3rd INTERNATIONAL DOCTORAL CONSORTIUM ON INFORMATICS ENGINEERING EDUCATION RESEARCH: METHODOLOGIES, METHODS, AND PRACTICE

Vilnius University Institute of Mathematics and Informatics in cooperation with
NNEER - Nordic Network in Engineering Education Research
The Research Council of Lithuania
Lithuanian Computer Society

Organisers:
Prof. dr. Valentina Dagienė, chair
Dr. Tatjana Jevsikova
Inga Žilinskienė

3–7 December 2012
Druskininkai, Lithuania

ALL PARTICIPANTS

prof. dr. **Valentina Dagienė,** Vilnius University, Lithuania (chair)
prof. dr. **Jonte Bernhard,** Linköping University, Sweden
prof. dr. **Albertas Čaplinskas,** Vilnius University, Lithuania
prof. dr. **Robin Clark,** Aston University, UK
dr. **Anna Eckerdal,** Uppsala University, Sweden
prof. dr. **Gerald Futschek,** Vienna University of Technology, Austria
dr. **Tatjana Jevsikova,** Vilnius University, Lithuania
dr. **Päivi Kinnunen,** University of Eastern Finland
dr. **Ari Korhonen,** Aalto University, Finland
dr. **Svetlana Kubilinskienė,** Vilnius University, Lithuania
dr. **Ričardas Kudžma,** Vilnius University, Lithuania
dr. **Eugenijus Kurilovas,** Vilnius University, Lithuania
prof. dr. **Mattia Monga,** Milan University, Italy
dr. **Noa Ragonis,** Beit Berl College, Technion, Israel
prof. dr. **Márta Turcsányi-Szabó,** Eötvös Loránd University, Hungary
dr. **Virginija Šimonytė,** Lithuanian University of Educational Sciences

Tapio Auvinen, PhD student, Aalto University, Finland
Renata Burbaitė, PhD student, Kaunas University of Technology, Lithuania
Nikoletta Ekker, PhD student, Eötvös Loránd University, Hungary
Natasa Grgurina, PhD student, Groningen University, the Netherlands
Natalija Ignatova, PhD student, Lithuanian University of Educational Sciences
Violeta Jadzgevičienė, PhD student, Lithuanian University of Educational Sciences
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Jūratė Urbonienė, PhD student, Vilnius University, Lithuania
Michaela Veselovska, PhD student, Comenius University in Bratislava, Slovakia
Inga Žilinskienė, PhD student, Vilnius University, Lithuania

A G E N D A

Monday, December 3

15:00	Transfer to Druskininkai – bus leaves from the Vilnius airport at 15:05
18.30	Dinner
19.30	Welcome, being together, and social activities (including sauna)

Tuesday, December 4

07.30 – 09.00	*Breakfast*
09.00 – 10.00	**Prof. dr. Márta Turcsányi-Szabó** (Eötvös Loránd University, Hungary): Innovations in Educational Technology - Augmenting teacher education to involve public education, professional development and informal learning.
10.00 – 11.00	**Dr. Robin Clark** (Aston University, UK): What's in a method? Choosing an appropriate methodology and why it is important.
11.00 – 11.30	*Coffee break*
11.30 – 12.15	**Prof. dr. Jonte Bernhard** (Linköping University, Sweden): What is the level of a PhD thesis in Engineering Education Research? Role of Nordic Network in Engineering Education Research.
12.15 – 13.00	**Dr. Ari Korhonen** (Aalto University, Finland): On research of the role of visualization in computer science education
13.00 – 14.00	*Lunch*
14.00 – 15.00	**Dr. Päivi Kinnunen** (University of Eastern Finland): Classifying computing education papers: taxonomies and what we can learn from them
15.00 – 16.00	**Dr. Anna Eckerdal** (Uppsala University, Sweden): Developing learning models in educational research: an example from computing education
16.00 – 16.30	*Coffee break*
16.30 – 17.30	**Prof. dr. Gerald Futschek** (Vienna University of Technology, Austria). Criteria for writing informatics education doctoral thesis from a reader's viewpoint. Group work
17.30 – 22.00	**Initial posters' presentations of doctoral students and discussions**
(19.00 – 20.00	*Dinner*)

Wednesday, December 5

07.30 – 09.00 *Breakfast*

09.00 – 13.00 Group work. Students will be divided in 4–5 working groups according to their topic. The senior researchers will be appointed to each group (*coffee break* at 11.00–11.30)

13.00 – 14.00 *Lunch*

14.00 – 15.00 **Prof. dr. Albertas Čaplinskas** (Vilnius University Institute of Mathematics and Informatics). Doctoral studies in Informatics engineering in Lithuania and relationship with education.

15.00 – 18.00 **Dr. Noa Ragonis** (Beit Berl College, Technion, Israel). Qualitative research methods in computer science education research: Review, demonstration and implementation approaches. An activity based lecture and workshop (*coffee break* at 16.00–16.30)

18.00 – 22.00 Group works continued

(19.00 – 20.00 *Dinner*)

Thursday, December 6

07.30 – 08.30 *Breakfast*

8.30 – 12.00 Excursion. Alternative: Group work and improvement of posters

12.00 – 13.00 **Dr. Päivi Kinnunen** (University of Eastern Finland). Qualitative data collection and analysis methods.

13.00 – 14.00 *Lunch*

14.00 – 16.00 Group work. Improve your initial poster which summarizes your research: Your BIG research question, goal, small subtasks, data collection and analysis methods, theoretical framework, scope, and use of results.

16.00 – 16.30 *Coffee break*

16.30 – 18.00 Doctoral poster presentations: all participants should read posters and write down their questions or comments.

18.00 – 19.00 *Dinner*

19.00 – 21.00 Summing up: overview and suggestions by group leaders. General discussion, including a brainstorming session about current and future research topics in the area.

Friday, December 7

07.30 – 09.00 *Breakfast*
09.30 Departure

The aims of the consortium are:

- To offer a friendly forum for doctoral students to discuss their research topics, research questions and design in the field of computing education / educational technology – informatics engineering and education.
- To receive constructive feedback from their peers and senior researchers, to help with choosing suitable methodology and strategies for research.
- To support networking with other researchers in the informatics engineering education research field.
- To discuss any relevant questions related to research and academic life.

Participants

The consortium is designed primarily for students who are currently enrolled in any stage of doctoral studies with a focus on informatics / informatics engineering / computing education research. Students, who are considering doctoral studies but not have yet a formal doctoral student researcher status, may participate as well.

Senior researchers in the field will provide feedback and suggestions for improvement of the research proposals.

Requirements

Each participant should submit a document, which includes the following information:

- a brief background of the applicant including information about prior studies, research topic, publications if any, and possible teaching experience;
- a summary of his/her research, including motivation, any relevant background, and main literature (3-5 items) to contextualize the research, research questions, methodologies used or planned, and possible results obtained;
- questions related to the research that the applicant would like to discuss and get feedback on in the doctoral consortium.

The summary will be made available for other participants of the doctoral consortium to allow providing feedback and preparing questions on the research. The research summaries are in free format and should be 2-4 pages long. The following elements must be addressed in the papers and we suggest that you use these as headings for the sections of your submission:

1. A clear formulation of the research question(s);
2. An identification of the significant problems in the field of research;
3. An outline of the current knowledge of the problem domain, as well as the state of existing solutions;
4. A presentation of any preliminary ideas, the proposed approach and achieved results;
5. A sketch of the applied research methodology (data collection and analyzing methods)
6. A description of the Ph.D. project's contribution to the problem solution;

A discussion of how the suggested solution is different, new, or better as compared to existing approaches **to** the problem.

SENIOUR RESEARCHERS

Jonte Bernhard

Jonte Bernhard is full professor professor in engineering education research (EER) at Linköping University, Campus Norrköping, Sweden. Before becoming full professor in 2012 he was associate professor in physics, especially electronics, at Linköping University between 1999-2012 and senior lecturer in engineering physics at the School of Engineering, Dalarna University, Borlänge, Sweden, between 1990-1999. He was a postdoc at RIKEN, Japan, in 1989-1990 and visiting professor in physics education research at University of Maryland, USA, in 1999. His research is presently focused on engineering and physics education with several grants from the Swedish Research Council, and he has initiated the Engineering Education Research Group at Linköping University. Previously Dr Bernhard has an extensive record of research in magnetic materials with a Ph.D. in Solid State Physics and a M.Sc. (Eng.) degree in Engineering Physics from Uppsala University. Presently he is co-ordinator for the Nordic Network for Engineering Education Research (NNEER) funded by the Nordic Council and he is an associate editor for European Journal of Engineering Education. Dr Bernhard has also been the chairman of the SEFI Working Group on Engineering Education Research (WG-EER).

Summary of presentation

What is the level of a PhD thesis in Engineering Education Research? Role of Nordic Network in Engineering Education Research

In recent years research studies into critical factors for learning in engineering education (EER) have started to emerge in Europe and worldwide. In a review by Case and Light (2011), it was "argued that methodological decisions need to be more explicitly represented in reports … in engineering education research", and in the review and meta-analysis conducted by Koro-Ljungberg and Douglas (2008), it was found that the issue of methodology has received limited explicit discussion in EER-literature and that many studies lacked epistemological consistency. As will be suggested below methodological and perspective awareness and epistemological consistency are important aspects of quality.

The conception of quality in scientific work is fundamental, and determines what researchers judge as reliable knowledge in their field. Although quality criteria are used daily in research, extensive reviews discussing research quality, especially in EER, are lacking. Borrego and Bernhard (2011) briefly discuss different views on quality in their review and specifically discuss method-led versus problem-led research as well as their different views on quality. When a thorough discussion is lacking it poses the risk that the criteria applied tend to be isolated to the individual and that each individual has more or less well thought-out ideas about what is 'good'

and what is 'bad'. Also, it could lead to an unquestioning acceptance of one research paradigm, or epistemology, which is often the dominant paradigm. This can lead to an inappropriate matching of research questions to methodologies, a confusion of reliability with validity, and a lack of transparency in the criteria being applied for what constitutes quality in research. Although what I will communicate in my presentation is relevant to quantitative research, I will focus on qualitative research since it is the area that induces the most controversial discussions about quality in contemporary EER.

Table 1. Tentative quality criteria for (qualitative) engineering education research.

Quality of a study in general	**Quality of the results**	**Validity of the results**
• *Perspective awareness* All studies have a perspective. • *Acknowledging different knowledge traditions and cultures* Respect and awareness of the perspective of other researchers. • *Upholding ethical values* How can the study contribute to enhancing the human condition? • *Informed by theory and other literature describing prior work* A researcher cannot perform significant research without first understanding the literature in the field. • *Research question* Worthy topic: Relevant, timely, significant, interesting. • *Internal consistency in a study (Including epistemology with methodology)* Harmony should exist between the research question, assumptions about the research and the nature of the phenomenon to be studied, data collection, and methods of analysis.	• *Richness in meaning* Capture the essentials and at the same time maintain the nuances. Highlight what is unique to the specific phenomenon at hand. • *Structure* Interpretations should have a good structure. It should be possible to follow the reasoning. • *Contribution to theory development and new knowledge* How well does one relate to earlier theory? What is the original contribution of the study; something decisive or just a note in the margin? • *Presentation of results* Presentation relevant to proposed audience, clear and precise language, and a good balance between different parts of the presentation.	• *Discourse criterion* In the criterion validity is viewed as a conversation about the world (or reality). The quality of argumentation and interplay of meanings. • *Heuristic value* To what extent will a reader be convinced by the presentation of the study in seeing a particular aspect of reality in a new way? • *Empirical anchoring* The relation between reality and interpretation. • *Consistency (including epistemological and theoretical underpinnings)* The interplay between part and whole. • *Pragmatic criterion* Consequences of what the results brought about (for example in relation to teaching). This is an aspect of what is also called ecological validity.

Some of the mentioned criteria could be considered contradictory and the right balance has to be established, while depending on the type of study, certain criteria are more important than others. The most imperative aspect of quality may be that we pose good research questions.

Robin Clark

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Robin gained his Bachelors and PhD in Mechanical Engineering from University College London, has an MBA from Western Connecticut State University in the USA and a Postgraduate Certificate in Learning and Teaching in Higher Education from Aston University. Robin has worked in the UK and the USA as both an engineer and manager during a 14 year career in industry. His work focused on inspection development and application in the nuclear and rail industries. On joining Aston University in 2003, he took a lead role in developing the School of Engineering and Applied Science MSc in Engineering Management (accredited by the Chartered Management Institute). Using experience gained in industry, Robin has developed a creative teaching practice that in 2007 resulted in the award of a National Teaching Fellowship. Although engaged in research in the engineering and management fields, most recently as a co-director of Aston's Centre for Project Management Practice, Robin is now focussing on Learning and Teaching and building a strong research capability at Aston focused on Engineering Education. In 2011 Robin initiated the Engineering Education Research Group in the School of Engineering and Applied Science. He is on the editorial boards of JEE, EJEE, EE and JPEER. Robin co-ordinates the UK Special Interest Group in EER, is one of 2 European representatives on REEN (the global Research in Engineering Education Network) and has recently been elected Chair of the SEFI EER Working Group. His interests lie in all areas of Engineering Education from developing the engineering imagination of primary school children to working with people in employment who want to develop their learning and skills. Robin is a Chartered Engineer and Fellow of the IMechE, a Chartered Manager and Fellow of the CMI, as well as being a Fellow of the Higher Education Academy. He has recently taken on the role of Head of Learning and Teaching Development in the School of Engineering and Applied Science and is leading the work to improve the student experience at Aston.

Summary of presentation

What's in a Method – Choosing an appropriate methodology and why it is important

As more activity takes place in the area of engineering education, the skills of PhD students embarking on a programme of study become ever more diverse. Often well versed in hard science research skills, the need to embrace the demands of a rigorous social science research project can be challenging.

Drawing on personal experience and good practice, the presentation will explore the importance of ensuring a well thought out research methodology is in place before any work is undertaken. The potential pitfalls will be discussed and the steps to ensuring that the chosen methodology yields a piece of research work that truly will make a 'contribution to knowledge' will be explored.

Albertas Čaplinskas

Prof. Albertas Čaplinskas is Chief research fellows and head of the Software Engineering Department at the Institute of Mathematics and Informatics, which is a part of Vilnius University (Lithuania). Albertas Caplinskas graduated (1966) in Mathematics from the Moscow Lomonosov State University. He defended his doctor thesis in computer sciences (1994) at the Vytautas Magnus Dux University (Kaunas, Lithuania). He is author of two and co-author of two books, editor and co-editor over 10 books, published over 100 research papers in information system engineering, software engineering, legislative engineering, knowledge engineering and related areas. He lectures "Software Engineering" course at Vilnius University (some time also at Vilnius Gediminas Technical University and at Vytautas Magnus Dux University) from 1972. In parallel, he taught many other courses, including different requirement engineering, programming languages, AI, discrete mathematic, numerical analysis, and singular integral equations. Currently he lectures "Research methods and methodology in Informatics and Engineering in Informatics", "Generative and Aspect-oriented programming methodology", "Logical Foundations of AI", "Ontological Foundations of IS" and "Mathematical Foundations of Informatics" courses for doctoral students and is a chairmen of Vilnius University Doctoral Studies in Engineering in Informatics Committee. Prof. Albertas Caplinskas has been awarded by the Council of Ministers of Soviet Lithuania for the research "Mathematical models and application packages for analysis, planning, control and design of the physical and technical systems" (1987), Lithuania Mathematicians Society Zigmas Žemaitis medal (2005) and by Lithuanian State Award in Science (2006).

Summary of presentation

Doctoral studies in Informatics engineering in Lithuania and relationship with education.
The following issues will be discussed in the presentation:

a) The differences between Informatics and Informatics Engineering in Lithuania.
b) Research in Informatics Engineering in Lithuania
c) Studies in Informatics Engineering in Lithuania
d) Informatics Engineering in Vilnius University
e) Main requirements for doctoral studies in Informatics Engineering at Vilnius University
f) Overview of the Study Programme for doctoral studies in Informatics Engineering at Vilnius University
g) Overview of the Curricula for the course „Research methods and methodologies in Informatics and Informatics Engineering"

Valentina Dagienė

Date of birth: December 18, 1954.

Academic position

Head of Informatics Methodology Department at Vilnius University Institute of Mathematics and Informatics

Professor at Vilnius University Faculty of Mathematics and Informatics

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Valentina Dagiene is professor at Vilnius University (MS in Applied Mathematics, PhD in Computer Science, Dr. Habil in Education). Her research interests focus on the teaching and learning informatics (Computer Science) at secondary schools, use of computer tools as mind tools for learning. She has published over 150 scientific papers and the same number of methodological works, has written more than 50 textbooks in the field of informatics and IT for schools. She is Editor-in-Chief of two international journals "Informatics in Education" (since 2002) and "Olympiads in Informatics" (since 2007).

She has been working in various expert groups and work groups, organizing the Olympiads in Informatics among pupils, also engaged in technology enhanced learning and computational thinking. She is vice chair of the IFIP TC3 Committee on Education, Member of the WG3.1, vice chair of the SIG3.9 (Special Interest Group on Digital Literacy). She is elected to the International Steering Committee on Olympiads in Informatics (since 2006) and established International conference on Olympiads in Informatics (held in Croatia, 2007, Egypt, 2008, and Bulgaria, 2009, Canada, 2010, Thailand, 2011, Italy, 2012). In 2004 she established the International Contests on Informatics and Computer Fluency BEBRAS (Beaver) which runs each year in more than 20 countries. She is the initiator and the leader in preparing informatics and IT curricula for Lithuanian schools.

Valentina is organizing this international doctoral consortium third year. Thank you all for joying us!

Anna Eckerdal

Personal data
Date of birth: September 18, 1957. Family: three children (1989, 1991, 1996).
Academic position
Lecturer at the Department of Information Technology
Education
M.Sc. in Scientific Subjects Education including Mathematics and Physics, Uppsala University, June 1982.
PhD in Computer Science with specialization in Computer Science Education, Uppsala University, March 2009.

Other qualifications

- Member of the UpCERG research group, Department of Information Technology, Uppsala University
- Since 2005 active in Sweden Group, a research collaboration with 7 participants from Sweden, UK and US.
- Organizer of the annual 4 days Sweden Group research meeting at Uppsala University, 2005 - 2011.
- Member of Nationellt nätverk för Fenomenografi och Variationsteori
- Leader of the programming teacher team at the IT-department, division of TDB.
- Co-organizer of the second workshop on Phenomenography in Computer Science Education research, PhICER, University of Kent, Canterbury, UK, September 11-12, 2006.
- Member of the Program Committee, for ICER 2010 and 2012, THE INTERNATIONAL COMPUTING EDUCATION RESEARCH WORKSHOP
- Invited Key note speaker at BRACElet workshop, Auckland, New Zealand, September 9-10, 2010
- Invited guest researcher, Auckland University of Technology, September 4-19, 2010
- Co-organizer of the Doctoral Consortium, to be held at the LaTiCE conference in Macau, March 2013.
- Reviewer for the journal International Scholarly Research Network, http://www.isrn.com/
- Research grants, selected
- Helge Ax:son Johnsons Stiftelse: 20.000 SEK 2007, 40.000 SEK 2009, 40.000 SEK 2011
- ACM SIGCSE grant, 5000 USD to Sweden Group 2009
- FORUM för ämnesdidaktiska studier, Uppsala University: 78.000 SEK, 2011
- The Swedish Research Council, 5,5 MSEK, 3 years. Start 2012

Research interests
My research area is computing education research. My thesis that I defended in March 2009 focuses on the complex relationship between students learning of theory and their learning of practice in programming education. I have currently a research grant from the Swedish Research Council together with colleagues from the UpCERG research group at the IT-department at Uppsala University, and the Royal Institute of Technology, Stockholm.
Beside this I have a research project together with six researchers from Sweden, the UK, and the USA. We have done research on threshold concepts in computer science and on self directed learning related to computer science education.

Summary of presentation

Developing learning models in educational research: an example from computing education

In this presentation I will discuss an ongoing research project, funded by the Swedish Research Council. In the project we aim to better understand the relation between how students learn theory and how they learn practice in the lab. The students are novices programming students taking their first programming course.

Our main research approach is phenomenography and variation theory (Marton and Booth, 1996; Marton and Tsui, 2004).We will study and compare the lived object of learning, the intended object of learning, and the enacted object of learning.

The research method includes video filming of students in the lab and subsequent stimulated recall interviews. From the video we identify a few sections in the film where students seem to gain some new theoretical and/or practical knowledge. In the subsequent interviews, we show these sections of the video film to the students and ask them questions on what new knowledge they came to see, and how they came to see it. In this way we aim at describing the lived object of learning as experienced by the students. We will furthermore interview the teacher who is responsible for the lab aiming at understanding his or her intention with the lab, and with the aim to describe the intended object of learning. Finally, we will analyse the lab material, aiming at describing the enacted object of learning. The three objects of learning will then be compared, and implications for teaching in the computer lab discussed.

In the analysis of the lived object of learning we use a framework, mainly inspired by phenomenography and variation theory. To study how students learn theory we use "the broken triangle" as developed by Anderberg et al (2008. To study how students learn practice we use a similar triangle developed by us (Thuné and Eckerdal, work in progress).

In the presentation I will focus on how we use models of learning to guide our analysis of the lived object of learning, and how we have developed existing models for the purpose of our research study.

Gerald Futschek

Prof. Dr. techn.
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Gerald Futschek has the position of an Associate Professor at the Institute of Software Technology and Interactive Systems at Vienna University of Technology. He studied Mathematics and Informatics at Vienna University of Technology and graduated to Dr. of technical sciences in 1984. He works on several initiatives to increase the digital fluency of all people and to prevent the digital divide: European Computer Driving Licence ECDL, Austrian Bebras Contest on Informatics and Computer Fluency, e-Learning for prisoners, etc. His research interests are Software Verification and Informatics Didactics. He has a lot of experience in teaching academic courses on Software Engineering, Software Verification and Validation, Proofing of software correctness, Algorithms and Data Structures, Introduction to Programming mainly at Vienna University of Technology, some of them also at University of Zurich and at Pristina University of Business and Technology. From 2007 to 2011 he was president of the Austrian Computer Society.

Summary of presentation

Criteria for writing informatics education doctoral thesis from a reader's viewpoint.
How to write a PhD Thesis?

The scientific work is almost done and it is time to write the thesis. Then there arise a lot of questions: What contents to write? In what order? In what style? How many details? What can be dropped? What should be put in the main part, what in the appendix? Who will read my thesis? What language should I use? What can be taken for granted? How differs a PhD thesis from a scientific paper? How to cite? How to avoid plagiarism? How to mention my helpful friends and colleagues? How to involve my own publications? How many pages? How to introduce in my topic? How to formulate my problem definition? How to present my results? How to use abbreviations? Etc., etc. We will discuss some of these topics.

Tatjana Jevsikova

Tatjana Jevsikova received her B.Sc. degree in mathematics and informatics from Vilnius Pedagogical University, Faculty of Mathematics and Informatics, in 2000.

In 2002 she received the M.Sc. degree in informatics and qualification of a teacher of mathematics and informatics from Vilnius Pedagogical University, Faculty of Mathematics and Informatics.

In 2009 she received a PhD degree in physical sciences (informatics) from the Institute of Mathematics and Informatics and Vytautas Magnus University. PhD thesis topic "Internet software localization".

Since 2001 Tatjana Jevsikova has been working as a researcher for the Vilnius University Institute of Mathematics and Informatics, Informatics Methodology Department.

Since 2008 she has been teaching at the faculty of Mathematics and Informatics, Vilnius University. She runs courses for pre-service teachers of mathematics and informatics (Bachelor and Master students): Virtual learning environments (since 2008), Software Localization (since 2008), Educational information technologies (2008–2010), Information processing with computers (since 2012), Textual and numeric data processing (since 2008), and Computer-aided design of teaching (since 2011).
Her area of interests include: e-learning, educational information technologies, learning objects, innovative learning and teaching methods, software localization, and computer terminology.

She has published over 20 scientific papers and several books (including monograph and textbook on software localisation, and computing dictionary).

Tatjana Jevsikova participated in European projects CALIBRATE (Digital learning resources for schools), 2006–2008, and e-Start (a Network of key players for promoting Digital Literacy in Primary and Lower Secondary (K-9) education in Europe and beyond), 2007–2009, and in more than 15 national Lithuanian projects on information technologies and e-content in education.
She is a junior member of International Federation for Information Processing (IFIP) TC 3 WG 3.1 (Informatics and ICT in Secondary Education), a member of Commission of the terms of informatics and information technologies.
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Päivi Kinnunen

Education:

- PhD, computing education, Helsinki University of Technology
- Lic. A. Educ, Helsinki University

Work Experience:

- *Senior researcher*, University of Eastern Finland, Philosophical Faculty, School of Educational Sciences and Psychology. September 2010 onwards.
- *Research associate*, University of California San Diego, 2009 –2010.
- *Researcher*, Helsinki University of Technology, Laboratory of Information Processing Science, 2003 – 2009.
- *Research assistant*, Helsinki University of Technology, Laboratory of Information Processing Science, 2001–2002.

Summaries of presentations

Qualitative data collection and analysis methods

In this presentation I will give an overview of qualitative research methods and designs that can be used in the field of computing education research. I will talk about different data collection and analysis methods as well as how to enhance quality in qualitative research. The emphasis between different aspects of this talk will be adjusted according to participators' interests and needs.

Classifying computing education papers: taxonomies and what we can learn from them

This presentation will give an overview of different kinds of taxonomies that have been used in computing education research. I will discuss about the motivation to classify research publications as well as what we can learn from the results. I will introduce two taxonomies in more details using examples of ongoing classification research projects.

Ari Korhonen

Personal information

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Current positions

1. Senior Scientist, Department of Computer Science and Engineering, Aalto University School of Science, 2011–
2. Co-Founder (2008), CEO, By The Mark CO, 2010–

Previous professional appointments

- Researcher, Department of Computer Science and Engineering, Faculty of Information and Natural Sciences, Aalto University School of Science and Engineering (2010)
- Adjunct Professor in Software Visualization, Helsinki University of Technology, 2006–2011
- Acting professor, Helsinki University of Technology, 2002 (12 mo)
- Lecturing Researcher, Department of Computer Science and Engineering, Helsinki University of Technology (2000–2009)
- Researcher, Helsinki University of Technology, 1998–2000

Education

Doctor of Science in Technology, Helsinki University of Technology (in Computer Science), 2003

Research interests

During the past 15 years, I have been researching science and computing education. My main interests are in developing advanced interactive learning environments and automatic assessment systems, especially for learning programming on various levels. I have directed related research projects financed by the Academy of Finland, and Technology Industries of Finland Centennial Foundation (TIFCF). My research group has a large number of contacts within international computing education research community, and European engineering education research community. The most active collaboration with US researchers includes developing an open framework for web-based learning environments in programming education (Prof. Cliff Shaffer, Prof. Stephen Edwards, Virginia Tech, Prof. Thomas Naps, U. of Wisconsin-Oskosh). Our work has also been recognized by the Ministry of Education in Finland. They have designated us three times as a national Center of Excellence in University Education for the periods 2001–2003, 2004–2006, and 2010–2012. My current research project is called “Interoperability and Social Media in CS Learning Environments”, 2011–2014 funded by TIFCF.

