



9th Doctoral Consortium on **Informatics Education and Educational Software Engineering Research**

joint with

Nordplus workshop on **Culturally Diverse Approaches to Learning Mathematics and Computational Thinking**

Organisers:

Prof. dr. Valentina Dagienė,

Dr. Eglė Jasutė

November 30 – December 5, 2018

Druskininkai, Lithuania

9th Doctoral Consortium on Informatics Education and Educational Software Engineering Research
joint with Nordplus workshop “Culturally Diverse Approaches to Learning Mathematics and
Computational Thinking“

November 30 - December 5, 2018, Druskininkai, Lithuania

The aims of the Doctoral Consortium are:

- 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.
- Provide a supportive setting for feedback on students' current research and guidance on future research directions.
- Offer each student comments and fresh perspectives on their work from researchers and students outside their own institution, as well as help with choosing suitable methodology and strategies for research.
- Support networking with other researchers in the informatics engineering education research field, and promote the development of a supportive community of scholars and a spirit of collaborative research.
- Support a new generation of researchers with information and advice on research and academic career paths.

Participants

The International Doctoral Conference provides an opportunity for doctoral students to explore and develop their research interests in a workshop under the guidance of distinguished senior researchers. We invite students who feel they would benefit from this kind of feedback on their dissertation work in Informatics (CS) and education to apply for this unique opportunity to share their work with students in a similar situation as well as senior researchers in the field. We welcome submissions from students at any stage of their doctoral studies.

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 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 school. The summary will be made available for other participants of the doctoral school to allow providing feedback and preparing questions on the research.

AGENDA

Friday, November 30

- 14:30 *Bus from Vilnius airport*
18.00 *Dinner*
20:00 *Welcome and discussion (please bring your bath suits)*

Saturday, December 1

- 07.30 – 09.00 *Breakfast*
09.00 – 10.30 Don Passey (Lancaster University, UK). Suggestions and criteria for developing computer science education research.
10.30 – 11.00 *Coffee break*
11.00 – 11.15 Valentina Dagiene (Vilnius University). Introducing to the Nordplus project: Bebras & ViLLE (including research questions)
11.15 – 12.00 Mikko-Ville Apiola (University of Turku, Centre for Learning Analytics) Presentation the collaborative education platform ViLLE
12.00 – 13.00 *Lunch*
13.00 – 14.30 Willem van der Vegt (Windesheim University for Applied Sciences, Zwolle, The Netherlands) Bebras tasks. A bridge between informatics concepts and challenging questions
14.30 – 16.00 Practical work in two groups: 1. Doctoral students (working on developing posters). 2. Nordplus participants (working on interactive Bebras tasks).
16.00 – 16.30 *Coffee break*
16.30 – 18.00 Reflection on students' posters: all participants will read posters and write down their questions and comments.
18.00 – 18.30 *Dinner*
19.00 – 22.00 Discussions on ViLLE. Doctoral research discussions in groups

Sunday, December 2

- 07.30 – 09.00 *Breakfast*
09.00 – 11.00 Erik Barendsen (Radboud University and Open University, The Netherlands). Workshop on research methods (topics to be chosen together with the participants).
11.00 – 11.30 *Coffee break*
11.30 – 12.00 Practical work in two groups.
12.00 – 13.00 *Lunch*
13.00 – 14.30 Don Passey (Lancaster University, UK). Developing a computer science curriculum underpinned by fundamental learning theory
14.30 – 16.00 Practical work in two groups: 1. Doctoral students (working on developing posters). 2. Nordplus participants (working on Bebras tasks integrating to ViLLE).
16.00 – 16.30 *Coffee break*
16.30 – 18.00 Continuation of the work in small groups.
18.00 – 18.30 *Dinner*
19.00 – 22.00 Read posters and write down their questions and comments

Monday, December 3

- 07.30 – 08.30 *Breakfast*

- 08.30 – 12.00** Visiting Druskininkai Saules progymnasium. Tour in the school. (1) Introducing ViLLE to 3rd grade pupils (Mikko-Ville). (2) Discussion on Informatics for primary education in UK, Netherlands, Finland, Sweden (panel discussion, Don, Erik, Willem, Mikko-Ville, Arnold).
- 12.00 – 12.30 Lunch (in the school)*
- 12.30 – 13.30** Informatics curriculum for primary schools (Valentina). Discussion with teachers and coffee break.
- 15.00 – 15.30 Beck to Dainava.*
- 15.30 – 17.00** Arnold Pears (KTH – Royal Institute of Technology, Sweden) and Valentina Dagiene (Vilnius University). *Nordplus* project: Preparation material for teacher training on cultural diverse approaches teaching mathematics and computational thinking.
- 17.00 – 18.00** Presentation of group works and new ideas.
- 18.00 – 18.30 Dinner*
- 18.30 – 20.00** Continuation of the Presentation of group works and new ideas.

Tuesday, December 4

- 07.30 – 09.00 Breakfast*
- 09.00 – 10.30** Mirjana Ivanovic (University of Novy Sad, Serbia) Learning Analytics: problems and future works.
- 10.30 – 11.00 Coffee break*
- 11.00 – 12.00** Arnold Pears (KTH – Royal Institute of Technology, Sweden). Proposals for further work and activities. Planning a research work and dissemination of the project ideas.
- 12.00 – 13.00 Lunch*
- 13.00 – 16.00** Practical work in two groups: 1. Doctoral students (working on developing posters). 2. *Nordplus* participants (working on Bebras tasks and ViLLE).
- 16.00 – 16.30 Coffee break*
- 16.30 – 18.00** Final discussion and proposals for future work.
- 18.00 – 18.30 Dinner*

Wednesday, December 5

- 07.30 – 09.00 Breakfast*
- 09.30 Departure to Vilnius airport*

Contents

INFORMATION TECHNOLOGY OF TELECOMMUNICATIONS NETWORK TRAFFIC PROCESSING	6
<i>Yurii Klishch</i>	6
METHODS AND TOOLS FOR PERSONAL KNOWLEDGE MANAGEMENT IN INTELLIGENT SYSTEMS ...	9
<i>Vasyl Lenko</i>	9
EVENT-DRIVEN PROGRAMMING IN INTRODUCTORY PROGRAMMING EDUCATION	14
<i>Aleksi Lukkarinen</i>	14
KEY FACTORS TO IMPROVE LEARNING THROUGH FINDING DATA MINING, MACHINE LEARNING TO HIGHER EDUCATION DATA ANALYSIS	21
<i>Davaasuren Nyamjav</i>	21
UNDERSTANDING OF STUDENTS' PERCEPTIONS ON THE EFFECT OF SOCIETAL INVOLVEMENT IN THEIR ENGINEERING EDUCATION.....	23
<i>Pantzos Panagiotis</i>	23
APPLICATION OF THE REFERENCE MODEL FOR SECURITY RISK MANAGEMENT IN THE INTERNET OF THINGS SYSTEMS	32
<i>Raimundas Savukynas</i>	32
PREDICTIVE MODELS AS EARLY WARNING SYSTEMS TO PREDICT STUDENT ACADEMIC PERFORMANCE IN INTRODUCTORY PROGRAMMING	38
<i>Ashok Kumar Veerasamy</i>	38
APPLICATION OF WEB TECHNOLOGIES FOR PROGRAMMING EDUCATION	44
<i>Márton Visnovitz</i>	44

INFORMATION TECHNOLOGY OF TELECOMMUNICATIONS NETWORK TRAFFIC PROCESSING

Yurii Klishch

First year of postgraduate studies.
Lviv Polytechnic National University,
S. Bandera Street, 12,
Lviv, 79013, Ukraine
chlichch@ukr.net

Biography

I hold bachelor's and master's degrees in computer science. My research interests focus on analyzing, modeling and forecasting traffic of telecommunications networks.

Publications:

- I. Dronyuk, Z. Shpak, Y. Klishch, "Optimization of Quality of Service of telecommunication networks based on Ateb-forecasting", PREDT, 2018 (<http://radiotech.cv.ua/?view=conference>)
- I. Dronyuk, Y. Klishch, "Models, tools for collecting and processing traffic parameters of telecommunication networks", Problems of use of information technologies by Ukraine legal-organizational structure and higher educational institutions, 2017
- Y. Klishch, V. Polzukov, "Application of systems with long-term dependence for computer networks traffic research", "CITEM", 2017

Research area description

The main problem is that modern society is dependent on the functioning of telecommunication networks as never before, therefore the study of their models for deeper analysis and further improvement remains relevant.

The aim of research is develop a method of forecasting and modeling of traffic flows in telecommunication networks. Expecting to use developed information technology to in adaptivbe control of traffic in networks by predicting load intensity and redistribution of node capacity in a given segment of a network platform.

Classical approaches to the theory of computer networks are based on the assumption that the input streams are stationary, that is, in fact, a superposition of a very large number of independent stationary flows. When considering telephone networks with channel switching, it can be claimed that such an assumption will be also equita-ble for them. However, researchers are claiming that traffic in modern computer and telecommunication networks with packet switching has a special structure that pre-vents the use of standard methods based on Markov models and Erlang's formulas in the simulation.

These models do not take into account the effect of self-similarity of traffic, that is, in the implementation always there is a certain number of strong enough fluctuations against the background of low average total traffic. This phenomenon leads to an increase in the loss of packets with data, delays in their transmission when passing such traffic through computer network nodes. Thus, the actual scientific task is to search and develop new mathematical models for describing the process of servicing self-similar network traffic of data in order to develop methods that will enable to improve the maintenance of such traffic on the hardware level.

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

Current model of traffic used by my supervisor is based on the application of asymptotic methods and the mathematical theory of Ateb-functions where fluctuations of traffic in a computer network as the function of time, as a nonlinear oscillating system with single degree-of-freedom in conditions of small disturbances.

This model can be improved for providing more complete and accurate picture of what processes occur in the computer network of service delivery platform, especially for self-similar traffic, that have a special structure that is persisted when using multiple scaling.

One of the proposed ways to increase accuracy of prediction is using a Hurst Exponent. Hurst Exponent is a classical self-similarity parameter that measures the long-range dependence in a time series and provides measure of long-term nonlinearity. Over the years, Hurst exponent has been applied in a wide range of industries. For example the Hurst exponent is paired with technical indicators to make decisions about trading securities in financial markets; and it is used extensively in the healthcare industry, where it is paired with machine-learning techniques to monitor EEG signals. In our research we will use the Generalized Hurst Exponent

Possible usage of developed model is described in figure 1., where model could be used on analysis and prediction calculation stage.

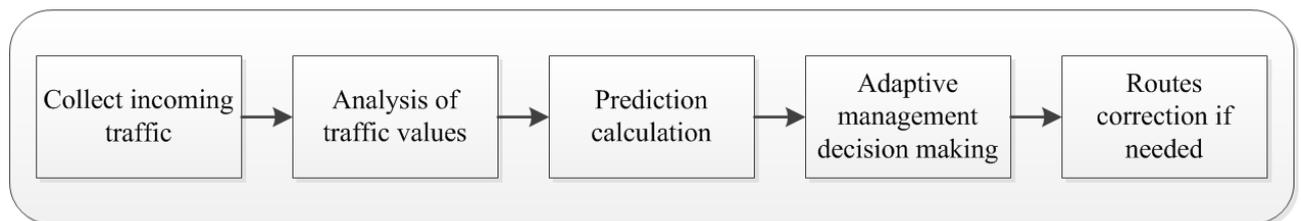


Figure 1. Improving telecommunication network traffic flow

Bibliographic References

1. Demydov, I., Dronjuk, I., Fedevych, O., Romanchuk V.: Traffic Fluctuations Optimization for Telecommunication SDP Segment Based on Forecasting Using Ateb-Function. In: Data-Centric Business and Applications, Evolutions in Business Information Processing and Management 20, P. 71-88. Springer, Cham (2019).
2. On The Estimation of the Hurst Exponent: A Case of Exponential Distribution, Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Issue-8, 2017 ISSN: 2454-1362, <http://www.onlinejournal.in>
3. Dronjuk, I., Nazarkovych, M., Fedevych, O.: Asymptotic method of traffic simulation. In: Distributed Computer and Communication Networks. Communications in Computer and Information Science, Vol. 279. pp.136-144. Springer, (2014)
4. Dronjuk, I., Fedevych, O., Lipinski, P. Ateb-prediction Simulation of Traffic Using OMNeT++ Modeling Tools. In: Proceedings of the 10-th International Scientific and Technical Conference Computer Science and Information Technologies, (CSIT) pp.96-98. Lviv, (2016).
5. Aljomar M (2014) Prediction of self-similar traffic in packet networks [Prognozuvannya samopodibnogo trafika u paketnyx merezhax]. In: Improving the development of complex systems, issue 20, no 12, pp 102–109

Expectations and motivation to attend Doctoral Consortium

The main goal of my participating in consortium is to receive new experience, hear different opinions, rethink my research methods. I'm particularly expect to hear any critical and helpful comments from experienced researchers and doctoral students who work in similar areas and/or with similar methods. I think that the possibility to exchange my ideas with the other doctoral consortium student participants will also provide me with insight in their interesting works. Also, getting into contact with other people from the informatics engineering education research community is an important reason why I want to attend this doctoral consortium.

