Contemporary Didactics, Methods and Technologies of Teaching Programming Using Microlearning and Automated Source Code Evaluation

Preprints submitted to Springer

Estimated manuscript delivery date 31/12/2021

Eugenia Smyrnova-Trybulska, Piet Kommers, Ján Skalka, Martin Drlík

Erasmus+ FITPED
Work-Based Learning in Future IT Professionals Education
Project 2018-1-SK01-KA203-046382

Co-funded by the Erasmus+ Programme of the European Union

Preliminary Table of the Content

Title: "Microlearning: scientific, didactics, new methods, technologies approaches to content preparation and evaluation"
OR (Subtitle)
"Contemporary Didactics, Methods and Technologies of Teaching Programming Using Microlearning and Automated Source Code Evaluation"

Table of Contents

Jan Skalka Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 01 Nitra, Slovakia
jskalka@ukf.sk

Abstract. Writing the source code of programmes is currently one of the basic skills of a modern employee. Many support systems of various levels, content and quality have been created to support the teaching of programming. However, within educational environments, in combination with practical lessons, it has become an exciting tool for developing the idea of gamification in learning programming. The main aim of the article is to present architecture, current state and experience with the pilot deployment of virtual learning environment Priscilla, based on the conceptual framework for teaching and learning programming. This environment effectively combines contemporary promising educational approaches, including microlearning and automatically evaluated source codes (automated assessment). The balanced combination of these methods allows effectively managing the time required for learning theory, applying the obtain knowledge immediately, minimising the time for source code evaluation, and providing immediate feedback, which is essential for learning programming.

Keywords: programming learning, education environment, VLE, microlearning, automated assessment, Priscilla.

Olena Kuzminska National University of Life and Environmental Sciences of Ukraine, Faculty of Information Technologies, Kyiv, Ukraine o.kuzminska@nubip.edu.ua
Nataliia Morze Borys Grinchenko Kyiv University, Kyiv, Ukraine n.morze@kubg.edu.ua
Eugenia Smyrnova-Trybulska University of Silesia in Katowice, Faculty of Arts and Sciences of Education, Cieszyn, Poland, esmyrnova@us.edu.pl

Abstract. The article provides an overview of research sources on microlearning. Micro-learning is a modern educational trend, as the development of digital technologies and limitations, in particular caused by COVID-19, change the ways of effective learning and teaching. Emphasis is placed on the terms used to describe microlearning. Furthermore, various methods of bibliometric analysis and mapping of the science were used for the presentation. The dynamics of the frequency of the application of the query "microlearning" in search engines and the dynamics of publication activity on this concept in the databases Scopus and Web of Science Core Collection for the period 2010-2021 are determined. Based on selected publications with the help of VOSviewer, the terminological maps are constructed and their main points of intersection are revealed. The results of the study revealed a stable exploratory and scientific interest in the application and effective implementation of microlearning as an interdisciplinary study. Clear visualization of the obtained data made it possible to identify the main areas of research in micro-learning in the fields of technical, engineering and educational sciences. Moreover, microlearning as an educational technology is the least favorable term represented in the publication field, which can be considered as a promising area of further research.

Keywords: microlearning, review, bibliometric analysis, Bibliometric Science Mapping

Chapter (Article) 3: Guidance for Introductory Programming Courses Creation Using Microlearning and Automated Assessment

Jan Skalka, Lubomir Benko, Martin Drlik, Michal Munk, Peter Svec

Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 01 Nitra, Slovakia
jskalka@ukf.sk, lbenko@ukf.sk, mdrlik@ukf.sk, mmunk@ukf.sk, psvec@ukf.sk

Abstract. Learning programming is a very complex activity. Student must understand and master the way of thinking, which is often different from the thinking to which he is accustomed in everyday life. A virtual learning environment named Priscilla is based on an educational framework combining primary microlearning activities with an automatic evaluation of programs using automated assessment. The article presents the form and structure of the Java programming course, a pilot course for using the Pricilla system in teaching. This course was used in university education in the COVID pandemic period. The article aims to describe the results of the pilot deployment and, based on the experience and feedback from students, generalise the principles and rules of creating educational courses based on microlearning and automated assessment.

Keywords: programming learning, automated assessment, microlearning, Java, e-learning.