Summary of presentation

On research of the role of visualization in computer science education

Software visualization (SV) studies visual representations of software artifacts and software systems to illustrate their structure, history, and behavior. SV has been utilized in computing education by producing interactive visualizations that portray the many abstract concepts regularly occurring in computer science. In this presentation, first, I'm going to introduce the engagement taxonomy (ET) that is a research instrument targeted to SV developers and researchers. Second, we'll discuss the role and importance of engagement in learning environments. Finally, I'll cover a couple of studies utilizing ET, and what I have learnt while conducting experimental studies with randomized groups.

Svetlana Kubilinskienė

Svetlana Kubilinskienė received the qualification of a physics, astronomy and informatics teacher at secondary schools from the Lithuanian University of Educational Sciences (former Vilnius Pedagogical University) in 1995 and a Master's degree in mathematics and the qualification of a mathematics and informatics teacher at high schools in 1996. She received the PhD in technological sciences (informatics engineering) at Vilnius University Institute of Mathematics and Informatics in 2012. The disertation „Extended metadata model for digital learning resources" was meant for solving the problems of using methodological resources and modern learning methods, which arise due to insufficiency of information in the metadata repositories of learning object (LO). Since 1995 she has been working at the Centre of Information Technologies in Education, responsible for the Lithuanian national LO metadata repository, its design and development. Her research interests include the management and reuse of digital learning resources, metadata specification and standards, development of learning object and related software, learning management systems and environments.

Project activity:

- The eContentplus program ASPECT (Adopting Standards and Specifications for Educational Content, 2008-2011), URL: http://aspect-project.org/ project.
  Coordination of project activities:
  - learning resources and repositories;
  - European Learning resources exchange;
  - learning resources handling and storage standards;
  - standards and interoperability.
- The EU 6th Framework IST program CALIBRATE ("Calibrating e-Learning in Schools', URL: http://calibrate.eun.org/ww/en/pub/calibrate_project/home_page.htm) project.
  Coordination of project activities:
  - learning resources and repositories;
  - European Learning resources exchange;
  - software evaluation and deployment;
  - dissemination of results.
- The EU's E-Learning program P2V ("Peer to Peer networking for Valorisation ', URL: http://www.europeanschoolnet.org/ww/en/pub/eun/projects/coordinator/p2v.htm) project.
  EUN INSIGHT 2007. ICT in education policy in Lithuania reporting.
  Coordination of project activities:
  - learning resources;
  - teachers' professional development;
  - virtual learning environments.
- EU eContentplus program EdReNe ('Educational Repositories Network', URL: http://www.edrene.org/) project.
  Coordination of project activities:
  - learning resources and their storage;
  - standards and interoperability;

    - learning resources for producers and users of incorporation;
    - digital rights management.
- Curriculum-based ICT development and deployment based on an Integrated Science Education course of 5-6 grade, URL: http://gamta.pedagogika.lt/
  Member of the expert group ICT-based curriculum recommendations and the preparation of the document.
- "Safer Internet", URL: http://www.draugiskasinternetas
  Lecturer:
    - Internet access and use in the education system;
    - the European Commission project "Safer Internet" mission, objectives and implementation;
    - suggestions on how to protect children from online threats;

safer use of the Internet.

Ričardas Juozas Kudžma

Ričardas Juozas Kudžma, born 10.07.1945.

Graduated secondary school in 1962, Vilnius University 1967.
Defended doctoral dissertation "Invariance principle in optimal stopping problems" 1973 at Vilnius University.
Stay abroad: Moscow M. Lomonosov University, 4 months, 1974, Jena Fridrich Schiller University (German Democratic Republic), 10 months, 1979-1980, Aalborg University, 1 month, 1996, Munich Technical University, 1 month, 1997, Agder University, 2 weeks, 2009.

Job activities:
Vilnius University, Faculty of Mathematics, 1967 till now, docent (associate professor) since 1981,
dean of the Faculty of Mathematics of Vilnius University 1992-1998,
associate professor at Adis Ababa University (Ethiopia) 1988-1990.
Since 1991 I am at the Department of Didactics of Mathematics.

Lectures delivered at the Faculty of Mathematics and Informatics:
1. Mathematical analysis, 1-4 semesters.
2. Methods of teaching mathematics, 5th semester (for prospective teachers).
3. Didactics of mathematics, 1st semester Master program (for prospective teachers).
4. Survival models, 6th semester.

Member of Program committees of international conferences *Teaching Mathematics: Retrospective and Perspectives* Tallinn (2003), Vilnius (2005), Tartu (2006), Riga (2007), Vilnius (2008), Tallinn (2009), Daugavpils (2010), Šiauliai (2011), Tartu (2012).

Member of the Board of Lithuanian Mathematical Society,
Member of the Board of the Lithuanian Actuarial Society.
Member of Education Committee of the European Actuarial Consultative Group,
Member of Education Committee of the International Actuarial Association.

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Eugenijus Kurilovas

Dr. Eugenijus Kurilovas is Research Scientist in Vilnius University Institute of Mathematics and Informatics, Head of International Networks Department of the Centre of Information Technologies in Education of the Ministry of Education and Science of Lithuania, and Associate Professor in Vilnius Gediminas Technical University.

His main research area is technology enhanced learning, i.e. interoperability and quality of learning objects, their repositories and virtual learning environments, learning personalisation, and Semantic Web application in education.

He has published over 80 scientific papers, 2 monographs, and 4 chapters in scientific books. The main articles are published and / or in print in a number of well-known international journals indexed / abstracted in ISI Web of Science e.g. *Decision Support Systems (DSS), Computers in Human Behavior (CHB), International Journal on Semantic Web and Information Systems (IJSWIS), International Journal of Engineering Education (IJEE), Journal of Web Engineering (JWE), Knowledge Management Research & Practice (KMRP)* as well as in several Lithuanian ISI journals e.g. *Informatica, Information Technology and Control, Technological and Economic Development of Economy* etc.

He is reviewer and member of 20 editorial boards and committees of international scientific journals and conferences.
He is also guest editor in several special issues on technology enhanced learning of international journals indexed / abstracted in ISI Web of Science e.g. *Journal of Universal Computer Science (JUCS)* etc.

He has also participated in over 10 large scale EU-funded R&D (e.g. 7FP) projects, as well as in several international research studies such as STEPS, SITES, and ICILS.

Hobby: historical books; music (rock of 70th and disco of 80th).

Mattia Monga

Mattia Monga is currently an Associate Professor at Università degli Studi di Milano, Milan, Italy with the Department of Computer Science. He holds a Ph.D. in Computer and Automation Engineering from Politecnico di Milano and his research interests are mainly in the field of software engineering and security. He is one of the founders of Aladdin, a team devoted to renovating the perception of informatics in the general public, with particular attention to the school pupils: Aladdin (http://aladdin.unimi.it) organizes a game-contest for schools called Kangourou of Informatics, informatics labs for children where the use of computers is not emphasized, and several other initiatives aimed at popularizing the idea of informatics as an exciting intellectual challenge. His web page is http://homes.di.unimi.it/~monga

Noa Ragonis

Academic degrees: Holds M.Sc. and PhD degrees from the Weizmann Institute of Science, and has post-doctoral position at the Technion - Israel Institute of Technology and Science.

CS lecturer: A lecturer in the Department of Computer Science, School of Education, Beit Berl College, served for ten years as the head of the department, and also adjacent senior lecturer in the department of Education in Technology and Science, Technion – Israel Institute of Technology. In the past, taught Computer Science to high school students for 16 years.

Academic position: serves as the chair of the Curriculum Committee and academic advisor, School of Education, Beit Berl College. This year establishes the Center of Instructional Development at Beit Berl College.

Academic activities and research: Teaches courses related to (a) Computer Science (e.g. Object Oriented Programming, Graph Theory, Computational Models, Logic Programming), to (b) the didactics of Computer Science and to (c) Information Technologies (e.g. Teaching and Learning in Online Environments, Query Learning with Spreadsheets). Activities over the last 20 years concern: educational research mainly focused on cognitive aspects of teaching and learning of computer science and integrating tutoring activities in teachers education; in-service teachers training; research supervision of Master and PhDs' students; development of high school text books as well as teacher guides; and serves as a member of the management staff of "Machsava" (Thought), the Israeli National Center for High School Computer Science Teachers, in 2011, a co-author of the book: *Guide to Teaching Computer Science, An Activity-Based Approach* (Springer) that serves Computer Science educators around the world.

Summary of presentation

Qualitative Research Methodologies in CS Education – My Principles, Approaches and Examples

The presentation will be focused on the implementation of qualitative research methods in computer science education research. In this framework I will share my experience, viewpoints, and approach. During the presentation I will demonstrate some of the qualitative research methods and tools I used in my research – in order to be concrete and to broaden the audience practices. The common aspect of the presented studies is the cognitive perspective. The target is to expand the knowledge of how students and/or teachers (pre-service or in-service) understand concepts, and how their conceptions are developed in the learning/teaching processes. Hence, the emphasis is on the processes rather than on achievements, and on different ways of understanding concepts rather than on the percentage of success. The presented studies are rooted in the constructivism approach, learning by doing – being active.

Márta Turcsányi-Szabó

Eötvös Loránd University, Budapest

Dr. Márta Turcsányi-Szabó (Ph.D.) is an associate professor, head of ELTE T@T Lab (formerly TeaM lab), Department of Media & Educational Technology at Eötvös Loránd University, Faculty of Informatics in Hungary.

With more than 25 years in teacher education she is now specialised in courses: Educational technology & Social Networking, Tele-mentoring, Authoring environments for children, Evaluating educational programs, Designing educational programs, Designing multimedia materials for B,Sc. & M.Sc. level as well as Research methodology, Innovative capacity building digital pedagogy, Current issues of e-Learning, Theoretical basis of ICT education for Ph.D. level.

Her research area is Technology Enhanced Learning and now concentrates on Media Informatics. Her most remarkable projects were: developing software for kindergarten children continuously since 1984; developing a model for Tele-houses, mentoring youth living in underdeveloped regions and providing them a perspective for their future; developing TeaM Challenge game series, that provides context based "e-problem solving" n team work, through interdisciplinary topics in upper elementary; building several mentoring models for practical teacher training, producing the basis for the needs of teachers/mentors and transferring innovation into public education by meeting the notion and requirements of the present age.

She received "Rezső Tarján" prize in 2003 by John von Neumann Computer Society for "her devotion invested and results attained in Informatics education of children and teaching of the Logo programming" and was nominated for several other international prizes by different international organisations.

She represents Hungary in IFIP Education Committee and has chaired the Working Group of ICT in Elementary Education, chaired the Euorologo Scientific Committee, she is the chair of the Public Education SIG at John von Neumann Computer society, and member of the Commission on ICT in Education, Education Committee, Hungarian Academy of Science. She has organised and chaired several international conferences in Hungary and around the world, took part in the review board of numerous conferences and prestigious journals, she is the member of quite a few journal editorial boards.

Summary of presentation

Innovations in Educatioal Technology - Augmenting teacher education to involve public education, professional development and informal learning

Innovation in ICT is escalating on a very high speed, most of it proliferating in everyday life. But, educational institutions are still resistant or skeptical, thus it is difficult to go through with innovations in pedagogy. Affordances of emerging technologies lead to news styles of existence,

which tend to suggest possible innovations in educational methodologies as well. Innovations in technology and pedagogy shall be discussed in their interrelational manner.
Yet, it is difficult to change the paradigm in education, spreading innovation to public education, motivating teachers to be aware to constant changes that should be included in their proffessional development and encouraging learners to step out of the conventional classroom set-up to find new form of learning in informal environments that could broaden perspectives and the ways of experiencing. Methods in augmenting teacher education to maintain sustainable innovation will be discussed.

SUMMARIES OF STUDENTS

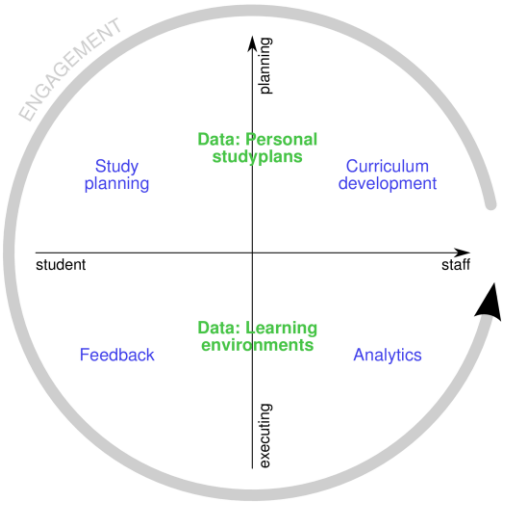
Tapio Auvinen

Aalto University
Department of Computer Science and Engineering

Research topic: educational technology, tools that support meta-level planning and feedback

I am working on a curriculum development and study planning software called STOPS (Software for Target-Oriented Personal Syllabus) (Paavola et al. 2012). With the tool, teaching staff creates a detailed graph of the learning outcomes of every course and the prerequisite dependencies between the outcomes. High-level competence goals, such as *Graphics programming* or *Web development*, and their dependencies from the course outcomes are defined as well. With the tool, students construct personal study plans by choosing high-level competence goals. Visualizations of how the course outcomes build on top of each other and form the competence are then shown. The aim is to increase students' motivation by making studies more goal-oriented and by linking the topics taught in each course to the high-level goals. The tool is also useful for curriculum developers because it can reveal bottlenecks, lacking contents, redundancies, etc.

Figure 1 is an illustration of the research field in two dimensions: what **students** do vs. what **staff** does, and **planning** studies or the curriculum vs. **executing** the plans. Reading counter-clockwise starting from the upper-right corner: 1. Instructors design a curriculum. 2. Students create their study plans. 3. Students take courses. 4. Instructors monitor students' performance and make adjustments to the curriculum.



The goal is to keep students engaged with their studies by offering them a well-designed curriculum, offering a way to construct a meaningful personal study plan, giving timely feedback about progress, and improving the curriculum if problems are observed.

1. **Research questions**
    1. Are curriculum visualizations a useful tool for curriculum developers? What kinds of visualizations are needed?
    2. Do goal-oriented study plans and curriculum visualizations increase student's engagement with their studies (as opposed to choosing arbitrary courses from a list in order to fill 300 ECTS)?
    3. Does visual feedback about students' performance ecourage to self-reflection and improve learning outcomes? We can visualize, for example, how a student is doing

related to their own goals or related to peers, and in a single course vs. the whole study plan.

4. Can student's engagement level be measured from the log data of online learning environments? How to detect which students are in a 'flow' and which ones have lost motivation?

2. **The significant problems in the field of research**

1. To quantitatively evaluate whether study plans made with the new approach are more engaging, longitudinal studies are needed. However, there is not enough time to collect enough longitudinal data in PhD studies. Other, qualitative, research methods, such as interviews, must be used instead.
2. It is even more difficult to measure if curriculum visualizations are helpful for curriculum developers. We cannot arrange an experimental study where one degree program is designed with the old method and one with the new method. Again, other research methods are needed.

3. **An outline of the current knowledge of the problem domain**

Some tools exist for curriculum visualization, e.g. [4]. However, the existing tools model interdependencies within whole courses while in our work, the interdependecies are defined between individual learning outcomes. This gives students a detailed picture about how different topics in each course are connected to the high-level goals. Intelligent tutoring systems, on the other hand, define course contents in great detail but are mostly used within single courses and not for complete university curricula [3]. It seems that there is not much research on educational technology that supports curriculum development or study planning in the high level.

Ways to increase student's engagement by visualizing their progress has been studied within single courses [2]. However, there does not seem to be much research on meta-level feedback regarding, for example, time management or how performance in course-level learning goals affects the high-level competence goals.

There is some earlier research in assessing the level of students' engagement based on log data from online learning environments [1]. However, the feedback that has been given back to students has been very simple, for example, a pop-up telling to try harder. It would be interesting to give students better tools for monitoring their of their own behavior in order to encourage self-reflection.

[1] M. Cocea and S. Weibelzahl. Cross-system validation of engagement prediction from log files. Creating New Learning Experiences on a Global Scale, pages 14–25, 2007.
[2] S. Edwards, M. Pérez-Quiñones, M. Phillips, and J. RajKumar. Graphing performance on programming assignments to improve student understanding. In Proceedings of the International Conference on Engineering Education, 2006.
[3] T. Murray. Authoring intelligent tutoring systems: An analysis of the state of the art. International Journal of Artificial Intelligence in Education (IJAIED), 10:98–129, 1999.
[4] R. Zucker. Vicurrias: A curriculum visualization tool for faculty, advisors, and students. Journal of Computing Sciences in Colleges, 25(2):138–145, 2009.

4. **A presentation of any preliminary ideas, the proposed approach and achieved results**

The STOPS tool is in prototype stage and is going to be used for curriculum development in Aalto university at some departments. This work is necessary in practice but it is difficult to research because controlled experiments are difficult to arrange. We have a few publications that describe the approach [1, 5], but they do not contain evaluation of the effectiveness of the method.

Several online learning environments with automatically assessed exercises are used in our courses. They offer a good testbed for experimental studies where randomized groups are treated with different educational methods while the effect on learning outcomes is measured. We have already done one experiment with achievement badges that encourage students to self-reflect, e.g. avoid trial&error problem solving, finish the exercises with full points, do recap exercises, etc. In future, we could experiment with giving feedback about students' progress related to their high-level competence goals.

5. **A sketch of the applied research methodology (data collection and analyzing methods)**

1. For evaluating the new curriculum and study planning methods, I may have to interview curriculum developers and students. For qualitative analysis methods, I hope to get hints from the DC.
2. To get some quantitative data, I could have randomized student groups use STOPS or traditional study plans, then measure changes in course-level learning outcomes. I am skeptical about getting statistically significant results, though.
3. I am planning to do more controlled experiments on the usefulness of feedback that supports self-reflection. Feedback embedded into learning environments has a higher chance of having a significant effect than a study plan that was done in the beginning of studies or a semester.
4. Educational data mining can be used to find interesting effects from the log data of the online learning environments.

6. **A description of the Ph.D. project's contribution to the problem solution**

This work increases understanding of

- how a learning outcome graph based curriculum model, and its visualizations, help curriculum developers and students
- if keeping students better aware of their performace related to high-level goals affects learning outcomes

7. **How the suggested solution is different, new, or better as compared to existing approaches to the problem**

No tools similar to STOPS exist to my knowledge, and there is not much research in the intersection of educational technology and curriculum development or study planning. Students are mostly given feedback about the subject matter of courses but not how they are doing overall in curriculum level. I believe that more detailed feedback than grade marks can be given.

8. **Publications**

1. T. Auvinen. Curriculum development using graphs of learning outcomes. In Proceedings of the First EUCEET Association Conference, November 2011.
2. T. Auvinen. Rubyric. In Proceedings of the 11th Koli Calling International Conference on Computing Education Research, pages 102–106, November 2011.

3. T. Auvinen, L. Hakulinen, and A. Korhonen. Tackling the challenges of a large course with blended learning. In T. Joutsenvirta and L. Myyry, editors, BlendedLearning in Finland, pages pp. 126–137. Faculty of Social Sciences at the University of Helsinki, 2010. ISBN: 987-952-10-5943-8.
4. T. Auvinen, V. Karavirta, and T. Ahoniemi. Rubyric: an online assessment tool for effortless authoring of personalized feedback. In ITiCSE '09: Proceedings of the 14th annual ACM SIGCSE conference on Innovation and technology in computer science education, page 377. ACM, 2009.
5. J. Paavola, T. Auvinen, and J. Hartikainen. Software for target-oriented personal syllabus – STOPS. In Proceedings of the 2012 AECEF Symposium, September 2012.

9. Questions

How do I measure if a study planning tool is better than an old method when there is no time for longitudinal studies? The hypothesis is that a better understanding on why the subjects taught are important for the student in question, would increase engagement and lead to better motivation, less drop outs, etc. Are interview studies reliable and what to ask? Users may like a tool even if it later turns out to be ineffective.

How do I evaluate if a curriculum development tool is *helpful* for curriculum developers, when experimental A/B studies are not meaningful?

In software engineering, we tend to implement tools for a practical need, and then get research out of it. Do we always need evaluative studies or can, for example, a new visualization method be a contribution?

Renata Burbaitė

3nd years PhD student
Kaunas University of Technology

Research topic: Conception and realization of advanced generative learning objects

The aim of research: create and investigate the methods of formation of advanced generative learning objects (AGLO), determine and investigate the characteristics of AGLO.

1. Questions

1. AGLO model: development and specification.
2. Transformation: GLO model specification → executable specification.
3. AGLO complexity: evaluation and management: multi-stage GLO.
4. Overall assessment and experimental study of AGLO.

2. The significant problems in the field of research

1. Development of e-learning, the role of learning objects in e-learning, especially in programming teaching and learning.
2. Effective use of technologies in e-learning: generative technologies in e-learning.
3. The justification for the concept of generative learning objects proposed by Boyle et al. provides better quality of learning objects in e-learning,
4. To create a flexible generation/transformation methods must first solve the specification problem.
5. Evaluation of AGLO for programming teaching and learning.

3. An outline of the current knowledge of the problem domain

Research topics on LOs are broad and include design, evaluation and use of LOs as well as instructional theories, standardization initiatives, evolution of LOs and e-Learning per se (Northrup, 2007; McGreal, 2006; Kay & Knaack, 2008). Related or similar terms to LOs are: knowledge object (Merrill, 1998), reusable LO (Polsani, 2003; Boyle, 2003; Silveira et al., 2007; Linsey & Tompsett, 2007), generic LO (Koohang & Harman, 2007; Allen & Mugisa, 2010), generative LO (Leeder et al., 2004), testable, reusable unit of cognition - TRUC (Meyer, 2006), online resource (Nash, 2005), mobile LO (Ayala & Castillo, 2008), customized LO (Gunawardena & Adamchik, 2003), LO generator (Ford, 2004), Conceptual Model for LO (Churchill, 2011), etc.

We focus on Generative Learning Objects (GLOs) in association with the Constructivist-Based Learning Model (CBLM) (Leonard, 2002). The GLO can hardly be understood in detail without analysis of LO models and their properties. The basic properties of LOs – granularity, adaptability and compositionality (IEEE, 2000; LOM, 2000; Polsani, 2003; Silveira et al., 2007) – are essential for constructing instructional theories (Wiley, 2000; Memmel et al., 2007). They can also serve for evaluating reusability of LOs. For example, Wiley (2000a) states on this account: "LO granularity can be viewed as a trade-off between the possible benefits of reuse and the expenses of cataloguing". Indeed, the lower granularity level is, the easier is to reuse a LO in another context. This is because we are usually expressing essential knowledge units at the lowest level (Merrill, 1998; Redeker, 2003). There are two basic models to transfer LOs for

reuse: black-box reuse (use without adaptation), and white-box reuse (use with adaptation). Black-box reuse happens rarely (Silveira et al., 2007), because teachers tend to adapt retrieved LOs to their own context of use. Though the e-Learning community understands the role of adaptability well and exploits the property in a variety of contexts, it is yet little known of mechanisms how to implement the automatic or semi-automatic adaptation. To understand such mechanisms, we need to analyze the existing LO models.

E-learning is a multi-target and multi-level process. It ranges from planning to delivery and assessment. Thus, the traditional LO models, such as metadata – content (Balatsoukas et al., 2008), or hierarchical models based on content granularity (Verbert & Duval, 2004; Balatsoukas et al., 2008), are not enough, because: e-Learning is rapidly advancing, and we need to have more flexible, more adaptable, more personalized, and more contextualized LOs to support advanced e-Learning; traditional component-based view on LOs has limited capabilities for adaptation and reuse; digital libraries are growing rapidly in volume with the expansion of the LO domain, and this situation may lead to serious managing and maintenance problems similar to the library scaling problem in software (Dreher, 2004; Nash, 2005); e-Learning has very wide choices of IT support (mobility, networking, tools, etc.).

The LO models should be relevant to respond to new challenges and IT advances. In this regard, the introduction of the GLO by (Leeder & Boyle et al., 2004) has been a significant event in LO research. In a wider context, a LO per se is a model to support reusability across large e-Learning communities (Liber, 2005). The GLO model, as "a next generation of LO", has new capabilities such as generativity and flexibility for adaptation and reuse. The basic idea, upon which a GLO works, is the separation of the LO structure from its content (Leeder et al., 2004; Morales et al., 2005; Boyle, 2009; Boyle, 2010). The separation is introduced by the LO model and implemented using a generative technology (hence the name 'generative LO'). Though research on GLOs is still in its infancy (despite the works of GLO pioneers and other researchers (Di Iorio et al., 2006; Oldfield, 2008; Han & Krämer, 2009)), the approach has a great potential for achieving advancements in e-Learning.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

We propose the model of technology-enhanced GLOs and a framework for systematic analysis and understanding of the impact of GLOs for e-Learning. As we use meta-programming-based (MPB) generative technology to specify GLOs, we called them MPB GLOs. Three basic interrelated properties define the proposed model:

- The possibility to express the structure of semantically different learning aspects (pedagogical, social, technological, content, etc.; we further identify that as learning variability) uniformly and explicitly via parameters and their values (pre-conditional aspects).
- The explicit incorporation (due to meta-programming) of anticipated learning variability features into the executable specification represented as MPB GLO (descriptive aspects).
- Automatic generation (by supporting tools) of the pre-specified content on demand, i.e., variants of concrete LOs and obtaining a final result of the task by running generated LOs, if those are programs (generative use/reuse aspects).

A View to GLO Domain in Large

The conceptual understanding of the LO-based research is possible through analysis of the following items for cognition: pedagogical models; underlying concepts; definitions; contexts; categories of LOs and GLOs; design principles; models and examples; properties (standards); relationships among the concepts; relationships of concepts with pedagogical approaches; relationships with teaching environments, where processes of actors (teachers and learners) are at the focus; applications and use cases. Here, we identify and define three categories of underlying concepts to analyze a teaching content abstractly: LO, TRUC and GLO. Ravenscroft & Boyle (2010) treat GLO as a case of 'reusable LO'. We see GLO as a generalization of the 'reusable LO' and TRUC as an intermediate concept to bridge the LO and GLO domains.

Definitions of Basic Terms

Below we provide the known definitions of LO/GLO along with ours that are related to understanding of MPB GLOs considered in this paper:

LO is "any digital entity, which can be used, reused or referenced during technology-supported learning" (adapted from (IEEE, 2000)). In most cases, an LO is a directly usable educational resource or a resource with adaptation for computer-aided teaching, such as an educational applet or a self-teaching module to be obtained from a DVD or Web site (PC).

TRUC (Testable, Reusable Unit of Cognition) is "an entity that embodies a collection of concepts, operational skills, and assessment criteria for codifying knowledge about a domain and its teaching" (Meyer, 2006).

Generative learning object (GLO) is a reusable LO (RLO) which entails a multi-level structure for implementing the content flexibly using a generative technology (adopted from the works of Boyle et al.).

Meta-programming-Based (MPB) GLO is the generative technology-driven entity that implements the learning variability concept as a family of related LO instances, which are automatically generated on demand by supporting tools (meta-language processor) for delivery and use. Shortly: MPB GLO is a parameterizable learning content generator.

Learning variability are pre-defined variants (features) of learning-related components (content, pedagogical model, social features, technology facility features, etc.).

Categories of GLOs and Some Principles to Construct GLOs

GLOs, in fact, are independent upon the content. However, GLOs highly depend upon the generative technology and models used. Though there is a variety of generative technologies (generative programming, aspect-oriented programming, template-based programming, etc.), they can be grouped into two large groups: template-based GLO (Leeder et al., 2004) and meta-programming-based (Štuikys, Damaševičius, 2008). Below we discuss taxonomy of models separately.

