

Transactions on Computational Science
and Computational Intelligence

Hamid R. Arabnia
Leonidas Deligiannidis
Fernando G. Tinetti
Quoc-Nam Tran *Editors*

Advances in Software Engineering, Education, and e-Learning

Proceedings from FECS'20, FCS'20,
SERP'20, and EEE'20

 Springer

Transactions on Computational Science and Computational Intelligence

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Preface

It gives us great pleasure to introduce this collection of papers that were presented at the following international conferences: Scientific Computing (CSC 2020); Parallel & Distributed Processing Techniques and Applications (PDPTA 2020); Modeling, Simulation & Visualization Methods (MSV 2020); and Grid, Cloud, & Cluster Computing (GCC 2020). These four conferences were held simultaneously (same location and dates) at Luxor Hotel (MGM Resorts International), Las Vegas, USA, July 27–30, 2020. This international event was held using a hybrid approach, that is, “in-person” and “virtual/online” presentations and discussions.

This book is composed of ten Parts. Parts I through IV (composed of 27 chapters) include articles that address various challenges in the area of scientific computing (CSC). Parts V through VII (composed of 31 chapters) include articles that discuss advances in the area of parallel and distributed processing (PDPTA). Recent progress in the fields of modeling, simulation, and visualization methods (MSV) appear in Parts VIII through IX (composed of 17 chapters). Lastly, Part V (composed of 10 chapters) presents advances in grid, cloud, and cluster computing (GCC).

An important mission of the World Congress in Computer Science, Computer Engineering, and Applied Computing, CSCE (a federated congress to which this event is affiliated with), includes “*Providing a unique platform for a diverse community of constituents composed of scholars, researchers, developers, educators, and practitioners. The Congress makes concerted effort to reach out to participants affiliated with diverse entities (such as: universities, institutions, corporations, government agencies, and research centers/labs) from all over the world. The congress also attempts to connect participants from institutions that have **teaching** as their main mission with those who are affiliated with institutions that have **research** as their main mission. The congress uses a quota system to achieve its institution and geography diversity objectives.*” By any definition of diversity, this congress is among the most diverse scientific meeting in the USA. We are proud to report that this federated congress had authors and participants from 54 different

nations representing variety of personal and scientific experiences that arise from differences in culture and values.

The program committees (refer to subsequent pages for the list of the members of committees) would like to thank all those who submitted papers for consideration. About 50% of the submissions were from outside the USA. Each submitted paper was peer reviewed by two experts in the field for originality, significance, clarity, impact, and soundness. In cases of contradictory recommendations, a member of the conference program committee was charged to make the final decision; often, this involved seeking help from additional referees. In addition, papers whose authors included a member of the conference program committee were evaluated using the double-blind review process. One exception to the above evaluation process was for papers that were submitted directly to chairs/organizers of pre-approved sessions/workshops; in these cases, the chairs/organizers were responsible for the evaluation of such submissions. The overall paper acceptance rate for regular papers was 20%; 18% of the remaining papers were accepted as short and/or poster papers.

We are grateful to the many colleagues who offered their services in preparing this book. In particular, we would like to thank the members of the Program Committees of individual research tracks as well as the members of the Steering Committees of CSC 2020, PDPTA 2020, MSV 2020, and GCC 2020; their names appear in the subsequent pages. We would also like to extend our appreciation to over 500 referees.

As sponsors-at-large, partners, and/or organizers, each of the followings (separated by semicolons) provided help for at least one research track: Computer Science Research, Education, and Applications (CSREA); US Chapter of World Academy of Science; American Council on Science and Education & Federated Research council; and Colorado Engineering Inc. In addition, a number of university faculty members and their staff, several publishers of computer science and computer engineering books and journals, chapters and/or task forces of computer science associations/organizations from three regions, and developers of high-performance machines and systems provided significant help in organizing the event as well as providing some resources. We are grateful to them all.

We express our gratitude to all authors of the articles published in this book and the speakers who delivered their research results at the congress. We would also like to thank the followings: UCMSS (Universal Conference Management Systems & Support, California, USA) for managing all aspects of the conference; Dr. Tim Field of APC for coordinating and managing the printing of the programs; the staff of Luxor Hotel (MGM Convention) for the professional service they provided; and Ashu M. G. Solo for his help in publicizing the congress. Last but not least, we would like to thank Ms. Mary James (Springer Senior Editor in New York) and Arun Pandian KJ (Springer Production Editor) for the excellent professional service they provided for this book project.