METHODS AND TOOLS FOR PERSONAL KNOWLEDGE MANAGEMENT IN INTELLIGENT SYSTEMS

Vasyl Lenko

3rd year of doctoral studies

Information Systems and Networks Department

Lviv Polytechnic National University

5 Mytropolyyta Andreja Str., room 122

Lviv, 79013, Ukraine

vs.lenko@gmail.com

Biography

Born: August 24, 1990 (aged 28)

School: Lviv City Council Lyceum #2 (with in-depth study of English, 2006)

University: Ivan Franko National University of Lviv

- B.Sc. in Applied Mathematics (2010, avg. 4.65/5.0)
Thesis: Numerical 2D-simulation of plate deformation using finite elements method
- M.Sc. in Computer Science (2011, avg. 5.0/5.0)
Thesis: An application of artificial intelligence methods to the image segmentation

PhD studies: Lviv Polytechnic National University

- PhD Student in System Analysis (2018, avg. 95/100)
- PhD Candidate in System Analysis (thesis to be presented in 2020)

Teaching experience: Ivan Franko National University of Lviv

- Graduate teaching assistant (2011-2014, Faculty of Applied Mathematics and Informatics)
Subjects: Artificial Neural Networks, Data Mining, AI Systems, Machine Learning, OLAP

IT Career:

- Romexsoft - Senior Software Engineer / Project Manager (2008-2015, Lviv, Ukraine)
- Brown Brothers Harriman - R&D engineer (2015-2016, Krakow, Poland)
- IRAengine - Chief Technical Officer, Co-Founder (2017, Lviv, Ukraine)
- Bitcab - Technical Advisor (2017-2018, Lviv, Ukraine)
- Perfectial - R&D engineer (2018, Lviv, Ukraine)

Miscellaneous:

- Assistant to Member of Parliament of Canada (2011, Ottawa, Canada)
- Best pitch of ITArena 2017 Startup Competition (2017, Lviv, Ukraine)
- Summited Stok Kangri peak 6,153m (2018, Ladakh, India)

Main problem: How to manage acquired personal knowledge effectively: so that it can be retrieved, updated, extended, inferred, and shared in the most reliable way?

Relevance: Knowledge transferring is considered to be a cornerstone mechanism of human evolution. While there are plenty of established means of knowledge transferring, like natural language, books, digital assets, teaching, etc. their structural properties in context of automated or semi-automated knowledge management are insufficient. Taking into account an exponential growth of information in recent years, there is a strong need for enhanced knowledge management methods and tools.

Aim of research: Create new method, concept and implementation of software-based system for personal and shared knowledge management.

Problem Domain: In the domain of Knowledge Management Systems (KMS), an *ontological model* of knowledge representation combined with the *descriptive logics* for knowledge inference became de-facto a standard. Since descriptive logics are subset of first-order logic (FOL), they suffer at least from the same limitations as FOL, i.e. don't provide encoding for quantification over predicates.

Contribution: The research specifies an innovative method of applying *higher-order logic* to the inference in ontological model. In addition, it provides a novel concept and modern technology stack of a *decentralized blockchain-based system* for personal and shared knowledge management, i.e. virtual scientific communities, smart cities, engineering teams.

Research Plan:

1. Elaborate on higher-order logical inference in ontologies
2. Present the conceptual and technological framework of the designed KMS
3. Development of the KMS
4. Draft version of thesis
5. Final version of thesis

Current Status:

1. Finalization of the paper on KMS concept and architecture
2. Research of Coq interactive proof assistant

Achieved Results:

- 6 published papers (2 in recognized citation databases, Scopus & IEEE Digital Explore)
- 14 published conference thesis
- Draft version of KMS architecture

Expected achievements:

- Publication of 2 or more Scopus-indexed papers
- Implementation of a software-based knowledge management system
- Thesis publication

Living in a post-industrial, information society a person on a daily basis faces the need for analyzing large amounts of information. From various sources comes both structured and unstructured information, which should be processed and in case of utility stored for the later use. It is worth emphasizing that information analysis consumes a lot of time and energy, therefore a person heavily utilizes its memory mechanism to avoid the cost of re-analysis of already processed material. Yet, the physiological characteristics do not allow to store and use all the analytical results that a person accumulates during a life. Hence arises a need for supplemental tools that could store and retrieve these results, and as an added value ensure their integrity.

The recent challenges in a knowledge-based systems engineering consist in researching the efficient models of knowledge representation (KR) and the methods of ensuring its integrity. There are various criteria for assessing the effectiveness of KR model, including expressiveness, extensibility, inference methods, etc. To build a successful knowledge-based system, it is

important initially to select the underlying KR model according to the defined goals. The paper provides a comparative analysis of the established approaches to knowledge representation and emphasizes an increasing role of a formal reasoning. Since the formal systems expose a significant technical difficulty to a regular user, it is proposed to hide the complexities behind the convenient “tell-ask” interface, which should allow managing the personal knowledge in a natural way.

Among the tools for knowledge management are the so-called “personal knowledge bases” – computer systems designated for storing and retrieving an integrated personal knowledge that was previously set by the user. A well-known example of these systems is “Popcorn” project, which implemented its own architecture for knowledge maintenance, based on the idea of concepts “transclusion” [1]. The classic use of “semantic networks” enabled a convenient appending and viewing of the knowledge, however it also revealed the complexities of knowledge reorganization. This creates a need to discover more efficient solutions for knowledge representation and management.

The fundamental work in a field of knowledge management automation is “As We May Think” by V. Bush [2]. It presents a theoretical machine called “Memex”, which is designed to serve as supplemental tool for human memory. The principles of machine functioning described in the paper significantly influenced the creation of World Wide Web and the concept of personal knowledge bases. In addition, in 2014 the DARPA agency launched a project with the same name “Memex”, which aims to create the next-generation of search technologies to revolutionize the discovery, organization and presentation of domain-specific content [3].

Knowledge representation appears to be a central problem in personal knowledge management system engineering, since it significantly affects an efficiency of the system in meeting the user’s needs. There exist many models of KR that could be grouped into four classes: logic-based, semantic networks, production-based and frame-based models. All they form a base for more complex KR approaches, such as ontologies. With the development of the theory of artificial neural networks (deep learning technique) and increase in computing power of hardware, more efforts are dedicated to the research of models that by their structure and mechanism of the functioning are similar to the biological models of knowledge processing in a human brain.

Another important task is to ensure integrity of new knowledge and the previously stored one, with an ability to detect and avoid semantic collisions. In the theory of knowledge integration there is a widely-used approach called “semantic matching” that is aimed to identify semantically related information. Among the latest trends in this field is the research of an applicability of deep learning technique to an assessment of semantic similarity of textual information. Identification of similar elements allows establishing relations between them. In order to avoid logical inconsistencies in the knowledge base, it worth to examine the applicability of an inference mechanism. Logic-based and production-based KR models are supplied with the well-developed formal inference mechanisms (i.e. natural deduction, forward chaining), while the inference in semantic networks and frame-based models is comparatively limited.

Nowadays ontology de facto became a standard among the models of knowledge representation. In addition to its deep roots in philosophy, ontology also incorporates the

strengths of the other KR models – hierarchy resembles a semantic network, the structure of classes and instances inherit a frame model, axioms and functions follow the logic model and production rules respectively. According to the refined definition, ontology is a formal, explicit specification of a shared conceptualization characterized by high semantic expressiveness required for increased complexity [4]. Here the conceptualization stands for an abstract simplified view of some selected part of the world that we wish to represent for some purpose. Typically, it consists of concepts, objects, entities that are in the scope of interest and relationships between them. From the perspective of system analysis, the relationship between a conceptualization and ontology can be classified as “many-to-many”.

An ontology that is used to specify the conceptualization of a real domain might contain hundreds of classes, instances, roles, axioms and tends to expand with a time. Keeping its logical consistency or testing the new hypothesis requires the presence of a reasoning mechanism that would help to avoid error-prone manual proof searching. Some reasoning mechanisms are tightly bound to the knowledge representation model, i.e. procedures in semantic networks, while the others exist as independent formal systems, like predicate calculus. Soundness, completeness, and decidability are the main characteristics of an inference engine. In ontologies, the most widely-used language for reasoning is OWL 2 [5] based on the description logic DL SROIQ^d. Description logics (DL) are a family of logics designed to be as expressive as possible while retaining decidability. Being a fragment of first-order logic the DL has limited expressiveness; in particular, the quantification of the classes is missing. In some cases, its expressiveness can be enhanced by the DL-safe SWRL rules [6], but in general, the operations on higher-order entities are still unavailable.

Higher-order logics, which are based on the type theories, provide even more expressiveness via stronger semantics and quantification over the arbitrary nested sets. Unfortunately, it comes with the price that model-theoretic properties are less well-behaved than in FOL. An introduction of Curry-Howard-Lambek isomorphism established a connection between proof theory, type theory and category theory. It gave a birth to the concepts like “propositions as types”, “proofs as programs” and “simplification of proofs as evaluation of programs”. Nowadays a lot of active research is conducted in the area of homotopy type theory, which links topology to “propositions as types” [7].

The logic in a simple type theory is a constructive one, which means that some classical rules of inference, namely law of excluded middle and double negation elimination, are not considered during proof derivation. Propositions correspond to types, and to prove a proposition means to show that an appropriate type is inhabited – there exists a token of a type. Token serves as a certificate to the proposition. Since a proposition might be proved in different ways, there might be multiple tokens of the same type. The beauty of the constructive approach is that besides the fact of a proof existence, it also represents the way a proposition was proved. The logic in type theory could be done through the usage of appropriate types according to Curry-Howard isomorphism [8].

Bibliographic References

1. Davies, S., Allen, S., Raphaelson, J., Meng, E., Engleman, J., King, R., & Lewis, C. Popcorn: the personal knowledge base. (2006). *Proceedings of the 6th conference on Designing Interactive systems*, 150-159.

2. Bush, V. As We May Think. (1945). *Atlantic Monthly* (176), 101-108.
3. Defense Advanced Research Projects Agency. (2014). Memex. <http://www.darpa.mil/program/memex>.
4. Feilmayr, C., Wöß, W. (2016). An analysis of ontologies and their success factors for application to business. *Data & Knowledge Engineering*, 101, 1-23.
5. OWL 2 Web Ontology Language Document (Second Edition), <https://www.w3.org/TR/owl2-overview>.
6. Sikos, L. DL-Safe Rules, <http://www.lesliesikos.com/dl-safe-rule>.
7. Wadler, P. Propositions as Types. (2015). *Communications of the ACM*, 58(12), 75-84.
8. Sørensen, M., Urzyczyn, P. (2006). Lectures on the Curry-Howard Isomorphism. *Elsevier Science, Amsterdam*.

Publications (in English):

1. Lenko V., Pasichnyk V., Kunanets N., Shcherbyna Y. (2019). Knowledge Representation and Formal Reasoning in Ontologies with Coq. In: *Hu Z., Petoukhov S., Dychka I., He M. (eds) Advances in Computer Science for Engineering and Education. ICCSEEA 2018. Advances in Intelligent Systems and Computing*, vol 754. Springer, Cham. doi: 10.1007/978-3-319-91008-6_74.
2. Lenko V., Pasichnyk V., Kunanets N., Shcherbyna Y. (2018). Type-theoretical foundations of derivation system in Coq. *IEEE First International Conference on System Analysis & Intelligent Computing (SAIC), Kyiv, Ukraine*. doi: 10.1109/SAIC.2018.8516885.
3. Lenko V., Pasichnyk V., Shcherbyna Y. (2017). Knowledge representation models. *Bulletin of Lviv Polytechnic National University. Series: Computer sciences and information technologies*, 864(1), 157-168.

