited using the embedded WYSIWYG editor. Also, Moodle can export and import documents according to SCORM and IMS standards.

Etherpad is fully web based solution for creating collaborative content in real time. It does not provide functionalities for uploading or saving documents, but it allows up to 8 people write at the same time on the same article by simply accessing the link of the article, stored on Etherpad server. Thus, it has a greater portability, allowing people having different operating systems to collaborate. Etherpad is the only authoring tool allowing authors to see in real time the changes made to the document by the other authors, by highlighting text according to the user that changed it. Also, Etherpad keeps the entire history of the documents so that each change made to the document can be undone no matter when it was made. [3]

The findings of the above analysis are summarized in Table 2.

Table 2. Summary of characteristics of collaborative authoring tools

Tool	**Characteristics**			
	License type	Web-based / Desktop	Work-spaces	Functionality
Google Docs	free	fully web-based	no	- synchronous editing, sharing, comments, revisions - other functions as separate services
MS Word	commercial	desktop	no	- text editing, comments, tracking of changes, versioning
MS Office Groove	commercial	desktop	yes	- file repository, messaging, discussions, calendar, notes - group membership, read/unread status of items
MS SharePoint	commercial	web-based (except document editing)	yes	- document library, check-in/check-out mechanism, versions - discussions boards, wikis, calendars
SELF	free	web based	yes	- management of documents in collections, secure web server, content management system - shelf management, internationalization
Moodle	free	web based	yes	- site, user and course management; - embedded WYSIWYG HTML editor, mail integration, file management, chat, wikis
Etherpad	free	Fully web based	no	- real time editing, highlighted author changes - chatting, syntax highlighting for editing code
Mindquarry	free / commercial	Web based , optional desktop client	yes	- file synchronization, tracking of changes, wiki editor, RSS feed - user and task management

CONCLUSIONS

There is a broad range of available tools for collaborative authoring, which differ significantly in terms of architecture and functionality. Most of these tools are covering a larger area of CSCW and are not restricted to collaborative authoring only; therefore, the extent to which the specific requirements of collaborative authoring are supported is also very different. It would be helpful for the end-user that a standard set of functionalities/requirements is defined, as a basis for a consistent characterization of such tools.

REFERENCES

[1] Bordin Sapsomboon, Restiani Andriati, Linda Roberts and Michael B. Spring Software to Aid Collaboration: Focus on Collaborative Authoring, 1997, School of Information Sciences University of Pittsburgh, USA

[2] David Megías1, Jonas Öberg2, Wouter Tebbens3, Rafael Macau - SELF: a collaborative platform to share and create free content about free software and open standards, PKP Scholarly Publishing Conference, July 11 - 13, 2007

[3] Etherpad, http://etherpad.com/, last accessed 16.07.2009

[4] Gerry Stahl - *Group Cognition: Computer Support for Building Collaborative Knowledge*, MIT Press, 2006

[5] Gerry Stahl – *Groupware Goes to School*, in the volume "Groupware: Design, Implementation, and Use", Springer, 2002

[6] Kevin Keenoy, Mark Levene, Sara de Freitas, Márta Turcsányi-Szabó, Eszter Bodnár, Bruno Emans, Judith Schoonenboom, Jean-Philippe Pernin, Carole Eyssautier, Ann Jones, Andrew Brasher, Jenny Waycott, Lydia Montandon - *Collaborative trails in e-Learning environments*, Kaleidoscope Deliverable D22.4.2, Dec. 2004, http://eprints.bbk.ac.uk/197/1/keenoy2.pdf

[7] Liu X, El Saddik A., Georganas, N. - An Implementable Architecture Of An E-Learning System, Electrical and Computer Engineering, Volume: 2, p. 717- 720, 2003, ISSN: 0840-7789

[8] Meena Kharatmal- SELF Platform A Teacher-Centric Collaborative Authoring System, National Conference on Open Source Software, NCOSS 2009, 25-26 may 2009, Navi Mumbai, India

[9] Mindquarry, http://www.mindquarry.com/publications/articles, last accessed 16.07.2009

[10] MOODLE, http://docs.moodle.org/en/About_Moodle, last accessed 16.07.2009

[11] Vita Hinze-Hoare - *Computer Supported Collaborative Research*, Nov. 2007, http://arxiv.org/ftp/arxiv/papers/0711/0711.2760.pdf

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University Virtual Laboratory for Education and Innovations in Scientific Researches

Boyanka Zhelyazova, Radoslav Miltchev

Abstract: *The purpose of article is to study the processes of creation and development of virtual laboratory for education, mathematical modeling and computer simulations in the scientific researches in the field of forestry, agronomy and veterinary medicine, corresponding to educational and scientific needs of University of Forestry.*

Key words: *Virtual Laboratory, Virtual modeling, e-learning, Life sciences, Forest resources, Agronomy, Veterinary medicine.*

INTRODUCTION

The purpose of the present study is to determine the founding moments in approach for creation and development of virtual laboratory for education, mathematical modeling and computer simulations in the scientific researches in the field of forestry, agronomy and veterinary medicine.

Laboratory will be established as specialized research section within the structure of University of Forestry, Sofia (UF) with main goal research, development and implementation activities for research, application and development of complex scientific and educational innovations in the field of multifunctional usage of forestry resources, in the stable agriculture growth, plant protection and veterinary medicine. The laboratory will execute tasks concerning analysis, development and transfer of technologies for virtual education and virtual modeling in the scientific experiments in expedient interdisciplinary scientific fields.

PROBLEMS AND CURRENT STATE OF VIRTUAL LABORATORIES IN EUROPEAN SPACE

Integration of modern technologies for education and perspective information and communication solutions in the national educational system is most effective within unified educational space and means reorganization of both content and organizational forms of educational activities, creation of modern means for information-technological support and development of both educational and research processes.

Realization of such strategy requires creation, within the educational institution (or network of institutions), of integrated information platform for education, based on specialized program-instrumental means and educational content, which could be defined as information-resourceful or rich in content virtual platform for education and innovations in the scientific researches.

Educational platform of modern educational systems is formed from cooperation between traditional and innovational learning models, systems of standards, integrated content of learning plans and programs, educational means and materials, as well as new interaction quality, dialogical and corporate communication between the educational subjects. Creation of mobile information-educational platform, based on modern information and telecommunication technologies, guarantees principally new level of access to quality education.

One of leading aims of high university degree specialists' preparation is their ability to produce and implement innovations, for which they should possess adequate knowledge, to be familiar with the technology for discovering novelties and their implementation. University education is connected to generation of new knowledge most of all, their management, as they are key components of the innovational process.

It is important to analyze whether form virtual laboratory for education and innovations in the scientific researches is being applicable currently and if it has potential and perspective. Analysis reveals, that such forms are up to date and used in Europe and Bulgaria. Brief analysis below illustrates the accumulated experience.

University of Rousse - "Angel Kanchev": Virtual laboratory in electronic education in discipline "Computer organization"; Virtual laboratory in physics – offers to students group of virtual exercises from all fields of physics.

Medical University – Sofia: Web-based course; enhances the traditional education in biochemistry with interactive simulations of clinical cases, virtual laboratory and visualization of complicated processes.

Technical university – Sofia: Laboratory and center for Virtual engineering. A connection is expected, between system for virtual reality in TU – Sofia and newly founded center for technological engineering solutions within University of Karlsruhe, Germany for combined projects and cooperation; Virtual laboratory within Faculty of telecommunication technique and technologies, part of global project – vLab – Virtual laboratory for "Automated systems for measurement and control".

University of Chemical Technology and Metallurgy – Sofia: Virtual laboratory in applied mechanics.

European Virtual laboratory in mathematics (EVLM) http://evlm.stuba.sk/.

University of Poznan – Vlab: Architecture of Virtual Laboratories (http://vlab.man.poznan.pl/eng/).

University of Oulu, Finland – http://vlab.oulu.fi/eng/index.html

Insitut für technische chemie, Universtät Leipzig – An Internet-Based Laboratory Course in Chemical Reaction Engineering and Unit Operations;

Alcalá University, Madrid – Internet Based Laboratory for Experimentation with Multilevel Medium-Power Converters.

The above stated examples show, that creation of Virtual laboratories is an ongoing practice in Europe and Bulgaria and is supported by research programs of European commission. Laboratories integrate the efforts of interdisciplinary teams of scholars.

APPROACH FOR CREATION OF VIRTUAL LABORATORY

Virtual laboratory is intended to combine, based on the program-goal principle, the scientific and educational capacity and resources of UF for researches and creation of high-end technologies for virtual modeling and education in the field of forestry and forest industry, landscape architecture, agronomy, plant protection and veterinary medicine.

In the work of virtual laboratory will be involved lecturers from Department of Computer Systems and Informatics, as well as leading lecturers and scientists from University of Forestry.

For completing its tasks and goals, vLAB will be used and will assist the development of information and technological structure of the university as a general virtual platform for education and development of scientific researches in prior interdisciplinary fields:

- ✓ stable usage and development of biological resources in forestry, agronomy and veterinary medicine;
- ✓ application of GIS-technologies and modern distance methods for protection, monitoring and reproduction of environment;
- ✓ stable management and development of forestry sector, agriculture and plant protection, veterinary medicine.