Chapter (Article) 4: "Learning by Designing, Imagination and Programming"

Piet Kommers, University of Twente, The Netherlands

Abstract

The FitPed Project focuses on students' efforts to acquire programming skills in order to become up-to-date professionals and become better life-long learners as well. The current chapter sketches the larger spectrum of learning/teaching paradigms in order to enable more flexible and effective didactic planning in diverse academic curricula. 'Active Learning' has been coined as one of the best striving to let students regain 'ownership' of their studying and cognitive development. Simulations, programming, gaming and storytelling are promising candidates for empowering the learning and increasing intrinsic motivation. The chapter will synthesize the various aspects of active learning like: Collaborative, Constructive, Authentic, Situational and Intentional Learning, in order to enable teachers to integrate these instructional ingredients for blended learning even after the Covid-19 era. Learning paradigms have shifted from cognitive acquisition into constructivist approaches, where the learner is encouraged to build more complex concepts from elementary primitives. In this evolution, programming experiences have an important generic role: Students from all major directions need to integrate their thinking in topics like: Algorithmic Thinking, Data Mining, Meta Data, Machine Learning, Deep Learning, Deep Fake, Analytics for Smart Environments, Privacy Issues, etc. For this goal, a basic programming education and experience is useful and necessary. This chapter will highlight how university curricula need to evolve and new teacher roles will develop as well. It will illustrate the transition from the current FitPed Project to its successor. Important additional notion is that the integration of Computer Science and Programming Courses need innovative didactic scenarios as well; Problem-based Learning and Challenge-based Learning are two of the most prominent candidates. After having read this chapter, you will be motivated and equipped to pro-actively design new ICT-oriented courses with your colleagues.

Keywords: Active-, Collaborative-, Constructive-, Authentic-, Situational- and Intentional- and Life-Long Learning, Simulations, Programming, Gaming and Storytelling.

Chapter (Article) 5: Micro-learning in improving professional competences of programmers - pilot studies

Anna Stolińska, Wojciech Baran, Josef Kapusta, Katarzyna Wójcik, Pedagogical University of Krakow, Institute of Computer Science, Poland

Abstract: In the world of dynamically developing technologies, constant improvement of professional competencies in IT department, in particular programmers. Learning to program is also an activity undertaken independently by adults who want to expand their professional competencies or make a change of profession. Learning to program can be done in different ways through different teaching methods. The article describes a pilot study in which an attempt was made to diagnose the scope of the use of micro-learning in the self-improvement of IT specialists' programming competencies and their possible interest in courses conducted in the micro-learning mode. 50 programmers coding in various languages and at various professional levels participated in the study. Based on the research results, it can be concluded that the knowledge of the issue of teaching with the use of small particles of knowledge is quite well known to programmers and, what is more, well assessed. This research shows that the courses can also be targeted at IT specialists - professionally active programmers.

Key words: microlearing, professional competencies, improvement of professional qualifications of programmers, programming course

Chapter (Article) 6: Modern educational methods based on Priscilla tools

Beata Zielosko, Małgorzata Przybyła-Kasperek, Kornel Chromiński, Arkadiusz Nowakowski, Eugenia Smyrnova-Trybulska, University of Silesia in Katowice, Poland

Abstract: The article describes an innovative teaching and learning active methods as flipped classroom model; Integrating a collaborative learning strategy; Problem-based learning, Jigsaw, STAD & TGT, Peer tutoring, Role-playing. Additionally will analyzed (e-)tutoring as an innovative method of personalized education; Differences and similarities between tutoring, mentoring and coaching; First meeting - setting goals and rules of meetings; Selected tutorial tools; Tutor circle; Table of values; Question matrix; SMART card Blended learning as one of the modern teaching methods that combines face-to-face learning and online learning. In the framework of FITPED project a platform Priscilla was created. It can be used as a platform, for e-learning classes concentrated around programming languages. The last chapter presents how virtual laboratory was created and tested and case study for using Priscilla in e-learning process for Python programming language.