Less or more, the proponents of GLOs and RLOs agree on the following heuristic principles:

- Focus on the design and context of GLOs with a priority to the pedagogical and social aspects as compared to the content, whereas technology is a bridging tool to connect the two with respect to the capabilities for adaptation of the content.
- Explicit separation of concepts that describe approaches and processes related to GLOs.
- A multi-level view to the separation of concepts.

Theoretical Background of MPB GLOs

The theoretical basis of meta-programming is the use of a higher-level parameterization which is expressed explicitly using some meta-language. In general, to be presented as a meta-program, a domain task has first to be expressed through a variety of features (parameters) with anticipated values, and then, it should be coded using the selected meta-language. Thus, the domain task variability is a primary condition to develop a meta-program and the domain variability transformation rules and approaches (such as variability modelling, types of meta-languages, etc.) form the theoretical basis of meta-programming (Štuikys, Damaševičius, 2007). From the technology-based perspective, MPB GLOs we propose have the same theoretical basis. However, MPB GLOs are domain-specific meta-programs meaning encoded learning variability.

The learning variability features are indeed very rich because all constituent parts of e-Learning (pedagogical models, learner's social context, teaching content and technological facilities for learning) can be expressed via explicit features and coded as parameters. Additionally, the learning variability can be extended by other external features (such as visualization to enhance the learners' engagement and attractiveness of content, see our case study). Though the different learning variability features differ in semantics, they are represented in the GLO specification uniformly.

An important issue is that that the different learning variability features may interact amongst themselves (in other words, they may be dependent). For instance, the only appropriate variant of content should be delivered for students of the same abilities. This dependency modelling is also a part of the theory to construct GLOs. The aim is to specify such dependencies in advance and to code them explicitly (similarly as the other learning features using capabilities of the technology). As MPB GLOs are higher-level executable programs, hence, they have well-defined structural and behavioural models, which we consider after the introduced framework to integrate CBPM and MPB GLO.

A Framework to Integrate CBPM and MPB GLO

An MPB GLO extends the known concepts of GLOs based on the previously formulated principles and, additionally, two underlying properties: 1) any domain, at its conceptual level of perception, can be expressed through features; 2) explicitly defined features can be mapped onto a generative technology. Note that features can be also called attributes, characteristics, aspects, or functions, etc., depending on the domain. The extension is not so much different from the underlying properties described by (Ravenscroft & Boyle, 2010). What is different in our case is what and how we extract from these domains. Here, by 'domain' to construct MPB GLOs we mean the following.

All concepts such as pedagogy, learner's behaviour or previous knowledge, learning process, learning content, context, and technology are domains in our approach. Each domain, however, can be considered either separately or in combination with others. What domains (sub-domains) we need to deal with explicitly, what features we need to extract from domains, and what priorities of using features we need to apply, is the matter of requirements to design the GLO. From the first glance, all these features may seem too much overcrowded and complicated. In practice, however, this looks much simpler. For example, context enables to combine some domains (pedagogy, psychology and their features). Furthermore, we express the prioritised features of pedagogy (learning/teaching aim, scenarios, etc.) explicitly, while others may be

introduced implicitly (e.g., teacher knows in advance that a particular GLO is for learners of the age between 14-15 years, or for learners with the high/low abilities, etc.).

We clearly separate context and content as other proponents of GLOs do. We give a higher priority to the context, because it introduces the pedagogy-related aspects. Unlike to other authors, we focus on learning variability (i.e., possible, anticipated or predictable variants of e-Learning components). In our understanding, learning variability is the explicit representation of context information in learning. Variability analysis opens a new way for considering adaptation and reuse in e-Learning more effectively and at a larger extent. The variability space can be seen as a source to manage variants of social context, teaching content, features of the pedagogical approach and teaching facilities. Figure 1 explains schematically how variant features are integrated with the CBPM. Though the CBPM is at the core of the approach, the variability of features implemented through metadata as higher-level parameters is the main focus.

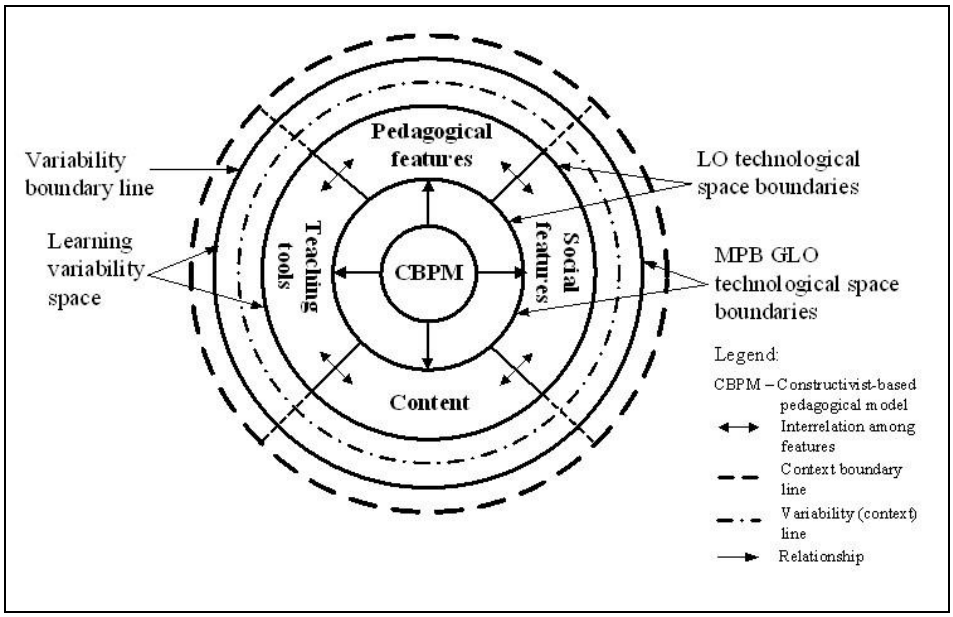


Figure 1. Interaction of pedagogical model and technological space in the MPB GLO framework

The generative technology we use enables to implement such a vision. The essential mechanism of the meta-programming technology is parameterization. When we map the context and content features onto the technology, we transform features into parameters (within the interface) and meta-functions (within the body). Both enable to perform flexibly manipulations on the representation to support automatic adaptation and generation dependent on demand through the selection/introduction of parameter values as we explain it in our case study. Also, all these can be understood, of course to some extent, by analyzing higher-level models presented below.

Structural Models of GLOs

In general, structural models describe the structure meaning the representation of essential constituent parts of a GLO, while ignoring the others that are not relevant in a given context. We consider two structural models here. The model (Figure 2, a) is an adaptation of (Boyle, 2006; Ravenscroft & Boyle, 2010), where context is implicit. Our model to represent an MPB GLO

(Figure 2, b) consists of two basic interrelated parts: interface and body. Interface is the internal metadata (in contrast to external metadata used in digital libraries) that specify learning variability expressed via parameters and their values. Interface is visible for a learner/teacher to make a choice of the needed content (i.e., LO instance) in the given context of use (see Case study).

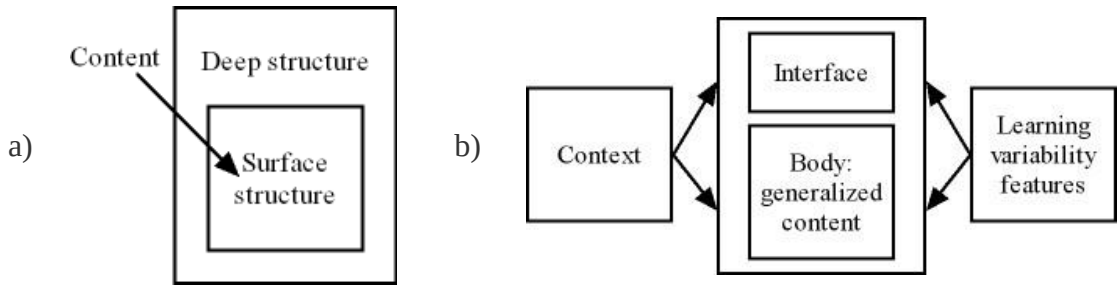


Figure 2. Structural view to GLO models: a) Boyle's et al. model; b) MPB GLO model

Body is the specification that specifies how the learning variability concept is implemented in full details using meta-programming techniques. In fact, body is a generalized representation of a family of related LO instances. This entity hides the information from the user because it contains the technology-related details woven together with the content and context information. Here, by 'context', we mean a variety of information to support wide-range reuse (see Figure 1). Though the discussed models conceptually are similar (e.g., the generalization aspect (our model) correspond to the 'deep functional decisions' within 'deep structure'; and the content generation corresponds to 'mapping of deep structure onto surface structure' (Ravenscroft & Boyle, 2010)), the implementation, however, is quite different.

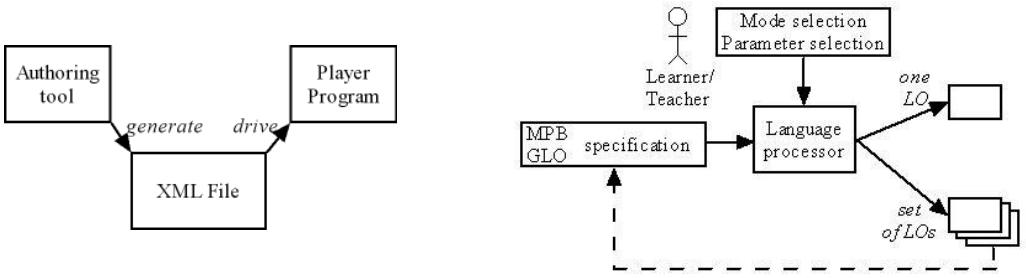
As we use meta-programming as a generative technology (the prefix meta- means higher-level here), the introduced and above defined terms (interface, body, parameter) may be also supplemented by the prefix meta- (i.e., meta-interface, meta-body, meta-parameter are relevant terms in use too).

Behavioural Models of GLOs

Behavioural models describe the GLO's functionality within a supporting environment (i.e., authoring tool). Again, we consider two behavioural models from the user perspective as follows: Boyle's and ours. We have extracted the first (Figure 3, a) from (Boyle, 2006) and its behaviour tested using GLO Maker (http://www.glomaker.org/). We use the original terms, such as 'Authoring tools' and 'Player Program', meaning the GLO Maker and the Program to present the GLO for a learner, respectively.

We describe the second model (Figure 3, b) in more detail. Let be given the specification of a MPB GLO designed by the instructional designer/teacher according to pre-scribed requirements and the structural model (Figure 2, b). Here, however, we do not consider the MPG GLO design problems, as they require a separate discussion, and focus on the MPB GLO functionality only. The MPB GLO specification is an input to the (meta-)language processor. The latter is the content generator. It generates either one LO or a set of LOs depending on the selected mode and context of use. User specifies the needed result by parameter values. This procedure is as simple as possible, because the user selects parameter values from the easy-to-read interface (graphical boxes in our case study). From the pure technological sense, there is no difference whether a

parameter represents context features or content features. To make the correct selection, however, the user clearly makes the distinction among the parameters' semantics, when he/she reads the interface. The system may ask the user to enter the use mode (one LO, set of LOs). Then the process is fully automatic. Here, the dotted line indicates the feedback process, if any (e.g., for adding the new parameter values without re-design of the specification).



a) b)

Figure 3. The use view to GLO behaviour models: a) Boyle's (2006) model; b) MPB GLO model

The language processor (when a user interacts with the system) completely hides the body implementation details. Thus, the user may not be an IT expert as the majority of teachers or instructors are. However, for CS students, the implementation of the body can be a specific learning topic. The body is completely generic with regard to the given space of parameters and their pre-specified values specified by the designer. In the case, when the user (learner/teacher) wants to specify own values for some parameter, he/she can do that without the intervention into the internal structure of the body, if the introduced value is independent upon other values of this parameter, or the values of other parameters. How the user can know about that? The designer should instruct the user in the well-designed and well-documented specification.

Juxtaposition of specific characteristics: GLO vs MPB GLO

Characteristics	Boyle's at al. GLO	MPB GLO
Structure (Model)	Multi-layered("deep structure-surface structure-content")	Interface and generalized content within body
User interface	Graphical	Textual (old technology) & Graphical (new technology)
Content delivery mode	Non-automatic (by tutor/learner)	User-guided automatic from pre-programmed body
Scope of pedagogy features	Tutor-oriented	Requirement specification-oriented as defined by designer and instructor
Context and content variability	Left open for tutor's/learner's flavour (i.e., implicit)	Pre-programmed in advance and represented explicitly
Adaptability mode	Open with the help of the GLO authoring tool	Through user-guided automatic generation of a specific LO
Generative technology	Linguistic grammar + template	Heterogeneous meta-programming

Tool support	GLO Maker	Dedicated meta-language based, Java-based (old technology), PHP-based (new technology)
Level of automation	Low	High
Impact on vision "teacher as LO designer"	Moderate (based on our restricted time of using GLO Maker)	High due to a higher level of automation
Impact on vision "learner as LO designer"	Low (based on our student restricted use of GLO Maker)	High but this depends on quality and functionality of GLO (on how learner's beliefs are embodied)
Maturity level	High at few organisations	High at two organizations (old Technology: University and gymnasium), low (new technology, gymnasium)

5. A sketch of the applied research methodology (data collection and analyzing methods)

1. Analysis and evaluation of the common structure and attributes of GLO – review and summary of latest references.
2. Pedagogical effectiveness of a GLO – evaluated by "engagement levels" using the methodology described in (Urquiza-Fuentes & Velázquez-Iturbide 2008).
3. Feature-based method (feature diagrams) for AGLO domain conceptual model.
4. Transformation of AGLO model specification to executable specification – metaprogramming.
5. Data mining methods to estimate the use of AGLO in education process.
6. Need to create the complexity estimation method of AGLO.

6. A description of the Ph.D. project's contribution to the problem solution

1. Advanced GLOs should be well-designed meaning: the well documentation, the use of approved design principles such as concept separation and modularization (i.e. deep granularity), explicit requirement (pedagogical, social, technological;) statement for both learning context features and learning content features, for example, through visualization, e.g. using feature diagrams.
2. Clear separation of specification for context modelling, design, test, and use phases.
3. In general, clear separation of actors roles: designers', instructors' (teachers'), students', though in specific cases it is highly beneficial to combine those roles, for example, for the enlargement the LO space to support various pedagogical approaches.
4. Introduction of quality measures for pedagogical aspects of the GLO and technological aspects, such as complexity of GLO.
5. Introduction of novel models such as multi-staged GLO for managing complexity and avoiding consequences of over-generalization problem.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

We claim that the approach (due to explicit learning variability representation via pre-programmed parameterization) enables to extend the reuse dimension and win benefits in:

- capability of content adaptation,
- contextualization of e-Learning,
- personalization of e-Learning,
- collaborative e-Learning,
- learning by doing, and self-testing for learners.

Difficulties and disadvantages of the MPB GLOs are as follows:

- design complexity and cost (the need to anticipate variants in advance, to understand a wider learning context, to master the generative technology, etc.);
- over-generalization problem due to the surpassed context modelling;
- low maturity as compared to the traditional approaches;
- some dependency on the content type (MPG GLO is more suitable for the text, though the restricted use of graphics, pictures is possible too);
- extra efforts for using (e.g., to integrate into processes);
- information redundancy (why do I need to read the information which is not interesting in my context?).

We provide the following guidelines to manage these issues:

- MPB GLOs should be well-designed and well-documented by the use of the approved design principles such as concept separation and deep granularity, explicit statement of requirements with clearly stated concepts for the context modelling, design, test and use.
- The clear separation of roles among designers, instructors, teachers and students; though, in specific cases, it is beneficial to combine some roles for the enlargement of the LO space within the MPB GLO to support various pedagogical approaches.
- Introduction of quality measures such as complexity evaluation and novel models such as a staged GLO for managing complexity and avoiding consequences of the over-generalization and complexity problem.
- To improve the understanding of social aspects of the GLOs by changing minds for designers, teachers and students, because a generalized description is much more valuable – one can learn more with less.

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Research topic: Museum Informatics Systems
The aim of research:
To find out how 21st century technology could enhance the museum experience. This includes virtual worlds, portals, mobiles and different immersive media and interfaces as well as navigation within the environment. To set up infrastructure for developing such artefacts with the inclusion of artists, computer scientist, museum pedagogues as well as curators and sponsors. To research and develop prototypes of good practices within different themes and set up user experience tests to prove usability. Research should also touch on accessibility.

1. Research questions

1. How can artists/computer scientists design together museum artefacts for the 21st century?
2. How could users get in a deeper interaction with artworks?
3. How can we aid visitors to navigate within the museum?
4. How can portals contribute in searching, examining, exploring, analysing and curating artefacts in a 2.0 manner?
5. What additional tools are necessary in order to attain accessibility?

2. Context of the research

In our days museums cannot ignore the phenomena of the technological developments and the change of learning and communication habits of new internet generations. While educators – themselves not belonging to the net generation – are heavily discussing the effect of the new learning and information seeking habits of those born after 1980. [1] Therefore, during my research I examined the possibilities of creating modern museums fit for the expectations of the 21st century.

According to my IT teacher and artist background I am searching for different approaches where experimental learning abilities go hand in hand with aesthetics and playfulness, this is the direction in which I am exploring the innovative opportunities of technology in order to develop an immersive learning experience.

3. A presentation of any preliminary ideas, the proposed approach and achieved results

1) We already developed a common platform in OpenQwaq for artists and computer scientists to working together. Although were created some valuable and spectacular exhibits from this collaboration, a project like this also has limitations such as technological expectations and human factor. (See: Publications 3., 6.)
2) We propose to map the possibilities of interactivity and analyze how big theirs influence is on understanding and on entertainment.
   Henceforth my plan is to make case studies, accordingly accomplish different foreign examples in Hungary in variant projects.
3) We have built up a 3D model which is a virtual copy of one floor of our Faculty's building.
   We also have a panoramic representation about it.
   Our plan is to compare the effects of these systems on navigation abilities and habbits.

4) We would like to involve the visitors, we are curious about their opinion and we would like to get feedback as well.
5) We are trying to specify what differences are among pretensions of normal and disadvantaged people in using those systems. We are making interviews and analyzing literature in this area.

4. A sketch of the applied research methodology

The frameworks of the research methodologies in the different parts of my work are fairly equable. First of all I should analyse literature of museum pedagogy, navigation, virtual environments and 21st century technologies and only after that could start the developing.

1. To construct 3D model or other application for users to training or learning
2. To implement the model and test it
3. To configure participant groups
4. Experiment in the 3D model / with application
5. To analyze the results and data
    a. Data come from
        i. Questionnaires
        ii. Log files (time, distance, number of wrong decisions)

5. A description of the Ph.D. project's contribution to the problem solution

1) One of the critical issues on cooperation between artists and computer scientists is that they are unable to use a common domain for communications - we shall try to set up infrastructure, proper environment and communication platform.
2) Providing prototypes for different immersive applications and interfaces in relation to exhibited artefacts could enhance the museum experience and make believe that one in actually surrounded by the environment relevant to the installation.
3) Almost every day people find their way from home to any of a myriad of destinations, and then back again. Most take this skill for granted, but is an amazingly complex ability that has been the subject of decades of research by cognitive psychologists. [4]
   Navigation in a diversified exhibition is also often problematic.
4) Museums have a lot of artefacts and artworks.
   If they do not categorize them, visitors maybe "waste away" among those several objects.
5) It is very important that everybody including disadvantaged people could reach the virtual contents and those applications help users as much as it is possible.

6. How the suggested solution is different, new, or better as compared to existing approaches to the problem

The interactivity of artworks plays a very important role. Developing systems for museums make the exhibitions much more interactive makes benefits for musea and visitors as well. Visitors enjoy more the meeting with the artefacts, children are more motivated and so on. To become this real we need principles how we should create virtual worlds.

7. Questions related to the research

1) What will be the best platform for collaboration?
2) How to design user interface to get the deeper immersive sense?
   How can the exhibited research object be evaluated, which methods are enough qualitative?
   How can we prove their usability?
3) How can we help the navigation in an exhibition?

How particular has to be the 3D model?
Have been panoramic applications tested as navigation helper systems? I cannot find scientific literature in this theme.
How to formulate tasks to measures the competencies and spatial abilities?

4) How can we involve visitors?

8. Publications

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Research topic: Computational Thinking in Secondary Education

The aim of research: to establish an operational definition of computational thinking (CT) within the context of the course of Informatics in secondary education in NL. To establish corresponding PCK. To develop an assessment instrument to assess CT. To develop teaching materials for students (and teachers) and establish their effectiveness.

1. Questions

1. What is an operational definition of Computational Thinking, tailored to the specific situation and needs of secondary education in the Netherlands?
2. How can students' CT problem solving skills be assessed?
3. What is a suitable pedagogical approach to teach students and stimulate their learning of CT problem solving skills?

2. The significant problems in the field of research

1. There is no operational definition of CT tailored to the needs of this specific population.
2. There is no assessment tool.
3. It is not know whether informatics courses actually do encourage CT.

3. An outline of the current knowledge of the problem domain

In 2006, J.M. Wing asserted "to reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability" [4]. Educators recognize this need and inquire into the precise description of this concept and the ways to teach it. In 2010 in the United States, the National Research Council held a workshop on the nature and scope of CT. While there was a broad consensus on the importance of (teaching) CT, the workshop did not result in an exclusive definition of this concept [3]. The Computational Thinking Task Force of CSTA did however suggest an operational definition of CT tailored to the needs of K-12 education. They state that:

CT is a problem-solving process that includes (but is not limited to) the following characteristics:

- *Formulating problems in a way that enables us to use a computer and other tools to help solve them*
- *Logically organizing and analyzing data*
- *Representing data through abstractions, such as models and simulations*
- *Automating solutions through algorithmic thinking (a series of ordered steps)*
- *Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources*
- *Generalizing and transferring this problem-solving process to a wide variety of problems*

These skills are supported and enhanced by a number of dispositions or attitudes that are essential dimensions of CT. These dispositions or attitudes include:

- *Confidence in dealing with complexity*
- *Persistence in working with difficult problems*
- *Tolerance for ambiguity*
- *The ability to deal with open-ended problems*
- *The ability to communicate and work with others to achieve a common goal or solution [1]*

4. A presentation of any preliminary ideas, the proposed approach and achieved result A sketch of the applied research methodology (data collection and analyzing methods)

Obviously, a number of aspects of CT can be recognized in regular CS teaching practice, albeit lacking coherence and not being explicitly specified as learning objectives in the CS curriculum. Therefore, we propose to conduct design research concerning the teaching and learning of Computational Thinking (CT) within the context of CS course in upper secondary education in the Netherlands.

It this research, a curriculum intervention (pedagogical approach, teaching materials and teacher education materials) and appropriate CT assessment tool shall be developed as a result of an iterative (cyclic) process.

The first phase of the research is dedicated to obtaining an operational definition of CT. In the second phase, an instrument for assessment of students' CT shall be developed. The results of these two phases shall yield the data for the pedagogical approach that shall be developed in the third phase of the research: a curriculum intervention for students as well as accompanying teachers' instructions shall be developed and tested in a pilot. In the fourth phase, the effects of the curriculum intervention shall be assessed in an experiment on a larger scale and the final version of curriculum intervention (i.e. teaching materials) shall be developed.

Phase 1.

Essential aspect of CT shall be described, based on the CSTA definition of CT, existing teaching materials and additional literature study. This draft definition shall be presented to a number of experienced CS teachers. Their pedagogical content knowledge (PCK) pertaining to aspect of CT described in the draft definition shall be established using content representation framework [2]. This shall yield a final operational definition of CT.

Phase 2.

The CT description obtained in phase 1 shall be used to develop an assessment instrument for the assessment of students' CT problem solving skills. After consulting with experts (and necessary modifications), the author shall test this instrument for usability and reliability in her own classroom while teaching CS using suitable sections of regular teaching materials. The findings shall lead to final adjustments of this instrument. At the same time, the students' learning shall be examined through video and sound recordings of individual and collaborative work, semi-structured interviews and other qualitative methods. Special attention shall be paid to the difficulties students experience, misconceptions, use of CT skills and visibility of problem solving strategies.

Phase 3.

The findings of the phases 1 and 2 shall contribute to the development of teaching materials for students and instructions for teachers (in the form of a course for teachers). The design of students' materials shall be based on the idea of working with concrete problems in real world situations (situated learning). The curriculum intervention includes programming and modelling using freely available software.

After consultations with experts (and possible modifications), these teaching materials shall be tested by a small number of teachers who shall report their experiences and findings through questionnaires and interviews. This shall lead to further adjustment of teaching materials.

Phase 4.

The experiment shall take place in a dozen or so schools. Using the CT assessment instrument mentioned earlier, the effect of curriculum intervention (i.e. teaching with newly developed teaching materials and associated pedagogical approach) on students' CT problem solving skills shall be assessed and compared to CT problem solving skills of the students in control groups who were not taught CT problems solving skills explicitly. This shall also lead to further adjustment of teaching materials.

5. A description of the Ph.D. project's contribution to the problem solution

There has not been much research on (the effects of) teachers' instructions on CT problem solving skills of their students. This research shall yield an assessment tool to make students' learning of CT visible, together with a validated assessment instrument to measure students' computational thinking. Furthermore, teaching materials for students and accompanying teachers' instructions shall be developed.

Since CT can be viewed as a form of situated learning, the results of this research shall be interesting for scientific research into situated learning in related STEM subjects.

New insights about teaching and learning CT shall help teachers to prepare their students more adequately to function in our modern society and effectively apply CT professionally, regardless whether ICT plays a central roll in their occupation or not. Teacher training departments shall be equipped better to prepare future (CS) teachers for their jobs.

Besides its contribution to the growth of the body of CS pedagogical content knowledge in general, for the author this shall mean a further development of pedagogical approach she has been practicing in her classes for years, whereby she increasingly stresses that CS is not an isolated art but one that facilitates endeavors in other disciplines.

6. How the suggested solution is different, new, or better as compared to existing approaches to the problem

This research and its results are specifically tailored to the needs of secondary (informatics) education in Netherlands.

7. Publications

This research is just started and did not yield any publications yet.

8. Questions

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Research topic: Evaluation of technology enhanced learning scenario matching personalized learning
The aim of research: to evaluate and describe TEL scenario enabling personalization by learner.

1. Questions

1. How educational technologies enable students to create their own learning?
2. What learning situation promotes students self-regulated learning (SRL)?
3. What are criteria that could be applied for the evaluation and description of personalized TEL scenario?

2. The significant problems in the field of research

1. To describe properly TEL scenario criteria, that are key descriptors of personalization by learner process is an issue required relevant research methodology. Theoretical foundation of the research made on the basis of several attitudes complex of such theories as: Self-regulated learning, Situated cognition, Ubiquitous learning, Situated Focus Theory of Power, others.
2. To associate theoretical attitudes with practical research there are good examples of TEL scenario implementation in several schools, where students were enabled to create their own learning? The problem is to evaluate and describe this innovative educational practice in terms of consistent and structured criteria commented to scenario facility to enable Personalisation by Learner in educational process.

3. An outline of the current knowledge of the problem domain

Review of the existing literature shows main pedagogical trends how to support learning personalization: blended learning scenarios by using project based, construction and creative activities; incentivising students to be more self-regulated, to create their own individual learning situation, and motivating students to be more responsible for their own learning. TEL personalization has a better likelihood where students are motivated and able to control their own learning. For example, use of e-portfolio or personal learning environment is much more effective for motivated students.