Expectations and motivation to attend Doctoral Consortium

- Present and validate PhD research results
- Improve research methodology
- Extend professional network
- Explore new research opportunities

EVENT-DRIVEN PROGRAMMING IN INTRODUCTORY PROGRAMMING EDUCATION

Aleksi Lukkarinen

Doctoral student, 2nd year
Aalto University, Department of Computer Science
Konemiehentie 2
FI-02150 Espoo, Finland
aleksi.lukkarinen@aalto.fi

Biography

I received my B.Sc. degree in software engineering from Helsinki Metropolia University of Applied Sciences in 2011 and my M.Sc. in software technology from Aalto University in 2016. Currently I am carrying out doctoral studies in Aalto as a part of the Learning + Technology (LeTech) research group and supervised by prof. Lauri Malmi. My research interests include teaching and learning event-driven programming, as well as psychological aspects of computing education in general.

Publications

Lukkarinen, Aleksi & Sorva, Juha. 2016. Classifying the tools of contextualized programming education and forms of media computation. In *Proceedings of the 16th Koli Calling International Conference on Computing Education Research* (Koli Calling '16), 51–60. New York, NY, USA: ACM.
<https://doi.org/10.1145/2999541.2999551>

Research Area

During the past twenty years, *event-driven* (also *event-based*, *event-oriented*) *programming* (EDP) has become a part of introductory programming education (e.g., [6, 29, 30, 31]). Its place and breadth in computer science curricula has been under discussion (e.g., [4, 14, 17]), but today even some teaching tools (such as Scratch [19] and Snap! [23]) used in elementary schools (e.g., [12]) are based on responding to events. On university level, an example of a current introductory programming course that follows the so-called *events-first* approach (e.g., [5, 32]) is the Programming 1 [1] taken by all CS majors at Aalto University. On it, students program in Scala [8] and are exposed to EDP from the second week onwards.

Despite of the current prevalence of EDP, the amount of directly related formal research reported in scientific publications seems to be rather small. For instance,

- technical solutions (e.g., [7, 9]) related to EDP are published continuously, but these publications are not concerned with teaching and learning EDP
- some publications report opinions their authors for example about the difficulty of teaching and learning EDP, but the generalizability of individual separate opinions is questionable
- many publications describe tools used or intended to be used for teaching EDP, but in most cases they lack formal research results to back up usefulness of the tools, save the usual summaries of end-of-class questionnaires and exam results

- **Contextualizations and technologies.** What new themes and tools (e.g., [11, 17, 18, 20]) could be used to contextualize teaching of EDP? What technologies could and should be taught and how?
- **Opinions and feelings.** Do students have prejudices regarding EDP? How do they experience EDP and their possible errors and misconceptions? Are they confident about their EDP-related learning? Does their confidence correlate with their real understanding? How could their possible negative feelings be alleviated, and their self-confidence reinforced?
- **Games, toys, and activities.** How is EDP present in computer and board games as well as children's toys and educational activities (e.g., Bebras [3]) that introduce computational thinking and programming? How could teaching EDP be (further) gamified and included to children's activities?
- **Programming paradigms.** How is event-drivenness (e.g., [14]) related for example to object-oriented programming and rule-based programming (e.g., [11])? What paradigms should be taught and how?
- **Theories.** What theories (e.g., psychological and sociological) could support specific ways of teaching and learning EDP? How could these theories be best applied? Do research results support any theories being applied?

All the above areas could naturally be researched at different educational levels, such as K–9, high school, and university, as well as in their various sub-contexts, such as majors vs. minors and differing levels of preliminary knowledge.

Research Methods

Prospective methods for deliberate data collection include questionnaires, (semi-structured) interviews, drawing, think-alouds, observation, and technical recordings (such as screen, keyboard, mouse, electrodermal, and brain activity, as well as eye movements). On the other hand, the datasets naturally produced by course implementations (e.g., exercise solutions, test scores, and course feedback) could also be analyzed. On higher level, there are possibilities for instance to develop grounded theories and conduct design-based research.

Bibliographic References

1. Aalto-yliopisto. [n.d.] Avoimet verkkokurssit [Website]. [Accessed: Oct. 20, 2018.] Available: <http://mooc.aalto.fi/>
2. Austing, Richard H. & Barnes, Bruce H. & Bonnette, Della T. & Engel, Gerald L. & Stokes, Gordon. 1979. Curriculum '78: Recommendations for the undergraduate program in computer science—a report of the ACM curriculum committee on computer science [PDF]. In *Commun ACM* 22, 3 (March 1979), 147–166. [Accessed: Oct. 20, 2018.] Available: <http://dx.doi.org/10.1145/359080.359083>
3. Bebras: International Challenge on Informatics and Computational Thinking [Website]. [Accessed: Oct. 20, 2018.] Available: <https://www.bebas.org/>
4. Bruce, Kim B. & Danyluk, Andrea P. & Murtagh, Thomas P. 2001. Event-driven programming is simple enough for CS1 [PDF]. In *Proc 6th ITiCSE*, 1–4. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <http://dx.doi.org/10.1145/377435.377440>

5. Bruce, Kim B. & Danyluk, Andrea P. & Murtagh, Thomas P. 2006. *Java: An Eventful Approach*. Upper Saddle River, NJ, USA: Pearson Education. 675 pp. ISBN: 0-13-142415-7.
6. Computer Science Teachers Association. 2017. *CSTA K–12 Computer Science Standards, Revised 2017* [PDF]. [Accessed: Oct. 20, 2018.] Available: <http://www.csteachers.org/standards>
7. Dunkels, Adam & Schmidt, Oliver & Voigt, Thiemo & Ali, Muneeb. 2006. Protothreads: Simplifying Event-Driven Programming of Memory-Constrained Embedded Systems [PDF]. In *Proc 4th Int Conf SenSys*, 29–42. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/1182807.1182811>
8. École Polytechnique Fédérale. [n.d.] The Scala Programming Language [Website]. [Accessed: Oct. 20, 2018.] Available: <https://www.scala-lang.org/>
9. Gasiunas, Vaidas & Satabin, Lucas & Mezini, Mira & Núñez, Angel & Noyé, Jacques. 2011. EScala: Modular Event-Driven Object Interactions in Scala [PDF]. In *Proc 10th Int Conf AOSD*, 227–240. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/1960275.1960303>
10. Gestwicki, Paul & Haddad, Andrew & Toombs, Austin & Sun, Fu-Shing. 2009. An Experience Report and Analysis of Java Technologies in Undergraduate Game Programming Courses [PDF]. In *J Comput Sci Coll* 25, 1 (October 2009), 102–108. [Accessed: Oct. 20, 2018.] Available: <http://dl.acm.org/citation.cfm?id=1619221.1619241>
11. Gordon, Michal & Rivera, Eileen & Ackermann, Edith & Breazeal, Cynthia. 2015. Designing a relational social robot toolkit for preschool children to explore computational concepts [PDF]. In *Proc 14th Int Conf IDC*, 355–358. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <http://dx.doi.org/10.1145/2771839.2771915>
12. Harlow, Danielle B. & Dwyer, Hilary A. & Hansen, Alexandria K. & Iveland, Ashley O. & Franklin, Diana M. 2018. Ecological Design-Based Research for Computer Science Education: Affordances and Effectivities for Elementary School Students [PDF]. In *Cogn Instr* (September 10, 2018). [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1080/07370008.2018.1475390>
13. Hanks, Brian. 2008. Problems Encountered by Novice Pair Programmers [PDF]. In *ACM J Educ Resour Comput* 7, 4 (January 2008), art. 2, 13 pp. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/1316450.1316452>
14. Hansen, Stuart & Fossum, Timothy. 2004. Events not equal to GUIs [PDF]. In *Proc 35th SIGCSE*, 378–381. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/971300.971430>
15. Hertz, Matthew. 2010. What Do "CS1" and "CS2" Mean? Investigating Differences in the Early Courses [PDF]. In *Proc 41st ACM SIGCSE*, 199–203. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/1734263.1734335>
16. Hubbard, Aleata. 2018. Pedagogical content knowledge in computing education: a review of the research literature [PDF]. In *Comput Sci Educ*, 28, 2, 117–135. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1080/08993408.2018.1509580>

17. Lambert, Ken & Osborne, Martin. 2000. Easy, realistic GUIs with Java in CS1 [PDF]. In *J Comput Sci Coll* 16, 2 (Jan. 2001), 209–215. [Accessed: Oct. 20, 2018.] Available: <https://dl.acm.org/citation.cfm?id=369358>
18. Lukkarinen, Alekski & Sorva, Juha. 2016. Classifying the tools of contextualized programming education and forms of media computation [PDF]. In *Proc 16th Koli Calling*, 51–60. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/2999541.2999551>
19. MIT Media Lab. [n.d.] Scratch: Create stories, games, and animations; Share with others around the world [Website]. [Accessed: Oct. 20, 2018.] Available: <https://scratch.mit.edu/>
20. Murtagh, Thomas P. 2007. Squint: barely visible library support for CS1 [PDF]. In *Proc 38th SIGCSE*, 526–530. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/1227310.1227489>
21. Robins, Anthony & Haden, Patricia & Garner, Sandy. 2005. My Program is Correct But It Doesn't Run: A Preliminary Investigation of Novice Programmers' Problems [PDF]. In *Proc 7th ACE*, 42, 173–180. Darlinghurst, NSW, AU: ACS. [Accessed: Oct. 20, 2018.] Available: <https://dl.acm.org/citation.cfm?id=1082446>
22. Robins, Anthony & Haden, Patricia & Garner, Sandy. 2006. Problem Distributions in a CS1 Course [PDF]. In *Proc 8th ACE*, 52, 165–173. Darlinghurst, NSW, AU: ACS. [Accessed: Oct. 20, 2018.] Available: <https://dl.acm.org/citation.cfm?id=1151891>
23. Snap! — Build Your Own Blocks [Website]. [Accessed: Oct. 20, 2018.] Available: <https://snap.berkeley.edu/>
24. Solomon, Amber & Guzdial, Mark & DiSalvo, Betsy & Shapiro, Ben Rydal. 2018. Applying a Gesture Taxonomy to Introductory Computing Concepts [PDF]. In *Proc 2018 ACM Conf ICER*, 250–257. New York, NY, USA: ACM. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1145/3230977.3231001>
25. Sorva, Juha. 2012. Appendix A: Misconception Catalogue. In *Visual Program Simulation in Introductory Programming Education* [PDF]. Doctoral dissertation. Espoo, Finland: Aalto University, School of Science, Department of Computer Science. Pp. 358–368. [Accessed: Oct. 20, 2018.] ISBN: 978-952-60-4626-6. Available: <http://urn.fi/URN:ISBN:978-952-60-4626-6>
26. Sorva, Juha. 2013. Notional Machines and Introductory Programming Education [PDF]. In *ACM Trans Comput Educ* 13, 2 (June 2013), art. 8, 31 pp. [Accessed: Oct. 20, 2018.] Available: <http://dx.doi.org/10.1145/2483710.2483713>
27. Sung, Kelvin & Shirley, Peter. 2004. A top-down approach to teaching introductory computer graphics [PDF]. In *Comput Graph* 28, 3 (June 2004), 383–391. [Accessed: Oct. 20, 2018.] Available: <https://doi.org/10.1016/j.cag.2004.03.005>
28. Tchamgoue, Guy Martin & Ha, Ok-Kyoon & Kim, Kyong-Hoon & Jun, Yong-Kee. 2011. A Taxonomy of Concurrency Bugs in Event-Driven Programs [PDF]. In *Software Engineering, Business Continuity, and Education*, ASEA 2011, Kim, T. *et al.* (eds.) Communications in Computer and Information Science, 257. DE: Springer-Verlag Berlin Heidelberg. [Accessed: Oct. 20, 2018.] Available: https://doi.org/10.1007/978-3-642-27207-3_48

29. The Joint Task Force on Computing Curricula. 2001. Computing Curricula 2001 (CC2001): Computer Science [PDF]. [Accessed: Oct. 20, 2018.] Available: <https://www.acm.org/education/curricula-recommendations>
30. The Joint Task Force on Computing Curricula. 2013. Computer Science Curricula 2013 (CS2013): Curriculum Guidelines for Undergraduate Degree Programs in Computer Science [PDF]. [Accessed: Oct. 20, 2018.] Available: <https://www.acm.org/education/curricula-recommendations>
31. The Joint Task Force on Computing Curricula. 2016. Computer Engineering Curricula 2016 (CE2016): Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering [PDF]. [Accessed: Oct. 20, 2018.] Available: <https://www.acm.org/education/curricula-recommendations>
32. Turbak, Franklyn & Sherman, Mark & Martin, Fred & Wolber, David & Pokress, Shaileen Crawford. 2014. Events-First Programming in APP Inventor [PDF]. In *J Comput Sci Coll* 29, 6 (June 2014), 81–89. [Accessed: Oct. 20, 2018.] Available: <https://dl.acm.org/citation.cfm?id=2602739>

Expectations and motivation to attend Doctoral Consortium

I wish to meet colleagues and have enlightening conversations. Constructive feedback, insights, and guidance would be quite welcome for instance about

- what theories and other knowledge would be crucial or useful
- how to approach my research areas (e.g., in terms of methodologies)
- what kind of good examples of related (in terms of topics/methods and so on) research there exist
- how could I compose a coherent, practical, and lucrative research plan (scope, scheduling, publications, etc.) around (some of) my research areas
- perspectives and potentially related research areas that are not covered above.