The approach for creation and development of virtual laboratory for education, mathematical modeling and computer simulations in scientific researches in the field of forestry, veterinary medicine, agronomy and plant protection is based on complex system for interdisciplinary scientific researches and education, including virtual and distant experimental components, interactions between courses, seminars and testing systems.

The task is to analyze the possibilities of virtual reality (VR technology) and simulation modeling for assisting the education and support of the scientific researches in above mentioned interdisciplinary fields.

Forestry and its compatibility with VR. Forestry is a field, where precision of the scientific prognosis and the effectiveness of the management strategy are essential parts of success. Temporal frames, within which the forest systems react on performed events, are wide. More and more often, scientists turn to computer tools for modeling and visualization, for projecting the changes in the forest and estimation of their influence. Not long ago, visualizations were used mostly for modeling the effect of the global ecological changes, for estimation of yields, for visualization of different features and changes in the forest or for visualization of landscape. The importance of visualization in forestry is obvious. The need of visualization tools is growing, in particular for such instruments that could model the future forest resources and visualize dynamics of the forestry processes and ecosystems in time. This determines the increased attention to VR in forestry decision making.

VR is particularly suitable for assistance in solving problems in the following fields of forestry: temporal dependence, decisions irreversibility, spatial-volume modifications and multifunctional forest management.

Interactive program/simulation/ models and applications in veterinary medicine. Veterinary profession requires precise estimation and dynamic decision making. Learning is based on approach related to monitoring and repeating. Simulation-based approaches provide option for multiple repeating of observations till sufficient level of experience is reached. Fields of veterinary medicine in which simulation models in education are created and used are as follows: animal, fish and birds feeding, histology, pathology, radiology, surgery, anesthesiology, medicine dosage, clinical laboratory, meat hygiene. Application of simulation models in virtual laboratory assumes students to gather and analyze data on screen in such way that can be done with traditional equipment; realization of educational activities related to answering questions with one or more possible answers for testing of factological knowledge; exercises, related to analyses and data interpretation.

Implementation of multimedia learning, in which various situations are analyzed, present expert decisions, allows development of skills for thinking and decision taking in observation of several perspectives and availability of more than one possible ways to solve the problem. Setting up active knowledge in students becomes possible with integration of situational, strategic and full of matter knowledge.

Geographical information systems (GIS) and their implementation in agronomy and plant protection. GIS is a software pack and hardware designed to collect, store, update, analyze and visualization of information, connected with geographical location of the objects, for which it stands for. This type of information is realized through maps, geographical data and models for data analyses. Modern GIS provide opportunity, information for current nature and social phenomena in all fields of human activities, related to geographical alteration, to be permanently actualized and provided to users for analyses and decision taking in processes management. Computer technologies and contemporary aeronautic devices for observation of Earth provide possibility for real time monitoring and detection of variation in Earth surface, which are result from nature phenomena and human interference. That is why GIS is becoming popular in the area of agricultural resources management, especially in agronomy and plant protection.

Increasing in yield volumes is the major goal for achieving success in contemporary competitive agricultural resources market. This situation requires growers to look for ways to increase the yields from the available lands under crops. One of the approaches for achieving effective results is the proper organization of the land fund in the agriculture, aiming achieving of effective cyclic recurrence in agronomic technologies for support and ecological self recovery of the soils.

Implementation of GIS-based models in learning process provides opportunity for achieving analytic skills, planning and management of agricultural activities, related to hydro melioration events, treatment with agrochemicals and fertilizers, fighting plant deceases and agricultural pests, based on structure information for the current and prognoses status of geographical characteristics (soil, landscape and climate conditions) of the cultivable area.

PRACTICAL STUDY OF POSSIBLE INSTRUMENTS FOR VIRTUAL LABORATORY

The approach for creation of virtual laboratory, includes examination of simulation and visualization tools and instruments in the field of streaming media as well as estimation of there possibility.

In the present investigation were researched and analysed following simulation and visualization instruments:

Forsi-simulator – product of the Finnish company Plustech. It is with high level of precision in representing the forest landscape, with marking structures on the map, but does not allow movement or interaction with the basic objects;

UVIEW – designed by Robert J. McGaughey from USDA Forest Service, Pacific Northwest Research Station – computerized graphic representation, which picture the existing or expected landscape conditions. System offers flexible tools for analyses;

Monsu – developed by Timo Pukkala, University of Joensuu, initially has been designed for multifunctional forest planning, but also includes high visualization abilities;

SmartForest – developed by Imaging Systems Laboratory, University of Illinois, in cooperation with USDA Forest Service and University of Helsinki. Contains advanced instruments for moving and interaction within forest area.

World Construction Set, Visual Nature Studio and Scene Express – developed by 3D Nature LLC. Provides options for realistic views of real nature objects and places, using vector data DEMs/DTMs and information from remote sensors. It can model long term forestry planning, underground flows, ecological projects and recreational scenarios. Allow creation of maps, plans, stereo panoramas and "flight". It can model disaster areas and show their progress.

The realistic view is possible through the option for setting digital data for leaves, clouds, mist, water, reflection, sun, sun rays, etc. The software allows modeling of objects alteration in time from one day to million years. Possible integration with ArcView/ArcInfo, ERDAS Imagine, ERMapper, AutoCAD, MicroStation, 3D Studio MAX/Viz, LightWave, etc.

The above mention instruments can complement different developments in the field of simulation modeling, based on scientific researches in university.

Some of the possibilities for high quality services connected to streaming media are:

HELIX SERVER – represents solution for acquiring streaming media with high quality. General advantages of this solution are acquiring of streaming resources in different audio and video formats, optimized ratio of investments to number of service users, and also possibilities for flexible politics towards using new formats. Observations show that solution fits well in heterogenic environment and allows decrease of expenses related to using different devices.

Another suitable solution for streaming media is *FLASH MEDIA INTERACTIVE SERVER 3*. Its advantage is the option to combine access to streaming media of large number of users, with flexible and functional platform for creation and processing of streaming content. Also interesting are the possibilities for security management of the streaming media considering their classification based on access rights, broadcasting in real time and supply of content to mobile users, using phones with Adobe compatible software. This solution helps for effective usage of possibilities of the network infrastructure to supply content, as well as optimizing the process in accordance to the client possibilities to work with the streaming media.

As for decision choice, solutions with open source can be used, for example *Darwin Streaming Server*. This server for streaming media represents solution based on Apple QuickTime Streaming Server and is using standardized protocols for supply of streaming media. Solution can be realized on different platforms, allowing change of outsource depending on specific needs, but on the other side assumes availability of well prepared IT and communication technology unit.

Microsoft Windows Media Services 2008 is free of charge as part of server operational system Windows. Solution is suitable for clients, using actively Microsoft products within their intra- and extranet networks, as well as internet services. Advantages of such solution must be found in opportunity for combining streaming media services with other network services, as well as many means for development activity. This can contribute for creation of new quality applications, combining different existing technologies and approaches.

CONCLUSIONS AND FUTURE WORK

Virtual laboratory provides opportunity for alteration of parameters of the researched objects, characteristics and scale of surroundings, construction of which is too complicated to be realized in the real physical experiment. Preservation of the created model with option for future usage and reproduction of the experiment under changed parameters and conditions will accelerate scientific researches.

Virtual laboratory will provide hypermedia platform for delivering all types of information – text, graphics, audio and video, which will ease and intensify communication between young scientists, PhD students and post-docs. Result of the scientific researches will be available anytime and from any place with access to Internet, which provides flexibility, dynamics, interactivity of communications between them and new opportunities for their development.

REFERENCES

[1] Aron, D, Developing multimedia-based case training for small animal orthopedic surgery. University of Georgia, USA, 2005.

[2] Brown, T, Daniel, T. Predicting scenic beauty of timber stands. For. Sci. 32(2): 1986.

[3] E-learning and simulation labs. HEEPF deliverables. http://www.heepf.org.eg

[4] E-learning project Fish in the Web. Biology and pathology of fish. 2005. E-learning academy Zagreb.

[5] Emergency case simulator. Royal veterinary college, University of London. http://www.rvc.ac.uk/review/cases/index.htm

[6] Heasley, J., McNamara, J. Simulating the visual effects of timber harvest practices. In Proc. Resource Technology 90 - Second Symposium on Advanced Technology in Natural Resource Management. Washington, D.C., American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, 1990.

[7] http://3dnature.com/

[8] Kellomäki, S., Pukkala, T. Forest landscape: A method of amenity evaluation based on computer simulation. Landscape Urban Plann., 1989.

[9] Magee, M. Simulation in education. Final report. Alberta online learning consortium, Calgary AB, 2006.

[10] Национална програма за ускорено развитие на информационното общество в Република България 2008 – 2010г., ДАИТС.

[11] Orland, B., LaFontaine, J., Daniel, T. Alternative Futures for Forested Landscapes. In Proc. Resource Technology 90, Washington D.C. American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, 1990.

[12] Orland, B., Daniel, T., Lynch, A., Holsten, E. Data-driven Visual Simulation of alternative Future for Forested Landscapes. In proc. IUFRO—Integrating Forest Information over Space and Time. Canberra, 1992.