Key words: Innovative teaching and learning active methods, Integrating collaborative learning strategies, blended learning, e-tutoring, Priscilla

Chapter (Article) 7: Priscilla Evaluation Pilot Study: A Rasch Measurement Analysis

Elspeth McKay, Keven Asquith, Cogniware, Melbourne, Australia, **Eugenia Smyrnova-Trybulska,** University of Silesia in Katowice, Poland

Abstract: Remote monitoring has taken prominence as hundreds of new opportunities flood the market to innovate business and household devices. On offer are efficient Web-based tracking and management tools as this digital transformation plays out. However, along with the alluring hype runs the stark reality, these digitised systems require experienced open-source scripting programmers to write the code. Priscilla emerges as a popular BETA home automation software environment with embedded routines for remote controlling of digital devices. A recent pilot study tested the Priscilla software programming tool's effectiveness, with 26-students given an online questionnaire with 27-questions, scored using a five-category Likert-scale. The data analysis used the Rasch measurement theory to examine the psychometric properties of the chosen Likert-scale. This pilot study's findings stand as an example of the importance of lessons learned to enhance the reliability of further work planned for examining the effectiveness of other such open-sourced programming language online courseware.

Key words: A Rasch Measurement Analysis, Priscilla, survey, microcources

Chapter (Article) 8: Microlearning formats in crisis? Theses in the field of tension between corona-induced short-term solutions, apodictic rhetorics of no alternatives and perspectives open to the future.

Theo Hug, Innsbruck University, Austria

Abstract: The article takes the corona-induced short-term solutions in education as an occasion for more fundamental questions about characteristics of current microlearning discourses. Starting from the historical, media and educational amnesia of these discourses as well as from the decreasing hype around microlearning, some desiderata are outlined in the form of theses. These concern the relevance of micro-, meso- and macro-structural interdependencies, the role of educational technology promises, the activities of the global education industry as well as the need for discussion regarding disposal-rationalistic tendencies and the limitations of datafication, AI applications and Big Data analyses. The suggested lack of alternatives for an innovation path on the part of industry and education policy is called into question.

Key words:

Chapter (Article) 9: A comprehensive discussion of emerging Automatic Programming Assessment in Learning Management Systems: the VPL example

Juan Carlos Rodríguez-del-Pino, Zenón José Hernández-Figueroa, María Dolores Afonso-Suárez, José Daniel González-Domínguez Universidad de Las Palmas de Gran Canaria, Spain

Department of Informatics and Systems, University of Las Palmas de Gran Canaria, 30, 35001 Las Palmas de Gran Canaria, Spain
jc.rodriguezdelpino@ulpgc.es, zenon.hernandez@ulpgc.es, marilola.afonso@ulpgc.es, josedaniel.gonzalez@ulpgc.es

Abstract:
Programming assessment is an especially costly task to develop in computer programming subjects, which are present in a wide variety of curricula, at all educational levels. This chapter introduces the currently more used approaches to Automatic Programming Assessment Systems (APAS) and their features. Starting with the explanation of these types of systems' design and the role of the actors involved; the core section focuses on Programming Assessment within Learning Management Systems (LMS); and finally, the adaptation of Unit Testing Frameworks to this ecosystem is shown, illustrated with the example of three different approaches: ProFormA, the Grenoble University Approach and the University of Las Palmas de Gran Canaria Approach.

Key words:
Automatic programming assessment, Programming assessment frameworks, Programming assessment, Computer-aided learning

Chapter (Article) 10: Database and SQL microlearning course

Authors: Pavel Turčínek, Radim Farana Mendel University in Brno, Czech Republic

radim.farana@mendelu.cz
pavel.turcinek@mendelu.cz

Abstract:
This contribution describes microlearning course Database and SQL. This course was created as a part of the international project Work-based Learning in Future IT Professionals (Grant. No. 2018-1-SK01-KA203-046382). The contribution focuses on a description of the content of the course and also analyzes how it was used by students of the course Database Systems and Database Design taught at Mendel University in Brno of summer semester 2020/2021.

Key words: Microlearning course, Database systems, SQL

Chapter (Article) 11: The Architecture of Visual Design in Modern Web Applications

David Sabol, Jan Skalka Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 01 Nitra, Slovakia david.sabol@student.ukf.sk, jskalka@ukf.sk

Abstract. The appearance of the application provides one of the first impressions that can engage the user and keep his interest. With many different applications with similar functionality, this element must not be underestimated during application development. Various procedures and methodologies are used to design applications. Many of them are relatively narrowly oriented and face various limitations when deploying them in complex web applications. The article describes selecting a suitable methodology, effective implementation, explanation of the critical points of the skinning process, and examples of skins for the day, night, and colour-blind mode created for the application. The basis of the proposed system skinning philosophy are techniques used for the organization and writing *CSS* code using the form of *ITCSS* methodology with *BEM* naming convention in combination with the capabilities of the *SASS* preprocessor. The article evaluated the implemented skinning philosophy, the visual design of the system, and the created skins. Subsequently, it presents the benefits of the proposed solution for the developers of similarly proposed applications. The application of defined procedures is described in a case study focused on skinning the web application Priscilla (https://priscilla.fitped.eu), a system focused on teaching and learning in programming for high schools and universities.