KEY FACTORS TO IMPROVE LEARNING THROUGH FINDING DATA MINING, MACHINE LEARNING TO HIGHER EDUCATION DATA ANALYSIS

Davaasuren Nyamjav

Year of your doctoral studies: 2018

Your Affiliation: Hungary

Address Line 1: Olto Utca 12

City, State, Postcode, Country: Budapest 1108, Hungary

Email address: davaa.mgl@gmail.com

Biography

- I'm currently doctorate student in ELTE, Eötvös Loránd University. I enrolled the doctoral program September 2018. I'm a native Mongolian, and I have my bachelor degree in Math and Informatics at Mongolian National University of Education. From 2000 until 2004, I had been worked as teaching assistant in Mongolian National University.
- I earned my master degree in Computer Science at Pacific States University in 2008 in Los Angeles, California, USA. I worked in The Holmangroup, behavioral health care company based in Los Angeles, as web and report developer between 2008 and 2014.
- After returning to my home country, I worked as lecturer in Mongolian National University of Education for IT courses.

I'm planning my doctoral study with 4 paces: literature review, needs of study, data analysis and solution or summary.

In the literature review, the research will focus on current trends in higher education institutions, the overview of educational data mining, e-learning analytics, artificial intelligence, and future of learning management systems.

Today, emerging technologies like artificial intelligence, data mining or big data analysis and machine learning are advancing at a rapid pace and theses technology becomes a part of everyday live ours. According to EDUCAUSE report, Nearly 9 in 10 jobs lost since 2000 were lost due to advancements in automation. World Economic Forum suggests that by 2025, more than half of workplaces tasks will be performed by a machine. Therefore, higher education institutes confront significant challenges in preparing students in the next generation of work-force. To address rapid changes, educational institutions must re-evaluate teaching methods and the curricula they offer. Artificial Intelligence, for instance, offers new possibilities for integration into existing curricula and contributing to student success.

The research is to make a collection, analysis, and reporting of large datasets related to learners, evaluating currently used learning management systems, comparative analysis between LMSs and find the factors in improvements. The application of technology-supported tools like virtual learning environments, learning management systems and online assessment has made it possible to continuously collect data about learners, their learning activities and behavior regarding preference of media, inquiry and queries, information search

and utilization processes, assessment, and achievement on various outcomes. For this reason, educational data mining techniques, artificial intelligence will be used to apply to statistics, visualization, classification, and clustering.

The result of the research will identifying key factors to improve learning, find key success factors for improving e-Learning systems, redesign LMS to implement key modifications and research purpose of e-learning.

Research area description

- Higher education institutes confront significant challenges in preparing students in the next generation of work-force. To address rapid changes, educational institutions must re-evaluate teaching methods and the curricula they offer.
- Artificial Intelligence and machine learning, for instance, offers new possibilities for integration into existing curricula and contributing to student success.
- The research is to make a collection, analysis, and reporting of large datasets related to learners, evaluating currently used learning management systems, comparative analysis between LMSs and find the factors in improvements.

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

- I'm planning my doctoral study with 4 paces: literature review, needs of study, data analysis and solution or summary. In the literature review, the research will focus on current trends in higher education institutions, the overview of educational data mining, e-learning analytics, artificial intelligence, and future of learning management systems.
- A sketch of the applied research methodology (data collection and analyzing methods)
- Expected achievements and possible evaluation metrics to establish the level of success of your results

Bibliographic References

Kozierkiewicz-Hetmańska, A., & Nguyen, N. (2011). A method for learning scenario determination and modification in intelligent tutoring systems. *International Journal of Applied Mathematics and Computer Science*, 21(1), 69-82. doi: 10.2478/v10006-011-0005-2

Expectations and motivation to attend Doctoral Consortium

My biggest expectation from this doctoral consortium is networking with many people who had a lot of experiences in many different areas or who are doing research in my interested research area. I hope I'll learn many others doctorate dissertation and research study and methods.

UNDERSTANDING OF STUDENTS' PERCEPTIONS ON THE EFFECT OF SOCIETAL INVOLVEMENT IN THEIR ENGINEERING EDUCATION

Pantzios Panagiotis

First (1st)

KTH, Royal Institute of Technology

Forskarbacken 9

Stockholm, 114 15, Sweden

Panoslk81@windowslive.com

Biography

I am a Doctoral Student at the Learning in Engineering Education unit in the Department of Learning in Engineering Sciences at KTH Royal Institute of Technology. I hold a 4 years' degree of Mechanical Engineering Educator from the School of Pedagogical and Technological Education. I am a qualified teacher in "Teknik"/Technology according to UHR in Sweden. Furthermore, I hold a Master of Education degree in Educational Sciences – Education with the use of New Technologies (ICT), with distinction "excellent", from the Department of Primary Education at University of the Aegean. Finally, I have a Master of Science degree in International and Comparative Education at Stockholm's University.

This doctoral position particularly caught my attention as it involves a qualitative study of different actors' views on the future of engineering, which would complement my previous knowledge and experience conducting research, supervision and teaching in higher education. My experience, as a lab. associate teacher at School of Pedagogical and Technological Education (ASPETE) in Greece for 4 years (2011-2014) where I taught the courses 'Pedagogical Applications with the use of ICT', 'Computers in Education', and 'Teaching Practice Placements', in teacher students engineering education program, will allow me to conduct a qualitative research for better development of engineering education.

I think this particular doctoral student-position can open up new lines of research for learning in engineering sciences and want to use it as the foundation for a fruitful research career. I am also interested in the wider development opportunities included in this PhD. My existing academic and professional work proves an ability to put forward ideas concisely and clearly. The analytical, critical and research skills I have honed throughout my master studies, as well as research and teaching experience in higher education, will provide a strong foundation to work closely and more effectively with the members of the research group at KTH. As a consequence will be the better development of engineering education internationally and locally. This fact will contribute to the qualitative upgrading of studies and research in the scientific community and society.

Spiratou, A., Pantzos, P. & Liakopoulos, T. (2012). From the self-activity project to pedagogic self-management of the school (in Greek). 2nd Scientific Conference SEP/ASPETE. Technological Developments and Teaching Applications to the Technological and Vocational Education. Innovative actions and prospects of the development. The Higher School of Pedagogical and Technological Education, Athens, 16-17 December 2012.

Pantzios, P. (2011). The transformative role of ICT in the "New" Technological High School (in Greek). 2nd Panhellenic Congress "Integration and Use of ICT in Educational Process"- Conference and Cultural Centre of

the University of Patras, Under the aegis of the Ministry of Education, Lifelong Learning and Religious Affairs. University of Patras, Patras, 28-30 April 2011.

Pantzios, P. & Karatzoglou, S. (2009). The Critical Pedagogy as a means of awakening the subjects of Technical and Vocational Education (in Greek). S.E.L.E.T.E. - ASPETE 1959 - 2009, Teacher Education of Secondary Vocational and Technological Education in Greece. The Higher School of Pedagogical and Technological Education, Athens, 11-12 December 2009.

Pantzios, P. & Papantonakis, G. (2008). Teaching Mathematics through Children's Literature and use New Technologies (in Greek). H' Panhellenic Conference, University of Athens, Department of Primary Education-Mathematics & Humanities. National and Kapodistrian University of Athens, Athens, 6-8 November 2008.

Introduction

How will we educate engineers who can take on our future challenges? This question has been raised globally as a number of reports have shown that nowadays engineering education does not deliver the engineers that the employers will need tomorrow (Royal Academy, 2007; Graham, 2018). Different actors also claim that there is a growing gap between education and societal needs. Society demands engineers to become capable of co-creating a sustainable society. In addition, industry demands engineers with experience in project management with ability to learn and adapt quickly, as career paths will change more rapidly (Hadgraft, 2017; OECD, 2017). Furthermore, digitalisation, increased system understanding and processing skills are other integral parts of the fourth industrial revolution (Schwab, 2016). In order to fill this gap, it is often argued that society, most often industry, should be more involved in future engineering education. Already, there are examples of new engineering programs (Graham, 2018) where most of the educational activities in an engineering program are placed in industry instead of at a university campus. Another example of modern industry collaborations are the courses in the Global Development Hub (GDH) at KTH where industry challenges the students to solve open ended problems with a sustainability focus.

However, there is a lack of research on investigating the effects of this new approach for societal/industrial integration, or more common approaches of societal interventions such as visiting lectures, study visits, and thesis collaboration in engineering education. Therefore, this PhD project will focus on understanding students' perceptions of the effects of societal involvement in their engineering education. More specifically, the study will investigate the students' motivation for choosing to become an engineer, or/and for continuing their studies towards the end of the program. Moreover, the study will examine how their understanding for the professional role is developed through societal interventions.

Finally, an imminent hypothesis is that different activities might have different impact on students with different backgrounds. In this study, we will both explore the effect of a variety of evidence informed activities and the responses of students with different genders or with different national backgrounds.

Theoretical frameworks

This chapter describes the theoretical frameworks and the conceptual background within which this research will be placed.

This study will investigate the participants' beliefs on motivational factors affecting their interest for engineering and the engineering profession. Because of the nature of the research questions asked which aim to investigate students beliefs, a focus on qualitative research will be employed. Moreover, a qualitative

strategy engages education as an action that is constantly being adapted, measured, valued, negotiated, acting and changing. This procedure is common within education research (Woods, 1993).

According to Bryman (2016), an epistemological issue “concerns the question of what is (or should be) regarded as acceptable knowledge in a discipline” (p. 24) whilst questions of ontology are concerned with the assumptions and claims about the nature of social entities (Bryman, 2016, p. 28). This research will be a qualitative study of an interpretive nature, within selected theoretical frameworks. The researcher will allow participants to express their beliefs and assumptions in a way, where they will be reacting in the entire research procedure. Furthermore, the researcher will use interpretivism in order to analyze and compare the qualitative data based on the students’ perceptions and critically identify the way these students’ beliefs are shaping the motivational factors in engineering education. As a consequence, in this study abductive reasoning characterizes the use of theory. The selected theories will be used as the theoretical lenses which will help the researcher to understand and explain students’ perceptions about motivational factors affecting their engineering education after a societal/industry intervention.

One of the disadvantages of qualitative research is that findings cannot be generalized to a larger population. However, Herr and Anderson (2005) claimed that in order to increase the degree to which the findings can be applied to a larger population, or to achieve a study’s external validity, it is necessary to clearly define/explain the theory which permeates one’s research. However, depending on preliminary findings, quantitative data collection may become necessary and appropriate to support the generalisation of new results. Therefore, the study might consider a mixed method approach if this is seen to be appropriate.

Motivation and learning processes have a close relationship as motivation is a crucial factor that reinforces students’ determination to cope with the tough, challenging and problematic circumstances that arise throughout their education. In order to understand this relationship and phenomenon, a systematic literature review will be conducted. A systematic literature review attempts to “identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a given research question” (Cochrane definition, 2013). This review will emphasise on several motivational theories that are related to the learning in education. Afterwards, the most relevant theory/ies will be selected and it will consist as the main theoretical background of the study.

However, a quick review of the literature shows that intrinsic and extrinsic motivation theory (Ryan & Deci, 2000) and social cognitive theory (Bandura, 1989) can be used as the theoretical frameworks to this study and contribute to the findings in the learning process. According to Ryan & Deci (2000), intrinsic motivation describes an activity done only for own satisfaction without any external expectancy. Extrinsic motivation describes external influences such as a reward (Ryan & Deci, 2009; Legault, 2016; Deci & Ryan, 2016), punishment (Tohidi & Jabbari, 2012), and compulsion (Tohidi & Jabbari, 2012; Riaz, Rambli, Salleh & Mushtaq, 2010). In addition, social cognitive theory relegates the obtainment of knowledge by direct interaction, outside media and societal influence, observation, and interaction (Bandura, 2002). Social cognitive theory is indicated from constructing meaning and knowledge from the social affect. Furthermore, it describes the correlation between environment factors, behaviour, motivation, and personal factors (Bandura, 2002).