[13] Orland, B. Smartforest: 3-D interactive forest visualization and analysis. In Proc. Decision Support-2001, Resource Technology 94, Toronto. American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, 1994.

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Research of the Model Characteristics of the Knowledge Dynamic aimed at Increasing the Effectiveness of the Educational Process

Svetlana Stefanova, Krasimira Filipova

Abstract*: The basic quantity characteristics of the knowledge dynamic models are presented in this article.A specific kind of net has been chosen – closed net. The determinations of the characteristics of a homogeneous closed net and inhomogeneous net, describing the knowledge dynamic are examined. The purpose of this paper is to research the possibilities for analyze system's behaving by using the instruments of the Petri nets.*

Key words: *Model characteristic, Education, Petri nets, Knowledge dynamic*

INTRODUCTION

In the educational process students assimilate various parts of the subject matter. Therefore it's very important to manage this process. The more efficient it is the bigger part of the subject is assimilated. According to an author the level of the student training is changing continuously [4]. Because of this, different important characteristics of the knowledge dynamic will be researched.

The educational process is very important and so is his efficiency. In connection with that quantity evaluations of the basic characters have to be created. Design of the macrographs of Petri nets has been offered to make the evaluation process easier. The grouping macro positions correspond to the separate themes that construct the relevant subject.

The purpose of this paper is to offer an easy accessible way for gathering impressions about the quantity dimension of the educational process and discovering potentional opportunities for increasing it's effectiveness.

QUANTITY CHARACTERISTICS OF THE KNOWLEDGE DYNAMIC

The analysis of the quantity characteristics of the knowledge dynamic allows the management of the school process to be optimized. The management optimization is examined this way: assimilation, forgetting and repeating of the school material are forming a casual process. The space of its realizations can be characterized with a certain possibility measure. To take into account the priorities of separate obligatory or additional terms in assimilation of certain topics, weight coefficients of the arcs in the Petri nets showing the school process on this topic are initiated. The next stage represents the learning of several topics from the school material in one school subject. Determining the steps in learning the topics must take into account the succession of some knowledge parts from one topic to another. This forces the introducing of one more kind of weight coefficient, which is the volume of inherited knowledge from the previous to current topics. The character of these weight coefficients is probability, of course. Because of the condition that it is obligatory to assimilate a term during a given stage from a previous topic, these possibilities can be only conditional.

Each combination of realizations of the casual process and the corresponding control have a quality parameter (stage of usefulness). Therefore, the task for optimization of the school process management is reduced to syntheses of the strategy of obligatory process management, which can guarantee extreme value of the quality parameter.

ASSIGNMENT THE PERFORMANCES OF A HOMOGENOUS CLOSED NET, DESCRIBING THE KNOWLEDGE DYNAMIC

The homogenous closed net describes studying on a topic from a current school subject. Such system is previewed in [2] and the corresponding Petri net /with weight factors of the arcs/ is given on Figure 1.

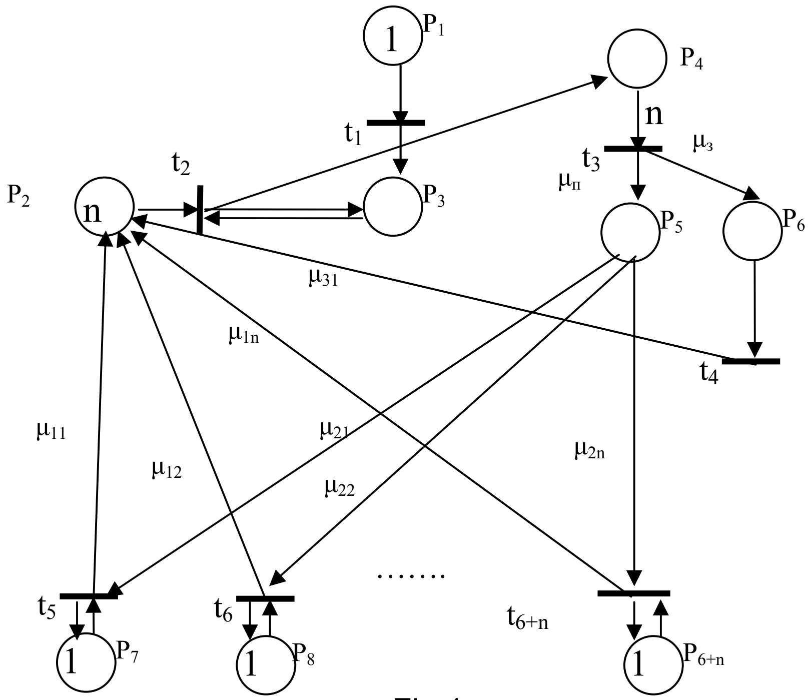

Fig.1

With p is registered the current number of the terms that have to be assimilated. The coefficient μ with first index 2 has to be with lowest possible value for the most obligatory term that has to be assimilated. Its value increases with decreasing the importance of the term in this school subject. Assigning values to the coefficients μ with first index 1 is in a reciprocal way, because it's about an opposite process – forgetting. With $\mu_п$ and $\mu_з$ are registered respectively the probabilities for once more assimilating and for forgetting the terms that have to be assimilated. To ensure correct input conditions to working the net instead of the values of r, $\mu_п$ and $\mu_з$ it's necessary only a mark to be marked in all positions from p_7 up.

(1,2,0,0,0,0,0,1,1,...,1)
t_1
(1,2,0,0,0,0,0,1,1,...,1)
t_2
(1,2,0,0,0,0,0,1,1,...,1)
t_2
(1,2,0,0,0,0,0,1,1,...,1)
t_3
(1,2,0,0,0,0,0,1,1,...,1)
t_4 t_5 t_6 … t_{6+n}
…………….

Fig.2.

On Figure 2. the reachability tree for the status when r=2 and the initial marking is M_0=(1,2,0,0,0,0,0,1,1,...,1). is shown.

In the net analyses for evaluation of the knowledge dynamic usage of the normalizing coefficient is also recommended. For opened nets this constant has a simple layout, and for the closed nets because of the complexity of the knowledge dynamics it is the sum of a product. The number of the addends in this sum is equal to the dimension of the status space of the net. For example, for the case of homogenous closed net the size H is:

$$H(N,M) = C^{M-1}_{N+M-1}, \text{ where}$$

(t)= $(n_1(t), n_2(t), \ldots, n_M(t))^T$ is a multidimensional vector of the casual process, consisting of the number of the terms on the stage S1 at a moment t.

Increasing the number of the stages M increases the dimension of the status space very fast. As a result from all this the immediate definition of the normalizing coefficient can turn out practically impossible. Because of this a necessity appears for special methods for defining the stationary possibility of the status vector and other properties of the closed nets. They can be based on the usage of the Buzen recursive algorithm. This algorithm is reduced to consecutive filling of a table, containing M columns and N+1 rows. The decision of the system based on equations is as accurate as the constants assigned in advance. Because of this the value of the normalizing constant is calculated by taking into account the specific for the assigned case conditions.

When using different stages of knowledge dynamic detailing at separate students or a group of students different net models can be used and because of this the characteristics of these net models can vary in the borders of an error.

When working with knowledge dynamic describing models the concepts of equivalence and tolerance are introduced. Two models are called equivalent if their properties are identical. If the differences between the properties of two models are not bigger than the admissible error tolerances, then such models are called tolerant or similar.

DEFINING THE PROPERTIES OF AN INHOMOGENEOUS NET WHICH IS DESCRIBING THE KNOWLEDGE DYNAMIC

An inhomogeneous closed system describes the education of one discipline, which includes several topics. Such a system is previewed in [2]. The specific characteristics here are:

- the graph of the net is a macrograph
- every position is a macroposition and represents the graph for assimilation of each topic.

The accepted symbols are not about the concepts, but about the separate topics, constructing the discipline. The closed net allows the system to be examined on a different surface as well. For example, let Pij(r) be the possibility the terms from class r of the school material to finish the process of the stage Si and pass to stage Sj, and nir is the count of the terms from r-th class of the stage Si of the net.

Then the quantity n_{ir} is influenced by different conditions, which are reflecting the status of the system. Some of those conditions can be obligatory, and some – not. For example, when the transfering from one stage to another the term class can be changed, then in the general case the number of the terms in the r-th class in the net can be changed. The nets with possibilities of changing the term class can be led down to equivalent ones with lack of this kind of possibilities.

For this purpose the set of classes is broken down to unintercepting subsets.

If in the net the term class is not changed, then everything from the mentioned subsets has identical term class.

Until now it was supposed that all N terms are equally important for the student. In the basic case this is not true. Depending on the importance stage, the terms can own different priorities as in assimilating and as in knowledge recovering.

Let there be two classes of priorities– 1 and 2, and the terms from the first class are with higher priority than these from the second class (the lower number corresponding to a higher). Besides, the first class consists N1 terms, but the second – N2. Therefore, the total number of terms is N = N1 + N2. In the terms of Petri nets this will lead to realization of this branch of the net, which arc possesses a lower weight coefficient.

If we examine a case of a two class system, then when a term with higher priority from first class is input, the assimilation of the lower priority, can be cancelled (this is the so called absolute priority), and to be put in the beginning of the row with terms from the second class.