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Contents

Part I Curriculum Design, Academic Content, and Learning Objectives

Empirical Analysis of Strategies Employed Within an ICT Curriculum to Increase the Quantity of Graduates	3
Nicole Herbert, Erik Wapstra, David Herbert, Kristy de Salas, and Tina Acuña	
Incorporating Computer Programming into Mathematics Curricula to Enhance Learning for Low-Performing, Underserved Students	17
Alan Shaw and William Crombie	
Examining the Influence of Participating in a Cyber Defense Track on Students' Cybersecurity Knowledge, Awareness, and Career Choices	31
Michelle Peters, T. Andrew Yang, Wei Wei, Kewei Sha, and Sadegh Davari	
Team-Based Online Multidisciplinary Education on Big Data + High-Performance Computing + Atmospheric Sciences	43
Jianwu Wang, Matthias K. Gobbert, Zhibo Zhang, and Aryya Gangopadhyay	
Integrating the Development of Professional Skills Throughout an ICT Curriculum Improves a Graduate's Competency	55
Nicole Herbert, David Herbert, Erik Wapstra, Kristy de Salas, and Tina Acuña	
Preparing Computing Graduates for the Workplace: An Assessment of Relevance of Curricula to Industry	69
Ioana Chan Mow, Elisapeta Mauai, Vaisualua Okesene, and Ioana Sinclair	

Benchmarking the Software Engineering Undergraduate Program Curriculum at Jordan University of Science and Technology with the IEEE Software Engineering Body of Knowledge (SWE Knowledge Areas #6 –10)..... 85
 Moh'd A. Radaideh

Part II Educational Tools, Novel Teaching Methods and Learning Strategies

Design for Empathy and Accessibility: A Technology Solution for Deaf Curling Athletes..... 103
 Marcia R. Friesen, Ryan Dion, and Robert D. McLeod

An Investigation on the Use of WhatsApp Groups as a Mobile Learning System to Improve Undergraduate Performance 117
 A. Rushane Jones and B. Sherrene Bogle

Using Dear Data Project to Introduce Data Literacy and Information Literacy to Undergraduates 131
 Vetricia L. Byrd

An Educational Tool for Exploring the Pumping Lemma Property for Regular Languages 143
 Josue N. Rivera and Haiping Xu

An Educational Guide to Creating Your Own Cryptocurrency 163
 Paul Medeiros and Leonidas Deligiannidis

Peer Assistant Role Models in a Graduate Computer Science Course..... 179
 Evava Pietri, Leslie Ashburn-Nardo, and Snehasis Mukhopadhyay

A Project-Based Approach to Teaching IoT 195
 Varick L. Erickson, Pragya Varshney, and Levent Ertaul

Computational Thinking and Flipped Classroom Model for Upper-Division Computer Science Majors 217
 Antonio-Angel L. Medel, Anthony C. Bianchi, and Alberto C. Cruz

A Dynamic Teaching Learning Methodology Enabling Fresh Graduates Starting Career at Mid-level 229
 Abubokor Hanip and Mohammad Shahadat Hossain

Innovative Methods of Teaching the Basic Control Course 249
 L. Keviczky, T. Vámos, A. Benedek, R. Bars, J. Hetthéssy, Cs. Bányász, and D. Sik

Part III Frontiers in Education – Methodologies, Student Academic Preparation and Related Findings

Towards Equitable Hiring Practices for Engineering Education Institutions: An Individual-Based Simulation Model 265
 Marcia R. Friesen and Robert D. McLeod

Developing a Scalable Platform and Analytics Dashboard for Manual Physical Therapy Practices Using Pressure Sensing Fabric 277
 Tyler V. Rimaldi, Daniel R. Grossmann, and Donald R. Schwartz

Tracking Changing Perceptions of Students Through a Cyber Ethics Course on Artificial Intelligence 287
 Zeenath Reza Khan, Swathi Venugopal, and Farhad Oroumchian

Predicting the Academic Performance of Undergraduate Computer Science Students Using Data Mining 303
 Faiza Khan, Gary M. Weiss, and Daniel D. Leeds

An Algorithm for Determining if a BST Node’s Value Can Be Changed in Place 319
 Daniel S. Spiegel

Class Time of Day: Impact on Academic Performance 327
 Suzanne C. Wagner, Sheryl J. Garippo, and Petter Lovaaas

A Framework for Computerization of Punjab Technical Education System for Financial Assistance to Underrepresented Students 337
 Harinder Pal Singh and Harpreet Singh