Research Methodology and design

In order to examine the students’ perceptions on the effect of societal involvement in their engineering education and gain a deep understanding of the motivation of students in engineering education, the researcher will primarily follow a qualitative research approach and conduct semi-structured interviews.

Interviews are a useful qualitative tool for getting direct responses from the students to get a better understanding of their beliefs, insights, and uncertainties on motivational factors affecting in their engineering education after a societal/industry intervention. For this reason, students who study, studied or/and will study at the KTH in Stockholm will be the interviewees for this project.

The design of the semi-structured interviews will include questions and sub-questions in thematic categories so that the research questions are covered (Bryman, 2016, p. 468). According to Bryman (2016) “what is crucial is that the questioning allows interviewers to glean research participants’ perspectives on their social world and that there is flexibility in the conduct of the interviews” (p. 469). The interview questionnaire will be built on key areas regarding the research questions in order to gather data for every key area separately, which aims to get a deeper understanding of the interviewees’ perceptions depending on the different sub-group.

Sampling design and selection process

Based on the characteristics of qualitative research (Bryman, 2016, p. 407; Cohen, et al., 2007, p. 114), purposive sampling will be used in this study. The researcher will not look to sample participants of the study in a random way. The aim of purposive sampling is to sample participants in a strategic method, with regards to the aims, the research questions, and the objectives that have been addressed (Bryman, 2016, p. 408). In this technique, the researcher will build up a sample that is meeting the specific research needs (Cohen, Manion & Morrison, 2007, p. 115). The interviewees will be students who study, studied or/and will study at the KTH in Stockholm and who have already undergone a societal/industry intervention. However, there are certain limitations of the sampling process, such as the challenge to find students willing to be interviewed, the difficulty to meet all the criteria of the chosen participants that the research will require, and the amount of time. In the event of these limitations occurring, specific decisions will be made concerning the data collection process and the analysis of data.

According to Bryman (2016), the sampling of contexts and sampling of participants will need to be taken into consideration (p. 409). In this study, the sampling of context may regard the below sample spectrum:

1. High school students visiting Vetenskapens Hus House of Science / participating in experiments designed by industry.
2. Students participating in Tekniksprånget - a project for 19-24 year old persons before they start at university
3. Students that participate in challenge driven education (CDE) courses
4. Students at bachelor level at KTH to examine their involvement in experiments, study visits and lectures
5. Students at master level at KTH to examine their involvement in these projects and internships

The participants in this research will be chosen based on criteria ensuring that they belong in one of the above sampling contexts and have already engaged with a societal/industry intervention.

Given the limitations and delimitations of the study, approximately 30-40 interviewees are expected to be required so that the research can be feasible. However, should theoretical saturation not be met with these participants, additional participants may need to be sought.

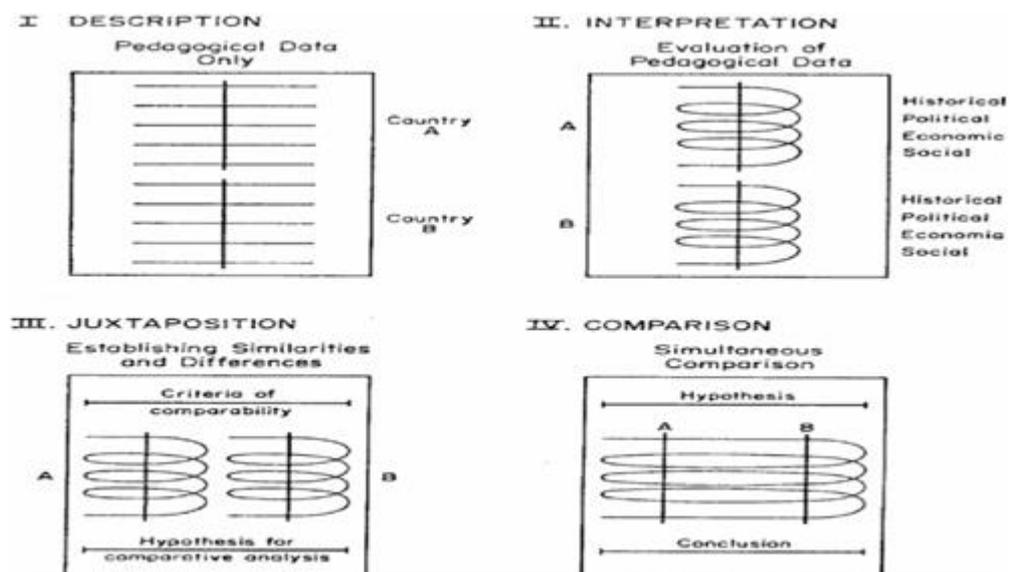
Data collection methods

Data will be collected using open-ended questions in a semi-structured interview approach corresponding to the qualitative character of this research in order to reveal the individual perceptions on motivational factors affecting students' engineering identity after a societal/industry intervention. The interviews will be flexible, lasting approximately 45 to 60 minutes. The students will be interviewed in English or in Swedish. Interviews will be recorded using digital tools such as voice recorder mobile phone applications or voice recorder cameras and the collected data will be transcribed and analysed thematically using qualitative data analysis software such as NVivo.

Data analysis

A thematic analysis approach will be employed (Bryman, 2016). The researcher will look inductively for emerging and compatible themes, which are primarily related to the research questions, however due to the inductive nature of the analysis, additional themes may emerge. Additionally, themes will be built on codes identified in field notes or/and transcripts of interviews (Bryman, 2016, p. 584). Ryan and Bernard recommended that when searching for themes in the transcripts, the researcher should mainly look for repetitions, similarities and differences, theory-related material and missing data (as cited in Bryman, 2016, p. 586). However, any issues in the transcripts and discrepancies must be checked before coding (Bryman, 2016, pp. 584-588). According to Bryman (2016), a theme can "provide the researcher with the basis for a theoretical understanding of his data that can make a theoretical contribution to the literature relating to the research focus" (p. 584). Finally, the researcher will create a chart of key themes and subthemes for the interviews.

Afterwards, differences and similarities will be determined and the empirical data will be compared simultaneously. For example, divergences and convergences among students with different ethnic background or different gender will be identified. The researcher will use the Bereday's (1964) approach of comparative analysis (Figure 1), consisting of description, interpretation, juxtaposition, and simultaneous comparison (Bray, et al., 2014, pp. 86-87).



Source: Bereday (1964), p. 28.

Figure 1. The Framework approach to comparative analysis

In conclusion, it is important to highlight that throughout the qualitative research analysis, the researcher will apply the selected theoretical framework of the study in order to explore and identify the perceptions that will be drawn from the data.

Trustworthiness criteria

In order to establish and assess the quality of qualitative research, alternative terms to reliability and validity (from quantitative research) must be specified. Guba and Lincoln proposed that there are two basic criteria for assessing a qualitative study: trustworthiness (credibility, transferability, dependability, and confirmability) and authenticity (as cited in Bryman, 2016, p. 384). All data collection and analysis methods will be underpinning by these two criteria.

Ethical considerations

Bryman (2016) argued that “the ethical issues that arise in the course of doing research are the ones that are most likely to impinge on students” (p. 123). The researcher will take into consideration ethical considerations during the research process in order to ensure anonymity and confidentiality of participants (Bryman, 2016, p. 133).

Research area description

This study seeks to develop an understanding of students’ perceptions on the effect of societal involvement in their engineering education. The overall aim is to gain a deeper understanding of the motivation of students in engineering education. Additionally, the purpose of this study is to investigate factors which influence how engineering students are motivated and the extent, if any, to which motivation can be nurtured by societal/industry intervention. This research also focuses on the impact of different societal interventions for students of different background with a specific focus on gender and ethnic background. The objectives to reach the aims of this study are as follows:

Objectives

- To identify and analyze students’ opinions on the effect of societal involvement during their studies in engineering education;
- To understand how societal/industry interventions may enhance students’ motivation in engineering education;
- To examine, identify and analyse motivational factors to determine to what extent they are affected by societal/industrial interventions in the context of engineering education;
- To discuss similarities and discrepancies among students’ perceptions, with different gender and ethnic background, which are caused by intervened motivational factors.

Research questions

- What are students’ perceptions of the effect of societal involvement during their studies in engineering education?
- What kind of societal/industry activities can strengthen and develop engineering students’ motivation?
- How do these societal/industry activities impact on students’ motivation in engineering education?
- Which are the motivational factors that influence students’ perceptions of engineering education when society/industry intervenes to them?

- How do these activities help to align engineering education and social reality?
- What are the similarities and the differences among perceptions of students with different ethnic backgrounds or different genders regarding intervened motivational factors?

The purpose of this study is to investigate factors which influence how students studying engineering education are motivated towards becoming an engineer, and to what extent, if any, motivation can be fostered by societal/industrial interventions.

The long-term goal of the study is to enhance education, in particular engineering education, in order to provide the best preconditions for becoming a future engineer. If a change in motivation for engineering can be observed in the analysis, then pedagogical or/and societal interventions may be designed to harmonize with the findings in order to enhance students motivation and thereby their learning experiences. This will hopefully increase the number of students entering engineering education programs as well as improving student fulfilment and preventing high drop-out rates.

The majority of studies on motivation have been conducted in primary and secondary schooling or in social science education (Leo & Galloway, 1996; Jacobs & Newstead, 2000), and, therefore, there is a demand for this research within engineering education. Identifying and understanding the students' perceptions of engineering education is essential as this knowledge can provide guidance for enhancing learning in engineering education (Schoepp, 2005, p. 2) and encourage more people to study engineering. There is a substantial amount of studies within engineering education that have focused on students' attraction and basically attempt to identify ways to prevent high drop-out rates through mainly new pedagogical interventions. However, there have been little to no studies within engineering higher education investigating the effect societal/industry interventions.

The lack of empirical studies makes this research remarkable and important for engineering education. Research on the motivational factors affecting engineering students and critical examination of societal/industry interventions will be important because of the challenges that are faced by the academic community. Students' perceptions are fundamental for understanding how to develop good engineering education. This research will not only give implications for students, but for many actors and stakeholders, such as empowered citizens, teachers and academic professors, educational authorities, curriculum/courses designers, policymakers, and critical researchers as they may find valuable knowledge and insights into students' experiences, theories-approaches, and conceptions about the motivation of students in engineering education.

Bibliographic References

1. Bandura, A. (1989). Human agency in social cognitive theory. *American psychologist*, 44, 9, p. 1175.
2. Bandura, A. (2002). Social cognitive theory of mass communication. In J. Bryant & M. B. Oliver (Eds.), *Media Effects: Advances in Theory and Research*, New York, NY: Routledge, pp. 94-124.
3. Bray, M., Adamson, B., & Mason, M. (Eds.) (2014). *Comparative Education Research: Approaches and Methods*. Second Edition. Hong Kong: Comparative Education Research Centre, University of Hong Kong and Dordrecht: Springer.
4. Bryman, A. (2016). *Social Research Methods*, (6th Ed.). New York: Oxford University Press.

5. Cohen, L., Manion, L. & Morrison, K. (2007). *Research methods in education* (6th ed.), London: Routledge.
6. Cochrane definition, (2013). *Systematic Literature review*. It retrieved from <http://sites.cardiff.ac.uk/curesmed/files/2014/10/NSAMR-Systematic-Review.pdf> on 21.10.2018.
7. Deci, E.L. & Ryan, R.M. (2016). *Optimizing students' motivation in the era of testing and pressure: A self-determination theory perspective*. Springer Singapore, pp. 9-29.
8. Graham, R. (2018). *The global state of the art in engineering education*. Retrieved from: <https://jwel.mit.edu/assets/document/global-state-art-engineering-education>
9. Hadgraft, R. (2017). *Transforming Engineering Education: DESIGN must be the Core*. Paper presented at the SEFI Annual Conference 2017, Azores.
10. Herr, K. & Anderson, G.L. (2005). *The action research dissertation*. Thousand Oaks, CA: Sage Publication.
11. Jacobs, P.A. and Newstead, S.E. (2000). *The nature and development of student motivation*. *British Journal of Educational Psychology*, 70 (2), pp. 243-254.
12. Legault, L. (2016). *Intrinsic and Extrinsic Motivation*. Springer International Publishing AG, pp. 1-4.
13. Leo, E.L. and Galloway, D. (1996). *Evaluating research on motivation: generating more heat than light?* *Evaluation and Research in Education*, 10 (1), pp. 35-47.
14. OECD, (2017). *Meeting of the OECD Council at Ministerial Level Paris, 7-8 June. ENABLING THE NEXT PRODUCTION REVOLUTION: A SUMMARY OF MAIN MESSAGES AND POLICY LESSONS*. Retrieved from Paris, 7-8 June 2017.
15. Pantzos, P. (2017). *The barriers and needs of IB PYP teachers in their efforts to integrate ICT in teaching and learning, A Comparative Case Study between Sweden and Greece*, Assignment for the course, *Introduction to Educational Research Methods*, IPA431.
16. Piper, R. (2013). *How to write a systematic literature review: a guide for medical students*. It retrieved from <http://sites.cardiff.ac.uk/curesmed/files/2014/10/NSAMR-Systematic-Review.pdf> on 21.10.2018.
17. Riaz, S., Rambli, D.R.A., Salleh, R. & Mushtaq, A. (2010). *Study to Investigate Learning Motivation Factors within Formal and Informal Learning Environments and their influence upon Web-Based Learning*, *iJET*, 5, 4, pp. 41-50.
18. Royal Academy of Engineering, (2007). *Educating Engineers for the 21st Century*. It retrieved from http://www.raeng.org.uk/news/publications/list/reports/Educating_Engineers_21st_Century.pdf
19. Ryan, R.M. & Deci, E.L. (2000). *Intrinsic and extrinsic motivations: Classic definitions and new directions*, *Contemporary educational psychology*, 25,1, pp. 54-67.
20. Schoepp, K (2005). *Barriers to technology integration in a technology-rich environment*. *Learning and Teaching in Higher Education: Gulf Perspectives*, 2(1), pp. 1-24.