The student can be in one of (N1 +1)(N2 +1) $E_{i,j}$ statuses,where (i=0,N1, j=0, N2), and $E_{i,j}$ is a status, when the student doesn't know i number of terms from the first class and j number of terms from the second class.

If $\mathbf{z_{11}}$ and $\mathbf{z_{12}}$ represent the intensity of the forgetting term from first and second class respectively, and $\mathbf{z_{21}}$ and $\mathbf{z_{22}}$ represent the intensity of the knowledge recovering respectively, then the change in the student knowledge can be represented with a markov process (in zij the first index i shows the stage number, and the second – j – the term class number). From here a schedule for the student transitions from one status to another can be composed, and on it to compose a differential equation system. From this system there can be found, for example, the stationary possibilities $\mathbf{l_{ij}}$

From this system, for example, the stationary probabilities $\mathbf{l_{ij}}$ for staying of the student into different situations are expected to be found. Later, quantity characteristics about the quality of the training can be found.

If the mathematical expectation about the number of the forgotten terms in the first class is L_1, and the second one – L_2 , than for all the forgotten terms we get $L = L_1 + L_2$. The intensity of the terms streams who enter and exit the S_1 stage are equal. As a result, the average amount of the terms processing during the S_1 stage can be found.

CONCLUSIONS

The advantage of using Petri net is the opportunity of analyzing the system's behavior and researching it.

The quantity valuation of the characters for the quality of the teaching process has always been serving to determinate the student's position depending on the level of the assimilated knowledge. On the other side, it can also serve to show the direction that the work must be done to, in order to correct or to upgrade the level of the student's qualification. That is why he can be continued to be taught or not.

REFERENCES

[1] Filipova, K., Sv. Stefanova, Defining the Performances of the Knowledge Dynamic Models, Annual School.Lectures- 2003, 3-5, vol.23, number 1, Sept 2001/2003.

[2] Filipova, K., Sv. Stefanova, Net Models of Knowledge Dynamic, Annual School.Lectures- 200,; 29-32, vol.23, number 1, Sept 2001/2003.

[3] Stefanova, Sv., K. Filipova, I. Zheliazkova, A Technology for Teaching by Means of an Intelligent Animation Environment, Annual School.Lectures- 2003, 17-19, vol.23, number 1, Sept 2001/2003.

[4] Sviridov A.P., I.A. Shalobina, Net models of knowledge dynamic, Moskva, MEI, 1992.

[5] Yulin Y. A Petri net model for temporal knowledge representation and reasoning, IEEE. Trans. On Systems, Man. And Cybernetics, v. 24, 9, 1994.

[6] Кр.Филипова, Св. Стефанова, Методът на Свиридов за ефективна организация на учебния процес, First International Conf. "Challenges in Higher Education in the 21st Century", pp.48-50, may, Sozopol, 2003

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Knowledge Management in Software Engineering

Wladimir Bodrow, Daniel Vila Suero, Alejandro Alonso Cabello

Abstract: *This research describes the relevance of knowledge management to software engineering. The applicability of knowledge management activities to different stages of software engineering is investigated and the value of them within the software life circles formulated.*

Key words: *Knowledge management, Software engineering.*

INTRODUCTION

The paper organized as following: in the second chapter we describe briefly the selected knowledge management approach. The third chapter is devoted to the software engineering body of knowledge. The next chapter represents the interdependencies between both and figure out the particular relevance of knowledge management approach to software engineering. Conclusions in the last chapter summarise the value of presented research for the software engineering.

KNOWLEDGE MANAGEMENT

There exist a number of approaches to knowledge management [1,2,3,4,5,6]. In this research we use the following one. Along the business processes we consider four core activities in respect to knowledge:

Knowledge generation – new knowledge in the system (application environment) will be generated in different ways: by brainstorming, scientific and applied research, social interaction, training, learning by doing, etc. Fundamental research regarding the generation of knowledge in the company was published by Nonaka and Takeuchi [7].

Knowledge storage – this activity is "responsible" for documentation of existing and newly generated knowledge in explicit and/or in implicit form. Various aspects of content management provide efficient support the storage of explicit knowledge. An important point in this context is the storage of organizational routines and existing customer relations.

Knowledge utilization – according to our focus on business processes this is the goal and output of knowledge life circle and consequently the aim of knowledge management. Because of knowledge specifics it is very difficult to recognize, measure, and document the utilization of the selected unit of knowledge in the particular business process or activity.

Knowledge sharing – within the knowledge based and knowledge oriented processes sharing occupies the exceptional position. It represents a kind of engine, which enables the generation, storage, and utilization of knowledge in the most business processes with the focus on knowledge. The well organized sharing has to provide every participant with the necessary knowledge at the right time and place in required quality. Different communications resources can be used for efficient knowledge sharing.

Above these four activities, which are directly connected to managing of knowledge we consider the two activities in the meta-level:

Knowledge identification – to be able to realize this activity one have to have certain amount of professional knowledge and capability for systematic analysis of knowledge. The investigation of customer requirement can initiate the understanding whether a single person or the company has the professional knowledge to be successful in the team or on the market.

Knowledge evaluation – this activity is focused on the investigation of the efficiency of available knowledge in knowledge utilization processes. Based on the evaluation results management can make their decisions and so improve the utilization of knowledge in the enterprise or in particular business process. European research activities in this field are currently focused on development of intellectual capital statement [8,9,10,11].

SOFTWARE ENGINEERING BODY OF KNOWLEDGE

The aim of presented study is the application of described knowledge management approach to software engineering. Software engineering is an excellent example of knowledge based and knowledge oriented process. There exist many approaches and concepts to software engineering. We follow the IEEE Computer Society definition of software engineering as the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software. Software engineering contain also the study of approaches such application. [12]. The basis for the investigation presented below builds the Guide to the Software Engineering Body of Knowledge developed in the SWEBOK project of the IEEE Computer Society Professional Practices Committee [12]. The aim of this document is established in the following five objectives:

1) To promote a consistent view of software engineering worldwide.

2) To clarify the place–and set the boundary–of software engineering with respect to other disciplines such as computer science, project management, computer engineering, and mathematics.

3) To characterize the contents of the software engineering discipline.

4) To provide a topical access to the Software Engineering Body of Knowledge

5) To provide a foundation for curriculum development and for individual certification and licensing material.

These were the decisive points to use the Guide in presented research as a basis document in respect to software engineering.

Ten knowledge areas of software engineering are defined in the Guide:

- Software requirements
- Software design
- Software construction
- Software testing
- Software maintenance
- Software configuration management
- Software engineering management
- Software engineering process
- Software engineering tools and methods
- Software quality

Every of these areas have very specific characteristics and, therefore they need different approaches and techniques in order to capture, store and manage the professional knowledge.

The Guide uses a hierarchical organization to decompose each knowledge area into a set of topics with recognizable labels. Then, it treats the selected topics in a manner compatible with major schools of thought and with breakdowns generally found in industry and in software engineering literature and standards.

Additionally to listed above knowledge areas the knowledge areas of related disciplines are also considered in the Guide. They are Computer engineering, Computer science, Management, Mathematics, Project management, Quality management, Software ergonomics, and Systems engineering. Every particular knowledge area of software engineering is specified and investigated in detail in the Guide. The presentation of this investigation is not the aim of this paper – our focus is the analysis of the applicability of knowledge management approach to software engineering.

APPLICATION OF KNOWLEDGE MANAGEMENT TO SOFTWARE ENGINEERING

Due to the fact that both the knowledge management activities and the knowledge areas in software engineering are fundamental concepts to get to understand the knowledge management and the software engineering, it is important to explain the basic relations between them.

Software Requirements: As one of the most important knowledge areas, the Software Requirements area involves almost all of the knowledge management activities. The relevant activities in this knowledge area are **generation, storage, utilization, identification,** and **evaluation** of professional knowledge.

Although it is implicit that the knowledge stored in the software requirements documents will be shared, we found that the **sharing** of knowledge is not a part of the process of development and formulating of the software requirements.

Software Design: While designing the software product, we think that the most important point is being able to use the knowledge created in the *Software Requirements* phase and transform it into graphics, diagrams, etc. So it is possible to translate the requirements to a more technical "language" and store them in the project documentation.

The relevant activities in this knowledge area are **storage, sharing,** and **utilization** of knowledge.

Software Construction: This step is in action when the system itself will be built and the source code will be produced. Within this process it is important to check stored libraries and repositories from the previous projects where the code has been tested and proofed and therefore can be used to the current project. Also new lines of code will be written and new libraries could be stored in repositories of source code.

Taking all this in account, the relevant activities in this knowledge area are **generation**, **storage, utilization,** and **evaluation** of knowledge.

Software Testing: The Software Testing area involves running tests, and checking all aspects of the application. Because of that reason, all the knowledge management activities are applied at this moment.

Software developers have to identify the critic parts of the application, those that are going to be under more pressure when the system is running. Also, tests packages from previous projects can be utilized to test some parts and new ones have to be created specifically for the present project.

Apart from that, all these new tests should be stored for future applications and documents have to be created with the results of the testing. Therefore, the relevant activities in this knowledge area are **generation, storage, utilization, sharing, identification,** and **evaluation** of knowledge.