It is obvious that good pedagogy should be supported by relevant technological solutions, mostly directed to learning personalization. Technology enhanced learning applied research allow designing environments that meet individual learner's differences. Our analysis qualified such conditional trends here as web based adaptive learning environment responding to learner profile features such as: knowledge level, technical experience, cultural background, type of disability, learning or cognitive styles, and content personalization. Other trend is artificial intelligence based on flexible agent technologies, optimization methods. These difficult technologies require big labour expenditures. Practice researches in schools shows that technology used could be very simple, but well known and essential to the learning task.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

We have performed interviews with teachers who piloted iTEC project scenario "A breath of fresh air" based on outdoor study activities, and main aspects of innovation mentioned by teachers' were identified. Most common or key characteristics of the learning scenario have been indicated: variety of students' and teachers' roles, mixed environment, opportunity to choose research topic and level of curriculum, diversity of learning resources and technologies used, recognition of students' competences and skills, the level of students' and teachers' motivation and responsibility for implementation of the goals envisaged and learning activities planned. These characteristics are corresponding to the REORDER model aspects of the applied "Personalisation by Pieces" approach elaborated by D. Buckley (2010), and it could be used as learning scenarios evaluation criteria.

<table>
<tr><td colspan="2">Description of Personalisation By the Learner (P-route model) using REORDER framework</td><td colspan="2">Indicated key characteristics of LS implementation "A breath of fresh air" and its description.</td></tr>
<tr><td>REORDER aspects</td><td>Main features of P-route of PbyP</td><td>Main aspects of innovations</td><td>Description / examples of innovations</td></tr>
<tr><td>Relationships: Negotiated democratic</td><td>- Collaborative working
- Universal rules applying to adults and children without privilege or exception
- Calm negation, non-threatening role models
- Positive language and ethos for all groups
- Teachers move rooms more often than groups</td><td rowspan="2">Teachers and students roles and their relationships. Various collaborative activities.

Students' autonomy, self-organized activities and responsibility for the task results.</td><td rowspan="2">Increased students' collaboration with teachers; teachers discuss with students topics, tasks and goals of projects. Students talk and communicate more with teachers while investigating research matters and performing their tasks. Teachers recognize their usual position to "stay in front of the students", and this is a real challenge for them to change their pedagogical approach.

Students feel responsible for the works they are doing, and for its results. They are distributing roles and tasks between themselves in groups, and enjoy to work in addition to the challenging tasks and technologies.</td></tr>
<tr><td>Distribution of Leadership: Driven towards widening leadership at all levels</td><td>- A clear programme for progressing learners leadership skills through managing real life services and projects
- Learners co-developing and co-running services
- Distribution of budgets is wide and includes some learner led groups and organisations.</td></tr>
<tr><td>Environments Variety of spaces</td><td>- Staff and learners have equal quality social spaces
- Qualified access to areas</td><td>Mixed schools and outdoor spaces: the</td><td>Students enjoyed performing exploratory creative activities outside</td></tr>
</table>

and functions, shared ownership	- Negotiated expenditure on décor and furnishings - Learners can choose between environments - Larger spaces so teachers collaborate	*students could choose between environments.*	*the school; they have performed extra activities at school and at home.*
Opportunities Diversity of routes	- Longer periods of time to allow for deeper engagement and self-organisation - Mixed age and stage working - Programme changes weekly or to fit projects - Frequent negotiation to set goals and set route	*Adaptability to the curriculum and learning goals.* *Simplicity, easy to match with curricula*	*Different subjects of sciences and technologies and natural sciences are involved in the LS, and students of different ages are participating: primary school students and 13-15-year-old students.* *Increased students' involvement into topic of their study project selection and discussion and opportunity to define goals and learning activities.* *Teachers didn't face any unexpected outcomes*.
Resources: Maximising learner choice	- Open access to most resources - Multi function rooms and spaces - Learner controlled access to some spaces and resources based on earned responsibility measures - Access to multiple teachers in any task - Some student controlled budget for resources	*Diversity of resources*	*Various tools, devices, and software are used;* *Students choose usable, well- known technologies; they consult with teachers of different subject, while performing interdisciplinary project.* *Students also create simple learning resources.* *Teachers discuss with students, which problem is to be solved during this LS.* *Among main factors that contributed to the success are choice of the problem to be solved and the participation of external experts.*
Evaluation: Examination based	- Competencies such as leadership and participation are measured in terms of progression - Attitudinal surveys and open		*Besides the formal evaluation which is applied by teachers, it is also used non-formal evaluation of students' competences and*

	debates are used to directly and openly influence decision making - Professional learning communities allow for evaluation and feedback on teacher practice - Whole school aims which are the basis of annual evaluation	*Diversity of forms of student assessment.*	*skills important for students like recognition between peers and school community.* *Teachers recognized better students' digital competence performing creative activities.* *Students' projects and resources are highly-rated on different subjects; students publish their created resources in the internet or simply present them at school.* *In this way students have a feedback, and they evaluate themselves.*
Recognition: High academic achievement praised progression	- Peer assessment is given high status - Aim to display or perform all work - Certificates awarded between peers, peers and teachers and recognising equal right to recognition - Variety of methods for recognising competency		
		Students' and teachers' attitudes and motivation	*Students learning motivation is increased. Non-formal evaluation of their competences and skills is very important for students. What is most important is to be recognized by their friends. Teachers' motivation to apply innovations in the future is high.*

5. A sketch of the applied research methodology (data collection and analyzing methods)

Theoretical models of learning personalization review, criteria choosing / creation of model for personalized learning: comparative analysis of existing models theories.

Qualitative data analysis of the teachers' and students semi structured interviews about scenario implementation practice was used. Structured template proposed for the structured teachers' interviews need to be revised on the basis of this pilot case study interviews analysis. Narrative analysis of teachers' interviews showed main aspects of new practice that all teachers had noticed. Comparative matrix between the categories of the interviews' analysis and the aspects of the REORDER applied model was used.

Self-regulated learning questionnaire need to be adopted to TEL scenario evaluation. Students' and teachers Self report on what TEL scenario enable personalization could help: *Phenomenografic research? Questions to identify personalization?*

Experts' (experienced teachers and students) interviews on the weights of these criteria concerning Personalization by Learner.

6. A description of the Ph.D. project's contribution to the problem solution

Main characteristics describing personalized learning process will be selected in practice research. It could be used as set of reliable evaluation criteria and descriptors of TEL personalization by learner scenario.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

The solution proposes to facilitate personalization of learning process that is on-going in TEL environment as ubiquitous process. Learning situation needs to be created by teachers at schools that could help students to learn to be more self-regulated in TEL environment creating their own learning and aiming their own learning goals.

8. Publications

1. Kurilovas, E.; Žilinskiene, I.; Ignatova, N. Evaluation of Quality of Learning Scenarios and Their Suitability to Particular Learners' Profiles. In: Proceedings of the 10th European Conference on e-Learning (ECEL'09). Brighton, UK, November 10–11, 2011, pp. 380–389.
2. N. Ignatova, E. Kurilovas. ICT based teaching and learning personalization trends in the context of Lithuanian education. PEDAGOGIKA, ISSN 1392-0340. 2012. 106.
3. N. Ignatova, A. Buinevičiūtė. Evaluation of iTEC project innovative practice of ICT based learning scenario from teachers' perspective. In: Proceedings of the ATEE Spring University 2012 conference: 20 Years for Sustainable Development: Learning from Each Other, May 3-5, 2012, pp. 130-135.

9. Questions

Violeta Jadzgevičienė

3th years PhD student
Lithuanian University of Educational Sciences

Research topic: Learning styles of university students in relation to programming teaching methods

The aim of research: to improve teaching programming by testing and developing teaching programming methods and techniques.

1. Questions

1. What programming teaching methods and techniques are more suitable for the learning styles of higher education students?
2. How virtual learning environment can help improve the introductory programming training, taking into account the different learning styles?

2. The significant problems in the field of research

1. What programming paradigm is right for the introductory programming course?
2. What is the essence of today's concept of programming?
3. There are difference: how students learn programming today and foretime?

3. An outline of the current knowledge of the problem domain

When we learn to program we have not only listen to lectures, analyze supplied and recommended learning material, listen to teacher's advises but also take an active participation in the learning process too. Modern information and communication technologies are influencing introductory programming training. Virtual learning environment is more and more often integrated in full time study. The majority of Lithuanian universities and colleges apply blended learning in educational process. Virtual environment tools (the most popular environment is Moodle) are implemented in parallel with traditional lectures and workshops. Such platforms are commonly used to present the learning material, to test student's knowledge (self-control and knowledge control for evaluation tests), and for communication with students when they are outside classes. According to various studies blended learning is most acceptable for both students and teachers. Increasingly, it comes about the individualization of learning, tutorial adaptation of a particular learner's needs, abilities and learning goals. It becomes relevant to organize teaching process applying it to learner's individual style. Mostly virtual learning environment provide with learning material, organization of learning activities, communication and cooperation means with the students but, the standard kit doesn't meet specific learning programming needs. Active researchers, developers and Moodle users community has developed and constantly creates new and additional instrumentality.

In this research, the researcher has chosen the learning style by Honey & Mumford's theory. They divided the learning style into 4 types to provide the method that according with learner's learning style as follow: Activist – prefers doing and experiencing, Reflector – observes and reflects, Theorist – wants to understand underlying reasons, concepts, relationships, Pragmatist – likes to have go try things to see if they work.

The suitable activities of the four learning styles are summarized in the following table (Mobbs, 2005):

Learning style	Activities
Activist	Brainstorming, problem solving, group discussion, puzzles, competitions, role-play
Theorist	Models, statistics, stories, quotes, background information, applying theories
Pragmatist	time to think about how to apply learning in reality, case studies, problem solving, discussion,
Reflector	Paired discussion, self-analysis questionnaires, personality questionnaires, time out, observing activities, feedback from others, coaching, interviews

If there is a purpose to organise the learning based on learning styles, at the beginning of learning activities the student's learning styles is determined by using a special test. Both, the teacher and the learner, taking into account the inherent style characteristics can plan their own learning activities.

In terms of a certain learner the above described classification of learning methods according to learning styles is not absolute. Taking into account personal qualities of a certain learner, he might like to use those methods which, in accordance with his identified learning style, are not appropriate for him. Also, the learner is usually characterized by several learning styles, with one of them to be more expressed.

4. A sketch of the applied research methodology (data collection and analyzing methods)

1. Review of scientific literature, analysis of educational documents;
2. Action research:
    a. design of the introductory programming learning model (take into account the learning styles);
    b. apply the introductory programming learning model;
    c. reveal the effective methods of this teaching and their application, and both theoretically and empirically to justify them;
    d. referring to results of practical application, to improve the introductory programming learning model and again apply it for teaching;
3. Data collection: individual interview, survey.
4. Data analysis and interpretation.

5. A description of the Ph.D. project's contribution to the problem solution

The tasks of the research:

- To investigate and describe the problems of the introductory programming teaching in higher education, to make a comparative analysis of the literature on this subject, to formulate the key questions of the research;
- To describe the selected Honey & Mumford’s student learning style classification interfaces with a programming training (learning) methods;
- To develop the introductory programming learning model (take into account the learning styles);

• To draw conclusions and recommendations on how it is possible to improve teaching programming take into account the learning styles in Lithuanian higher education schools.

6. How the suggested solution is different, new, or better as compared to existing approaches to the problem

Honey & Mumford's learning styles theory on teaching introductory programming is not investigated.

Introductory programming training in higher education is lacking of methodological literature in Lithuanian.

7. Publications

1. Bennedsen, J. (2008). Teaching and Learning Introductory Programming – A Model-Based Approach. Dissertation for Dr. Philos degree in the Faculty of mathematics and Natural Sciences, University of Oslo, Norway, 2008.
2. Honey P., Mumford A. (1992). The manual of learning styles (Vol. 3). Maidenhead.
3. Honey P. (2006). Learning Styles Questionnaire (40-Item). Maidenhead Berks: Peter Honey Publication Limited.
4. Honey P., Mumford A. (1999). Learning styles questionnaire. [online]. http://www.psychpress.com.au/psychometric/products/others/LSQ%20Report%20%28Sample%29.pdf.
5. Richard Mobbs. (2005).Honey and Mumford Learning Styles. http://www2.le.ac.uk/departments/gradschool/training/resources/teaching/theories/honey-mumford

Eglė Jasutė

3th years PhD student

Vilnius University Institute of Mathematics and Informatics

Research topic: Computer-based model of constructive geometry proof

The aim of research: To construct computer-based model of interactive visualization of geometry.

1. Questions

1) How to make easier for teachers to use dynamic geometry programs?

2) How to prepare interactive images to improve students' geometric abilities?

3) What technological and methodological criteria interactive images have to implement to improve students' abilities and teachers usage of dynamic geometry program?

2. The significant problems in the field of research

To equip teachers with tools for using dynamic geometry in lessons.

3. An outline of the current knowledge of the problem domain

Constructionist ideas can be effectively realized in mathematics lessons. However, there is still a strong focus on mathematical knowledge acquisition (Dagiene et al., 2007). Therefore constructionist approach is integrated into the teaching of mathematics very slowly because teachers have to adapt to the new ideas and methods, to spend more time for preparing. Teaching mathematics is mostly based on an academic approach – it is intended for the national school – leaving mathematics exam obligatory for almost every higher school. In view of that, the majority of our mathematics teachers can be considered as traditional teachers.

Some more reasons, why mathematics teachers do not use constructionist learning tools, i.e. dynamic geometry in their lessons, have been found by analyzing literature: the lack of the skills in information technology has an impact on the use of dynamic geometry for teaching mathematics (Stols, Kriek, 2011). The dynamic geometry is relatively complex for a math teacher for several reasons: first, a dynamic geometry construction is based on a hierarchy and to construct a sketch, teachers must have (or acquire) new skills of developing algorithms and programming by geometry; second, most tools of dynamic geometry software are rather complex for the teacher (Hohenwarter et al. 2009).

Some scientists see quite the other problem of information technology: the usage of digital tools depends on the teacher's disposition. If the teacher uses active learning and constructive methods of teaching, he/she is willing to use the dynamic geometry for teaching, if the teacher uses traditional teaching methods, he/she is not willing to use the dynamic geometry for teaching (Stols, Kriek, 2011).

While there are some problems of using the dynamic geometry, the software can help teachers to use a variety of constructionist teaching and learning methods. Four methods are defined for teaching mathematics with dynamic geometry which are related more or less with the ideas of constructionism:

1) a student is constructing dynamic sketches himself by his experience;

2) a student is analyzing individually geometric concepts and properties of geometric objects in

the pre-created dynamic sketches with some instructions and directed questions;
3) a student is analyzing pre-created dynamic sketches with the teacher in the class, if the teacher uses the dynamic sketch to illustrate the explanation of geometry;
4) a student is learning by a pre-created book of dynamic sketches, when he has all the sketches that consistently illustrate all the topics of geometry and can analyze them individually (Jasutiene, 2007).
All the learning methods described can be used with the model presented in Figure 2.
These studies have inspired the ideas how to develop an approach making the mathematics studies easier for both students and teachers. The developed approach links together a traditional way of teaching mathematics with the facilities of uptodate media. Thus, we are not going to force teachers for quick changes, vice versa we offer them support by developing flexible interactive tools for dynamic geometry.

4. A presentation of the proposed approach and achieved results

In order to help the teachers to use the dynamic geometry and other information technologies is developed an interactive geometry visualization model. It is recommended to create an interactive book using dynamic geometry according to this model and distinguished principles of the interactive geometry visualization.
In the first step the principles of the interactive geometry visualization using dynamic geometry have been chosen. All the principles for interactive book is divided into three main parts: 1) the common principles which are applied for all the interactive book; 2) the principles of an interactive image, which are applied for one window with the dynamic drawing and additional tools (buttons, measures, parameters, text inputs etc.) and 3) the principles of the dynamic drawing, which are applied for a drawing (Figure 1). The common principles are three:

- The independence of the dynamic geometry software. The interactive book can be created with any dynamic geometry software.
- The dependence of educational program. The interactive book has to correspond to learning goals and students abilities of national mathematics educational program.
- The division of topic. Whole topic has to be divided into smaller parts depending on student's abilities which have to be trained.

The other group of principles for the interactive image is more technological:

- An adjustment of the activities for a student;
- The flexibility for an image. The image can be simplified or can be made more difficult for separate student;
- The integrity of the image. The possibility to integrate algebraic calculator, functions, geometric objects ant it's measures in the interactive image have to be;
- The simplicity of image. The image has not be complex and there have to be as many objects (dynamic and not) as it needed to explain main geometric idea or to train student's ability.

And the third group of the principles is applied for the dynamic drawing:

- The final drawing has to be simple and constructed using optimal number of objects;
- The basic objects have to be highlighted by colors;
- Drawing has to impart main idea of geometric phenomenon.

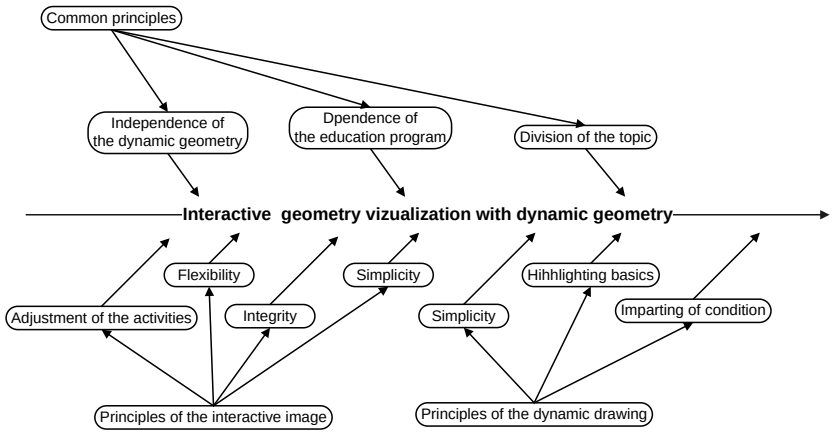

Figure 1. The principles for the interactive geometry visualization using dynamic geometry model

The final interactive book has to implement all the principles. The model of an interactive geometry visualization using the dynamic geometry is presented in Figure 2. Model has three main stages:

- The division of activity domain. The creator of the interactive book has to divide geometric domain into small parts depending on the learnable student's abilities. It means to divide it into concepts, properties of geometric objects, axioms, theorems, proofs, methods and problems as it is required in the principles.
- The creation of the interactive image. An interactive image using dynamic geometry is designed for every activity type by the principles of the interactive image.
- Every interactive image has at least one dynamic drawing which is created by the principles of the dynamic drawing. All the interactive images have to be joined into one interactive book.

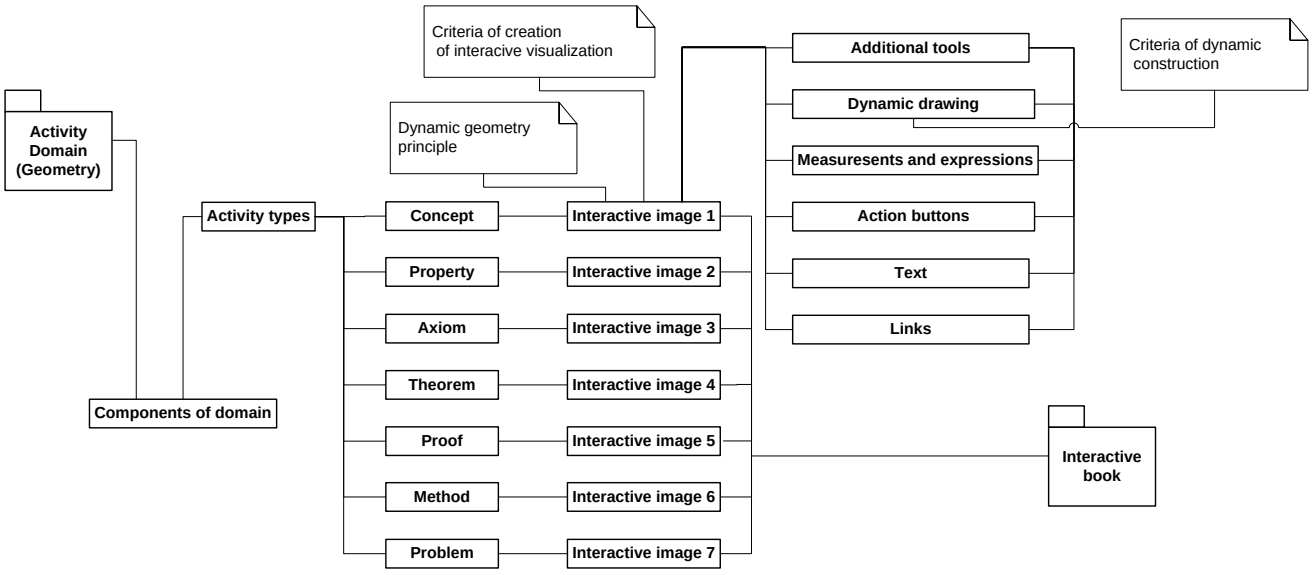

Figure 2. The model of the interactive geometry visualization using dynamic geometry

here have to be done two ways of evaluation this model: 1) pedagogical experiment t to ascertain improves of students' abilities and 2) expert evaluation of Interactive book created by model.

The efficiency of dynamic geometry for teaching and learning is grounded in several ways. The most relevant among them are: 1) the usage of the dynamic geometry for geometric proof teaching (and learning) (Hoyle, Jones 1998, Jones 2000), 2) the usage of the dynamic geometry for teaching (and learning) geometric concepts (Gomes, Vergnaud, 2010). However, the most common use of the dynamic geometry is the construction of sketches that the students make by they own when starting from teachers pre-set instructions. Such an effective learning method is undoubtedly interesting, but it has to be remarked here that many teachers find very complicated the use of the dynamic geometry or information technology in mathematics lesson (Stols, Kriek 2011). Therefore, we have prepared the set of interactive images with the dynamic geometry by the presented model and the influence of them to student's geometric abilities is ascertained by the experiment. The authors' research questions arise here:

1) If interactive images created by the above model and used for geometry teaching, have any effects for students' geometric skills?

2) What changes the interactive images have for students' geometric skills?

3) What abilities are improved when interactive images are used for teaching-learning?

For this purpose the experiment on the usage of pre-created sketches in the mathematics learning has been accomplished.

The experiment was performed by the schema (Figue 3).

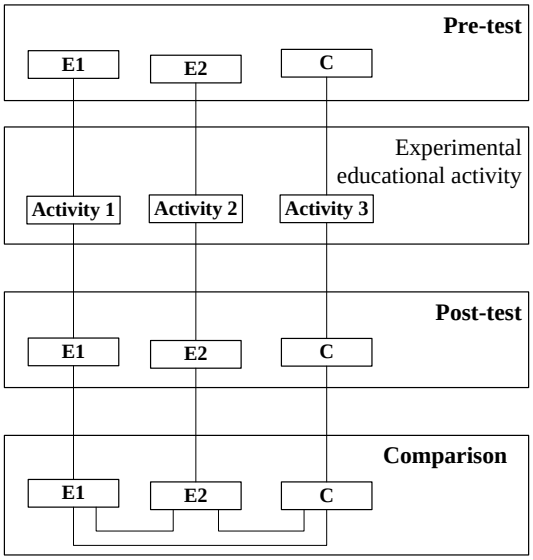

Figure 3. The schema of experiment

Two teaching and learning methods for the measure of the experimental factors (independent variables) are used in the experiment: 1) the interactive geometry images are used for the individual learning in the computer class and 2) the interactive images are used to visualize teacher's explanation.

The sample for the experiment has been chosen according to several criteria, in order to make more accurate results of the experiment: 1) all the participants in the experiment have to be

taught by the same teacher, 2) the participants have not to be taught previously mathematics using dynamic geometry, 3) all the participants have to belong to the same age group, 4) each group of participants has similar ratio of the girls and boys, 5) the mathematical preparation of all the participants has to be similar. The experiment has been performed with 13-14 years (grade 7) students which have been chosen following the above criteria. The whole sample has been split into three groups depending on the experimental factors (Table 1):

- The experimental group one (E1). The students of this group have been taught in a computer classroom. Each student has got the tasks and instructions how to use pre-created interactive images individually;
- The experimental group two (E2). The teacher has used interactive images for the demonstration of geometric topics during the explanation for this group in the class;
- The control group (C). No interactive learning images or tools have been used in this students' group.

The geometric topic "Lines and angles" has been chosen for the experiment. It has been the first geometric topic to be taught in that school year to the students involved in the experiment. The geometric concepts, properties, and drawing methods of this topic have been chosen for visualizing by dynamic geometry. The corresponding interactive images have been created with "Geometer's Sketchpad" (Figure 4).

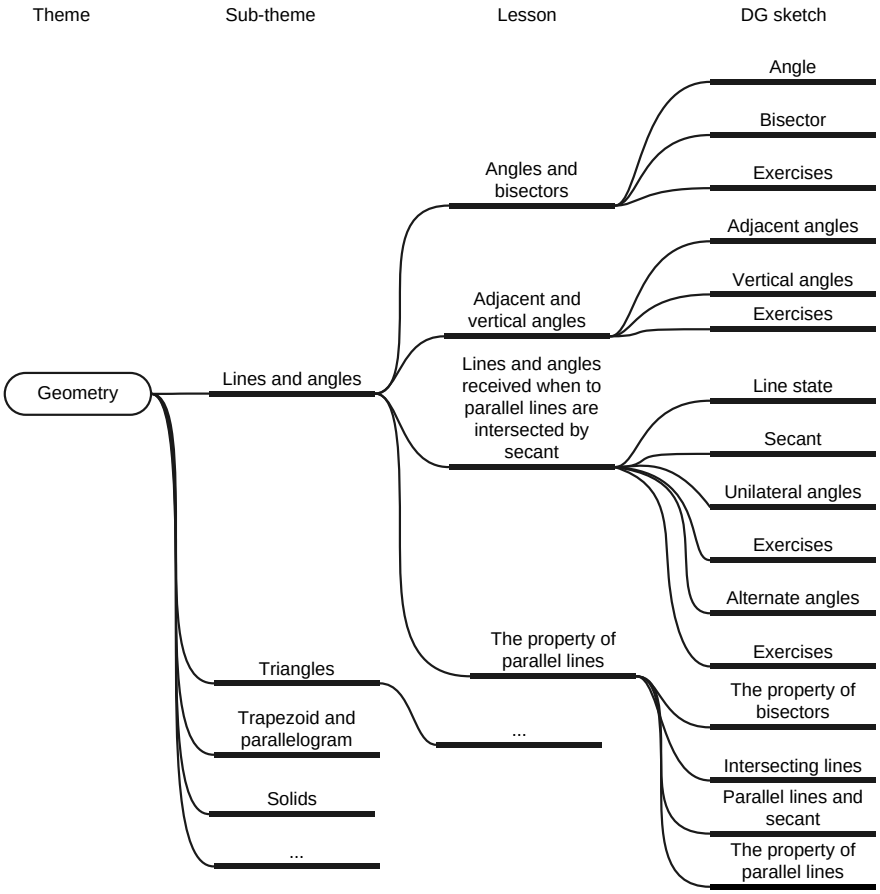

Figure 4. The resolution of one geometry topic for the experiment sketches

The dynamic sketches have been created consider the above model and principles of the interactive visualization. The sketches have been prepared with the instructions about what objects to move, draw, measure, what parameters to change, and what objects to follow. The teacher has provided worksheets with purposive questions and tasks for group E1 and prepared sketches for visualization purposes (text has been increased; comments not required during the demonstration have been removed, etc.) for group E2.