21. Schwab, K. (2016). *The Fourth Industrial Revolution*, Geneva: World Economic Forum.
22. Tohidi, H. & Jabbari, M.M. (2012). The effects of motivation in education, *Procedia-Social and Behavioral Sciences*, 31, pp. 820-824.
23. Woods, P. (1993). *Critical Events in Teaching and Learning*. London: Falmer Press.

Expectations and motivation to attend Doctoral Consortium

Support networking with other researchers in the informatics engineering education research field, and promote the development of a supportive community of scholars and a spirit of collaborative research. Furthermore, support a new generation of researchers with information and advice on research and academic career paths.

APPLICATION OF THE REFERENCE MODEL FOR SECURITY RISK MANAGEMENT IN THE INTERNET OF THINGS SYSTEMS

Raimundas Savukynas

Third year doctoral student

VU Institute of Data Science and Digital Technologies

Cyber-Social Systems Engineering Group

Akademijos str. 4, LT-08412 Vilnius, Lithuania

raimundas.savukynas@mii.vu.lt

Supervisor dr. Virginijus Marcinkevičius

Consultant prof. dr. Albertas Čaplinskas

Biography

I am a doctoral student in the Group of Cyber-Social Systems Engineering at the Institute of Data Science and Digital Technologies, which is part of Vilnius University (Lithuania). I studied a program of information system software engineering and got a master degree in Vilnius Gediminas Technical University. I started PhD studies at the Vilnius University two years ago and focus on my research about security risk management in the internet of things systems. I'm giving lectures on Software Engineering, Systems Theory and Information Security at Vilnius Gediminas Technical University. My research interests focus on advanced database systems, business process engineering, intelligent information systems, social computing technologies, software systems engineering, security, and safety management.

Publications:

1. Savukynas, R.; Marcinkevičius, V.; Čaplinskas, A. (2016). A Review of Infrastructures of Internet of Things for Smart Enviroments, *Proceedings of the 8th International Workshop on Data Analysis Methods for Software Systems (DAMSS)*, Druskininkai, Lithuania, December 1-3, 19-20. ISBN: 978-9986-680-58-1. doi: 10.15388/DAMSS.2016.
2. Savukynas, R.; Marcinkevičius, V. (2017). Comparison of Methods for Identifying Objects of Internet of Things, *Journal of Information Sciences* 78(4), 66-82. ISSN 1392-0561. doi: 10.15388/Im.2017.78.10835.
3. Savukynas, R.; Marcinkevičius, V.; Dzemydienė, D. (2017). A Research on Safety Methods of Communication Protocols of Internet of Things, *Proceedings of the 9th International Workshop on Data Analysis Methods for Software Systems (DAMSS)*, Druskininkai, Lithuania, November 30 - December 2, 42-43. ISBN: 978-9986-680-64-2. doi: 10.15388/DAMSS.2017.
4. Savukynas, R.; Marcinkevičius, V. (2018). Blockchain Technology for Security and Privacy in Internet of Things, *Proceedings of the 10th International Workshop on Data Analysis Methods for Software Systems (DAMSS)*, Druskininkai, Lithuania, November 29 - December 1, 34-35. ISBN: 978-609-07-0043-3. doi: 10.15388/DAMSS.2018.1.
5. Savukynas, R.; Dzemydienė, V. (2018). Security Means in Multilayered Architecture of Internet of Things for Secure Communication and Data Transmission, *Proceedings of Baltic DB&IS 2018 Conference Forum and Doctoral Consortium co-located with the 13th International Baltic Conference on Databases and Information Systems (Baltic DB&IS 2018)*, Trakai, Lithuania, July 1-4, 127-134. ISSN 1613-0073.

6. Savukynas, R.; Marcinkevičius, V. (2018). A Review of Security and Privacy Issues in Multilayered Architecture of the Internet of Things, *Baltic Journal of Modern Computing* 6(4), 1-18. ISSN 2255-8950.

Research area description

Internet of Things (IoT) is a network of connected devices and systems to exchange or accumulate data and information generated by users of embedded sensors in the physical objects. Among the privacy, energy awareness, environment, and other concerns, security plays an important role, as the potentially sensitive data is sent among the devices and multiple users. In cases where such data is intercepted and used for non-intended purposes, it may lead to the damages of the valuable system and/or environmental assets. There exist a number of surveys related to the IoT security [6], security of the IoT frameworks [11], or specific components of the IoT systems [7]. However, they lack a systematic approach to manage IoT security risks and reason about the introduced security countermeasures.

The aim of the research is to propose an initial comprehensive reference model for security risks management to the information and data assets, managed and controlled in the connected vehicle system.

Few studies have reported on the IoT security. Most of them focus on the security risks and threats of the IoT. For instance, Basu *et al.* [1] discusses the IoT application design and security challenges. These include the following properties: heterogeneity, interoperability, connectivity, mobility, scalability, addressing, identification, spatiotemporal services, resource constraints, and data interchange. The study characterises security threats such as spoofing, tampering, repudiation, information leakage, elevation of privilege, user privacy, replay attacks and cloning of nodes. Some security framework is proposed to mitigate them. Elsewhere in [2] Benabdessalem *et al.* explores different methods to address security and privacy requirements (e.g., confidentiality, authentication, integrity, authorization, non-repudiation, and availability) in the IoT systems. The study discusses eavesdropping and denial of service attacks and proposes encryption, hash and digital signature to secure data communication between the IoT devices. In [3] Fink *et al.* discusses vulnerabilities of the IoT systems and highlight importance of the privacy and security standards. More specifically it focuses on crime, emergent behavior, scientific and technological, social and regulatory challenges was made. In [4], Hossain *et al.* reports on a series of new security and privacy challenges regarding secrecy, confidentiality, data integrity, and authentication access control in the IoT systems. The study discusses some IoT architecture and interoperability between interconnected networks, security problems and attacks mitigation strategies. Elsewhere in [11], Qiang *et al.* consider the privacy protection, wireless communication, and information security. Authors propose a new IoT security method for processing of the massive amount of data, and for ensuring security and reliability. In [5] Jing *et al.* classifies security concerns to different levels of abstraction. Specifically, it focuses on the radio frequency identification, wireless sensor network, robust security network technology and proposes solutions to secure them. Similarly, in [8], Mahmoud *et al.* analyzes the general and specific IoT security challenges at different layers of the IoT architecture. On one hand, technological (e.g., wireless communication) challenges include maintenance of scalability and low consumption of energy. On another hand security challenges are confidentiality, authentication, and integrity. The study reports on the attacks in the perception (e.g., replay attacks, timing, and node capture attacks) and network (e.g., man-in-the-middle attack) layers. Elsewhere, in [9], Matharu *et al.* describes the IoT architecture consisting of four layers. The authors highlight the importance of the IoT connectivity robustness, interoperability, and standardisation (especially regarding identity management, safety, and security of objects, data confidentiality, and encryption). In [12], Suo *et al.* also discusses the security architecture, features, and requirements at different layers of the IoT system. Hence the authors focus on the key agreement, identity

authentication, cloud computing, and authentication at the perceptual, network, support, and application layers. Zhao and Ge, in [13], proposes a three-layer IoT system structure. Hence the study investigates how security threats (e.g., node capture, fake node, malicious data, replay attack, and routing threats) could be performed. The cryptographic algorithms and key management techniques were deployed in order to mitigate those attacks. The compatibility and cluster security problems were resolved using a key agreement mechanism. Although all above studies suggest different IoT security architectures consider various security risks and suggest countermeasures to mitigate them, the state of the art does not suggest a systematic approach for security risk management. In this research illustrate how IoT reference model for security risk management could help to explain security risks.

The information systems security risk management (ISSRM) domain model in Figure 1 suggests three conceptual pillars to explain *secure assets*, *security risks* and their *countermeasures* [10]. Here, the *business asset* is understood in terms of the information, data and processes, which bring value to the organisation. Business assets are supported by the *system assets*. *Security criteria* are the constraints of the business assets and define the security needs. *Security risk* is defined as a combination of the *event* and *impact*. Here, *impact* negates the security criterion and harms at least two assets. Event is defined in terms of *threat* and *vulnerability*. A *vulnerability* is a characteristic of the system assets and it constitutes a weakness of this asset. A *threat* targets the systems assets by exploiting its vulnerability. Threat is defines as combination of the *threat agent*, an active entity who has interest to harm the assets, and the *attack method*, the means used to carry on the threat. Security risk treatment concepts include risk treatment decision, security requirements, and controls. *Security risk treatment* is a decision to treat the identified risk. It is refined to the *security requirements*, which define the condition to be reached by mitigating. Finally the *controls* implement the defined security requirements.

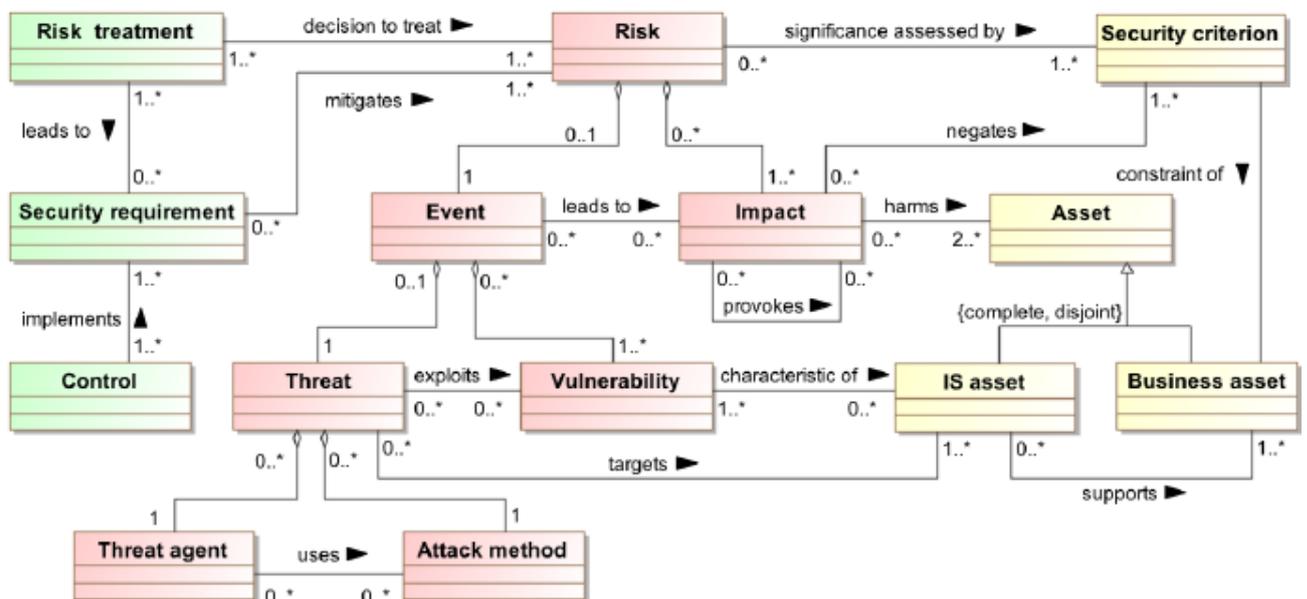


Figure 1. The ISSRM domain model, adapted from [10]

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

Current status of the research plan:

1. Perform a scientific research:
 - 1.1. Create a research methodology.
 - 1.1.1. Formulate problems for experimental and analytical researches.