Software Maintenance: In the Software Maintenance knowledge area, may seem that all knowledge activities could be applied, but in fact the most significant in this area is the identification and evaluation of the knowledge needed to maintain the application with the less effort and more efficiently. Also it is important to share this knowledge with the rest of the team and so provide the support for everyone work. Based on this, the relevant activities in this knowledge area are **sharing, identification,** and **evaluation** of knowledge.

Software Configuration Management: This knowledge area is more or less a supporting software life cycle to help with the project management, development, etc. Consequently all the knowledge activities will be applied in this knowledge area.

The relevant activities in this knowledge area are **generation, storage, utilization, sharing, identification,** and **evaluation** of knowledge.

Software Engineering Management: As the previous knowledge area, the Software Engineering Management involves a lot of different tasks, like planning, coordinating, monitoring, etc. to ensure that the development and maintenance of software are systematic, quantified and disciplined.

Therefore, the relevant activities in this knowledge area are **storage, utilization, sharing, identification,** and **evaluation** of knowledge.

Software Engineering Process: Analogous to the Software Configuration Management Area, the Software Engineering Process area is related with the complete software life cycle. Among others it contain changes that induct some improvements of software engineering.

Taking the process perspective of the whole life cycle schema into account one can point out that the relevant activities in this knowledge area are **generation, storage, utilization, sharing, identification,** and **evaluation** of knowledge.

Software Engineering Tools and Methods: In order to recognize which tools or methods are the best to be applied to the software product, is most important to know what has to be build up and for what purpose or use.

Then, the relevant activities in this knowledge area are **utilization, identification,** and **evaluation** of knowledge.

Software Quality: In order to improve the quality of the software product, it is important to identify which parts or modules of the application should be improve, how and with what purpose. As a result, the relevant activities in this knowledge area are **storage, utilization, identification,** and **evaluation** of knowledge.

All described interdependencies are presented in the figure below.

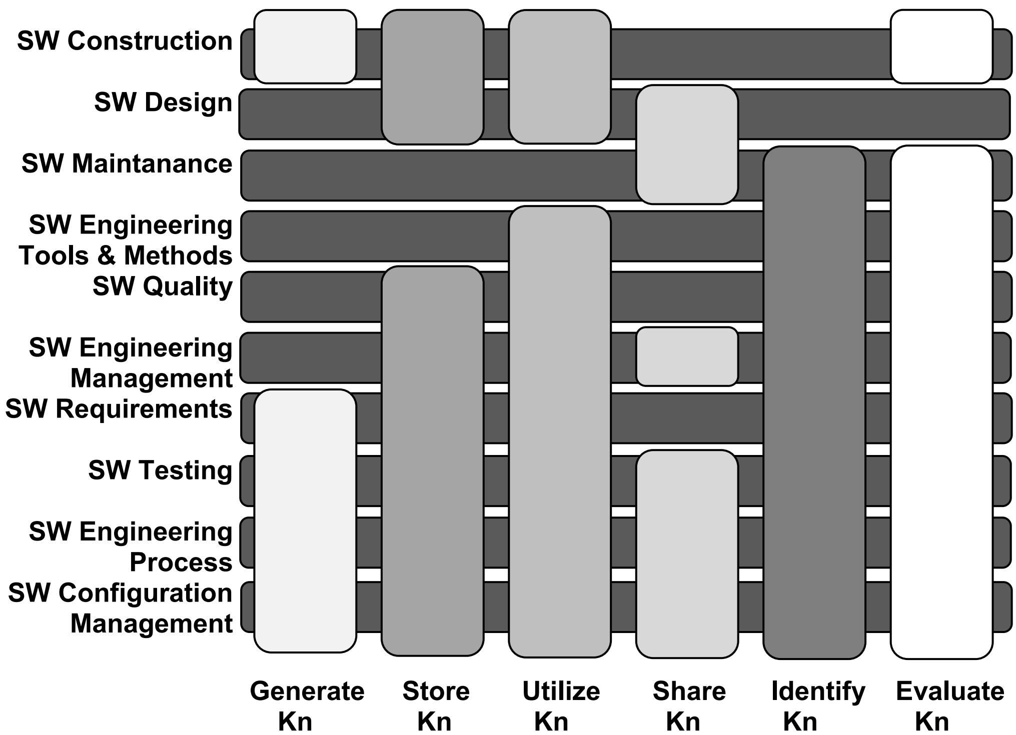

Fig.1. Knowledge areas and knowledge activities
(Abbreviations: SW – software, Kn – knowledge)

In the graphic, the knowledge areas (software engineering) are represented with horizontal bars, and the six knowledge management activities are represented by vertical bars. The interrelations are represented with the "crossing" of the activities over the knowledge areas. That is, if the selected activity is relevant in a particular knowledge area, the vertical bar representing it will be above the horizontal bar representing the knowledge area.

CONCLUSIONS AND FUTURE WORK

In this paper we analysed the applicability of knowledge management approach to software engineering. The relevance of selected knowledge management activities to all knowledge areas of software engineering was figured out and presented in the overview. This presentation provide a) the better understanding of knowledge value of each knowledge area in software engineering. And b) it allows the practitioners (software developer) to improve their activities within software engineering with respect to managing their professional knowledge. The next step in this research is the development and implementation of the skills manager tool to manage the professional software engineering knowledge in the practice.

REFERENCES

[1] Holsapple, C.W. (ed.), Handbook on Knowledge management I, Springer, Berlin, 2003

[2] Mertins K. / Heisig P. / Vorbeck P. (eds.), Knowledge Management,. Springer, Berlin, 2001

[3] Bodrow, W. / Bergmann, Ph., *Wissensbewertung in Unternehmen*, Erich Schmidt Verlag, Berlin, 2003

[4] North, K., *Wissensorientierte Unternehmensführung*, 3. Ed., Gabler, Wiesbaden, 2002

[5] Probst, G. / Raub, S. / Romhardt, K., *Wissen managen*, 3. Ed., Gabler, Wiesbaden, 1999

[6] European Guide to good practice in KM, Proceedings of CEN/ISSS workshop in Madrid, 2003

[7] Nonaka, I. / Takeuchi, H., *The Knowledge Creating Company*, New York, Oxford, 1995

[8] Koch, G., *ICR Made in Austria*, in: Contribution at Intellectual Capital for Comunities, Paris, 2005

[9] Mertins, K./ Alwert, K. / Heisig P. (eds.) *Wissensbilanzen*, Springer, Berlin, 2005

[10] http://www.incas-europe.org/index-en.htm/, last visit 23.7.2009

[11] http://www.seneca.de/, last visit 23.7.2009

[12] http://www2.computer.org/portal/web/swebok, last visit 23.7.2009

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Simple Expert System Shell Running on Mobile Information Terminal Device. Data Organization

Margarita Teodosieva, Georgi Krastev

Abstract: *This paper describes the date organization of the developed light shell for expert system working on a mobile information terminal.*
Keywords: *expert system, mobile information terminal, production rules.*

1. INTRODUCTION

MIDlet application is one of the most accessible and effective ways for extending a mobile phone functionality. How it will serve, an assistant for doing business activities or entertaining device, it is just up to the user.

MIDletPascal [1. 5] is a Pascal-like programming language designed for development of mobile applications. MIDletPascal compiler translates the Pascal output code into a byte-code Java™ micro edition (J2ME). Programs written in MIDletPascal can be run on any mobile information terminals (devices, phones) which support Mobile Information Device Profile (MIDP) 1.0 and Connected Limited Device Configuration (CLDC) 1.0 platforms.

The shell created by the authors in MIDletPascal and described herein represents an expert system [2,3,4,6,7,8] running in environment of mobile information terminal device.

MIDP defines a Record Management System modeled on a basic record-oriented database.

The developed simple expert system shell uses the following data types:

- Data that has to be stored longer because of its multiple usages. It is organized in record archives stored in the flash memory of the mobile device.
- RUL data archive – it contains processed expert concepts concerning the subject domain in the following format:

Questions to the object:
QUESTION<OBJECT>=<QUESTION TEXT>

The question text length is up to 256 characters, each line being not more than 80 characters. The "/" character is used to mark the end of a line to a given question.

- legal object values:
LEGAL <OBJECT> = <VALUE 1>, <VALUE 2>...
For example:
legal (c1) = true, false

- production rules for inference:
IF < CONDITION > THEN < RESULT >
The rule condition and result are in the form of facts:

<OBJECT> =<VALUE>, CL(confidence level) = < VALUE >, note that facts conjunction is also allowed.

The "AND" character is used to mark a conjunction. The end of a Rule is marked with "." e.g.

```
IF
      c1 = true
      c2 = false
THEN
      damage = g1
      damage = g2.
```

- file .DEF

The record archive is used to facilitate the display of the consultation results. The archive data is organized in the following format:

<OBJECT-GOAL VALUE > =<TEXT FOR DECODING >

Decode text length is up to 256 characters.

The "/" character is used to designate that a given line belongs to it.

e.g.

g1 = worn-out crank

g2 = faulty cooling system /scale, thermostat, driving belt, radiator/

2. DATA INTERNAL REPRESENTATION

List structures are used for data internal representation. Two main list types are created – objects list and rules list.

Objects internal representation structure is shown on Fig. 1a.