The study has used a pre-test and post-test for measurement (Figure 3). The results of pre-test and post-test of each group have been compared. Also the growth of average score of each group has been compared with other groups: the group E1 average growth has been compared with average growth in group C, the group E1 average growth has been compared with average growth in group E2, and the group E2 average growth has been compared with average growth in group C.

The results of experiment show that:

1) interactive geometry images improve student's geometry skills. But for group when interactive images have been used for demonstration the improvement has been significant.
2) However it does not help the students to improve their skills significantly when they learn geometry individually using interactive images.
3) Traditional methods also improve students' geometry skills in the experiment. The importance of teachers' role in the lessons can be discussed here.
4) The experimental results shows that the drawing skills are improved when used interactive images.
5) The most skills are improved when these interactive images with dynamic geometry are used for demonstration of the teacher's explanation. However the ability to understand the mathematics text and the ability to identify and to apply properties of geometric objects to solve problems are not improved in the experimental group with the significant mean growth.
6) The demonstration of the interactive images is effective method for teaching mathematics. The analyzing pre-created sketches also improves students' abilities, but it is not significant in this experiment.
7) We still recommend to use these or other methods using pre-created sketches for the teaching and learning mathematics of the students in the secondary school. The experiment shows that most effective results may be attained when the traditional methods are combined with new one in our schools initially.

5. A sketch of the applied research methodology in the project (data collection and analyzing methods)

1) Systematization and a comparative analysis for analytic part.
2) The construction method for model investigation.
3) Pedagogical experiment.
4) The obtained results of experiment were processed using the statistical package SPSS and descriptive statistics.

5) Approaches and methods proposed by Multiple Criteria Decision Analysis, in particular, modeling, the Goal/ Question/ Metric framework and the expert evaluation, Value measurement theory are expected to be applied in the creation of the evaluation scheme for model.

6. Application of the research work

1) Model of the interactive geometry visualization (Fogure 2) can help to create qualitative and consecutive interactive imagines or environments for dynamic geometry and mathematics education experts.
2) The realization of model has to make easier teachers and students to use dynamic geometry programs.
3) The realization of model has to help students consecutive analyze math themes.
4) The realization of model has to help teachers to use constructive methods for learning and teaching.

7. How the suggested model is different, new, or better as compared to existing approaches to the problem

1) We provide the first extensive analysis of the problem field of interactive (dynamic) visualisation in geometric contests of secondary education (to our knowledge).
2) A novel idea has been suggested and investigated to visualize geometric contest of secondary education consistently using dynamic geometry principle.
3) There is engineering solution (model) for visualization of secondary school geometry domain presented.
4) Expected (it is not done yet): the evaluation criteria and method to evaluate interactive images with dynamic drawing for geometric domain.

8. Publications

1. E. Jasutė, V. Dagienė (2012). Towards Digital competencies in mathematics education: a model of interactive geometry. International Journal of Digital Literacy and Digital Competence, 3(2), p. 1-19.
2. E. Jasutė, V. Dagienė (2012). Construcionist learning of geometry. Constructionism 2012: Theory, Practice and Impact, Conference proceedings. August 21-25, 2012. The education technology Lab, Athens.
3. Jasute, E., Dagiene, V. (2011). A Model of Interactive Geometric Visualization with Dynamic Geometry. Information Sciences 2011 Vol. 56. ISSN 1392-0561 [in Lithuanian]
4. Dagiene, V., Jasutiene, E. & Jevsikova, T. (2007) An Approach to Combine Learning Entities to Support Mathematics Curriculum in Schools. In: D. Benzie, M. Iding (Eds.) Informatics, Mathematics and ICT: a "golden triangle". CD proc.: Working Joint IFIP Conference. Northeastern University, Boston, Massachusetts, USA, June (p. 27–29), 2007.
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6. Jasutiene, E. (2007). Constructive methods of mathematics teaching, Lithuania mathematics collection, Vilnius university, no. 47, 2007, 233 p. ISSN 0132-2818 [in Lithuanian]
7. Dagiene, V. & Jasutiene, E., (2006). Developing Dynamic Sketches for Teaching Mathematics in Basic Schools, The 17th ICMI (International Commission on Mathematical Instruction) Study: Technology Revised, Hanoi University of Technology, Vietnam, (p. 120–127).
8. Dagiene, V. & Jasutiene, E., (2004). Teaching and learning mathematics with Geometer‘s Sketchpad, Lithuania mathematics XIV conference. [in Lithuanian]

9. Questions

I am concentrate on description of my work (writing thesis) in this stage of my work and my questions are associated with formulating of some main parts of thesis.

My work arose from practical idea – to help teacher to use dynamic geometry program (so powerful tool) for teaching and learning. I expect to present phD thesis for informatics engineering commission. So I have to formulate our scientific problem in this domain. I have written some suggestions about formulating scientific problem: To equip teachers with tools for using dynamic geometry in lessons. Maybe it can be formulated in more scientific way? Maybe I can get some discussions in this way or some navigation how to get answer to this question?

However I have some scientific novelty presented in chapter 7 [page 6]. Here I am not convinced too. I would like to ask if my novelty formulation is correct and possible for informatics engineering domain.

The last stage of my work is to evaluate model. I suppose to find out evaluation criteria and method to evaluate interactive images with dynamic drawing for geometric domain. I would like to know more about Multiple Criteria Decision Analysis for evaluating my model. Maybe I can get some navigation in this way (some articles or books what I must to read)?

I will be very grateful for any note of my work.

Anita Juškevičienė

4th year PhD student

Vilnius University Institute of Mathematics and Informatics

Research topic: Research on Web 2.0 technologies in education

The aim of research: Virtual learning environment (VLE) adaptation by semantic search engine (SSE). There is an interconnection between SSE and VLE adaptation quality criteria. Personalization is one the adaptation criteria.

1. Questions

1. To make literature review on existing approaches to the adaptation capabilities of VLE.
2. To analyze literature of web 2.0 technologies experience used in education and determine how this experience can be transferred to the resulting ontology.
3. To examine existing learning style (LS) models. To extract the learning activities from chosen LS model.
4. To examine ontology development theory, to choose (or create) the right methodology for ontology development.
5. To examine semantic search engine architecture, design process and methods, to choose the right methodology for the resulting system development.
6. To offer the method for selecting technology for effective learning based on learning activities.
7. To evaluate the proposed method implemented by ontology and experimental search system.
8. To evaluate adaptive virtual learning environment.

2. The significant problems in the field of research

1. There is a lack of the research on using semantic search of the VLE services/tools suitable for the particular learning styles.
2. Although in practice, and in many literature is highlighted the need for the application of web tools in education, however it is lack of clear methods exist, how these tools could be applied in the learning for higher learning quality.

3. An outline of the current knowledge of the problem domain

Adaptive e-learning system, deal with appropriate personalization techniques in order to maximize the effectiveness of learning. Personalized e-learning is an important research area of modern educational technology. At present, totally utilizing computer techniques to implement the personalized learning is very difficult. There are plenty of web 2.0 technologies and their use in education examples. Although in practice, and in many literature is highlighted the need for the application of web tools in education, however it is lack of methods exist, how these tools could be applied in the learning for higher learning quality.

In paper [Starkey, 2011] is described the digital age learning matrix which combines categories of use of digital technologies with aspects of learning. The aspects were identified through examining the work of researchers in the field of knowledge and the digital age. Author

says that learning through connections and sharing of ideas and emerging knowledge are important aspects of how knowledge is developed in an information-rich Web 2.0 society.

In study [Bower, 2010] is presented an approach to conceptualising and performing Web 2.0-enabled learning design. It shows how particular Web 2.0 technologies may be implied from the pedagogical, content, modality and synchronicity requirements of tasks, and it is these properties that will determine the utility of new Web 2.0 tools as they emerge. It is hoped that the constructs presented in paper supports educators to more immediately and effectively leverage the potential of Web 2.0 technologies as they reach out to their students in a range of contexts.

Also, you can find a lot of literature which describes various technologies usage examples for learning/teaching.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

Adaptive e-learning system, deal with appropriate personalization and adaptation techniques in order to maximize the effectiveness of learning. Most of the researches focus on such VLE's personalization functionalities as personalizing learning plans, learning materials for learners.

We propose to give the higher adaptation level to VLE by developing ontology based semantic search engine and implementing it in VLE. This engine gives the possibility to develop adaptive learning environment with better access to specific learning content managing tools (i.e. Web 2.0 tools) thus facilitates the search process by optimizing workloads, thereby improving learner's satisfaction and improving the efficiency and effectiveness of the learning process.

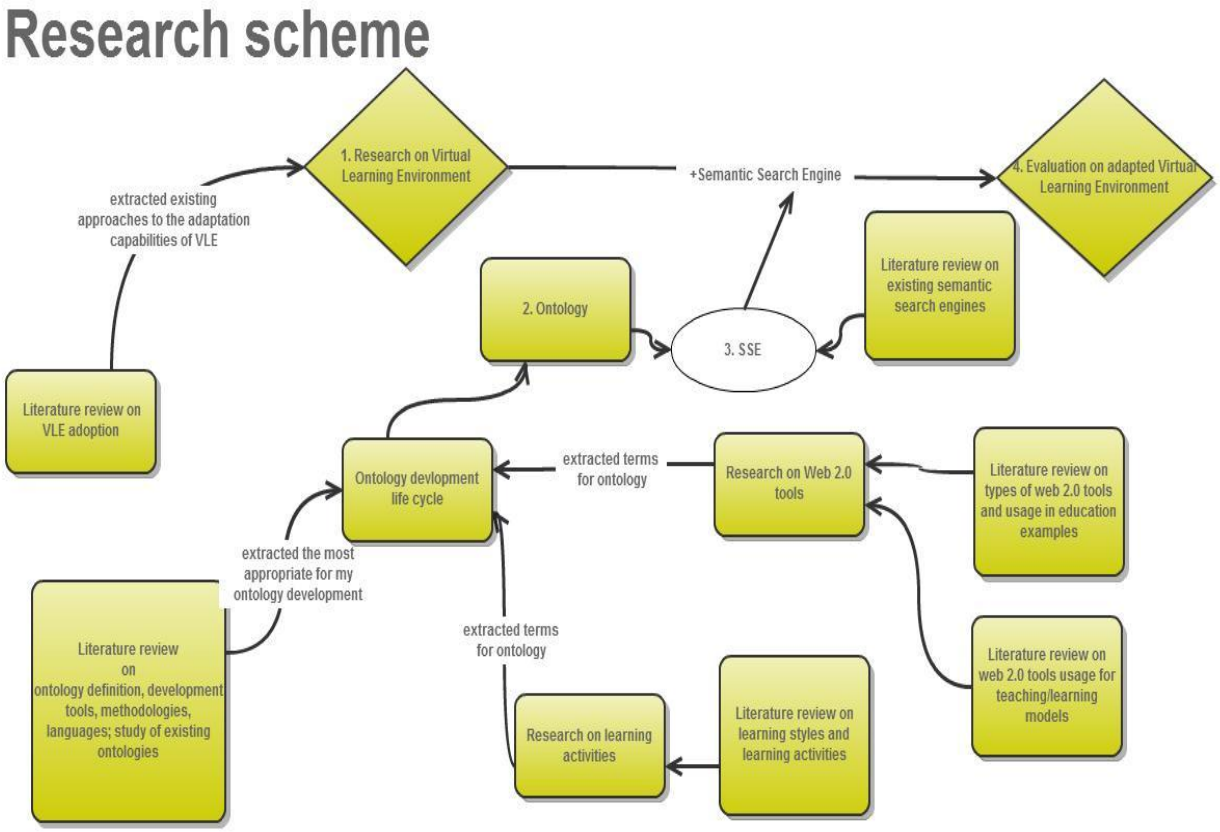


Figure 2. Research scheme.

1. Research on VLE

In order to extract existing approaches to the adaptation capabilities of VLE the literature review on VLE adaptation was conducted. The VLE adaptation criteria are as follows [Graf, 2005]:

- Adaptability: it includes all facilities to customise the VLE to suit the educational institution needs (e.g. the language or design).
- Personalisation aspects: indicate the facilities of each individual user to customise his/her own view of the VLE.
- Extensibility: in principle, it is possible for all open source products. Nevertheless, there can be great differences, e.g. a good programming style or the availability of a documented application programming interfaces could be helpful.
- Adaptivity: it indicates all kinds of the automatic adaptation to the individual user's needs (e.g. personal annotations of LOs or automatically adapted content).

We focus on personalisation and adaptivity capabilities which have direct extremely important impact on personalising one's learning in VLE. Here learners can customise some VLE features to match his/her learning style. Besides that, VLE could automatically adapt its own features incl. communication/collaboration plug-ins to match the requirements of the particular learning style.

2. Ontology

For ontology developing the ontology developing life cycle was created mainly based on the IEEE 1074-2006 is a standard for developing a software project life cycle processes and Uschold and Gruninger [Uschold, 1996] which proposes skeletal methodology: (1) Identifying purpose and scope; (2) Building the ontology (capture, coding, integrating existing ontologies); (3) Evaluation; (4) Documentation; (5) Initial guidelines for designing ontologies:

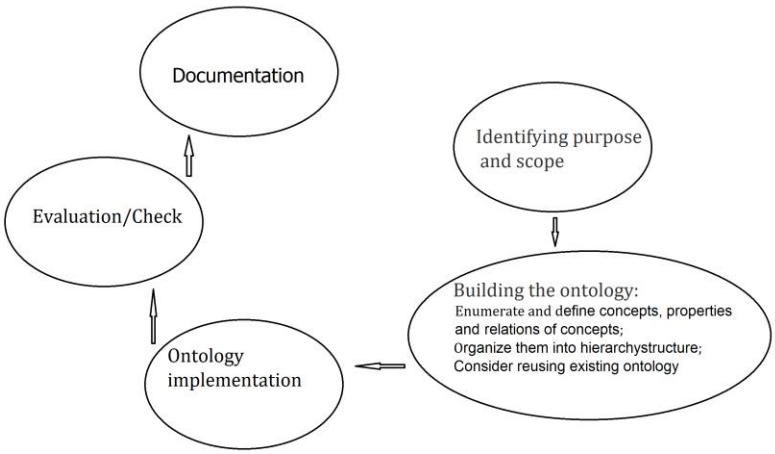


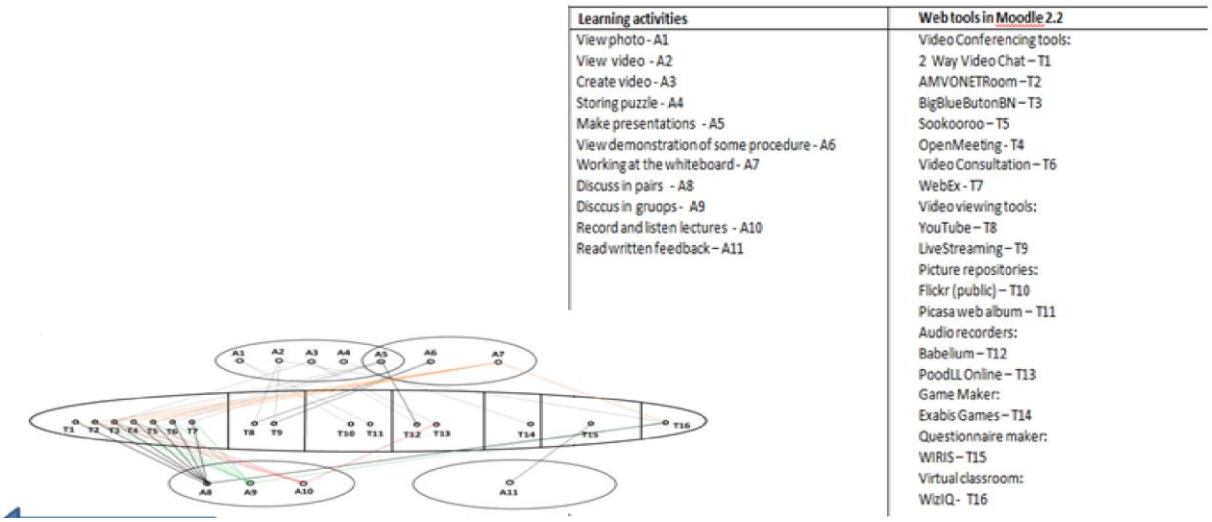
Figure2. Ontology life cycle.

Also the literature review on web 2.0 technologies experience used in education and learning style models was conducted in order to extract necessary domain knowledge. In order to

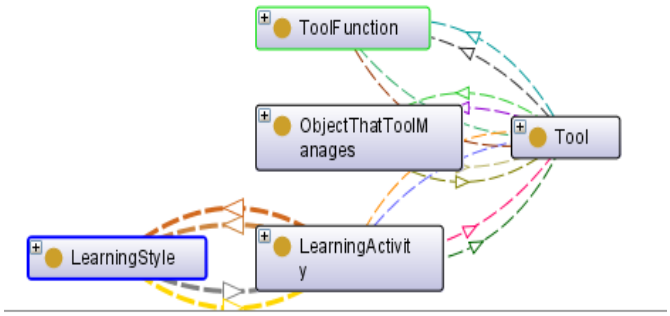
specifically find clear definitions and the roles of ontology, ontology development tools, and ontology representation language/formats, an exhaustive search conducting a Systematic Review was performed. This systematic review was conducted following the process proposed by [Kitchenham, 2004; Biolchini, 2005]. The term Systematic Review in software engineering is used to refer to a specific methodology of research, developed in order to gather and evaluate the available evidence pertaining a focused topic. This process presents three main phases: (1) Phase 1 – Planning: In this phase, the research objectives and the review protocol are defined. The protocol constitutes a pre-determined plan that describes the research questions and how the systematic review will be conducted; (2) Phase 2 – Conduction: During this phase, the primary studies are identified, selected and evaluated according to the inclusion and exclusion criteria established previously. For each selected study, data are extracted and synthesized; and (3) Phase 3 – Reporting: In this phase, a final report is formatted and presented.

By systematic review, we have evaluated some ontology developing tools according three dimensions. First, there is a general dimension, which refers to the aspects of the tools that can also be found in the other types of programs. This dimension refers to information about the user interface and the different actions the user can perform (8 criteria). The second – the ontology dimension, refers to ontology related issues found in the tools, such as the amount of help on ontology building and the high-level primitives provided (7 criteria). The last dimension is that of cooperation, which is used to evaluate the tool's support for constructing ontology by several people at different locations. This evaluation is based on [Duineveld, 2000]. Protégé tool was selected for our domain ontology development during this evaluation procedure.

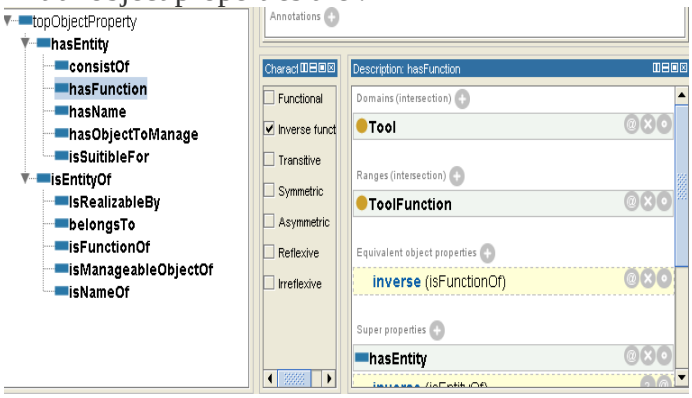
Interconnections between learning styles, preferred learning activities, and related Web 2.0 tools using sets portrait method was established:



Web 2.0 tools ontology to interconnect preferred learning activities with relevant Web 2.0 tools in VLE Moodle v2. was created. Initial classes of developed ontology are:



Initial object properties are :



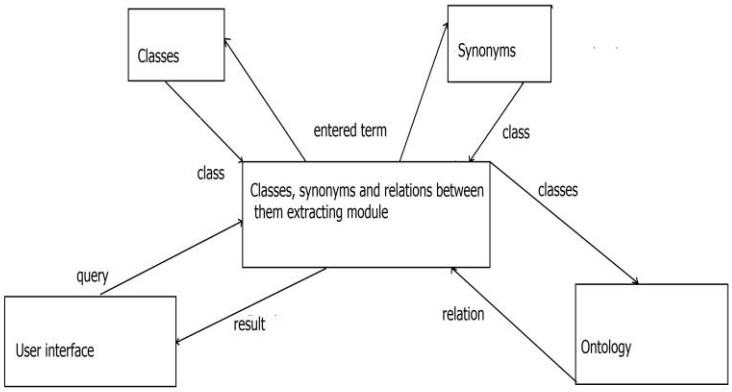
We have used a standard Protégé plug-in – the DL Query tab which provides a powerful and easy-to-use feature for searching a classified ontology. Queries can be executed only on a classified ontology by reasoner built in Protégé. We have used FaCT++ and HermiT1.3.4 reasoners. Also, ontology was implemented in OWL language. OWL ontologies have similar components to Protégé frame based ontologies. OWL classes are interpreted as sets that contain individuals. They are described using formal (mathematical) descriptions that state precisely the requirements for membership of the class. Properties are binary relations on individuals, i.e. properties link two individuals together, e.g. the property hasFunction might link the individual Tool to the individual ToolFunction. Properties can have inverses, e.g. the inverse of hasName is isNameOf.

3. *Semantic search engine*

For search engine developing the literature review on ontology based search engines was conducted. Most of the existing studies focus on learning material searching. But experiences found in the literature could be applied for suitable tools searching engine developing. We will develop system mainly based on [Mukhopadhyay, 2011].

In this paper is presented the design methodology and development of a semantic Web search engine which provides exact search results for a domain specific search.

Initial search engine model:



A user interface is designed where the user enters his query and the results are returned back to him. For example, the user need tool for record and lissen audio. The query could be as folows „tool that can record and play audio". Then the system will return back the list of appropriate tools, for example „BigBlueButton, OpenMeeting".

4. *Adaptive VLE*

VLE with implemented semantic search engine will be evaluated according to specified requirements (objective evaluation) and by students which will try system and will fill out questionnaires (subjective evaluation).

5. A sketch of the applied research methodology (data collection and analyzing methods)

1. The literature review on VLE adaptation was conducted.
2. The literature review on web 2.0 technologies experience used in education was conducted.
3. The literature review on learning styles was conducted.
4. In order to specifically find clear definitions and the roles of ontology, ontology development tools, and ontology representation language/formats, an exhaustive search conducting a Systematic Review was performed.
5. Triangular Fuzzy Numbers (TFN) method was used to select the best relevant ontology development tool. This method is convenient for evaluating the quality of many different kinds of software alternatives in the market [Ounaies, 2009; Kurilovas, 2010].
6. For establishing interconnections between the sets of learning styles, preferred learning activities, and related Web 2.0 tools sets portrait method was used.
7. Ontology was developed following the created life cycle.
8. Adapted VLE will be evaluated by the expert evaluation method based on the [Kurilovas, 2010] MCEQLS methodology and by students which will try system and will fill out questionnaires. Expert evaluation is a multiple criteria evaluation of learning software aimed at the selection of the best alternative based on score-ranking results.

6. A description of the Ph.D. project's contribution to the problem solution

Ontology gives the possibility to develop adaptive learning environment with better access to specific learning content managing tools (i.e. Web 2.0 tools). This possibility is necessary for particular learners to implement their preferred learning activities using suitable Web 2.0 tools in VLEs and thus to optimise their learning paths. The search engine based developed ontology facilitates the search process by optimizing workloads, thereby improving learner's satisfaction and improving the efficiency and effectiveness of the learning process. The engine gives the possibility to move from "simple" VLE to VLE having higher adaptation level.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

Adaptive e-learning system, deal with appropriate personalization and adaptation techniques in order to maximize the effectiveness of learning. Most of the researches focus on such VLE's personalization functionalities as personalizing learning plans, learning materials for learners. We propose the new method for VLE adaptation focus on learning tools search personalization function.

8. Publications

1. A. Juškevičienė. Web 2.0 tools and education/Antrosios kartos saityno technologijos ir švietimas. Lietuvos matematikos rinkinys. Lietuvos matematikų draugijos darbai. ISSN 0132-2818. T. 51, 2010, p. 103-108.
2. J. Urbonienė, A. Juškevičienė. The research on the web 2.0 technologies adaptation for teaching programming/Web 2.0 technologijų adaptuojamumo programavimo mokymui galimybių tyrimas. Mokslinis leidinys "Studijos šiuolaikinėje visuomenėje". 2011 Nr. 2(1). p. 161-170.
3. A. Juškevičienė. Web 2.0 tools for education/ Antrosios kartos saityno technologijos mokymui(si). Lietuvos matematikų draugijos 52-oji konferencija, 2011 m. birželio 17–18 d.)
4. A. Juškevičienė. E.Kurilovas. Web 2.0 tools for VLE Moodle personalization/VMA Moodle personalizavimo galimybė antrosios kartos saityno technologijomis. *Lietuvos matematikos rinkinys*. Lietuvos matematikų draugijos darbai. ISSN 0132-2818. T. 53, 2012. – in print
5. Kurilovas, E.; Juškevičienė, A. (2013). Several Semantic Web Approaches to Improving the Adaptation Quality of Virtual Learning Environments. Journal of Web Engineering - in print
6. Kurilovas, E.; Juškevičienė, A.; Bireniene, V. (2013). Web 2.0 Tools Ontology to Personalise Learning. In: M.D. Lytras et al. (Eds.): WSKS 2013, Communications in Computer and Information Science (CCIS) 111, Springer, Heidelberg (2013)- in print

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[Mukhopadhyay, 2011] D. Mukhopadhyay, A. Banik, S. Mukherjee, J. Bhattacharya, and Y. Kim, A Domain Specific Ontology Based Semantic Web Search Engine. ;In Proceedings of CoRR. 2011.
[Ounaies, 2009] H. Z. Ounaies, Y. Jamoussi and H. H. Ben Ghezala, Evaluation framework based on fuzzy measured method in adaptive learning system, Themes in Science and Technology Education 1(1), 2009, pp. 49–58.
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1st year PhD student, Education
Vytautas Magnus University, Lithuania.

Prior studies:

- Master Degree in Informatics (1994), Kaunas University of Technology, Lithuania;
- Postgraduate Degree in Higher Education. Grade Académique de Diplômé d'Etudes Spécialisées en Pédagogie de l'Enseignement Supérieur (2005), Due to Bologna, Master Complémentaire en pédagogie universitaire et de l'enseignement supérieur (2007) University of Liege, Belgium

Research topic: Informal and non-formal learning in rural communities through social networks

Publications: Books (6); methodological handbooks (2), articles.