- 1.1.2. Describe the tasks designed to solve the established problems.
- 1.1.3. Choose the research methodology to solve the intended tasks.
- 1.1.4. Develop a theoretical and empirical research plan according to the chosen methodology.

A sketch of the applied research methodology (Figure 2):

1. Specification of the IoT requirements and model formation.
 - 1.1. Specification of the IoT requirements.
 - 1.2. Specification of the IoT safety requirements and model.
 - 1.3. Specification of the IoT energy consumption requirements and model.
2. Selection and implementation of the IoT framework.
 - 2.1. Transformation of model requirements into the framework specification language.
 - 2.2. Aggregation object requirements framework into the specification language.

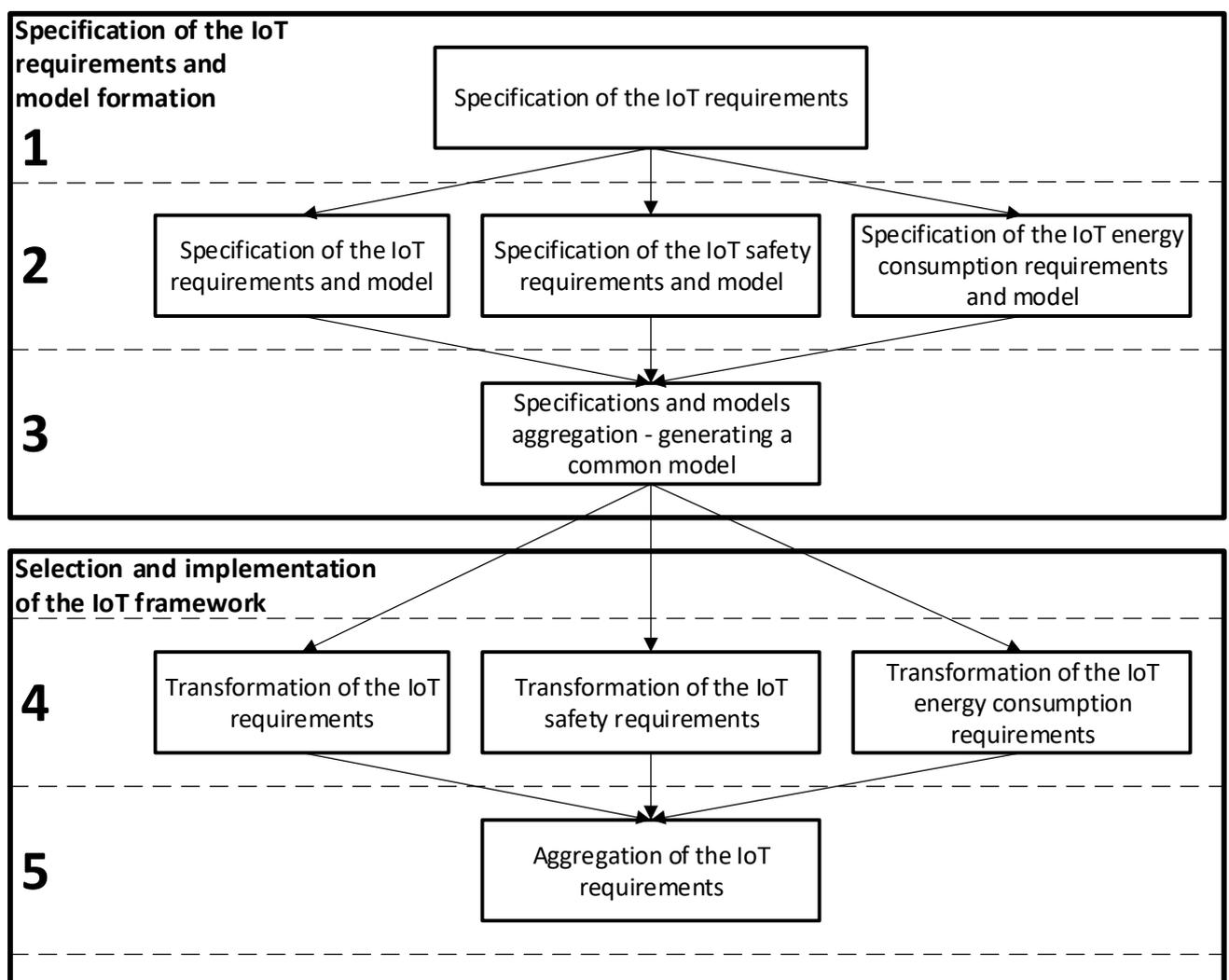


Figure 2. Research methodology

Expected achievements and possible evaluation metrics to establish the level of success of your results are to apply the reference model to explain analyses of the security risks for the connected vehicle. The application

of the reference model shows that it contains a few limitations. Firstly, it basically covers the system assets and their vulnerabilities but leaves the analysis of business assets and their security criteria aside. Regarding the security risk analysis, the reference model concentrates on the vulnerabilities. The analysis is needed to highlight the profile of the threat agents, her attack method, as well as the impacts on the IoT system and business assets. On the system countermeasure side, need to make an assumption that to treat the IoT security risk one takes risk reduction decision. However, it is also important to understand consequences of treatment decision, differentiate between the security requirements and controls. This concern requires further analysis.

Bibliographic References

1. Basu, S. S., Tripathy, S., Chowdhury, A. R. (2015). Design Challenges and Security Issues in the Internet of Things. In: *Proceedings of the IEEE Region 10 Symposium (TENSymp)*, Ahmedabad, India, May 13-15, 90-93.
2. Benabdessalem, R., Hamdi, M., Kim, T. H. A Survey on Security Models, Techniques, and Tools for the Internet of Things. In: *Proceedings of the 7th International Conference on Advanced Software Engineering and Its Applications (ASEA)*, Haikou, China, December 20-23, 2014, 44-48.
3. Fink, G. A., Zarhitsky, D. V., Carroll, T. E., Farquhar, E. D. (2015). Security and Privacy Grand Challenges for the Internet of Things. In: *Proceedings of the International Conference on Collaboration Technologies and Systems (CTS)*, Atlanta, GA, USA, June 1-5, 27-34.
4. Hossain, M. M., Fotouhi, M., Hasan, R. (2015). Towards an Analysis of Security Issues, Challenges, and Open Problems in the Internet of Things. In: *Proceedings of the 11th IEEE World Congress on Services*, New York, NY, USA, June 27-July 2, 21-28.
5. Jing, Q., Vasilakos, A. V., Wan, J., Lu, J., Qiu, D. (2014). Security of the Internet of Things: Perspectives and Challenges, *International Journal of Wireless Networks* 20(8), 1-30.
6. Khan, R., Khan, S. U., Zaheer, R., Khan, S. (2012). Future Internet: The Internet of Things Architecture, Possible Applications and Key Challenges. In: *Proceedings of the 10th International Conference on Frontiers of Information Technology*, Islamabad, India, December 17-18, 257-260.
7. Kim, H., Wasicek, A., Mehne, B., Lee, E. A. (2016). A Secure Network Architecture for the Internet of Things Based on Local Authorization Entities. In: *Proceedings of the 4th IEEE International Conference on Future Internet of Things and Cloud (FiCloud)*, Vienna, Austria, August 22-24, 114-122.
8. Mahmoud, R., Yousuf, T., Aloul, F., Zualkernan, I. (2015). Internet of Things (IoT) Security: Current Status, Challenges and Prospective Measures. In: *Proceedings of the 10th International Conference for Internet Technology and Secured Transactions (ICITST)*, London, UK, December 14-16, 336-341.
9. Matharu, G. S., Upadhyay, P., Chaudhary, L. (2014). The Internet of Things: Challenges and Security Issues. In: *Proceedings of the International Conference on Emerging Technologies (ICET)*, Islamabad, Pakistan, December 8-9, 54-59.
10. Patra, L., Rao, U. P. (2016). Internet of Things - Architecture, Applications, Security and Other Major Challenges. In: *Proceedings of the 3rd International Conference on Computing for Sustainable Global Development (INDIACom)*, India, March 16-18, 1201-1206.
11. Qiang, C., Quan, G., Yu, B., Yang, L. (2013). Research on Security Issues of the Internet of Things, *International Journal of Future Communication and Networking* 6(6), 1-10.
12. Suo, H., Wan, J., Zou, C., Liu, J. (2012). Security in the Internet of Things: A Review. In: *Proceedings of the International Conference on Computer Science and Electronics Engineering (ICCSEE)*, Hangzhou, China, March 23-25, 648-651.
13. Zhao, K., Ge, L. A Survey on the Internet of Things Security. In: *Proceedings of the 9th Conference on Computational Intelligence and Security (CIS)*, Leshan, China, December 14-15, 2013, 663-667.

Expectations and motivation to attend Doctoral Consortium

Doctoral Consortium is my opportunity to present my PhD thesis and to get ideas from others students working in the same field. I hope that presenting and discussing my PhD thesis during the Doctoral Consortium will help me to focus on what is need to improve in the research. My main motivation for attending the Doctoral Consortium is to discuss with senior researchers the contributions of my PhD and get a feedback on research. I think that the possibility to exchange my ideas with the other Doctoral Consortium student participants will also provide me with insight in their interesting works.

PREDICTIVE MODELS AS EARLY WARNING SYSTEMS TO PREDICT STUDENT ACADEMIC PERFORMANCE IN INTRODUCTORY PROGRAMMING

Ashok Kumar Veerasamy

PhD – 3rd year

Department of Future Technologies , University of Turku

Turku, Finland

askuve@utu.fi

Biography

Ashok Veerasamy hold Master of Philosophy in Computer Science, and Master of Computer Applications postgraduate degrees. Ashok Veerasamy has successfully completed the graduate certificate course in Tertiary Teaching and Learning (TTL), and Research Fundamentals course to conduct lecture and research in computer science/IT at RMIT University_Australia. He worked as an IT Lecturer cum Researcher at RMIT University-Vietnam for 6 years (from 2009 - 2015 January). At present, he is working as a researcher (VILLE Team Research group- from June 2015) and pursuing his PhD (from January 2016) at University of Turku, Finland.

As a researcher and doctoral student, Ashok Veerasamy has published a few research papers at national and international level conferences such as Nation's first science & Technology conference in the country of Papua New Guinea, Pre-ICIS conference (Paris: France), ISBEIA-2012 (IEEE-Indonesia) and ICEMI-2014 (Hong Kong). Furthermore, he has published FIVE research articles related to his PhD studies at journals. As his published research papers reveals, he has strong interest and progressive experience in doing research on computer science/IT education, learning analytics, and factors that impact learning outcomes of students.

Articles published during 3 years of studies

1. *The Impact of Lecture Attendance on Exams for Novice Programming Students*, Veerasamy, A. K., D'Souza D., Lindén R., Kaila E., Laakso M.-J., and Salakoski T. , International Journal of Modern Education and Computer Science (IJMECS), 05/2016, Volume 8, Issue 5, (2016)
2. *Identifying Novice Student Programming Misconceptions and Errors from Summative Assessments*, Veerasamy, A. K., D'Souza D., and Laakso M.-J. , Journal of Educational Technology Systems (ETS), 09/2016, Volume 45, Issue 1, (2016)
3. *Cultural Issues that Affect Computer Programming: A Study of Vietnamese in Higher Education*, Veerasamy, A. K., and Laakso M.-J. , Asian Journal of Education and E-Learning, 04/2016, Volume 4, Issue 2, (2016).
4. *The impact of prior programming knowledge on lecture attendance and final exam*, Veerasamy, A.K., Linden R., D'Souza D., and Laakso M.-J., Journal of Educational Computing Research, Volume 56, Issue 2, (2018).
5. *Relationship between perceived problem-solving skills and academic performance of novice learners in introductory programming courses*, Veerasamy, A.K., D.Souza D., Lindén R., and Laakso M.-J., Computer Assisted Learning Journal DOI: 10.1111/jcal.12326 (2018)

Research area description

Computer programming is fundamental to Computer Science and IT curricula. At the novice level it covers programming concepts that are essential for subsequent advanced programming courses. However, introductory programming courses are among the most challenging courses for novices and high failure and attrition rates continue even as computer science education has seen improvements in pedagogy **Invalid source specified**. In addition, “How to code a program in a computer language” presents various challenges and difficulties to students and teachers. Therefore, the pursuit of a better understanding of factors that influence student performance outcomes has long been one of the aims of both researchers and teachers in the computing education community. A number of studies have explored significant factors with the aim of developing predictive models for early prediction of student academic performance, in order to better support potentially at-risk students needing early intervention and assistance **Invalid source specified**. Furthermore, a variety of mathematical techniques such as classifiers and regression, have been employed in predictive modelling, including both traditional and modern data mining techniques. However, the predictor variables used in these various models, and the models themselves, varies from one context to another, with variations occurring in student cohort, cultural setting, class size and classroom and academic environments **Invalid source specified**. Moreover, many studies are in need of further verification due to inconsistencies in results obtained over a range of identified factors **Invalid source specified**.