Parent-Teacher Portal (PTP): A Communication Tool 351
 Mudasser F. Wyne, Matthew Hunter, Joshua Moran, and Babita Patil

Part IV Foundations of Computer Science: Architectures, Algorithms, and Frameworks

Exact Floating Point 365
 Alan A. Jorgensen and Andrew C. Masters

Random Self-modifiable Computation 375
 Michael Stephen Fiske

ECM Factorization with QRT Maps 395
 Andrew N.W. Hone

What Have Google’s Random Quantum Circuit Simulation Experiments Demonstrated About Quantum Supremacy? 411
 Jack K. Horner and John F. Symons

Chess Is Primitive Recursive 421
 Vladimir A. Kulyukin

How to Extend Single-Processor Approach to Explicitly Many-Processor Approach 435
 János Vég

Formal Specification and Verification of Timing Behavior in Safety-Critical IoT Systems 459
 Yangli Jia, Zhenling Zhang, Xinyu Cao, and Haitao Wang

Introducing Temporal Behavior to Computing Science 471
 János Vég

Evaluation of Classical Data Structures in the Java Collections Framework 493
 Anil L. Pereira

Part V Software Engineering, Dependability, Optimization, Testing, and Requirement Engineering

Securing a Dependability Improvement Mechanism for Cyber-Physical Systems 511
 Gilbert Regan, Fergal Mc Caffery, Pangkaj Chandra Paul, Ioannis Sorokos, Jan Reich, Eric Armengaud, and Marc Zeller

A Preliminary Study of Transactive Memory System and Shared Temporal Cognition in the Collaborative Software Process Tailoring 523
 Pei-Chi Chen, Jung-Chieh Lee, and Chung-Yang Chen

Mixed-Integer Linear Programming Model for the Simultaneous Unloading and Loading Processes in a Maritime Port 533
 Ali Skaf, Sid Lamrous, Zakaria Hammoudan, and Marie-Ange Manier

How to Test Interoperability of Different Implementations of a Complex Military Standard 545
 Andre Schöbel, Philipp Klotz, Christian Zschke, and Barbara Essendorfer

Overall Scheduling Requirements for Scheduling Synthesis in Automotive Cooperative Development 557
 Arthur Strasser, Christoph Knieke, and Andreas Rausch

Extracting Supplementary Requirements for Energy Flexibility Marketplace 567
 Tommi Aihkisalo, Kristiina Valtanen, and Klaus Känsälä

A Dynamic Scaling Methodology for Improving Performance of Data-Intensive Systems 577
 Nashmiah Alhamdawi and Yi Liu

Part VI Software Engineering Research, Practice, and Novel Applications

Technical Personality as Related to Intrinsic Personality Traits 597
 Marwan Shaban, Craig Tidwell, Janell Robinson, and Adam J. Roche

Melody-Based Pitch Correction Model for a Voice-Driven Musical Instrument 609
 John Carelli

Analysis of Bug Types of Textbook Code with Open-Source Software 629
 Young Lee and Jeong Yang

Implications of Blockchain Technology in the Health Domain..... 641
 Merve Vildan Baysal, Özden Özcan-Top, and Aysu Betin Can

A Framework for Developing Custom Live Streaming Multimedia Apps . 657
 Abdul-Rahman Mawlood-Yunis

Change Request Prediction in an Evolving Legacy System: A Comparison 671
 Lamees Alhazzaa and Anneliese Amschler Andrews

Using Clients to Support Extract Class Refactoring 695
 MUSAAD ALZAHrani

Analyzing Technical Debt of a CRM Application by Categorizing Ambiguous Issue Statements 705
 Yasemin Doğancı, Özden Özcan-Top, and Altan Koçyiğit

Applying DevOps for Distributed Agile Development: A Case Study 719
 Asif Qumer Gill and Devesh Maheshwari

Water Market for Jazan, Saudi Arabia 729
 Fathe Jeribi, Sungchul Hong, and Ali Tahir

Modeling Unmanned Aircraft System Maintenance Using Agile Model-Based Systems Engineering..... 741
 Justin R. Miller, Ryan D. L. Engle, Brent T. Langhals, Michael R. Grimaila, and Douglas D. Hodson

Benchmarking the Software Engineering Undergraduate Program Curriculum at Jordan University of Science and Technology with the IEEE Software Engineering Body of Knowledge (Software Engineering Knowledge Areas #1 –5)..... 747
 Moh’d A. Radaideh