- G. D'Angelo, J. Kasperiūnienė, D. Rutkauskienė (red.), 2010, From didactics to e-didactics. E-learning paradigms, models and methods.(Lithuanian edition) ISBN 978-9955-25-848-3, p. 464, Technologija
- Mentoring for 21st century skills. It's all about the learning. 2009, University of Salford, UK. p. 156; ISBN:978-1-905732-79-1, contributor. http://www.amazon.com/Mentoring-21st-Century-Skills-learning/dp/1450589707
- Cibulskis G., Čepaitienė N., Kaklauskas A., Kasperiūnienė J., Trinkūnas V., Volungevičienė A.. Methodic of e-learning quality evaluation and its implementation (Nuotolinių studijų kokybės vertinimo metodika ir jos taikymo tvarka, metodiniai patarimai ekspertams vertinantiems institucijos pasirengimą vykdyti studijas nuotoliniu būdu), Vilnius: Kopa, 2007 p. 63
- Cibulskis G., Čepaitienė N., Kaklauskas A., Kasperiūnienė J., Trinkūnas V., Volungevičienė A..Recommendation to prepare self- analysis in e-learning in higher institution (Metodiniai patarimai savianalizės rengėjams, institucijos pasirengimo vykdyti studijas nuotoliniu būdu savianalizė), Vilnius: Kopa, 2007 p. 98
- Cibulskis G., Čepaitienė N., Kaklauskas A., Kasperiūnienė J., Trinkūnas V., Volungevičienė A.. Learning materials to evaluators, (Vertintojų mokymo medžiaga, Vertinantiems institucijos pasirengimą vykdyti studijas nuotoliniu būdu), Vilnius: Kopa, 2007 p. 124

Teaching experience: reader (KTU, ASU) – 9 years; teacher in vocational courses for youngsters and adults – 18 years; e-learning mentoring, coaching – 10 years.

Research problem questions:

- How social internet media are and can be used for non-formal and informal learning and knowledge construction;
- How social networks are used for non-formal and informal learning in rural communities (Lithuania and other countries perspective);

- Which and how qualified non-formal and informal learning content could be found in social nets;
- Do social media motivate for lifelong learning and how much;
- In which way and how effective social networking tools are used in the goal to become the living style of the learner.

The aim of the research: to formulate theoretical model for non-formal and informal learning using social internet media and verify its appliance in rural communities of Lithuania and other foreign countries.

Research hypotheses:

1. A gap exists between rural and internet communities (Cloonan, 2012);
2. The process of non-formal and informal learning develops fast using social internet media but this circumstance still is ignored by some researches and not used for effective identity training
   (S. Daukilas);
3. Rural users will set their profiles to private at higher rates than urban users and this after-effect to lower learning effectiveness in rural communities;
4. The geography of virtual friends enlarges learning topics and it becomes easier to reach learning meaningfulness and quality of content;
5. The effective use of social networking tools for non-formal and informal learning motivates learners and lifelong learning becomes part of their lives.

Research just started. Preliminary investigations and analysis in Lithuania, Scandinavian countries, Turkey, Greece, Bulgaria and Hungary were done in the frames of LdV project "Mentoring rural women through social network" LLP-LDV-TOI-2009-LT-0052 (co-ordinator Aleksandras Stulginskis University) and TuCoDe "Tutor competence development for RIAPs managers" LLP-LdV-TOI-2007-LT-0008 (co-ordinator Baltic Education Technology Institute, Lithuania).

The main interest to participate in 3rd international doctoral consortium: gain new knowledge and skills, networking, sharing ideas, group work, common research activities

Karolína Mayerová

2th year PhD student

University in Bratislava, Faculty of Mathematics, Physics and Informatics

Research topic: Educational robotics in primary school.

The aim of research: In this work we are making an overview of robotic kits available on global market and also in Slovakia. Another aim of this work is to make an overview of robotic kits used in schools, collect a variety of activities and materials that are used in lessons or in hobby groups. The aim of this review is to establish different criteria that will clearly help to choose robotic kits for different purposes. In our research we use robotic kits, which are the most appropriate for this target group – primary school students according to our criteria. We want to design, test and analyze a series of activities, which should be easy to implement to the educational process in schools. During testing we want to analyze collected data and create a theory how students progress in acquisition of knowledge and skills in classes where the LEG0 kits are used.

1. Questions

1. What is the current situation in field of educational robotics in Slovakia and abroad?
2. What is the appropriate method of classification of educational robotics in informatics education?
3. What is the process of learning during robotic activities?

2. An outline of the current knowledge of the problem domain

In Slovakia and in many other countries educators conduct various pilot projects focused on educational robotics in primary education (GAUDIELLO, ZIBETTI, PINAUD, 2012). Educators have to solve one of the nontrivial tasks, to find a suitable robotic kit that would be appropriate for this target group (children 7-10 years old). Another problem is the cost of these robotic kits and their affordability for primary schools. Based on the set of criteria that we already stated in a previous paper (MAYEROVÁ, 2012) we concluded that the best option is LEGO WeDo robotic kit. But we read a lot of articles in which authors describe successes in primary school with NXT robots. However, we have found many reasons to think that in this target group of children is not fully able to understand the modular structure, hence teaching with LEGO NXT is not so effective. We decided to use LEGO WeDo in our further research and for this kit we propose a set of activities targeted at primary school. So far we have prepared five activities (5 lessons) for 2nd graders (7-8 years old children). These activities have been tested in the 2nd grade class and also in the 3rd and the 4th grade classes that have never worked with LEGO WeDo before. In our literature review we haven't found enough relevant materials describing such young children working with this particular kit.

We have estimated the number of hours (5) that teachers could devote to this topic according to specific curricula that we have collected from several teachers from practice. In Slovakia, as in one of a few countries, education of information technology is a compulsory subject at primary, secondary and high school. The national curriculum contains recommendations for teachers to use robotic kits or build according to instructions during these lessons. The fact teachers are

encouraged to use robotics in school is a great success, because national curricula of other countries (e.g., Italy, Greece or Austria) do not include educational robotics. Therefore, also at TWR TR conference, which was this year in Italy, senior members were trying to establish a common space on the internet where people from different countries would be able to share their data on this topic. This project is only at the beginning and its further existence is still unclear. However, we are involved and we believe it will bring a lot of benefits.

The closest to our topic of research and the most inspiring for us was the use of robotic kits in primary school in Bulgaria. Ilieva (ILIEVA, 2010) describes six projects using an older kit LEGO Dacta. These projects are very interesting and inspiring since they lead the pupils to systematic learning and to discovery of knew knowledge. However, these activities are not suitable for our needs – we have to tailor our activities to much smaller amount of time and financial support (Ilieva describes to have one robotic kit for each child in a class, 2 lessons of logo programming per week and 2 lessons of LEGO activities per week, while we are likely to have one kit for 3children and one lesson for both programming and LEGO activities per week). In spite of these differences, there are several conclusions form Illievavo's work (ILEVA, 2010) that correspond with our findings.

During our research we identified a number of conclusions and recommendations for teaching and learning with LEGO WeDo in the education of information technology. Many of these findings agree with the information given in the book by M. GURA (Getting started with LEGO Robotics, 2011) which is primarily intended for older students.

3. A presentation of any preliminary ideas, proposed approach and achieved results

We propose

- Overview of
    - Robotic kits
    - Materials for working with robotic kits
- Activities
    - Motivation and Development of key competencies
    - Constructing robots
    - Creating program for robot
    - Problems solving
    - Evaluation
    - Implementation
- Theory: knowledge acquisition at constructionist lessons with LEGO WeDo

Overviews

Since the beginning of our research we have been using grounded theory, therefore our review of robotic kits and materials are not yet completely finished. However, analysis of existing available resources shows, that there probably isn´t a lot of robotic kits appropriate for pupils in primary school and that as well offer development of fine motor skills and that are also programmable. Supply of materials for teachers is also very poor, because most studies at primary schools with robotic kits are only pilot studies. We are just working intensively on the more detailed review for the article that should be done till the beginning of the December 2012.

Activities

- Motivation and Development of key competencies

One of the most important aspects is a high motivation that these kits bring to the classroom and enthusiasm of the pupils that are working and playing with robotic kits. We think that it is highly important to develop mentioned set of skills already in the primary school, as it will help the pupils to develop them further in their higher education and in their daily lives. One of the skills that should not be neglected is an ability of learning to learn and related metacognitive skills which are also developed during our lessons. We suggest that systematic development of skills from primary schools to high school is crucial for acquisition of durable living knowledge and skills.

We think, that using robotic kits for education of information technology develops 21st century skills such as: Communications, Collaborations, Social aspects, ...

- Evaluation

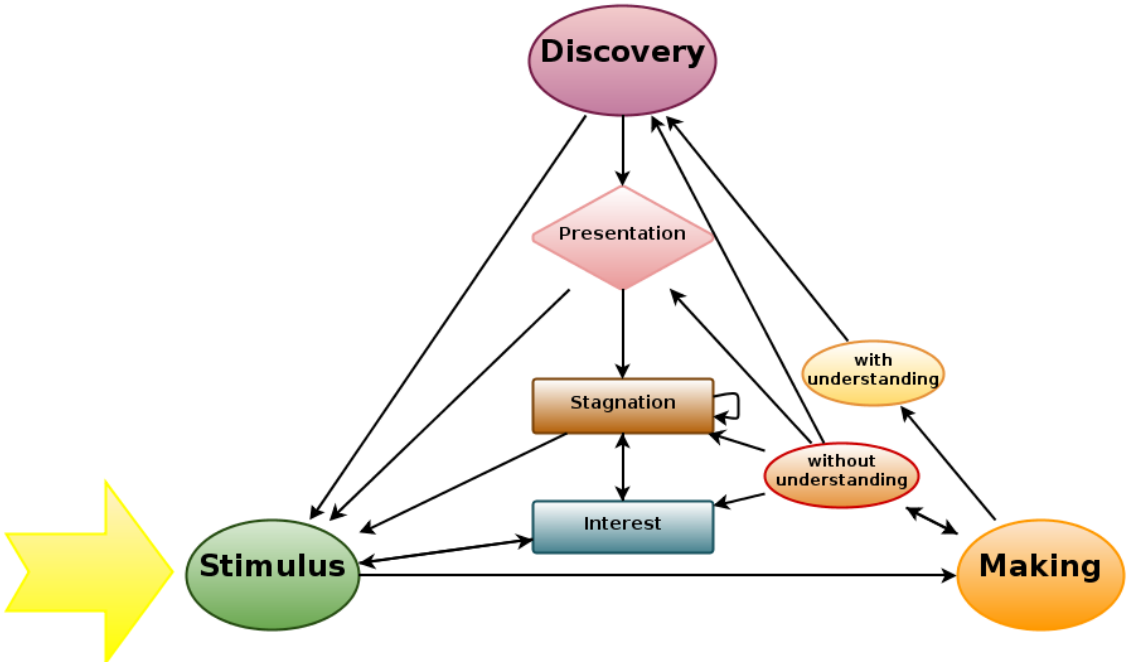
We are just working intensively on this theme to the article that should be done till the beginning of the December 2012. We suggested several appropriate types of assessment for this type (constructionist) lessons that we are testing and analyzing.

- Implementation

As we mentioned above, we designed activities, which we can implement into teaching and these activities don´t take time from other topics. This is evidenced by many primary schools, which have agreed to test our activities there during the school year.

Theory

Based on the data analysis, which we are unable to present in full because of the lack of space, we created a diagram that represents the stages, which occurred in the process of the creation of knowledge in the constructionist lesson for pupils working with LEGO WeDo. On diagram we are able to see a big yellow arrow that shows the motivation from which we derive. In this assumption there is also included the inner motivation which has an important function in the constructionist activities. Therefore the pupil not only feels the inner need to do the given work but he/she is also working. On the diagram we can see the procedure of acquiring new discoveries - knowledge.



Picture 1. Knowledge acquisition

4. A sketch of the applied research methodology (data collection and analyzing methods)

We conducted qualitative research and we used several methods of data collection: involved semi-structured observation, field notes, analytical notes, analysis of products (videos and photography) and interview. Methodologies that were used are:

1. Design based research
2. Grounded Theory
    a. The method of constant comparison
    b. Open coding
3. Theoretical research

5. A description of the Ph.D. project's contribution to the problem solution

I have hope that this work will help contribute to using robotic kits in educational in Slovak schools. It offers an overview of robotic kits that can be bought in the Slovakia and it will include hints for their choosing. Next, it will offer teachers a collection of tested activities with various expansion possibilities. It will also contain materials not only for students but also methodical material for teachers. I.e., teacher who does not feel able to work with a robot will have a simple and clear user guide of robotic kit.

6. How the suggested solution is different, new, or better as compared to existing approaches to the problem

As we mentioned at the beginning, we couldn´t find enough relevant materials that would tell teachers how to teach with Lego WeDo. We can carefully say, that we actually haven´t found any materials that would describe primary school pupils using LEGO WeDo kit. Materials that exist are mostly for LEGO NXT and this robotic kit is designed for older students. We think that using these materials in primary school wouldn´t be so beneficial for students as using our proposed activities.

7. Publications

1. Mayerová, K.: Pilot activities: LEGO WeDo at primary school. In: Teaching Robotics Teaching with Robotics Integrating Robotics in School Curriculum. Proceedings. Padova : University of Padova, 2012 S. 32-39 [CD-ROM]
2. Mayerová, K., Veselovská, M. Knowledge acquisition at constructionist lessons with LEGO WeDo at primary 77chol. In: Proceedings of the Student science Conference 2012. Bratislava: Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics, 2012, s. 348-354. ISBN 978-80-8147-001-0.
3. Mayerová, K., Veselovská M.: Robot kits and key competences in primary school. In: Information and Communication Technology in Education. Proceedings. Ostrava: University of Ostrava, Pedagogical Faculty, 2012, s. 175-183. ISBN 978-80-7464-135-0.

8. Questions

Does anyone know some primary schools or projects where primary school pupils are worked with robotic kits?

9. Literature:

GAUDIELLO, I., ZIBETTI, E., PINAUD, C.A., (2012) Control heuristics for educational robots: a pilot study. In: Proceedings of 3rd International Workshop Teaching Robotics, Teaching with Robotics, Riva del Garda (Trento, Italy), pp. 67-75, ISBN 978-88-95872-05-6

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Vilnius University, Faculty of Mathematics and Informatics

Research topic: Interactive Video in Education

The main aim is to create an interactive informatics and mathematics lessons tutorial for students that will help better understand the lesson topic and make learning attractive for students.

1. Questions

1) When and how can video collection be used to produce data for basic research on teaching and learning processes in classroom settings?
2) How do people learn with and from video?
3) What factors need to be taken into account in deciding how to produce and index video recordings?
4) What factors influence designs for selecting segments of video recordings for analyses?

2. The significant problems in the field of research

1) Video collection that produces data for basic research on teaching and learning processes in formal learning settings such as classrooms, the goal of which is to help researchers.

2) Research on how people learn with and from video, the goal of which is to help researchers design educational environments that use video as a major tool for learning;

3. An outline of the current knowledge of the problem domain

New types of video technology, including Internet applications, provide the educational research community with powerful ways of collecting, sharing, studying, and presenting detailed cases of practice and interaction for both research and instructional purposes. Because many educational research projects now include a substantial video research component, and because use of video in educational research is growing rapidly and constitutes a broad range of practices, the federal Interagency Educational Research Initiative1 (IERI) sought the assistance of qualified scholars to help develop standards for using video research in education.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

Flip teaching is a form of blended learning which encompasses any use of Internet technology to leverage the learning in a classroom, so a teacher can spend more time interacting with students instead of lecturing. This is most commonly being done using teacher created videos that students view outside of class time. It is also known as backwards classroom, reverse instruction, flipping the classroom, and reverse teaching.

The traditional pattern of education has been to have classroom lectures, in which the teacher explains a topic, followed by homework, in which the student does exercises. In flip teaching, the student first studies the topic by himself, typically using video lessons created by the instructor or shared by another educator. In the classroom, the pupil then tries to apply the

knowledge by solving problems and doing practical work. The role of the classroom teacher is then to tutor the student when they become stuck, rather than to impart the initial lesson. This allows time inside the class to be used for additional learning-based activities, including use of differentiated instruction and project-based learning.

Flip teaching allows more hands-on time with the instructor guiding the students, allowing them to assist the students when they are assimilating information and creating new ideas (upper end of Bloom's Taxonomy).

5. Publications

1) The Khan Academy, http://www.khanacademy.org/
2) Sharon J. Derry (Editor). Guidelines For Video Research in Education , July 2007
3) Teachers Use Technology to Flip Their Classrooms, http://www.techsmith.com/flipped-classroom.html

Justė Petronytė

1st year MSc student, 0th year Ph D student
Vilnius University, Faculty of Mathematics and Informatics

Research topic: Integrating Information Technology into Mathematics lessons

The aim of research: to create integrated lessons program for schools, investigate foreign countries that use integrated models and programs of information technology and mathematics, also search for the most effective methods of education of critical and structural thinking.

1. Questions

1. What teaching principles are the best, while using integrated lessons? First of all, we have to decide, which model is the best for teaching mathematics, and which one is the best for teaching information technology. Then we will need to find or build a model, which best fits for the integrated lessons.
2. How is the information technology used in other subjects (for example, mathematics) in foreign countries, which do not have information technology as a separate subject?
3. Do the teachers need integrated lessons in Lithuanian schools? If yes, how to present integrated mathematics and information technology lessons that would be available for teachers and also what to do to encourage teachers to use these lessons at school.

2. The significant problems in the field of research

1. Information technology school programme requires some of the information technology lessons to be integrated into other subjects. However, at the moment most teachers do not fulfil this requirement. There are few integrated information technology lesson examples on the internet, as well.
2. In Lithuania teachers do not know how to use information technology in mathematics lessons and they need a good example. So, the problem is that teachers do not know the possibilities or they just reject them because it is the simplest way.

3. An outline of the current knowledge of the problem domain

In foreign countries, which have integrated lessons, but do not have information technology as a separate subject, pupils are not motivated to pursue education in information technology. Whereas in those foreign countries, in which information technology is just a separate subject, pupils have more limited information technology education and lack variety of skills in information technology. What is more, integrated lessons in Lithuania are used very rarely, which causes similar problems as in other countries. Therefore, we need to find a better way to teach information technology and this can be achieved by using integrated lessons along with the separate subjects.

4. A description of the Ph.D. project's contribution to the problem solution

The result of this project will be a plan of mathematics lessons, which are supplemented by information technology. This plan can then be used as an example for teachers and it should help and enable them to apply such lessons at their schools.

5. How the suggested solution is different, new, or better as compared to existing approaches to the problem

Currently there are no good integrated lesson plans, which would be well adapted for use in Lithuanian schools. The result of this project will be an example for such lessons and should enable better information technology integration into mathematics lessons.

Gražina Pyž

4th years PhD student

Vilnius University Institute of Mathematics and Informatics

Research topic: Analysis and synthesis of Lithuanian phoneme dynamic sound models

1. Questions

1. How to measure sound naturalness?
2. How to improve sound naturalness?

2. The significant problems in the field of research

1. Yet there is no automatic Lithuanian speech synthesis system equivalent to human speech.
2. The commercial TTS systems have not yet supported Lithuanian language.

3. An outline of the current knowledge of the problem domain

Speech is the most natural way of human communication. Researchers are trying to automate speech synthesis. Yet there is no automatic Lithuanian Text-to-speech (TTS) system equivalent to human speech. A TTS system – a system that takes a sequence of words as input and converts it into speech.

The best known commercial TTS systems:

- Bell Labs TTS,
- Festival developed at University of Edinburgh.

The commercial TTS systems have not yet supported Lithuanian language. The problem of developing of Lithuanian synthesizer arises. There exists Lithuanian synthesizer developed by P. Kasparaitis (2001). It is based on concatenation speech synthesis type. Concatenation synthesis relies on speech sounds recorded in advanced database. One of the main drawback of concatenation synthesis is that the database has to be sufficiently large. That, however, requires extensive computer resources. If a word is not in the database, then it could not be synthesized. The synthesized speech quality does not achieve the natural speech quality since glitches occur on the concatenation boundaries.

Formant synthesis does not require a sound database. This is an advantage. The main drawback of formant synthesis is that the sounds obtained by this synthesis type sound unnaturally, robot-like.

Aim of the work: to improve formant synthesis method by reducing synthetic sounding.

Text-to-speech (TTS) problem arises in various applications:

- services for the hearing impaired,
- reading email aloud,
- reading web pages aloud,
- services for the people with speech disorders.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

Multiple input and single output systems whose inputs are sequences of amplitude modulated impulses are used for sound modelling.

The synthesizing consists of the following two stages:
1) phonemic synthesizer parameter estimation from the characteristic period data
2) determining of the exciting input impulse periods and amplitudes.

5. A sketch of the applied research methodology (data collection and analyzing methods)

1. Digital signal processing
2. System theory
3. Optimization methods
4. Matrix algebra
5. Mathematical statistics
6. Programming in Matlab environment
7. Programming in C # language.

6. A description of the Ph.D. project's contribution to the problem solution

I have acquainted with speech production apparatus, main speech synthesis methods and the existing text-to-speech systems of other languages. I use for Lithuanian speech sound modelling a linear dynamic system with many inputs and one output. The frequencies, damping factors, amplitudes and phases are parameters of these systems. I have developed an automatic system for estimation these parameters. I have developed algorithms and programs for synthesis of various Lithuanian speech phonetic units (vowels, diphthongs, semivowels) and their joining.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

The practical results show that the synthesized sounds of this method are sufficiently natural, pleasantly sounding. The advantage of my developed system is that anyone can use it and it can synthesize any phoneme of vowel and semivowel and their joining for any speaker.

8. Publications

1. Pyž, Gražina; Šimonytė, Virginija; Slivinskas, Vytautas. An automatic system of Lithuanian speech formant synthesizer parameter estimation // ECT-2012 : selected papers of the 7th international conference. Kaunas : Technologija, 2012. ISSN 1822-5934. 2012, p. 36-39.
2. Pyž, Gražina; Šimonytė, Virginija; Slivinskas, Vytautas. Lithuanian speech synthesis by computer using additive synthesis // Elektronika ir elektrotechnika. Kaunas : Technologija. ISSN 1392-1215. 2012, vol. 18, nr. 8, p. 77-80.
3. Pyž, Gražina; Šimonytė, Virginija; Slivinskas, Vytautas. Joining of vowel and semivowel models in Lithuanian speech formant-based synthesizer // Electrical and control technologies : proceedings of the 6th international conference, ECT 2011. Kaunas : Technologija. ISSN 1822-5934. 2011, p. 114-119.
4. Pyž, Gražina; Šimonytė, Virginija; Slivinskas, Vytautas. Modelling of Lithuanian speech diphthongs // Informatica. ISSN 0868-4952. 2011, vol. 22, no. 3, p. 411-434.
5. Slivinskas, Vytautas; Šimonytė, Virginija; Pyž, Gražina. Modeling of iron wolf howling // Solid state phenomena. ISSN 1012-0394. Vol. 164 (2010), p. 249-254.
6. Šimonytė, Virginija; Pyž, Gražina; Slivinskas, Vytautas. Signals and their parameter estimation [in Lithuanian]. Vilnius, BMK, 2010. 121 p. ISBN 978995588444.
7. Šimonytė, Virginija; Pyž, Gražina; Slivinskas, Vytautas. Application of the MUSIC method for estimation of the signal fundamental frequency // Lietuvos matematikos rinkinys. Lietuvos matematikų draugijos darbai. ISSN 0132-2818. T. 50 (2009), p. 391-396.

Bronius Skūpas

Final year PhD student
Vilnius University Institute of Mathematics and Informatics

Research topic: Automatic and semi-automatic evaluation and testing systems for programming assignments, their architecture, operating methods and algorithms, interaction with the users.
The aim of research: to analyse existing automatic and semi-automatic evaluation systems for programming assignments and to create a method for semi-automatic evaluation and testing to achieve higher efficiency and objectivity for the evaluation.

1. Questions

1. Does semi-automatic evaluation for programming assignments have possibilities to develop?
2. What are the possibilities to create higher quality feedback in the evaluation of programming assignments?

2. The significant problems in the field of research

1. Most current automatic testing systems are not suitable for high quality evaluation of programs containing minor errors.
2. Most semi-automatic systems provide testing results for the evaluator; however the final evaluation process is not interactive and it is based on use of external tools without aid from the system.
3. The feedback generated by most automatic and semi-automatic testing systems is poor. Evaluator feedback typically is based on phrases from specific dictionary.

3. An outline of the current knowledge of the problem domain

Most programming courses require solving programming assignments. The students have to be trained to create not only running, but also qualitatively designed reliable, properly functioning programs. However manual evaluation of programming assignments is time consuming – teachers need to assess a large number of solutions and identification of errors in programs is not an easy task.
Automatic and semi-automatic testing systems for programming assignments were developed to support educators in evaluation. There are two main areas of use for these systems: curricular (e.g. practical classes, assignments and exams) and competitive (e.g. programming contests).

Several high quality surveys of automatic testing systems have been published since 2005:

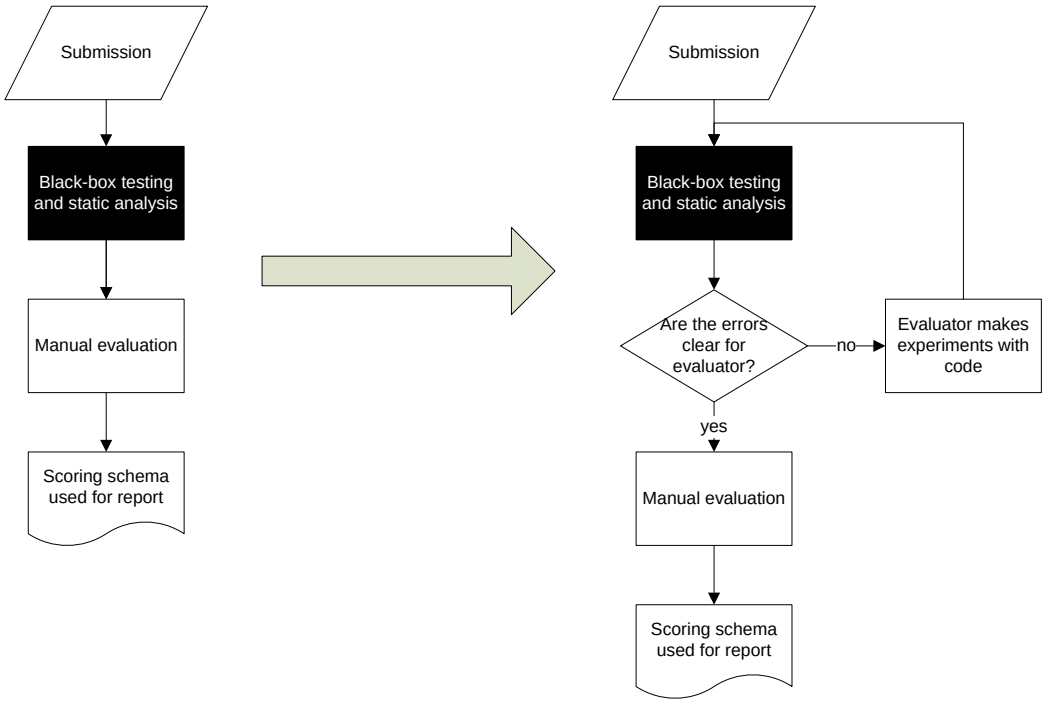
Author	Methodology	Trend
Douce et al. (2005)	Details features of systems organized in 3 generations	Evaluation of GUI programs, meta-testing (evaluation of the students' tests), Service Oriented Architectures and use of interoperability standards
Kirsti AlaMutka (2005)	Organizes systems in dynamic and static evaluators	Content and communication standardization.

