IFIP Advances in Information and Communication Technology

Editor-in-Chief

Kai Rannenberg, Goethe University Frankfurt, Germany

Editorial Board Members

TC 1 – Foundations of Computer Science
Luís Soares Barbosa , University of Minho, Braga, Portugal
TC 2 – Software: Theory and Practice
Michael Goedicke, University of Duisburg-Essen, Germany
TC 3 – Education
Arthur Tatnall ¹ , Victoria University, Melbourne, Australia
TC 5 – Information Technology Applications
Erich J. Neuhold, University of Vienna, Austria
TC 6 – Communication Systems
Burkhard Stiller, University of Zurich, Zürich, Switzerland
TC 7 – System Modeling and Optimization
Fredi Tröltzsch, TU Berlin, Germany
TC 8 – Information Systems
Jan Pries-Heje, Roskilde University, Denmark
TC 9 – ICT and Society
David Kreps ¹ , National University of Ireland, Galway, Ireland
TC 10 – Computer Systems Technology
Ricardo Reis, Federal University of Rio Grande do Sul, Porto Alegre, Brazil
TC 11 – Security and Privacy Protection in Information Processing Systems
Steven Furnell ₁₀ , Plymouth University, UK
TC 12 – Artificial Intelligence
Eunika Mercier-Laurent [®] , University of Reims Champagne-Ardenne, Reims, France
TC 13 – Human-Computer Interaction
Marco Winckler [®] , University of Nice Sophia Antipolis, France
TC 14 – Entertainment Computing
Rainer Malaka, University of Bremen, Germany

IFIP - The International Federation for Information Processing

IFIP was founded in 1960 under the auspices of UNESCO, following the first World Computer Congress held in Paris the previous year. A federation for societies working in information processing, IFIP's aim is two-fold: to support information processing in the countries of its members and to encourage technology transfer to developing nations. As its mission statement clearly states:

IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP's events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

IFIP distinguishes three types of institutional membership: Country Representative Members, Members at Large, and Associate Members. The type of organization that can apply for membership is a wide variety and includes national or international societies of individual computer scientists/ICT professionals, associations or federations of such societies, government institutions/government related organizations, national or international research institutes or consortia, universities, academies of sciences, companies, national or international associations or federations of companies.

More information about this series at http://www.springer.com/series/6102

Lynette Drevin · Natalia Miloslavskaya · Wai Sze Leung · Suné von Solms (Eds.)

Information Security Education for Cyber Resilience

14th IFIP WG 11.8 World Conference, WISE 2021 Virtual Event, June 22–24, 2021 Proceedings



Editors Lynette Drevin North-West University Potchefstroom, South Africa

Wai Sze Leung University of Johannesburg Johannesburg, South Africa Natalia Miloslavskaya The National Research Nuclear University MEPhI Moscow, Russia

Suné von Solms University of Johannesburg Johannesburg, South Africa

 ISSN 1868-4238
 ISSN 1868-422X
 (electronic)

 IFIP Advances in Information and Communication Technology
 ISBN 978-3-030-80864-8
 ISBN 978-3-030-80865-5
 (eBook)

 https://doi.org/10.1007/978-3-030-80865-5
 ISBN 978-3-030-80865-5
 (eBook)

© IFIP International Federation for Information Processing 2021

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This volume contains the papers presented at the 14th World Conference on Information Security Education (WISE 14) held during June 22–24, 2021. It was held in conjunction with the 36th IFIP TC-11 SEC 2021 International Information Security and Privacy Conference (IFIP SEC 2021).

WISE 14 was organized by the IFIP Working Group 11.8, which is an international group of people from academia, government, and private organizations who volunteer their time and effort to increase knowledge in the very broad field of information security through education. WG 11.8 has worked to increase information security education and awareness for almost two decades. This year, WG 11.8 organized the 14th conference of the successful WISE series under the theme "Information Security Education for Cyber Resilience." We received 19 submissions from around the world. Each submission was blind reviewed by at least three international Program Committee members. The committee decided to accept 8 full papers. The acceptance rate for the conference was thus 42%.

This conference took place thanks to the support and commitment of many individuals. First, we would like to thank all TC-11 members for continually giving us the opportunity to serve the working group and organize the WISE conferences. Our sincere appreciation also goes to the members of the Program Committee, to the external reviewers, and to the authors who trusted us with their intellectual work. We are grateful for the support of the WG 11.8 Officers: Erik Moore, Jacques Ophoff, and Matt Bishop. In addition, the hosting of WISE would not have been possible without the efforts of the SEC 2021 organizers, Audun Jøsang and Nils Gruschka. Finally, we would like to thank the IFIP SEC 2021 organizers for their support. Furthermore, we wish to acknowledge the EasyChair conference management system which was used for managing the submissions and reviews of WISE 14 papers. As for the preparation of this volume, we sincerely thank Miriam Costales and our publisher Springer for their assistance.