Each node contains the following data:

- object name /name/
- question to the object /question/
- type of object multiple values /multivalid/
- value list top pointer /value_list/

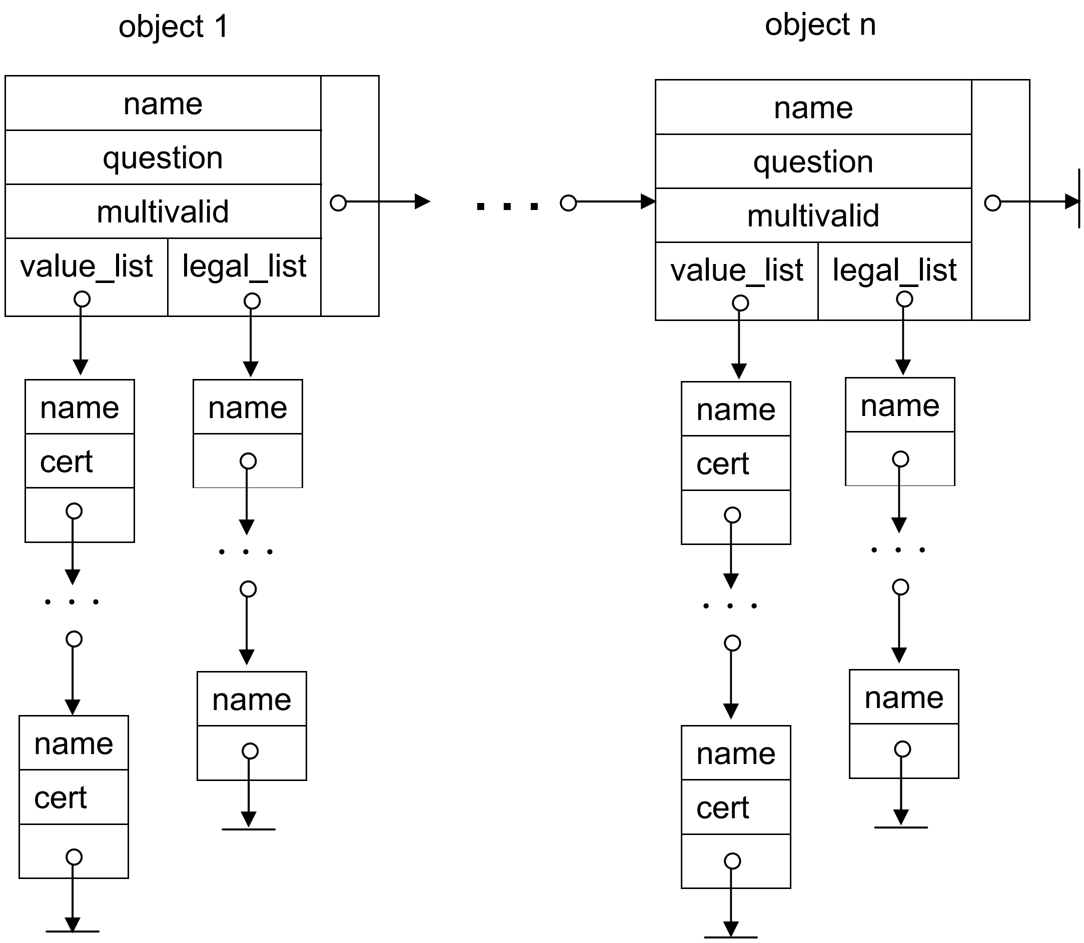

Fig.1a. Structure of objects internal representation

Each node contains data of the value /name/, its confidence level /cert/, pointer to the next object value /next/.

- Pointer to the object legal list top /legal_list/

Each node contains data of the legal value /cert/ and pointer to the next legal value /next/

- Pointer to the next node of the object list /next/

The structure of rules internal representation is given on Fig. 1b.

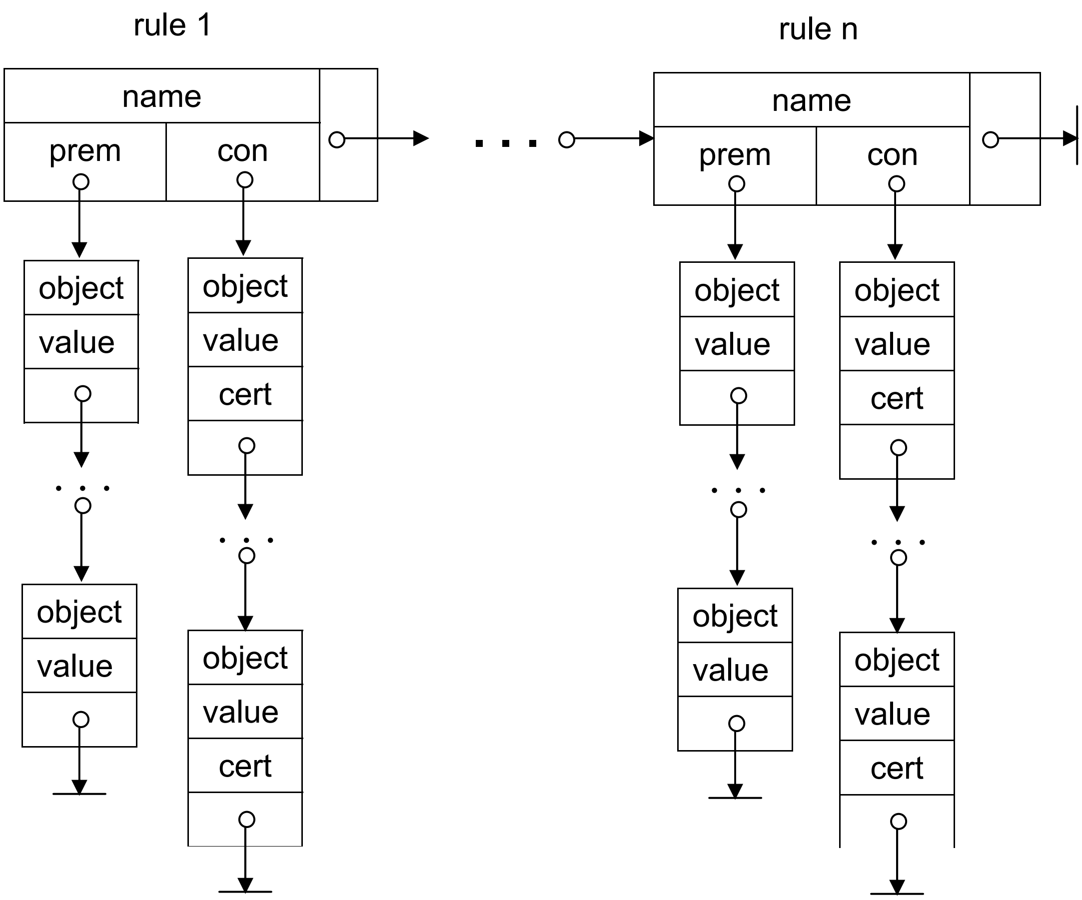

Fig.1b. Structure of rules internal representation

Each node of the rules list contains the following data:

- Rule name /name/
- Pointer to the preconditions list top /prem/

Each node of the preconditions list contains data of the object name /object/, its value /value/ and pointer to the next precondition /next/.

- *Pointer to the conclusions list top /con/*

Each node of the conclusions list contains data of the object name /object/, its value /value/, conclusion confidence level /cert/ and pointer to the next conclusion of the list /next/.

- *Pointer to the next rule /next/*

For building up the above structure the following types are declared in the program:

1 – for variables limits of string type:
WORD_STRING – variable length up to 40 characters
LINE _ STRING – line length up to 80 characters

2 – for pointers to records type given below:
VALUE_PTR = ^VALUE
Pointer to objects values list
LEGAL_PTR = ^LEGAL_VALUE
Pointer to objects legal values list
OBJECT_PTR = ^OBJECT
Pointer to objects list
PREM_PTR = ^PREM
Pointer to rule preconditions list

CONP_PTR = ^CON
Pointer to rule conclusions list
RULE_PTR = ^RULE
Pointer to rules list

3. RECORD TYPES

a/ OBJECT = RECORD
NAME : WORD_STRING;
QUESTION : STRING;
MULTIVALD : BOOLEAN;
LEGAL_LIST : LEGAL_PTR;
VALUE_LIST : VALUE_PTR;
NEXT;
The record fields have the following values:
NAME – object name
QUESTION – question text to the object
MULTIVALID – flag of multivalue
TRUE – the object is multivalued
FALSE - the object is not multivalued
LEGAL_LIST – pointer to the legal values top
VALUE_LIST – pointer to the object values list

b/ VALUE = RECORD
NAME : WORD_STRING;
CERT : INTEGER;
NEXT : VALUE_PTR;
The record fields have the following values:
NAME – object values;
CERT – value confidence level

c/ LEGAL_VALUE = RECORD
NAME : WORD_STRING;
NEXT : LEGAL_ PTR;
The field value is the following:
NAME – for the extended value

d/ PREM = RECORD
OBJECT : WORD_STRING;
VALUE : WORD_STRING;
NEXT : PREM_PTR;
The record fields have the following values:
OBJECT – precondition object name
VALUE – object value

e/ CON = RECORD
OBJECT : WORD_STRING;
VALUE : WORD_STRING;
CERT : INTEGER;
NEXT : PREM_PTR;
The record fields have the following values:
OBJECT – conclusion object name
VALUE – object value
CERT – confidence level value for the conclusion

f/ RULE = RECORD
NAME : WORD_STRING;
PREM : PREM_PTR;