A Study of Third-Party Software Compliance and the Associated Cybersecurity Risks..... 769
 Rashel Dibi, Brandon Gilchrist, Kristen Hodge, Annicia Woods, Samuel Olatunbosun, and Taiwo Ajani

Further Examination of YouTube’s Rabbit-Hole Algorithm 775
 Matthew Moldawsky

Part VII Educational Frameworks and Strategies, and e-Learning

Characterizing Learner’s Comments and Rating Behavior in Online Course Platforms at Scale 781
 Mirko Marras and Gianni Fenu

Supporting Qualification Based Didactical Structural Templates for Multiple Learning Platforms 793
 Michael Winterhagen, Minh Duc Hoang, Benjamin Wallenborn, Dominic Heutelbeck, and Matthias L. Hemmje

Enhancing Music Teachers’ Cognition and Metacognition: Grassroots FD Project 2019 at Music College 809
 Chiharu Nakanishi, Asako Motojima, and Chiaki Sawada

Scalable Undergraduate Cybersecurity Curriculum Through Auto-graded E-Learning Labs 825
 Aspen Olmsted

The Effect of Matching Learning Material to Learners’ Dyslexia Type on Reading Performance 837
 Hadeel Al-Dawsari and Robert Hendley

Individualized Educational System Supporting Object-Oriented Programming 847
 F. Fischman, H. Lersch, M. Winterhagen, B. Wallenborn, M. Fuchs, M. Then, and M. Hemmje

Part VIII e-Business, Enterprise Information Systems, and e-Government

Emerging Interactions of ERP Systems, Big Data and Automotive Industry 863
 Florie Bandara and Uchitha Jayawickrama

Software Evaluation Methods to Support B2B Procurement Decisions: An Empirical Study 879
 F. Bodendorf, M. Lutz, and J. Franke

Sentiment Analysis of Product Reviews on Social Media 899
 Velam Thanu and David Yoon

Research on Efficient and Fuzzy Matching Algorithm in Information Dissemination System 909
 Qinwen Zuo, Fred Wu, Fei Yan, Shaofei Lu, Colmenares-diaz Eduardo, and Junbin Liang

Agile IT Service Management Frameworks and Standards: A Review 921
M. Mora, J. Marx-Gomez, F. Wang, and O. Diaz

Contingency Planning: Prioritizing Your Resources 937
Kathryne Burton, Necole Cuffee, Darius Neclos, Samuel Olatunbosun,
and Taiwo Ajani

Smart Low-Speed Self-Driving Transportation System 943
Zhenghong Wang and Bowu Zhang

Are Collaboration Tools Safe? An Assessment of Their Use and Risks 949
Cquoya Haughton, Maria Isabel Herrmann, Tammi Summers,
Sonya Worrell, Samuel Olatunbosun, and Taiwo Ajani

Tourism Service Auction Market for Saudi Arabia 961
Saad Nasser Almutwa and Sungchul Hong

The Use of Crowdsourcing as a Business Strategy 971
Hodaka Nakanishi and Yuko Syozugawa

Correction to: Random Self-modifiable Computation C1
Michael Stephen Fiske

Index 985

Part I
**Curriculum Design, Academic Content,
and Learning Objectives**

Empirical Analysis of Strategies Employed Within an ICT Curriculum to Increase the Quantity of Graduates



Nicole Herbert, Erik Wapstra, David Herbert, Kristy de Salas, and Tina Acuña

1 Introduction

The University of Tasmania (UTAS) commenced a curriculum renewal process in 2012. At the time, there was concern both within the information and communication technology (ICT) industry and within government agencies about the number of the ICT graduates [1, 2]. Potential students had incorrect perceptions of the field of ICT [3], and this resulted in low commencement rates for ICT higher education courses in comparison to other disciplines [4]. High attrition rates in ICT courses, caused by a number of factors mostly relating to a lack of student engagement [5], motivation [6], and academic success [7, 8] were also impacting on the number of graduates.

This chapter reports on a broad and deep ICT curriculum change and uses data collected over a 9-year time period to conduct an empirical evaluation of the changes to the quantity of graduates. This chapter contributes to the field of ICT curriculum design as it provides implementation techniques for strategies that can have positive long-term outcomes. The research question explored is: *What is the impact of strategies designed to amend misconceptions and improve perceptions, motivation, engagement, and academic success on the quantity of graduates?*

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2 Related Work

Rapidly evolving technology has resulted in a continuous demand for competent ICT graduates. In 2019, the Australian Computer Society (ACS) released figures forecasting that Australia will require an additional 100,000 ICT specialist workers by 2024 [9]. A potential source of these workers is tertiary ICT graduates.