Keywords: skinning, theming, web application, user interface, front-end.

Chapter (Article) 12: Virtual Programming Lab For Moodle – Automatic Program Assessment in a First-year University Course

Juan Carlos Rodríguez-del-Pino, Zenón J. Hernández-Figueroa, José Daniel González Domínguez, Department of Informatics and Systems, University of Las Palmas de Gran Canaria, 30, 35001 Las Palmas de Gran Canaria, Spain jc.rodriguezdelpino@ulpgc.es, zenon.hernandez@ulpgc.es, josedaniel.gonzalez@ulpgc.es

Jan Skalka Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 01 Nitra, Slovakia jskalka@ukf.sk

Abstract. The ability to prepare algorithms to solve the problem and rewrite it into program code is one of the necessary skills in finding work in the IT sector. Automated assessment represents a tool that automatically checks source code and provides feedback at a level defined by the instrument or module, providing the automatic evaluation operation. The article aims to use the automated assessment tool in the university environment and evaluate its contribution by students. The research used the Virtual Programming Lab module for LMS Moodle (VPL) integrated into the university e-learning environment. The article describes VPL as a technological solution with its components and processes for running and evaluating student source code. The research was conducted through a questionnaire. The results show that students who are beginning to program perceive VPL and automated assessment as a very useful and effective tool for mastering programming.

Keywords: programming learning, virtual learning environment, automated assessment, LMS Moodle, Virtual Programming Lab.

Chapter (Article) 13: Evaluation of Primary School Mathematics Education: Applied Research Results

Viktor Gorokh, Ukrainian Center for Education Quality Assessment (UCEQA)
Liliia Hrynevych, Borys Grinchenko Kyiv University, 18/2 Bulvarno-Kudriavska Str, Kyiv, Ukraine, E-mail: liliia.hrynevych@gmail.com Phone: +380 50 373 6333 https://orcid.org/0000-0002-5818-8259

Eugenia Smyrnova-Trybulska, University of Silesia in Katowice, Poland, Faculty of Arts and Sciences of Education in Cieszyn, Bankowa 12, 40-007 Katowice, Poland. E-mail: esmyrnova@us.edu.pl Phone: +48 33 8546 135, mob.: +48 608 655 386
https://orcid.org/0000-0003-1227-014X
Vasyl Tereshchenko, **Tetiana Vakulenko**
Volodymyr Vynnychenka Str, Kyiv, Ukraine, E-mail: gorokh_v@ukr.net, syntva@gmail.com, vakulenko_tetyana@ukr.net
Phone: +38 066 191 20 84 https://orcid.org/0000-0001-9829-9343

Abstract: This paper discusses Ukrainian primary school students' learning outcomes in Mathematics, obtained from a study. The researchers' hypothesis is that the use of the methodological approaches providing meaningful mathematical activities for students, even in the initial stages promoted in the New Ukrainian School Reform (the NUS Reform) facilitates progress. The conclusions presented are based on the first cycle of the National Monitoring Study of the Quality of Primary Education. The authors believe that students' low performance in the External Independent Evaluation (EIE) in Mathematics at the final stage of compulsory secondary education partly results from ineffective primary education. The results also reveal an extensive gap between rural and urban students as well as small and large class sizes. The authors consider MSQPE results as base-line, allowing for tracking the differences in the students' performance while implementing the NUS Reform.

Keywords*:* mathematical competences, mathematics education, evaluation, External Independent Evaluation (EIE), Monitoring Study of the Quality of Primary Education (MSQPE)

Chapter (Article) 14: Microelerning as a research subject. Basic research problems

Jolanta Szulc
Institute of Culture Studies
University of Silesia in Katowice, Poland

Abstract
The aim of the article is to analyze the scientific literature on Microelerning, found in selected databases: ERIC, LISA, LISTA, Web of Science. Thematic and quantitative analysis of publications registered in Web of Science is part of this article. Particular attention was paid to such research problems as: didactics of microlearning, microlearning vs a new methods of teaching, content in microlearning. A summary is presented at the end of article.