June 2021

Lynette Drevin Natalia Miloslavskaya Wai Sze Leung Suné von Solms

The original version of this volume was revised: The last name of an author of the first workshop paper has been corrected to "Scarano" and the title of the second workshop paper has been corrected in the Book Backmatter.

Organization

WISE 14 Conference Chair

Erik Moore Reg	gis University, USA
----------------	---------------------

WISE 14 Program Chairs

Lynette Drevin	North-West University, South Africa
Natalia Miloslavskaya	National Research Nuclear University MEPhI, Russia

WISE 14 Conference Secretariat

Matt Bishop	University of California, Davis, USA
-------------	--------------------------------------

WISE 14 Publications Chairs

Wai Sze Leung	University of Johannesburg, South Africa
Suné von Solms	University of Johannesburg, South Africa

WISE 14 Logistics Chair

Lynn Futcher	Nelson Mandela	University,	South Africa

WISE 14 Web Chair

Jacques Ophoff	Abertay University, UK
Jacques Option	Moentary Oniversity, OK

Program Committee

University of Cambridge, UK
Nelson Mandela University, South Africa
California State University, Sacramento, USA
University of Regensburg, Germany
Karlstad University, Sweden
University of Plymouth, UK
University of the Aegean, Greece
Open University of Cyprus, Cyprus
Norwegian University of Science and Technology,
Norway
Trier University of Applied Sciences, Germany
University of South Africa, South Africa
North-West University, South Africa

Costas Lambrinoudakis	University of Piraeus, Greece
Dan Likarish	Regis University, USA
Javier Lopez	University of Malaga, Spain
Emmanouil Magkos	Ionian University, Greece
Annlize Marnewick	University of Johannesburg, South Africa
Herbert Mattord	Kennesaw State University, USA
Stig Mjolsnes	Norwegian University of Science and Technology, Norway
Ruxandra F. Olimid	Norwegian University of Science and Technology, Norway
Günther Pernul	University of Regensburg, Germany
Tobias Pulls	Karlstad University, Sweden
Kai Rannenberg	Goethe University Frankfurt, Germany
Carlos Rieder	isec ag, Switzerland
Leo Robert	Laboratory of Informatics, Modelling and Optimization of the Systems, France
Rudi Serfontein	North-West University, South Africa
Alireza Shojaifar	University of Applied Sciences and Arts Northwestern Switzerland, Switzerland
Kerry-Lynn Thomson	Nelson Mandela University, South Africa
Alexander Tolstoy	National Research Nuclear University MEPhI, Russia
Rossouw von Solms	Nelson Mandela University, South Africa
Edgar Weippl	University of Vienna, Austria
Susanne Wetzel	Stevens Institute of Technology, USA

Contents

A Roadmap for Building Resilience

3

Innovation in Curricula

Formation of General Professional Competencies in Academic Training	
of Information Security Professionals.	13
Natalia Miloslavskaya and Alexander Tolstoy	

Electronic Voting Technology Inspired Interactive Teaching and Learning	
Pedagogy and Curriculum Development for Cybersecurity Education	27
Ryan Hosler, Xukai Zou, and Matt Bishop	

Teaching Methods and Tools

Minimizing Cognitive Overload in Cybersecurity Learning Materials:	
An Experimental Study Using Eye-Tracking.	47
Leon Bernard, Sagar Raina, Blair Taylor, and Siddharth Kaza	
A Layered Model for Building Cyber Defense Training Capacity	64
Erik L. Moore, Steven P. Fulton, Roberta A. Mancuso,	
Tristen K. Amador, and Daniel M. Likarish	
Measuring Self-efficacy in Secure Programming	81
Matt Bishop, Ida Ngambeki, Shiven Mian, Jun Dai, and Phillip Nico	

End-User Security

Children's Awareness of Digital Wellness: A Serious Games Approach	95
J. Allers, G. R. Drevin, D. P. Snyman, H. A. Kruger, and L. Drevin	
Environmental Uncertainty and End-User Security Behaviour:	
A Study During the COVID-19 Pandemic	111
Popyeni Kautondokwa, Zainab Ruhwanya, and Jacques Ophoff	

x Contents

What Parts of Usable Security Are Most Important to Users?	126
Joakim Kävrestad, Steven Furnell, and Marcus Nohlberg	

WISE Workshops

Foundations for Collaborative Cyber Security Learning: Exploring Educator and Learner Requirements Jerry Andriessen, Steven Furnell, Gregor Langner, Gerald Quirchmayr,	
	143
Vittorio Scarano, and Teemu Tokola	
Reimagining Inclusive Pedagogy in Cybersecurity Education	
(A Workshop Proposal)	146
Angela G. Jackson-Summers	
Author Index	151