While the ACS reported that domestic undergraduate enrolments rose from a low of around 19,000 in 2010 to 30,000 in 2017 [9], this growth is not large enough to meet the forecasted demand, and it is further degraded by a high attrition rate. Even though there has been steady growth in completions since 2012, there were only 4400 domestic undergraduate completions in 2017 [9]. It is imperative that domestic completion rates in ICT courses improve for the growth of the ICT sector.

International students that graduate from ICT courses in Australia are also a potential source of skilled employees. In 2012, the growth in international student commencements in ICT courses had stagnated and started to decline [4], though since then, there has been significant growth, with international students comprising 39% of the national ICT undergraduate student population [9]. Similar to domestic graduates, there has been steady growth in completions since 2012, with 4000 international undergraduate completions in 2017 [9]. Even with this growth in total graduates, the supply of ICT employees from domestic and international graduates is much smaller than the predicted increase in the size of Australia's technology workforce over the next decade [9].

It is well recognized that students choose not to study ICT due to their perceptions of the field [3, 10–13]. A career in ICT is perceived as male-dominated, repetitive, isolated, and focused on the technical rather than the professional [3]. While this perception was valid in the past, the industry has transformed, and potential applicants need to be aware of how fulfilling an ICT career can be and how diverse the opportunities are.

To increase the quantity of ICT graduates, it is necessary to not only increase the commencements in ICT courses but also reduce the rate of course attrition. National attrition across all disciplines was around 17% in 2012 [4], in comparison to a national attrition rate of 43% for ICT courses [1]. There have been a number of studies identifying the causes of this high course attrition.

Poor course choice due to student misconceptions of what ICT is and what is involved in studying ICT is a leading cause of course attrition [3, 10–13]. Beaubouef et al. [11] summarized a number of misconceptions that can impact on both course commencements and attrition:

Nature of the field – ICT is much wider than producing reports and collating data and infiltrates a wide range of industries.

ICT is easy – ICT requires maths and problem-solving skills and a disciplined approach to solve complicated problems.

Social issues and communication skills – ICT careers are not solitary positions and require written and oral communication skills to convey ideas and concepts to develop systems that meet user requirements.

Programming – while it is essential that all ICT personnel have some ability to program, it is only one of the many important skills required. Biggers et al. [12] found that, although the primary reason students gave for leaving was allegedly a loss of interest, the underlying explanation was often related to the undesirability of a programming-only career.

One difference between students who complete and students who leave is their motivation to study [6, 14]. Providing evidence that the course can result in a secure, satisfying, and financially rewarding career can influence the decision to continue [14, 15]. Smith et al. [8] found that a lack of academic success is also a major factor in the decision to withdraw and ICT students who pass subjects were more likely to continue. A lack of student engagement in ICT courses was also found to be a leading cause of course attrition, particularly for first-year students [5, 16]. This was often a result of poor course design: poor quality teaching, feedback, or course structure [7, 10, 13, 14, 16–19], poorly related practical work to professional practice [10, 13, 14, 17–19], and low levels of interaction with peers and staff [6, 12–14, 18, 20].

3 The UTAS Situation

The University of Tasmania (UTAS) is responsible for developing competent graduates for a broad local ICT industry. In 2014, the Tasmanian ICT sector employed over 4500 people and generated industry value add of around \$640 million, representing less than 1.6% of the Australian ICT sector’s total [21]. The Tasmanian ICT sector had been constrained by skills shortages for a decade [21].

As had been the case for ICT courses nationally, the student numbers had stagnated, and the attrition rates were high, as shown in Table 1. As Tasmania is an island state with a small population, there is a very limited domestic market of tertiary applicants. There was reliance on international student enrolments, but these were in decline – down to 22% in 2012 [4]. 11% of the students were enrolled in the Bachelor of Information Systems (BIS), while the rest were in the Bachelor of Computing (BComp). The attrition rate in the UTAS ICT courses prior to 2013 was 57%, much higher than the national ICT course average of 43% in 2012 [1].

Table 1 Student data for the BComp/BIS

	2010	2011	2012	2013
Commencing students	131	137	135	167
Domestic student ratio	73%	69%	78%	78%
Attrition rate	55%	54%	63%	74%