Liang et al. (2009)	Details dynamic and static analysis methods of systems	Security, algorithms for automatic generation of test data and content standardization
Ihantola et al. (2010)	Discuss systems created in period 2006-2010 and their features (e.g. tests definition, resubmission policies and security)	Integration with LMS and assessment of web applications
Romli et al. (2010)	Evaluate approaches for test data generation	Test data generation techniques, interoperability and security
Queirós et all. (2012)	Analyses interoperability features of systems.	Integration with LMS, export and import features of systems.

4. Presentation of any preliminary ideas, the proposed approach and the achieved results

In Lithuania the graduating students develop programs at the maturity exam in information technologies. This exam has specific requirements of high quality of evaluation of assignments. However analysis of solutions shows high percentage of programs which cannot be compiled. Sometimes the errors causing compilation failure are minor from the point of view of the algorithm.

The author analysed data from the experimental exams and proposed to develop a new model of semi-automatic evaluation and testing system which would include interactive environment for the evaluator. This environment should provide possibility for the evaluator to perform experiments with the code and retest the modified code with the usual system testing component. The method of improvement is presented in following diagram.



5. A sketch of the applied research methodology (data collection and analyzing methods)

1. There was identified that the process of manual evaluation of programming exam submissions is too slow and the quality of fully automated evaluation is not satisfactory.
2. There was performed the analysis of scientific papers, classified research methods and solutions in the area of automatic testing systems for programming assignments.
3. A constructive research approach was chosen for the research.
4. There was constructed a new method for semi-automatic evaluation in programming exam.
5. A semi-automated evaluation system for Lithuania IT maturity exam was designed and developed.
6. The developed system has been used for evaluating the submissions of the graduation exams for 6 years; usage statistics collected, improvements were implemented.
7. There were analysed the possibilities to use the proposed method in other systems. I tried in use it in Edujudge component, which was developed for LMS Moodle.

6. A description of the Ph.D. project's contribution to the problem solution

Proposed method has been used in practical exam area for several years. The collected data prove its efficiency and suitability in practice. However the regulations of the exam have tendency to change and system updating is a regular process.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

Ph.D. project is presenting new approach in semi-automatic evaluation, which demonstrates higher efficiency than manual evaluation and quality of evaluation is similar to that of manual evaluation. Fully automated evaluation provides the results faster, however the evaluation output is of lower quality than that of the proposed method.

8. Publications

1. SKŪPAS Bronius, DAGIENĖ Valentina (2008). Is Automatic Evaluation Useful for the Maturity Programming Exam? Proceedings of 8th Koli Calling International Conference on Computing Education Research, ISBN 978-1-60558-385-3, 117–118.
2. SKŪPAS Bronius}, DAGIENĖ Valentina, REVILLA Miguel (2009). Developing Classification Criteria for Programming Tasks. Proceedings of the 14th annual ACM SIGCSE conference on Innovation and technology in computer science education, ISBN 978-1-60558-381-5, 373–373.
3. SKŪPAS Bronius, DAGIENĖ Valentina (2010). Observations from Semi-Automatic Testing of Program Codes in the High School Student Maturity Exam. Proceedings of the 10th Koli Calling International Conference on Computing Education Research, ISBN 978-1-4503-0520-4, 31–36.
4. DAGIENĖ Valentina, SKŪPAS Bronius (2011). Semi-Automatic Testing of Program Codes in the High School Student Maturity Exam. Proceedings of the 12th International Conference on Computer Systems and Technologies, (ACM International Conference Proceedings Series Vol. 578), ISBN 978-1-4503-0917-2, 564–569.
5. POHL Wolfgang, BURTON Benjamin A., DAGIENE Valentina, SKŪPAS Bronius, FAKCHAROENPHOL Jittat, FORIŠEK Michal, HIRON Mathias, OPMANIS Martinš, van

der VEGT Willem (2010). Get Involved! The IOI Workshop 2010, Its Goals and Results. Olympiads In Informatics, ISSN 1822-7732, Vol. 4, 158-169.

6. SKŪPAS Bronius (2010). Feedback improvement in automatic program evaluation systems. Informatics In Education, ISSN 1648-5831, Vol. 9, N. 2, 229–237.
7. SKŪPAS Bronius (2009). Automatinio mokinių programų vertinimo sistemų lyginamoji analizė. Informacijos mokslai, ISSN 1392-0561, 50, 147–152.
8. SKŪPAS Bronius (2010). Automatinio ir pusiau automatinio vertinimo ypatumai IT valstybiniame brandos egzamine. Lietuvos matematikos rinkinys Lietuvos matematikos rinkinys, ISSN 0132-2818, 51, 154–159.
9. SKŪPAS Bronius (2011). Pasikeitimų IT valstybiniame brandos egzamine analizė. Informacijos mokslai, ISSN 1392-0561, 57, 115–123.

9. References

1. Douce, C.; Livingstone, D. and Orwell, J. (2005) Automatic Test-Based Assessment of Programming: A Review. ACM Journal of Educational Resources in Computing, 5, 1-13.
2. Ala-Mutka, K.M. (2005) A survey of automated assessment approaches for programming assignments. *Computer Science Education*, vol. 15, 83-102.
3. Liang, Y.; Liu, Q.; Xu, J. and Wang, D. (2009) The Recent Development of Automated Programming Assessment. International Conference on Computational Intelligence and Software Engineering (CiSE 2009), 1-5.
4. Ihantola, P.; Ahoniemi, T.; Karavirta, V. and Seppälä, O. (2010) Review of recent systems for automatic assessment of programming assignments. Proceedings of the 10th Koli Calling International Conference on Computing Education Research, ACM, 86-93.
5. Romli, R.; Sulaiman, S. and Zamli, K. (2010) Automatic programming assessment and test data generation a review on its approaches. International Symposium in Information Technology (ITSim 2010), 3, 1186-1192.
6. Queirós, R. and Leal, J. P. (2012) Programming Exercises Evaluation Systems - An Interoperability Survey. CSEDU (1), 83-90
7. Blonskis, J., Dagienė, V. (2008) Analysis of students' developed programs at the maturity exams in information technologies. *Lect. Notes in Computer Science*, vol. 5090, Springer, 204-215.

10. Questions to be discussed

1. How improved semi-automatic testing systems can influence programming teaching?
2. Which of the outputs of the semi-automatic testing system can be most important for the students?
3. Does “the movie” of fixing the student’s program could be considered as useful feedback?

Tomas Šiaulys

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Vilnius University

Research topic: Non-sharing culture and the state of e-learning of mathematics in Lithuania

The aim of research: To explore the reasons and possible solutions to non-sharing culture among teachers of mathematics in Lithuania and to evaluate the current coverage of school curriculum by free online learning resources.

1. Questions

1. How willing are teachers of mathematics in Lithuania to share the teaching content and how is this question connected to economical, institutional, copyright aspects, age of the teachers, personal beliefs and so on? Do they really feel the need to exchange the teaching resources?
2. What can be possibly done to influence the teachers to share more of their work with others?
3. What part of school curriculum of mathematics is covered by free online learning resources? Is this coverage sufficient? What part of the curriculum does wikibooks, learning-objects, educational sites and other learning resources cover separately?
4. What is the quality of wikibooks comparing to textbooks?

2. The significant problems in the field of research

1. How to perform the survey about the teachers to find out the sincere opinions on information sharing?
2. How to find all the free learning resources online offered in Lithuanian? How to evaluate how much of the mathematics curriculum they cover? How to evaluate the quality of learning resources?
3. How to compare the quality of textbooks?

3. An outline of the current knowledge of the problem domain

In the last decade the use of ICT in education in Lithuania and other countries became promoted a lot. The use of technologies was usually seen as a positive influence towards learning process. However this approach has caused some problems. According to elaborate study in UK in 2012 by Royal Society, there is a drop of motivation of students connected to the use of ICT and the teachers lack qualifications in this subject.

According to Department of Statistics in 2012 there were 57 % of the households in Lithuania had personal computers and percentage of households with internet access dropped to 55.2 %. 97.6 % of the schools are connected to internet and there are now 13.4 computers per 100 students on average at schools. The figures about technical provision could be higher, but the important question is about educational content online. There are less problems with content online in English, since most of the curriculum is covered by free systematic e-learning websites like khanacademy.org, mathforum.com and so on. In Lithuania, however, this is not true. Since schools have a limited amount of computers, only the adequate use of them is relevant, like

presentations to be shown in front of the class etc. Hence the sharing of teaching and learning resources takes an important role in ever changing process of education.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

I want to investigate the views of teachers of mathematics on exchanging teaching and learning resources online between each other. For that purpose I chose questionnaire. The outcome of the survey expected is the knowledge of the basic needs of teachers on information sharing. The possible solution would be a new environment online designed to fulfil those needs. Other part of the work would be to prove or disprove the hypothesis that there are not enough learning materials for mathematics online by analysing the resources online. Both parts would give the view on current situation about teaching and learning materials online.

5. A sketch of the applied research methodology (data collection and analyzing methods)

1. Literature analysis.
2. Statistical analysis of the survey.
3. Analysis of the online learning resources and coverage of maths curriculum.
4. Comparative analysis between textbooks and wikibooks.

6. A description of the Ph.D. project's contribution to the problem solution

In order to solve the problem of non-sharing culture between math teachers it is essential to understand their views and needs. Then if the needs of the teachers and the current quality state of e-learning resources are correctly identified, we can think of the possible solutions.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

I have no data on this.

8. Literature

1. Samulionis G., Statistical department of Lithuania, *Information technologies in Lithuania*, 2012, ISSN 2029-3615.
2. The Royal Society, *Shut down or restart? The way forward for computing in UK schools*, 2012.
3. Atkins D., Brown J. S., Hammond A. L., *A Review of the Open Educational Resources (OER) Movement: Achievements, Challenges, and New Opportunities,* 2007.

Václav Šimandl

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Research topic: The skills of ICT teachers in the field of e-safety

The aims of research:

1. To map the current skills of ICT teachers in the field of e-safety
2. To analyze the determinants of the quality of the skills
3. To sketch an optimization of the skills

1. Questions

1. What are the skills of ICT teachers in the field of e-safety?
   - ❑ How are ICT teachers familiarized with risks associated with using ICT?
   - ❑ What habits do the ICT teachers have?
   - ❑ How far are ICT teachers able to cope with threats?
2. What are the basic determinants of the quality of the ICT teachers' skills?
   - ❑ How and where do ICT teachers gain the awareness of e-safety?
   - ❑ Which of these methods are effective?
   - ❑ How important is the pre-service teacher's education in ICT??

2. The significant problems in the field of research

There is a lot of evidence of children's and parents' skills in the field of e-safety. There is only a little evidence of teachers' skills. Therefore more research is needed on teachers' skills and literacy in the field of e-safety (Livingstone 2008). Moreover, there is little evidence of what support members of staff in schools need to teach children and young people about online risks and how to protect themselves from them (Spielhofer 2010).?

3. An outline of the current knowledge of the problem domain

Nowadays it is important to use ICT not only effectively but also safely. There are a lot of threats – e.g. malware, hoax, phishing, spam, computer crash or breach of the copyright law by the user. Many computer users are not able to cope with these threats, so they need help. One of the most endangered groups of users are children. They use ICT as a common tool – both for work and for fun. Their parents are not able to help them – some of them say that they have worse technical skills while working with ICT than their children. Fortunately it is possible to improve children's e-safety skills at school.

The research field of e-safety is usually divided into two parts: the field of virtual communication (threats such as cyberbullying, cybergrooming, stalking, sexting etc.) and the technological field. Research which is focused on the technological field of e-safety usually deals with the threats I mentioned in the first paragraph. In my proposed research I would deal with the technological field of e-safety.

Most of the research in the field of e-safety is focused on children and young people. They are not aware of the threats and methods how to protect themselves. Although many lower-school pupils say that they have thought about e-safety, they haven't understood the risks and their methods of protecting are not sophisticated. Upper-school pupils have efficient technical skills while working with ICT. However, they are not able to manage their online behaviour and critically judge online content – e.g. they don't use complex security passwords and they open

email attachments from unknown sender without any antivirus check. Most pupils have experienced a malware or spam attack. Many of them say that they have caused a malware attack.

Some research has been done in the field of e-safety and adult ICT users. They are usually aware of the e-risks. However, they don't have the right e-safety habits and don't know how to cope with threats. Some of them don't use any antivirus or firewall, they don't back up their important data and don't use the encryption of email messages. Moreover there is some space for improvement in the field of use of security passwords. Many adult users agree that they have been a target of a cybernetic attack.

Some research reviews say that school should play a key role in the field of e-safety (e.g. Byron 2008). School is considered to be the best place for learning e-skills, which are necessary to maximise opportunities and minimise risks while online (Livingstone 2010). One of the widespread methods, how to keep pupils in safety while working with ICT at school, is the use of supervising and filtering software. Contrary to that, this method doesn't have any impact on development of adequate e-safety skills.

Education has a big impact on development of pupils' skills in the field of e-safety and therefore it is necessary to focus on it. This opinion is shared by the absolute majority of both teachers and parents. Therefore the role of teachers is very important in ensuring the e-safety of the young generation. The majority of teachers think that teaching of e-safety should be ensured by ICT teachers. Moreover teachers should be models for their pupils in the field of securing their privacy, making backup copies of data, antivirus protection and observing the copyright law.

There is only a little research on teachers in the field of e-safety. These research studies usually deal with online interaction between a teacher and his pupils. They show that many teachers aren't able to protect their privacy against pupils – e.g. they are their friends in the environment of social network sites.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

I would like to deal with ICT teachers and their e-safety skills. I would like to conduct qualitative research which would be based on interviews with ICT teachers. I suppose that I will reveal their skills in the field of e-safety and the basic determinants of the skills.

5. A sketch of the applied research methodology (data collection and analyzing methods)

1. The mapping of current teachers' skills will be led as a qualitative study, the participants of which will be the ICT teachers. The teachers will be chosen according to several factors, such as age, sex, length of experience, pre-service education or the size of their school. The method of semi-structured interviews will be used.
2. Besides a simple description of the current skills, the research will be concentrated on deeper relations between skills and external influences. The grounded theory method will be used in this part of the research and I plan to reveal the determinants of the ICT teachers' skills.
3. The sketch of a suitable way, how to increase the skills, will result from the second part of the project. Therefore I wouldn't predict it at this moment; an e-learning course may be created. The sketched method and its effectiveness will be tried out on a group of ICT teachers.

6. A description of the Ph.D. project's contribution to the problem solution

In my Ph.D. project I would describe the current skills of the ICT teachers in some areas of e-safety. This will be important to decide, what group of teachers need help to improve their e-safety skills and in which parts of e-safety. This information would be important for authors of textbooks of ICT and for tutors of courses for ICT teachers.

Moreover I would reveal determinants of current skills of ICT teachers. This would contribute to the finding of effective methods how to increase these skills. I would like to find and test one of the methods. This would be useful for ICT teacher trainers and for tutors of courses for current ICT teachers.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

While reading literature sources related to the field of e-safety, I have found only a little research focused on the skills of teachers. The relevant sources deal with sharing of personal information or contain some brief messages about these topics in relation to pupils. The proposed research would be focused primarily on teachers and would include a broader range of e-safety.

8. Publications

1. BYRON, T., 2008. *Safer Children in a Digital World: The Report of the Byron Review* [online]. Department for Children, Schools and Families [of UK] [cit. 2012-03-22]. ISBN: 978-1-84775-134-8.
2. LIVINGSTONE, S. a HADDON, L., 2008. Risky experiences for children online: charting European research on children and the Internet. *Children & society* [online]. 22(4). 314-323 [cit. 2012-04-13]. ISSN: 0951-0605. Available from: http://eprints.lse.ac.uk/27076/
3. LIVINGSTONE, S., HADDON, L., GÖRZIG, A., ÓLAFSSON, K., 2010. *Risks and safety on the internet: The perspective of European children. Initial Findings.* LSE, London: EU Kids Online.
4. SPIELHOFER, T., 2010. Children's online risks and safety*: A review of the available evidence* [online]. nfer [cit. 2012-10-04]. Available from: http://www.nfer.ac.uk/nfer/publications/COJ01/COJ01.pdf
5. ŠVAŘÍČEK, R. a ŠEĎOVÁ, K. *Qualitative research in pedagogical sciences* (in Czech language). Praha: Portál, 2007, 377 s. ISBN 978-80-7367-313-0.

9. Questions

1. Has any research been conducted in your country which has been focused on the skills of teachers in the field of e-safety?
2. Is it possible to research the e-safety habits of teachers without asking them?
3. How to employ pupils to research the e-safety skills of their teachers?
4. How to test the effectiveness of the proposed optimization method? Note: I don't beleave that a usual pretest and posttest to check knowledge will be useful.

Jūratė Urbonienė

4th years PhD student

Vilnius University Institute of Mathematics and Informatics

Research topic: Design of adaptive algorithmization tools

The aim of research: By examining problems of programming training, student learning opportunities and needs, to develop the model of adaptive tool for programming learning.

1. Questions

1. How to individualize programming training according to the learners characteristics, learning styles and learning experience?
2. How to find a way to assess the learner's learning style?
3. How to design a system that takes into account learner's learning style?
4. How should look like adaptive functioning programming learning system?
5. How to assess a student learning outcomes using the system?

2. The significant problems in the field of research

1. Systems for programming teaching do not estimate learners learning styles, abilities and learning progress, and therefore it does not work adaptively throughout the learning process.
2. There are no methods to elect learning objects according student's learning styles.

3. An outline of the current knowledge of the problem domain

Programming is a challenging cognitive process. For programming learning first of all it is necessary to learn syntax and semantics of a programming language. The beginners need this in order to start solving tasks. What is more important than to learn syntax structures is to be able to apply them in solving a real problem. It is also important to master the techniques and methods of a programming language. While learning the programming techniques, the language is only a means for expression and application of common programming concepts. Learning a programming language also promotes student's thinking skills (Mayer et al. 1986). Actually, the case of false conception of programming learning is quite frequent, as it is believed that it means learning to put down the task solution in a form of a program text by using structures of a programming language. However, program writing is just one of the programming skills. The ability to read and understand the program text is equally important. For a programmer spends a considerable time examining the patterns, i.e. programs written by others (e.g. Mannila 2007), and adapting them to his task solving. One might think that while learning to write programs you automatically learn to read them, and to keep track of the program implementation. However, studies have shown that the ability to write a program and the ability to read it has a low correlation (Winslow, 1996). Therefore, during programming learning it should be always kept in mind the importance of developing the reading skills and understanding of programs written by others.

Due to its complexity programming seems to be not very attractive, that is why, in order to engage the learners, it is necessary to present it as easy as possible, in a clear and attractive way. However, no matter how attractively it would be presented, it is not enough to have only knowledge or good patterns, for it is necessary to actively engage oneself in this process, to

develop the skills, to think logically and algorithmically. Thus, often skills in creating algorithms (which is an integral part of programming) are implicitly developed in the junior school grades already - by analysing real-life problems, splitting them into smaller tasks, reasoning solution options as well as making synthesis of the results to obtain a general solution to the problem. The acquired thinking skills help to understand the essence of programming and make programming learning more productive (Mayer et. al. 1986).

In a range of literature (Gomes, Carmo, etc., 2006; Bennedsen 2008; Jenkins 2002; Mannila 2007) the causes that determine programming learning problems have been set out:

- ✓ it is difficult to understand program's objectives and their relationship with the computer;
- ✓ it is difficult to understand the specific programming language's syntax and semantics;
- ✓ incorrect understanding of programming constructs;
- ✓ inability to resolve the problems;

inability to read and understand the code of the program.

There are five components leading to difficulties in programming learning: methods of training, learning techniques, learning skills and attitudes, the nature of programming, and psychological reasons (see Table 1) (Dagienė, Urbonienė 2010).

Table 1: Causes of programming training difficulties

Component	Cause of difficulties
Methods of training	✓ programming training is still not personalized, ✓ teacher used training methods are not consistent with learning styles of the students, ✓ dynamic concepts are often taught through static content, ✓ a teacher is more focused on teaching a programming language and its syntax rather than dealing with task solving through a programming language and environment.
The use of learning techniques	✓ learners use irrelevant learning techniques or methodology, ✓ learners work not enough independently to acquire programming expertise.
Skills and attitudes of learners	✓ learners must have acquired or wish to acquire a wide range of skills related to program development: understanding of problems, knowledge linking to a problem, reflection of a task and its solution, persistence in task solving, application of basic mathematical and logical knowledge, specific knowledge of programming (Gomes, Carmo, etc., 2006), ✓ it has been observed that the main difficulty for learners is not to get a result itself, i.e. to write a program, but to go through the development process, ✓ a lot of beginners improperly use their skills of writing a stepwise specification in a natural language, i.e. they incorrectly transform natural language semantics into a programming language (Bennedsen, 2008).
Programming nature	✓ programming requires a high level of abstraction, ✓ programming language syntax is very complex.
Psychological reasons	✓ learners are not motivated, ✓ generally they begin programming learning in a complicated

period of their life, e.g. adolescence (Jenkins, 2002).

To find out learners' attitude towards programming training a survey has been carried out, which involved different groups of respondents who have already completed the programming course. The participants of the survey were 29 respondents studying Technologies of Information Systems program, 13 studying Programming Engineer specialization, 13 students of Informatics, 12 students of Mathematics and Informatics, and 9 studying Programming and Internet Technologies. In total 76 students were interviewed. Almost half of respondents, i.e. 48.68 % of all respondents, said that programming is difficult to learn, 39.47 % of respondents stated that programming is not difficult to learn, while the remaining 11.84 % could not decide. However, opinions differed depending on a future field of work. Students who in the future would have to program in their profession, were more opting for the response that programming was not difficult to learn (88.46 %), while those who would not need to program in the future, were more stating that programming was difficult to learn (56 %). Upon request to identify the reasons why they thought it was difficult to learn to program, the respondents were quite self-critical and pointed out that the difficulty stems from the fact that the students worked not enough independently (as stated by 44.74% of respondents) and also the lack of motivation (47.37%). Such reasons as complexity of the syntax of programming languages (30.26 %), difficulty for learners not to get a result itself (to write a program) but to go through the all development process (36.84 %) also were identified. Also, a survey to determine student needs: learning when the teacher explains individually; communication and cooperation; learning through technology; fast feedback; the need for imagination (visualization).

Learning success depends on how the maximum learning goals are being achieved, i.e. whether the necessary knowledge and skills are being acquired, and what emotions are experienced by learners during the learning process. Learning success is to a large extent determined by learning efficiency, which depends on the willingness to learn and knowledge how to learn. It is also influenced by an attractive learning environment.

However, regardless of attractive learning environment good learning results are still determined by learner's personal qualities and his learning style. There are many classifications of learning styles (Hawk and Shah 2007). For programming training are most important the classifications of Herrmann and Felder-Silverman.

Herrmann Brain Dominance Instrument (HBDI). This method classifies students in terms of their relative preferences for thinking in four different modes based on the task-specialized functioning of the physical brain. The four modes or quadrants in this classification scheme are

- *Quadrant A* (left brain, cerebral). Logical, analytical, quantitative, factual, critical;
- *Quadrant B* (left brain, limbic). Sequential, organized, planned, detailed, structured;
- *Quadrant C* (right brain, limbic). Emotional, interpersonal, sensory, kinesthetic, symbolic;
- *Quadrant D* (right brain, cerebral). Visual, holistic, innovative.

Most engineering instruction consequently focuses on left-brain Quadrant A analysis and Quadrant B methods and procedures associated with that analysis, neglecting important skills associated with quadrant C (teamwork, communications) and quadrant D (creative problem solving, systems thinking, synthesis, and design).

Felder-Silverman Learning Style Model. This model classifies students as:

- *sensing learners* (concrete, practical, oriented toward facts and procedures) or *intuitive learners* (conceptual, innovative, oriented toward theories and meanings);
- *visual learners* (prefer visual representations of presented material--pictures, diagrams, flow charts) *or verbal learners* (prefer written and spoken explanations);

- *inductive learners* (prefer presentations that proceed from the specific to the general) or *deductive learners* (prefer presentations that go from the general to the specific);
- *active learners* (learn by trying things out, working with others) or *reflective learners* (learn by thinking things through, working alone);
- *sequential learners* (linear, orderly, learn in small incremental steps) or *global learners* (holistic, systems thinkers, learn in large leaps).

For the past few decades, most engineering instruction has been heavily biased toward intuitive, verbal, deductive, reflective, and sequential learners. However, relatively few engineering students fall into all five of these categories. Thus most engineering students receive an education that is mismatched to their learning styles. This could hurt their performance and their attitudes toward their courses and toward engineering as a curriculum and career.

Computer Science Curriculum 2008 defines the main sections and topics that must be trained in a Programming Fundamentals course (*Fundamental Constructs; Algorithmic Problem Solving; Data Structures; Event Driven Programming; Recursion; Object Oriented; Foundations Information Security; Secure Programming;*). The knowledge area of Programming Fundamentals includes those skills and concepts that are essential to programming practice independent of the underlying paradigm. As a result, this area includes units on fundamental programming concepts, basic data structures, algorithmic processes, and basic security. There are defined to each topic appropriate learning outcomes. The learning outcome corresponds to some one of Bloom's taxonomy level (see Table 2). In learning process, it is important to gradually move all levels of Bloom's taxonomy. Accordingly, the teaching material and knowledge area appropriate learning objects must be elected considering to Bloom's level.

Table 2: Bloom's taxonomy levels description

Level	Category	Cognitive Processes
1.	Remember	recognizing, recalling, describing, stating
2.	Understand	interpret, exemplify, classify, infer, compare, explain, paraphrasing, summarizing
3.	Apply	execute (i.e. carry out), implement (i.e. use), compute, manipulate, solve
4.	Analyze	differentiate, organize, attribute, discriminate, distinguish, sub-divide
5.	Evaluate	check, critique, assess, compare, contrast
6.	Create	generate, plan, produce, innovate, devise, design, organize

4. A presentation of any preliminary ideas, the proposed approach and achieved results

We propose the method for electing the knowledge are appropriate learning objects from *Learning Objects Repositories* according student's learning styles.

- This method will allow the selection of instructional material and tasks in accordance with the learner's needs and abilities, learning experience and learning styles;

- Designed adaptive programming teaching tool will assess level of learner's achievement and increase the effectiveness of programming learning.

5. A sketch of the applied research methodology (data collection and analyzing methods)

1. Literary analysis, research analysis and technology analysis are used for understanding of existing situation in the world and for finding the best solutions.
2. Questionnaire surveys will be used for gathering various opinion related to my research area.
3. Modeling using UML will be used for create the tool's project.

6. A description of the Ph.D. project's contribution to the problem solution

To find methods to elect learning objects according student's learning styles, it will be defined learning objects characteristics that are appropriate to knowledge area. Also, it will be appointed relation between student's learning styles and knowledge area appropriate learning objects. For electing the knowledge are appropriate learning objects from *Learning Objects Repositories* will be defined relation of the features of RDF (*Resource Description Framework*) and MLR (*Metadata for Learning Resources*). It will be defined how to find learning objects according RDF schema.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

There are no methods to elect learning objects according student's learning styles. For electing the knowledge are appropriate learning objects from *Learning Objects Repositories* will be used combination of features of RDF (*Resource Description Framework*) and MLR (*Metadata for Learning Resources*).