CON : CON_PTR;
NEXT : RULE_PTR;

The record fields have the following values:
NAME – rule name
PREM – pointer to preconditions list top
CON – pointer to the conclusions list top

g/ DEF = RECORD
NAME_DEF : STRING;
VAL_DEF : WORD_STRING;
CF_DEF : INTEGER;

The record fields have the following values:
NAME_DEF – object-goal value
VAL_DEF – text for decoding
CF_DEF – confidence level of the object-goal value

4. CONSTANTS

WORD_MAX = 40 – number of characters in the character line
COLON = " : "
PERIOD = " = "
COMMA = " , "
SPACE = " "
EQUALS = " ="
SLASH = "/"
DEFINITE = 100

5. DATA USED DURING PROGRAM EXECUTION

a/ variables of INTEGER type:
= variables used for storage of:
st_left, st_right, com_place – position of a character found in a character line
len – length of a character line
cf, cf1, cf2, prem_cert, lowest –confidence level read
pick - for the current number of object legal value
= variables used for counters:
num_vals – for object legal values
n – for object-goal values
= variables used for cycles organization:
i, j, x

b/ variables of STRING type:
line – storage of questions and object-goals values
type WORD_STRING
name_file, name_deffile – names of files
s_object, s_value, s_word, dummy, word – names of resp. objects, values, meanings
rule_name – rule name
type LINE_STRING
s_line – for storage of a character line

c/ variables of CHAR type
c – for storage of a current character of a character line
ch – for storage of a read character of the keyboard

d/ variables of POINTER type
top_fact – pointer to the objects list top
top_rule – pointer to the rules list top

last_tru – pointer to the last object searched in the objects list
curr_object – pointer to a current object
curr_value - pointer to a current object value
curr_rule - pointer to a current rule
curr_prem, curr_con - pointer to the precondition and conclusion of a concrete rule

e/ variables of BOOLEAN type
explain – flag for conclusion reasoning
true - consultation with conclusion reasoning
false - consultation without conclusion reasoning
cf_on - flag for result display
true - with confidence level
false - without confidence level
done - flag for cycle ending when a value is not found
suppress-flag for differentiation of the line processing, having question to the object
found - flag for found rule, containing object with a settling value
solved – flag for non-found object-goal value
bod - flag for fixing a new goal
e: - variable of ARRAY type
def - array containing data of the object-goal values

f/ variable of TEXT type
def_file, rules – variables for operating with DEF and RUL records archives

6. CONCLUSIONS

1. The built-in possibility for setting up a multivalue of an object allows the processing of unspecified and indefinite data.
2. The built-in possibilities for conclusions reasoning make the expert system transparent and comprehensive to the user and allow its usage for diagnostics aims.
3. The reasoning capacities of the ES can be further developed with respect to providing more information to the user concerning the conclusion tracking, goals tracing, objects values displaying, etc.

REFERENCES:

[1] G. Krastev, M. Teodosieva. Programming of mobile information terminals with MIDLetPascal. PH University of Ruse, ISBN 954-9906-68-X, 2008.
[2] Jackson P., Introduction to Expert Systems. Moscow: Вильямс, 2005, -623 p.
[3] Aikins J.S. Prototypical knowledge for expert systems. Artificial Intelligence, 2003, 210 p.
[4] Buchnan B.G. Constructing an expert system. Reading MA: Addison-Wesley, 485 p.
[5] http://www.midletpascal.com/
[6] http://www.expertsystem.net/
[7] http://www.pcai.com/web/ai_info/
[8] http://eu.wiley.com/

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The Checking of Information Systems Models Using Rules[7]

Ruta Dubauskaite, Olegas Vasilecas, Algis Saulis

Abstract: *Different models are developed when information system (IS) is designed by data, process and other aspects. The representation of information system through various models is related to the problem of ensuring consistency among different models. The problem of models inconsistency can be solved by using of formal or partially formal models with constraints. However formal models are often too complex to be used in practice. Semi-formal models are widely used, but constraints used in such a models often are suitable only for one model and relationships among models are not defined. Hence the author of paper suggests extending of IS approach based on semi-formal models and constraints, by adding the consistency rules for IS models. The proposed approach is illustrated by a case study.*

Key words: *information systems models, consistency, checking models, ensuring consistency.*

INTRODUCTION

The models of processes, states, structure and other models are created when modelling information system by various aspects. Sometimes the models of different aspects are not related. Even more, contradictory information can be provided in them. The expressing of information system through various models is related to the problem of ensuring consistency among different models. Consistency means that the structures, features and elements that appear in one model are compatible and in alignment with the content of other models [1].

Model-driven architecture (MDA) puts models into the centre of the information system development process as the source of transformation to platform-specific models (PSM). PSM is used for code generation [2]. Unambiguous models are necessary for the successful accomplishment of the tasks of models transformation and code generation [3]. Therefore checking consistency among related models is very important. Hence the objective of paper is to improve consistency of information systems models.

The remainder of the paper is organized as follows. Section "Related Work" gives a brief overview on approaches of ensuring information systems models consistency. Section "Checking of Information Systems Models Using Rules" presents the suggested approach of ensuring IS models consistency. Section "A Case Study" illustrates the usage of suggested approach for ensuring consistency. Section "Conclusions and Future Works" concludes the paper.

RELATED WORK

The problem of ensuring models consistency can be solved: i) using matrixes; ii) modelling system using semi-formal language with constraints; iii) modelling system using formal language.

Matrix can be used for showing consistency rules among different aspect semi-models [4]. For example the usage of entity-function matrix helps to check the consistency of structure and behaviour models. But this approach does not take into consideration constraints of every aspect model. Consistency of information systems models means correctness both of one model and among all models of information system.

Information system models can be created using natural language, semi-formal or formal modelling language. UML (Unified Modelling Language) is the most popular semi formal modelling language [3]. But the usage of UML can not ensure that created

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models are consistent, because of lack of formal semantics [2]. Part of semantics is defined by OCL (Object Constraint Language) constraints, most of them are provided in UML specification by natural language that is claimed to be precise. Berkenkotter [3] rectifies UML constrains expressed in OCL and formalizing UML constrains express in natural language. The main disadvantage of these works [3, 5] is that constrains only for one model are defined, but consistency rules among different models are not present.

Another suggested approach of ensuring models consistency is based on formal models [2, 6, 7]. Formal models are expressed by formal modelling language, for example Maude (based on rewriting logic) [2] description logic [7]. Most formal languages have inference mechanisms. These inference mechanisms allow to reason about the consistencies of knowledge bases. The approach based on formal models considers both static and dynamic features of object-oriented systems. The result of models checking is formal text. It is difficult enough to understand formal text even for developers of information systems.

More information about approaches of ensuring models consistency is provided in our paper [8].

CHECKING OF INFORMATION SYSTEMS MODELS USING RULES

The analysis of ensuring consistency approaches shows the inconsistency problem can be solved by using of formal or semi-formal models with constraints. Formal models are often too complex to be used in practice. Semi-formal models are widely used, but their constraints often are applied only for one model and relationships among models are not defined. Semi-formal languages are more understandable in comparison with formal languages. Semi-formal languages are also more precise in comparison with natural languages. Therefore it is relevant to improve consistency of semi-formal models.

Based on the research performed the authors of paper suggest to define constraints for aspect model in explicit way and define consistency rules among aspect models in explicit way. The approach of ensuring models consistency in object-oriented models is presented in fig. 1.

The usage of defined constraints and consistency rules allows detecting models consistency conflicts. If constraints are expressed in explicit way then it is possible to automate the process of checking consistency of developed models. When conflicts are detected then they can be removed in such way improving consistency of models. The usage of suggested approach and defined constraints and consistency rules are illustrated by a case study in the following section of the paper.

A CASE STUDY

According to suggested approach it is recommended to define constraints and consistency rules in explicit way. The example of UML model consistency rule and using of it for detecting inconsistencies in models of books library information system are presented in the chapter. Due to space limitations only one consistency rule is presented.

The authors of this paper define consistency rule between UML class and sequence models. Classes and their relations show static structure of data, while sequence model presents interactions of classes. Consistency rules are defined for metamodel. According to UML superstructure specification [9] the lifeline of sequence model can be related with class of class model through ConnectableElement ("The classifier containing the referenced ConnectableElement must be the same classifier, or an ancestor, of the classifier that contains the interaction enclosing this lifeline.").

Let's consider we are analysing books library domain and modelling:

- The process of books search using sequence model.

- The static structure of books using class model.

We remind the main elements of class model are classes and relations among them.