Consequently, the quest to identify factors that affect student learning and academic performance in introductory computer programming courses has been a long-standing problem. The goal of this study is to develop validated predictive models with suitable predictors to predict student academic performance in introductory programming courses. The model utilises the machine learning techniques to analyse student data and is based on the principle of parsimony. Furthermore, an additional objective is to propose this validated predictive model(s) as an early warning system (EWS), to predict at-risk students early in the semester and, in turn, potentially to inform instructors and students for better interventions.

Problem statement

As stated before, identifying attributes that affect student learning and academic performance, and predicting students’ learning preferences in computer programming has been a long-standing problem. So, it is important to develop an effective model to predict student academic progress, and factors that influence students’ academic performance in learning programming. This study also focuses on developing and validating mathematical models that can be used as early warning systems to predict low performance students at early stage of the computer programming course.

The goals of the proposed research are as follows:

Identify and select suitable machine learning techniques to develop a predictive model(s) for programming courses in align with educational psychology/learning theories.

1. Develop and validate a predictive model using the educational data collected from programming courses to
 - a. Identify the factors that foster/influence student learning performance in programming.
 - b. Explore the course specific factors that influence student academic performance.
 - c. Predict low performance students at early stage of the course.

- d. Propose one of those developed models as early warning system.

Research questions

1. Which data mining algorithms to be used to identify the influential factors that affect student learning and academic progress based on available academic data?
2. Which machine learning algorithm based model(s) can be used to identify the factors that foster student's learning performance in computer programming course?
3. What combination of predictor/independent variables yields the highest prediction accuracy to predict student's academic performance?
4. What is the percentage of academically at-risk students that can be correctly identified by the model?
5. Is it possible to deploy the proposed model as an early warning system for educators to identify student that need assistance in introductory programming courses?

Significance of the study

This study will be a significant attempt in promoting the technology enhanced learning environment and students' personalized learning skills. The findings of this study will benefit to the society considering that computer programming courses play an important role in computer science and IT curriculum today. The greater demand for graduates with programming skills justifies the need for more effective life-changing teaching methods. The recommended approach derived from the results of this study can be applied at schools to train students better. Educators will be guided on what should be emphasized in the university curriculum to improve students' performance in computer programming courses.

The findings of this study will be helpful for educators, students and researchers in the following ways:

- Provide a model that predicts course specific factors that influence student's learning skills and academic performance- will help educators to redefine their teaching methods and strategies in teaching programming courses.
- Provide a process to design and create a prediction model that predicts at-risk students who may face academic difficulty at early stage of the course- will help educators to help them succeed.
- Provide suggestions to foster student learning skills, self-efficacy and increase in academic achievement based on the results of student's academic progress from the defined models.
- Expected results may help the researchers to uncover critical areas in the educational process that many researchers were not able to explore.
- These expected models may have implications like can be used for other courses to obtain similar goals.

Overall Framework

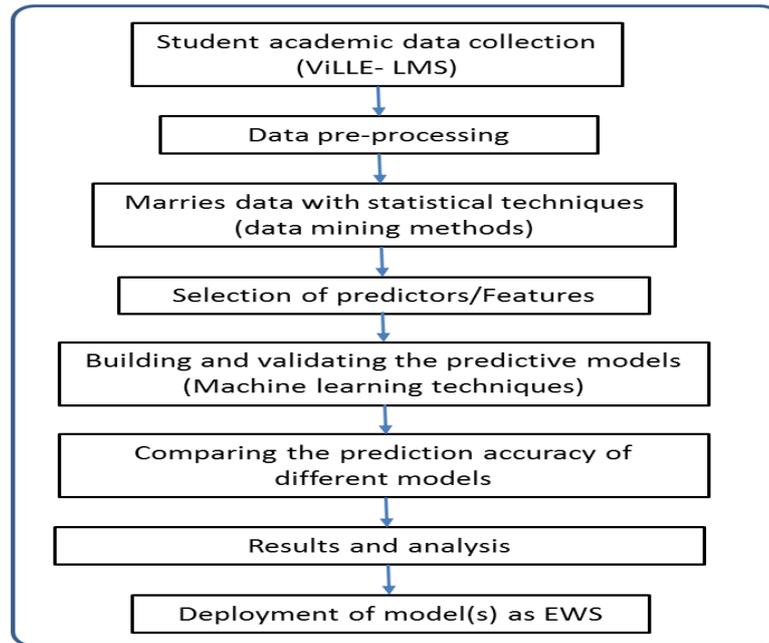


Figure 1. The modeling framework of this study.

This research is targeted towards undergraduate/graduate students that have taken / studied computer programming courses at University of Turku, Finland. Student academic data will be collected via ViLLE-learning management system / e-learning tool (LMS) based surveys, tutorial based learning, student response system, homework, demonstration, and mentoring session of specific programming courses. The collected will be preprocessed in order to apply data mining methods to find hidden patterns and information to uncover the answers for defined research questions. The modeling framework of this study is developed based on the review of past research studies, data mining techniques, student performance indicators and learning theories. Figure 1 shows the modeling framework.

Work performed

Semester	Year I - 2016	Year II - 2017	Year III - 2018	Year IV - 2019
Spring	<ul style="list-style-type: none"> Field of study agreed by Supervisor and UTU Setting schedule for supervisory meetings and progress reports literature review preparation <p>COMPLETED</p>	<ul style="list-style-type: none"> Submission of first year's research work to supervisor(s) for improvement Data collection Data preprocessing <p>COMPLETED</p>	<ul style="list-style-type: none"> Application of data mining and machine learning techniques for research question 3 Data collection Data preprocessing <p>COMPLETED</p>	<ul style="list-style-type: none"> Prepare a research article based on findings of research questions 4 & 5 and submit to Supervisor for amendment in March 2019. Final Research paper Submission in April 2019 Submission of all research
Autumn	<ul style="list-style-type: none"> Identification of data mining methods for research question 1 	<ul style="list-style-type: none"> Application of data mining methods for research questions 1 and 2 	<ul style="list-style-type: none"> Research paper - 3 publication Application of developed models by utilizing learning 	

	<ul style="list-style-type: none"> • Research paper publication <p>COMPLETED</p>	<ul style="list-style-type: none"> • Identification of machine learning algorithms for research question 2 • Submission of findings of 1 & 2 to Supervisor for amendment. • Research paper 2 publication <p>IN PROGRESS</p>	<p>analytics for research questions 4 and 5</p> <ul style="list-style-type: none"> • IN PROGRESS 	<p>findings to supervisor(s) for final amendment in order to proceed for thesis writing – from May 2019 onwards.</p> <ul style="list-style-type: none"> • Thesis write up and final procedure completed to defend PhD work (December 2019).
--	--	---	--	--

Bibliographic References

2. There are no sources in the current document.

Expectations and motivation to attend Doctoral Consortium

I strongly believe this consortium would give me an opportunity to present my research plans and preliminary results in order to get constructive feedback and suggestions from fellow and prominent researchers with substantial experience in the field to enhance my research work. In addition, I am interested to learn and discuss fellow researches' work in order to enhance my research skills.

APPLICATION OF WEB TECHNOLOGIES FOR PROGRAMMING EDUCATION

Márton Visnovitz

1st year PhD student

Eötvös Loránd University, Faculty of Informatics

Pázmány Péter sétány 1/C

Budapest, 1117, Hungary

visnovitz.marton@inf.elte.hu

Biography

Studies

- | | |
|------|--|
| 2017 | MA degree in Teacher Education (informatics, environmental science)
Eötvös Loránd University, Budapest, Hungary |
| 2014 | BSc degree in Computer Science
Eötvös Loránd University, Budapest, Hungary |

About

I am PhD student and an assistant lecturer at Eötvös Loránd University. While I mostly teach at university level, I have some experience in both secondary school and high school education. My passion has always been the teaching of programming and web technologies. In my PhD studies I am working on combining the two and try to successfully integrate web technologies into high school and university programming curricula.

Interests

- Web applications, Progressive Web Apps
- Canvas-based web programming education
- Simulations and basic games in programming education
- Functional programming in education

Publications

1. Visnovitz, M. (2017). Programozási tételek funkcionálisan [Fundamental Algorithms with Functional Programming]. In Proceedings: INFO DIDACT 2017, Zamárdi, Hungary
2. Horváth, Gy., Visnovitz, M. (2017). Egy bevezető webfejlesztési kurzus módszertani megfontolásai [Methodological Considerations of an Introductory Web Development Course]. In Proceedings: Informatika a felsőoktatásban 2017 [Informatics in Higher Education 2017], Debrecen, Hungary, University of Debrecen, Faculty of Informatics. p. 265- 274.

Relevant Conferences

1. CONSTRUCTIONISM 2018, Vilnius, Lithuania. Poster: The Web – A Platform for Creation
2. INFO DIDACT 2018, Zamárdi, Hungary. Presentation: Programozási tételek funkcionálisan [Fundamental Algorithms with Functional Programming]
3. DAMSS 2016, Druskininkai, Lithuania. Presentation: Aspects for Choosing Textual Programming Languages for High School Education

The aim of research

In my research I wish to investigate if it is possible to use web technologies to teach introductory programming in high school and university. Currently these technologies are usually treated as a separate subject and mostly viewed only from the point of the technology and not as an integral part in teaching programming. I wish to prove that the web can be an optimal platform to introduce programming to students.

Main research question: *Is it possible to utilize web technologies to support introductory programming?*

In the past several years script languages gained popularity in education, and some researchers started to investigate the possibility of using web as a programming platform for education using JavaScript and TypeScript as a programming language.

Proposed approach and achieved results

In the past I studied programming languages from an educational point of view and the result showed that script languages show great promise for educational use. As a web enthusiast I would like to prove that JavaScript (or TypeScript) can be used to realize the current Hungarian curriculum for high school and first year in university, then I wish to use the unique opportunities provided by the platform to improve upon the current methodologies in various ways:

- Create engaging programming activities for education using the web platform and constructionist approaches,
- Provide a transition from block-based programming (e.g. Scratch) to textual programming languages using the Canvas API of the web,
- Use a single programming language to introduce multiple programming concepts and paradigms instead of using 3-5 languages in the first year of university.

In 2018 we organised a summer camp for selected secondary and high school students where we used a constructionist approach of teaching programming using web technologies and canvas-based drawing. Based on the feedback provided by the pupils the method proved successful, although there are a lot of areas where I believe there is space for improvement. I wish to reflect on the experiences and feedback from the summer camp to improve the methods used.

Bibliographic References

6. Horváth, Gy., Menyhárt, L. (2014). Teaching introductory programming with JavaScript in higher education. In Proceedings: *Proceedings of the 9th International Conference on Applied Informatics*, Eger, Hungary. p. 339-350.
7. Horváth, Gy., Menyhárt, L., Zsakó, L. (2016). Viewpoints of programming didactics at a web game implementation. In Proceedings: *Proceedings of the XXIX. DidMatTech 2016 Conference*, Budapest, Hungary. Eötvös Loránd University, Faculty of Informatics.
8. Mahmoud, Q. H., Dobosiewicz, W., Swayne D. (2004). Redesigning Introductory Computer Programming with HTML, JavaScript, and Java. In Proceedings: *SIGCSE '04 Proceedings of the 35th SIGCSE technical symposium on Computer science education*, Norfolk, Virginia, USA, ACM SIGCSE Bulletin. p. 120-124.
9. Kruglyk, V., Lvov M. (2012). Choosing the First Educational Programming Language. In Proceedings: *Proceedings of the 8th Integration, Harmonization and International Conference on ICT in Education*, Kherson, Ukraine, p. 188-198.

Expectations and motivation to attend Doctoral Consortium

I wish to discuss my ideas with fellow PhD students and experts of the field of informatics and programming education. I'd like to get some ideas on what aspects of the field is worth delving into and what aspects do others feel important. My previous experience from the Consortium was very positive. Back then I was just a master's student and the Consortium inspired me to pursue the field of educational research. I hope that this year I will get further inspiration and ideas for my PhD topic.