8. Publications

1. Hawk, T. F. and Shah, A. J. Using Learning Style Instruments to Enhance Student Learning. *Decision Sciences Journal of Innovative Education*, Volume 5 Number 1, January 2007 U.S.A., p. 1-19
2. Felder R. M. Matters of Style. *ASEE Prism*, 1996 (December), *6*(4), p. 18-23.
3. Graf S. Adaptivity in Learning Management Systems Focussing on Learning Styles. PhD Thesis. 2007, p. 1-185
4. Parko Ok-Ch. Adaptive Instructional Systems. *Handbook of Research for Educational Communications and Technology*, 2005, p. 634-664. Available on: http://www.aect.org/edtech/ed1/
5. *Computer Science Curriculum 2008*. Association for Computing Machinery, IEEE Computer Society

9. Questions to be discussed

1. What theoretical background and methodological framework should be followed during the research?

Michaela Veselovská

1st year PhD student

Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics

Research topic: The potential of educational robotics in secondary school and its integration into the subject of computer science

The aim of research is to study and to iteratively develop methodology to integrate educational robotics in computer science at secondary school with cross-curricular activities. Another essential aim of research is to explore the possibilities of educational robotics in support of cross-curricular activities and organization of project-based approach to teaching and learning.

The next aim of research is to design a collection of appropriate activities to work with LEGO kits at secondary school and it will also contain methodological material for teachers.

1. Questions

1. What is the current status of educational robotics in Slovakia and in abroad?
2. How to create and design a collection of appropriate activities with robotic kit at secondary school and its methodological material for teachers?
3. What are the potential benefits of educational robotics in connection with other subjects at secondary school?

2. The significant problems in the field of research

1. When do students start working with robotic kit at secondary school?
2. Which robotic kit is suitable for students at secondary school and why?
3. How can robotic kit support cross-curricular activities?
4. How to assess activities with LEGO robotics?

3. An outline of the current knowledge of the problem domain

Our doctoral thesis is dealing with educational robotics at secondary school. It is robotics occurring in schools in the form of virtual environments, robotic construction kits or programmable toys. There are many types of robotics kits. But one of the most interesting kits is LEGO „Mindstorms“, which includes the RCX and NXT. The other significant kit made by LEGO is WeDo.

According to (CVIK, 2005), the integration of robotics in education is becoming a reality. In Slovakia, there has first appeared robotic kit LEGO Mindstorms, which contains a cube RCX and software Robolab. Later it was the LEGO Mindstorms NXT and LEGO WeDo. Teaching science tends to use a variety of sensors and so according (CVIK, 2005) we may apply robotics kit to technical instruction, computer science, physics, chemistry, interest in extracurricular activities and clubs.

Educational robotics has found its place even in national curriculum in Slovakia. Programmable kits are found in many schools and in clubs. Robotic competitions attract more and more participants. In Slovakia, there are robotic competitions for students of secondary school such as FIRST LEGO League, RoboCup Junior, Robotic day in Trencin. There is also Eurobot Junior in neighbour country.

Our research is currently in the orientation iteration. In this phase we are doing a overview of our field of study both in Slovakia and in the international sources. Along with review of literature we are also testing our pilot activities. We are considering two robotic kits, choosing one and we will continue our research (other activity with students) with it.

4. A presentation of any preliminary ideas, the proposed approach and achieved results

We propose

- choose suitable robotics kit at first,
- clarify the concept of robot (mind maps),
- create your first robot or
    - explore actions of build and programmed robot and explain it,
- create an extraordinary robots not only with robotics kits but use other materials like (different fabrics, drawing paper, markers, pencils, … and other materials usually used in art class,
- make journal, photos, video, tell a story about your robot and share it with your friends and family.

5. A sketch of the applied research methodology (data collection and analysing methods)

1. Design-based research
2. Qualitative research methodology
    a. Observation,
    b. notes,
    c. interview,
    d. artefacts, photos, video,
    e. portfolio, …

6. A description of the Ph.D. project's contribution to the problem solution

For several years, we have seen a growing interest of researchers and educators in many countries in the potential that hidden in educational robotics (in some sense, which represent for example LEGO WeDo and NXT, along with the environment of the robotic programming model behaviour through sensors and actuators). It is shown by the recent publication of M. Gura: Getting Started with LEGO Robotics, ISTE 2011. The aim of this dissertation project is to study and to develop methodology integrating educational robotics in computer science and cross curricular activities at the secondary school. Through iterative development we will create and validate a methodology of integration approach that will support the learning objectives of informatics in all its five topics and also it will contribute to the development of 21st century skills. Another aim will be to research possibilities of educational robotics to support cross curricular activities and project-based approach to organize process of teaching and learning.

7. How the suggested solution is different, new, or better as compared to existing approaches to the problem

Nowadays, there are emerging some schools, where lessons take place with robotic kits. So, there is a need for specific guidance material that would be useful in teaching. Therefore, we are

going to develop activities that will combine multiple items. Our goal is to link computer science and visual arts or even music.

8. Publications

1. VESELOVSKÁ, M. Cooperation of children in teams at robotics competitions (in Slovak language). In: Proceedings of the Student science Conference 2012. Bratislava: Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics, 2012, s. 369. ISBN 978-80-8147-001-0.
2. MAYEROVÁ, K., VESELOVSKÁ, M. Knowledge acquisition at constructionist lessons with LEGO WeDo at primary school. In: Proceedings of the Student science Conference 2012. Bratislava: Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics, 2012, s. 348-354. ISBN 978-80-8147-001-0.
3. MAYEROVÁ, K., VESELOVSKÁ, M. Robot kits and key competences in primary school. In: Information and Communication Technology in Education. Proceedings. Ostrava: University of Ostrava, Pedagogical Faculty, 2012, s. 175-183. ISBN 978-80-7464-135-0.

9. Questions

Inga Žilinskienė

4th years PhD student

Vilnius University Institute of Mathematics and Informatics

Research topic: A model for learning path selection for learners according to their learning style

The aim of research is to propose and evaluate the model for a personalized learning path selection according to learners' profile in a dynamic learning environment in order to provide adaptive, personalized e-learning.

1. Questions

1. How to select the most suitable path through learning objects for a learner in dynamic learning environment in order to build the required competence in an effective and efficient way?
    - What kind of learning material is used to provide in online courses?
    - What kind of online courses models exist?
    - What are the approaches to measure LP "suitability" to a learner?
    - What kinds of methods have been used to select LP to a learner' preferences?
    -
2. What are the effects of a proposed technique on practice?
    - What do learners experience in terms of suitability of learning material to them?

2. The significant problems in the field of research

1. Virtual learning environments are used widely at the universities in formal studies. Therefore there is a lack of adaptive, personalized functionality of them. Besides this there are many researches on Adaptive Hypermedia systems and Intelligent tutoring systems, but they suffer from the following problems:
    - systems are either developed for specific content (e.g. accounting) or for specific features (e.g. adaptive quizzes)
    - content cannot be reused
    - require big efforts from course designer to prepare a course.
    - it is based on specific user and learning material model.
2. In particular, the existing e-Learning solutions, based on the predefined content; first they superimpose to learners how they have to learn without taking into account learners dispositions or preferences, and second, constrain learners to learn and teachers to teach following a predefined approach.
3. Moreover, recently "buttom-up" methodology is emerging in the e-learning research context and it stipulates a shift from the existed approach "One size fits all" to personalized learning to more suitable models and processes that dynamically and intelligently create e-Learning experiences (i.e. a structured collection of content and services able to facilitate learners in acquiring a set of competencies about a specific domain) adapted to learner expectations and objectives in the new Web environment.

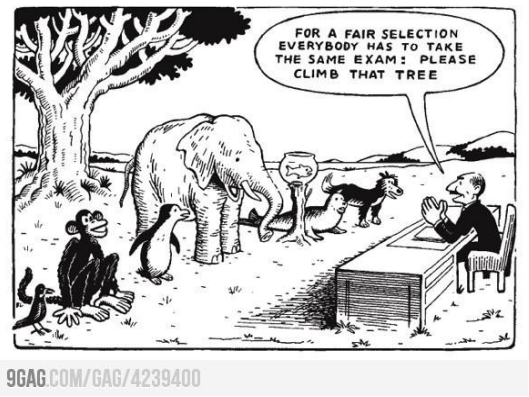


Figure 1. A shift from learning paradigm "One size fits all" to personalized learning

4. An outline of the current knowledge of the problem domain

The research topic is one of topics of Technology Enhanced Learning (TEL) with primary focus on delivery of learning material and learning activities to a learner. Literature review shows, that learning styles influences the learner during his/her learning. There are different learning styles classifications. My research is based on Honey and Mumford learning Styles typology, which defines learning style as "description of the attitudes and behaviors that determine our preferred way of learning" and claims that each learner choose different learning strategies during learning. According to this assumption, there have been different approaches applied how to adapt, personalize learning according to a learner's learning styles: ontologies, multiple criteria decision approaches (MCDA), different optimization algorithms, recommendation algorithms, soft computing techniques, evolutionary computing (Genetic Algorithms, Swarm Intelligent techniques (they explored the use of indirect social interaction to solve this problem.))

Therefore, so far most of the approaches has been based on "top-down" approach, when a teacher or a tutor creates rules, by which one or another learning activity is more suitable for a learner according to his/her learning style. Recent researches show that application of artificial intelligence for the solution of this problem can be beneficial and it allows implementing "bottom-up" methodology, when the personalization is done from the learner's perspective. Consequently my research is based on one of swarm intelligence technique – adaptation of algorithm of Ant colony optimization (ACO) for personalized learning. Literature review shows that there have been several researches done (Semet, Lutton et al. 2003; Wang, Wang et al. 2008; Yang and Wu 2009; Feng-Hsu 2011; Wong and Looi 2011), where change of learning environment had not been taken into account, i.e. both learners and learning material and activities are changing over time. So it must be taken into account not only a learner characteristic, but also the conditions of the environment. Consequently the modification of ACO including solution for aforementioned problem is analyzed. The proposed method allows efficiently recommend the whole learning path to learners and assumes a tutor to improve his/her learning course according to learners' preferences.

5. A presentation of any preliminary ideas, the proposed approach and achieved results

We propose the model for learning path selection for a learner in a dynamic learning environment based on one of artificial technology approaches, mainly, swarm intelligence. These techniques abstract away the individual properties of learners drawing efficient learning paths from the emergent and collective behavior of a ''swarm'' of learners. Learning path selection, as

well as curriculum sequencing is an NP-hard problem (Acampora, Gaeta et al. 2011). To solve this problem an artificial intelligent technique was chosen.

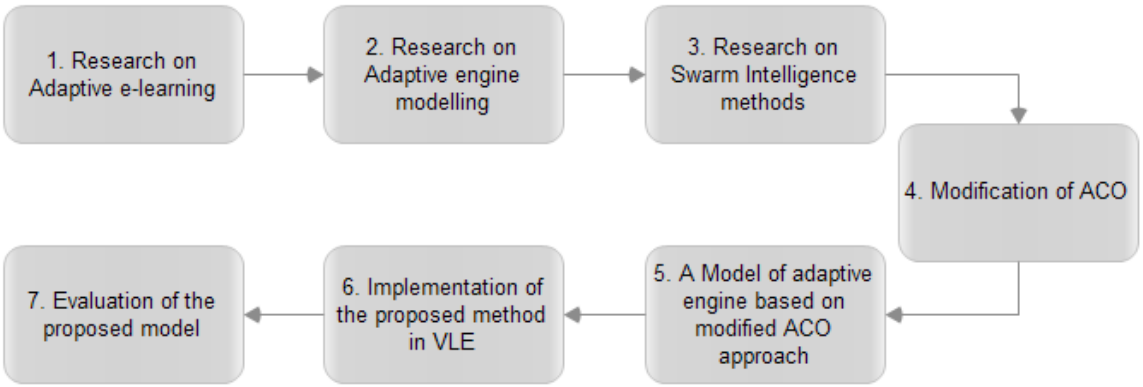


Figure 2. Scheme of research

1. *Research on Adaptive e-learning*

Research adaptive e-learning has revealed main components of e-learning: learners and tutors, multimedia and learning content and virtual learning environments. Based on this structure three big research trends can be distinguished: researches on user modeling, researches on learning material (LO), and on learning systems (VLE). According to (Brusilovsky 2003) there are two basic adaptive learning systems: Adaptive Educational Hypermedia Systems and Intelligent Tutoring Systems. These systems comprise beforehand mentioned three components and include one a very important element in such kind of systems – an adaptive engine. A model of adaptive engine plays a very important role for all adaptation/personalization process, because the main goal of this model is to match e-learning context with learner' personality.
Research on adaptive systems is based upon three principles:

- Systems need to be able to dynamically adapt to the skills and abilities of a student. -> user model (criteria for user profile was chosen: learner' knowledge and learning style)
- Systems must have the ability to be flexible and allow for easy addition of new content. -> instructional model – LO, teaching strategies, etc. (learning material and learning activities are chosen as "open corpus" content, which means that there is no unique instructional design or model, in the contrary, flexible management of learning material)
- Systems need to also adapt to the skill level of the educators. -> to minimize educator' involvement in adaptation/personalization process from technological point of view.

2. *Research on Adaptive engine modelling*

So far mostly all models were based on rule-based, or other top-down approaches greatly depending on expert knowledge and requires his/her involvement in design process.

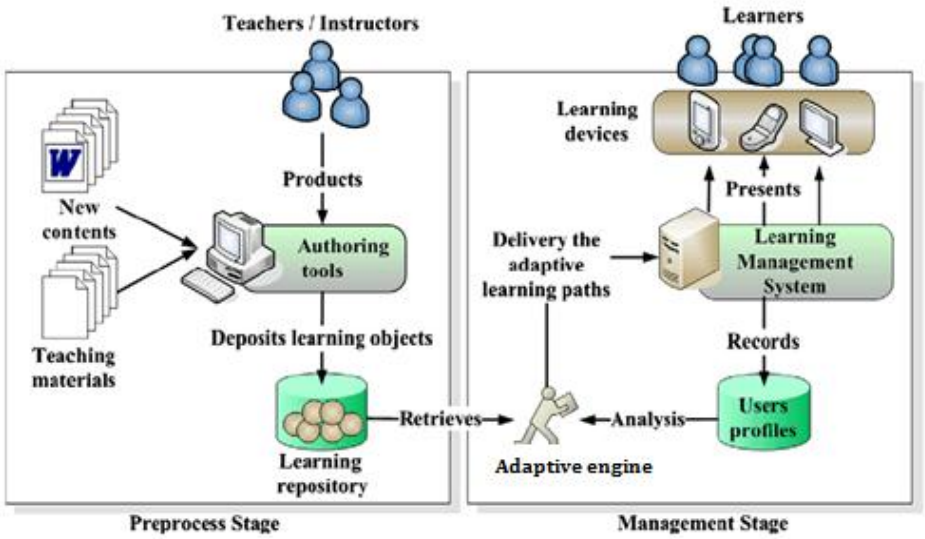


Figure 3. General framework of adaptive e-learning system

3. Research on Swarm Intelligence methods

Swarm intelligence (SI), which is an artificial intelligence (AI) discipline, is concerned with the design of intelligent multi-agent systems by taking inspiration from the collective behaviour of social insects such as ants, termites, bees, etc. An artificial Ant Colony System (ACS) is an agent-based system, which simulates the natural behaviour of ants and develops mechanisms of cooperation and learning. ACS was proposed by Dorigo et al. (Dorigo 1996) as a new heuristic to solve combinatorial optimization problems. This new heuristic, called Ant Colony Optimization (ACO) has been found to be both robust and versatile in handling a wide range of combinatorial optimization problems. Frequent usage of ACO is to model a problem as the search for a minimum cost path in a graph.

Advantages of the Ant Colony Optimization:

- Inherent parallelism
- Positive Feedback accounts for rapid discovery of good solutions
- Usable for Traveling Salesman Problem and similar NP problems
- Can be used in dynamic applications (adapts to changes such as new distances, etc)

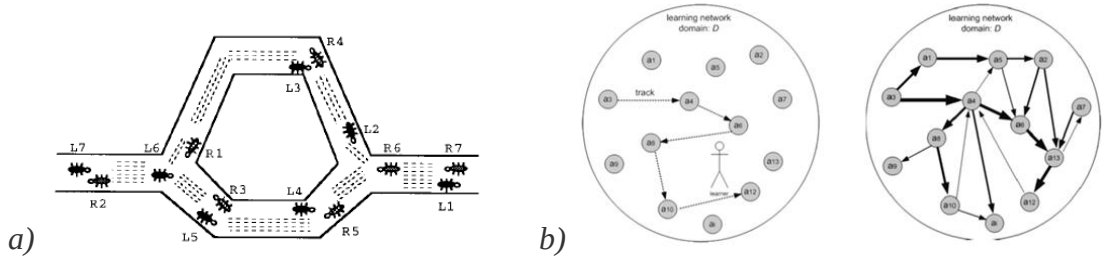
Disadvantages of the Ant Colony Optimization

- Theoretical analysis is difficult
- Sequences of random decisions (not independent)
- Probability distribution changes by iteration
- Research is experimental rather than theoretical
- Time to convergence uncertain (but convergence is guaranteed!)

4. Adaptation and modification of ACO

Main idea of ACO is as follows: a colony of ants moves through different nodes and their movement decision is influenced by trails and attractiveness. Each ant incrementally constructs a solution to the problem by depositing the pheromone information. This pheromone information will direct the search of the following ants. Furthermore, the algorithm also includes trail

evaporation (it reduces all trail values over time thereby avoiding any possibilities to getting stuck in local optima) and local search actions (they are used to bias the search process from non-local perspective).



a) *b)*

Figure 4. ACO algorithm based on real ant philosophy (a) and its application to e-learning context (learner moves through different LOs) (b)

Learning path (LP) is presented as a fully connected graph GV= (V,L) whose nodes are the components V, and the set L fully connects the components V. The GV is called the construction graph and the elements of L are called the connections or arcs (r,s), r,s ∈ L. At each construction step, an ant k applies a probabilistic action choice rule to decide which node to visit next.

1.1 Adaptation of ACO

Learning environment (LE) decomposed into time slots that contain the learning content presented as a particular path. In this case, navigation is possible through all LOs in all the corresponding time slots. The learner can navigate through the course and the topics analysed, improve his knowledge and continue his learning till he/she achieves the planned learning goals.

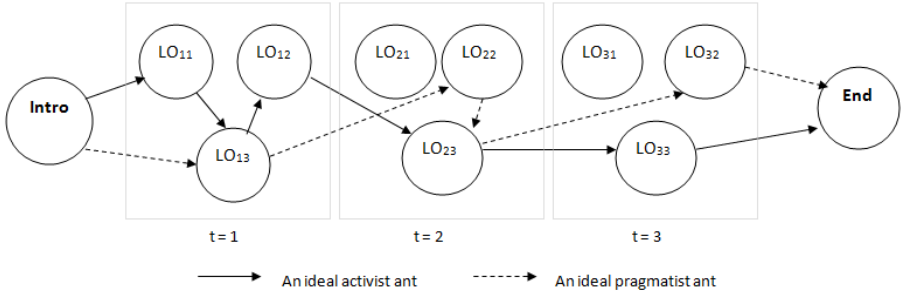


Figure 5. A time slot t assignment for each LO defined by a tutor

This provides initial logical grouping and sequencing of learning material and corresponds to real world terms like lesson, theme, module, learning goal, etc. Each time slot can have one or more learning objects assigned.

A learner is modelled as an entity having two characteristics: knowledge level (KL) and learning style (LS) based on Honey and Mumford LS typology (Honey 1992). With reference to the analysis of some literatures resources it is noted that researchers have not considered the importance of the proportion of different LS that is if it stated that the student is activist no consideration is shown to this type proportion value, therefore the authors propose to model the student as a set of four independent criteria {w1, w2, w3, w4}. So the learner represented as an ant k should have LS represented as {wk1, wk2, wk3, wk4}, where wkx in [0..1]. By visiting learning objects the ant leaves the trail on a path by a set of pheromones corresponding to ant's LS and achieved results. Another ant z reacts to a pheromone traces by its pheromones sensitivity. It means that each ant may leave up to 4 different pheromone traces and

correspondingly may react to 4 kinds of pheromones. KL is defined by dimensions Master, Experienced, Novice.

1.2 Modification of ACO

In order to have the ability to be flexible and allow for easy addition of new content by using ACO for LP selection a modification for dynamic environment is proposed. When a new LO is added or the existing one is modified, the problem could arise how to accumulate more information on its suitability to a particular learner‘s LSt, i. e. how to attract learners (ants in the ACO terms) to visit it and how to save pheromones accumulated before the modification. An idea is based on the assumption, that LOs in LS are replaced or modified to a more qualitative from the pedagogical point of view. Consequently, the modification of LP should help learners to perform better. In terms of the ACO algorithm, there exist connections among other LOs and information (pheromones) is stored in them which is used to recommend learner to go from one LO to another one. Thus, a new LO has no information on its connections to other LOs. As a result, by inserting a new LO all, connections with other LOs must be initialized and the „new LO“pheromone should be applied to the connections in order to attract learners (ants) to validate the modification.

5. A model of adaptive engine based on modified ACO approach

A model is based on these assumptions: 1) the information about a student’s LS and KL is known; 2) the course should be attended by many students; 2) the course structure is given by a tutor keeping in mind the time allotted; 3) the course is comprised of LOs and their alternatives; 4) the efficiency of algorithm is treated here as an improvement of students’ performances, viz., the algorithm is going to be efficient if students show better results in their learning.

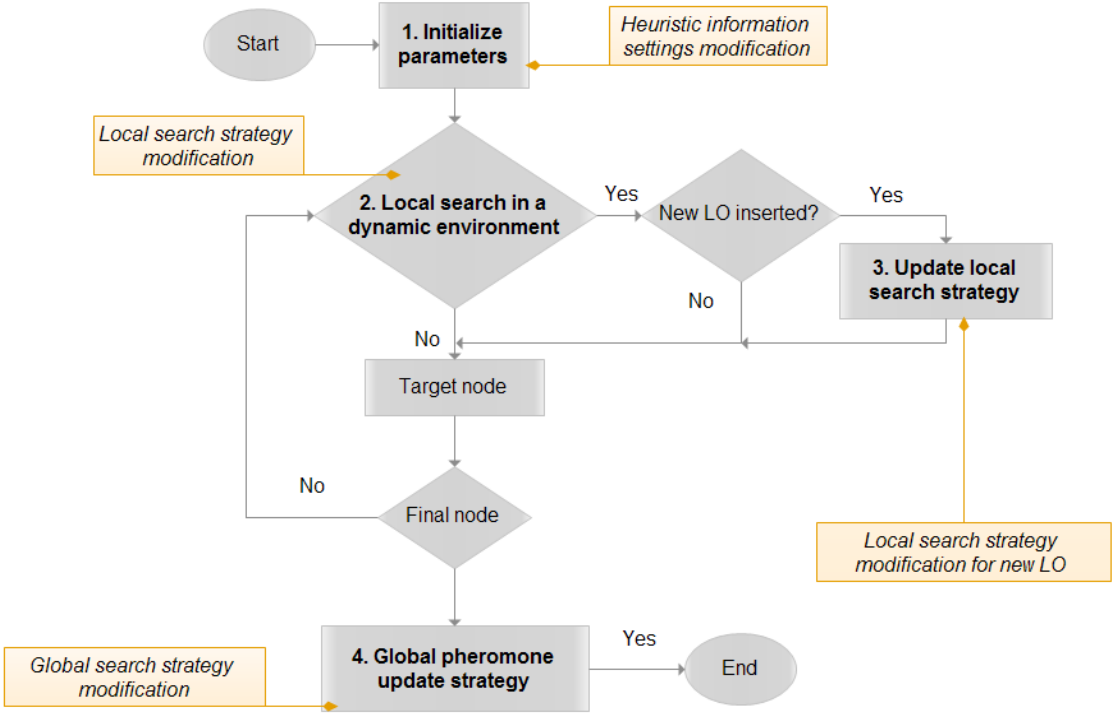


Figure 6. A model of adaptive engine model based on ACO

The term “model” is used here to denote an adaptive stochastic mechanism for efficient learning path selection. In order to apply this approach the adaptation was done:

- Expression of heuristic information
- Solution construction
- Local search strategy
- Pheromone update strategy

6. Implementation of the proposed model in VLE and 7. Evaluation of the proposed model

The evaluation of the proposed model consists of two stages: technological and educational perspectives.

In order to evaluate the proposed model from technological point of view computer simulations were executed and measures of parameters settings were optimized.

In order to evaluate it from educational point of view prototype of the model is implemented in VLE “Moodle” and 100 learners from the university are studying the course “Applied mathematics and qualitative methods”. I am gathering data for this kind of evaluation.

6. A sketch of the applied research methodology (data collection and analyzing methods)

1. Analysis of adaptive e-learning, criteria for user models and learning material – review and summary of latest references.
2. Analysis of models of adaptive engines – review and summary of latest references.
3. Analysis of swarm intelligence methods – review and summary.
4. Adaptation of ACO approach for selection of learning path and its extension/modification for effective use in dynamic environment.
5. Computer simulations and mathematical statistics methods to estimate effectiveness of the proposed model based on ACO extension from technological point of view.
6. Survey research to estimate learners experience using the proposed model.

7. A description of the Ph.D. project's contribution to the problem solution

The research contributes to knowledge in the following ways:

1. it contributes to an already established scientific theory and line of empirical research -> an approach of dynamic learning paths selection, based on swarm intelligence, mainly extension of ACO algorithm and adaptation of it to the personalized selection of the dynamic learning path;
2. it meets a practical need -> it affords ground for personalized/adaptive learning in virtual learning environment.

8. How the suggested solution is different, new, or better as compared to existing approaches to the problem

The suggested method differs from the existing ones because of its ability to work in a dynamic environment and is not based on linear mapping/suitability function of learners to learning material, which allows modeling more realistic learning context.

9. Publications

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5. Preidys S., Zilinskiene I. (2012) An e-learning personalization model from learning activities perspective. Electronic Learning, Information and Communication: Theory and Practice, Vilnius University, 111-132. ISBN 978-609-459-030-6
6. Kurilovas, E.; Žilinskiene, I.; Ignatova, N. (2011). Evaluation of Quality of Learning Scenarios and Their Suitability to Particular Learners' Profiles. In: Proceedings of the 10th European Conference on e-Learning (ECEL'09). Brighton, UK, November 10–11, 2011, pp. 380–389.

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Semet, Y., E. Lutton, et al. (2003). Ant colony optimisation for E-learning: observing the emergence of pedagogic suggestions. Swarm Intelligence Symposium, 2003. SIS '03. Proceedings of the 2003 IEEE.

Wang, T.-I., K.-T. Wang, et al. (2008). "Using a style-based ant colony system for adaptive learning." Expert Systems with Applications 34(4): 2449-2464.

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11. Questions

Technological:

1. ACO algorithms greatly depends on parameters settings. What are methodologies how to set them in a scientific way?
2. Computer simulation as an experiment was executed to measure its efficiency in finding LP then new LO is inserted according to the original one. Consequently parameters were optimized. What kind of others parameters or features must be evaluated to show that the proposed solution is good enough?

Pedagogical:

1. Are there any illogical constructions in the proposed model of learning material as a fully connected graph? I do not use any ontology or other tools to describe domain model, I suppose lesson/lecture only has at least several relevant LOs to reach the same learning goal.

Methodological:

1. The evaluation of the proposed method could be done both from technological and pedagogical (from learners perspective) point of view. From the technological side there are computers simulations (simulated learners, simulated learning context, etc.) as a tool to do that and methods of mathematical statistics to show measures and their significance.
2. How to implement an experiment, which approach to choose in the circumstances, when amount of students are not big (~150)?