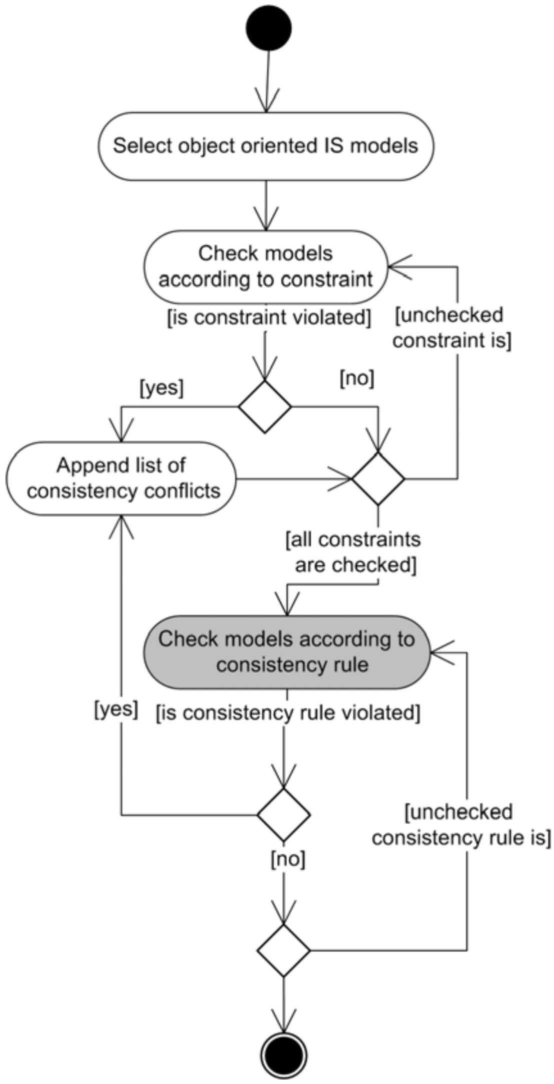

Fig. 1 Approach of checking consistency of IS models

Class consist of three parts: name, attributes and operations. Class defines type of object data. The main elements of sequence model are lifelines of objects and messages, sent and received by lifelines in order to perform process.

The authors of the paper suggest defining consistency rule between operations of class and messages of lifeline in order to test the suggested approach. Consistency rule consists of a textual description and a formal constraint expressed in OCL.

The operation of classifier containing the referenced Message of Connectable element must be the same operation of the classifier that contains the interaction enclosing this message of lifeline.

```
context ce : UML::CompositeStructures::InternalStructures::
ConnectableElement inv OperationOfClassMustBeMessageOfLifeLine :
    ce.class.operation=ce.lifeline.interaction.message
```

Using consistency rule OperationOfClassMustBeMessageOfLifeLine helps to detect consistency conflict between models presented in fig 2. Static structure, classes and their relations can be presented graphically using UML class diagram. While interactions can be showed using UML sequence diagram. Lifeline Book (fig. 2, right column) is related with class Book (fig. 2, left column). Lifeline Book has message getBookDetails. While class Book, which is equivalent of lifeline Book, has no operation. Operation getBookDetails is also not present is this class. It means that static structure and behaviour models are inconsistent.

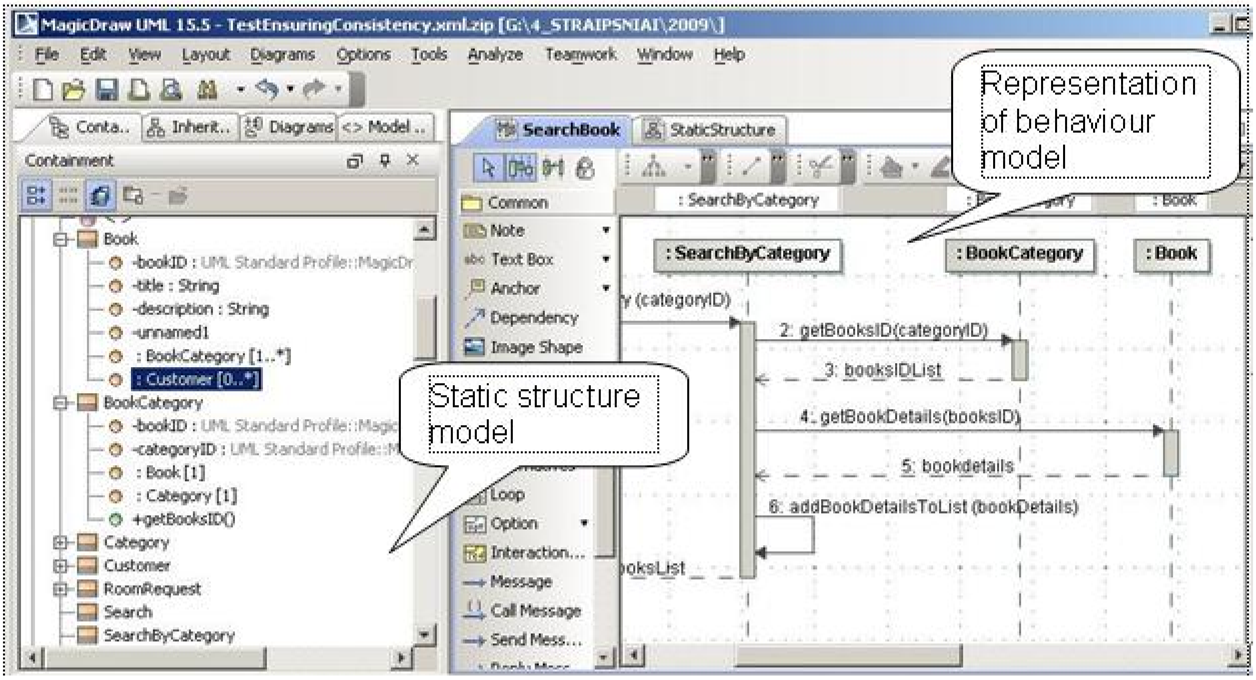

Fig. 2 The example of models and their consistency conflicts

If designer add operation getBookDetails to class Book, then consistency between static structure and behaviour models would be improved.

The process of checking models consistency rules can be automated using CASE tools. Because of space limitations, CASE tools are not detailed here. Checking consistency of UML models using MagicDraw UML and PowerDesigner tools is presented in our paper [12]. The authors of the paper implement consistency rules using MagicDraw UML tool [8].

CONCLUSIONS AND FUTURE WORK

The analysis of related works shows semi-formal models are widely used, but their constraints often are applied only for one aspect and relations among models are not defined. Despite many results that have been achieved on models consistency, the problem of ensuring models consistency is still open and relevant.

Based on the research performed the authors of paper suggest extending of object-oriented methods by defining constraints for aspect model in explicit way and consistency rules among aspect models in explicit way.

A case study shows that the using of suggested approach allows detecting of inconsistencies of different aspect models.

In future works we are going to elicit consistency rules from different object oriented methods and from metamodels of modelling languages expressed in explicit and implicit way. The next step is implementing of defined rules in MagicDraw UML tool and testing the suggested approach with defined consistency rules.

REFERENCES

[1] Rozanski, N.; Woods, E. (2005). Software System Architecture. London: Addison-Wesley. 546 p.

[2] Mokhati, F.; Gagnon, P.; Badri, M. (2007). Verifying UML Diagrams With Model Checking: A Rewriting Logic Based Approach. Proceedings of the Seventh International Conference on Quality Software. USA,p. 356–362.

[3] Berkenkötter, K. (2008). Reliable UML Models and Profiles. Electronic Notes in Theoretical Computer Science (ENTCS), vol. 217, p. 203–220.

[4] Saulis, A.; Vasilecas, O. (2008). Informacinių sistemų projektavimo metodai. Vilnius: Tehcnika. 247 p.

[5] Pakalnickienė, E., Nemuraitė, L. (2007). Checking of conceptual models with integrity constraints. Information technology and control, T. 36, no. 3, p. 285–294.

[6] Van Der Straeten, R.; Simmonds, J.; Mens, T.; Jonckers, V. (2003). Using Description Logic to Maintain Consistency between UML Models. UML 2003: LNCS 2863. Berlin: Springer-Verlag. 326–340.

[7] Simmonds, J.; Bastarrica M. C. (2005). Description Logics for consistency checking of architectural features in UML 2.0 models. DCC Technical Report TR/DCC-2005-1, Departamento de Ciencias de la Computacion, Santiago, Chile.

[8] Vasilecas, O., Dubauskaite, R. (2009). Ensuring Consistency of Information System Rules Models. Stoilov, T., Rachev, B. (eds.), Proc. of the International Conference on Computer Systems and Technologies "CompSysTech'09", Ruse, Bulgaria, 18-19 June (in press).

[9] OMG. (2007). OMG Unified Modeling Language (OMG UML), Superstructure, v2.1.2 , OMG Document: formal/2007-11-04. Available at <http://www.omg.org /docs/formal/07-11-02.pdf>, last visit 2009 04 01.

[10] Booch, G.; Rumbaugh, J.; Jacobson, I. (1998). The Unified Modeling Language User Guide. Addison Wesley 512 p.

[11] Chonoles, M., J.; Quatrani, T.. Lockheed M. Advanced Concepts Center, Rational Software Corporation. (1996). Succeeding with the Booch and OMT methods: a practical approach, Addison-Wesley, 378 p.

[12] Dubauskaitė, R.; Vasilecas, O. (2009). Checking Consistency of UML Models Using MagicDraw UML and PowerDesigner Tools, Informatics: proc. of 12th conference of Lithuanian‘s researchers, Vilnius: Technika (in press).

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