


Francisco José García-Peñalvo ·
Alicia García-Holgado
Editors

Proceedings TEEM 2022:
Tenth International
Conference on Technological
Ecosystems for Enhancing
Multiculturality

Salamanca, Spain, October 19–21, 2022

Editors

Francisco José García-Peñalvo 
GRIAL Research Group
Universidad de Salamanca
Salamanca, Spain

Alicia García-Holgado 
GRIAL Research Group
Universidad de Salamanca
Salamanca, Spain

ISSN 2196-4963 ISSN 2196-4971 (electronic)
Lecture Notes in Educational Technology
ISBN 978-981-99-0941-4 ISBN 978-981-99-0942-1 (eBook)
<https://doi.org/10.1007/978-981-99-0942-1>

© The Editor(s) (if applicable) and The Author(s), under exclusive license
to Springer Nature Singapore Pte Ltd. 2023

This work is subject to copyright. All rights are solely and exclusively licensed 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 Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

TEEM 2022 Preface

We celebrated the tenth edition of the Technological Ecosystems for Enhancing Multiculturality (TEEM) International Conference in the University of Salamanca, the institution in which it was born. Nine years ago, this academic conference project started. We had the goal to create a new interdisciplinary event in which the new advances in technology would be reflected in the resolution of the problems of Education and the Knowledge Society. We pursued the establishment of a new research community with a strong aim to help Ph.D. students to have opportunities to know and collaborate with consolidated researchers worldwide.

Looking back, we are very satisfied with the obtained results. We are a consolidated research community that has grown, many research projects were born in the previous editions, many collaborative papers in prestigious books and journals have been published, many international internships have occurred, but we are very proud because tens of new Ph.D. participated in the previous editions of TEEM Doctoral Consortium track and contribute to help the future Ph.D. to be part of the TEEM family.

This edition is a reunion event, fully face-to-face, after two editions in virtual and hybrid mode due to COVID-19. More than one hundred and ninety researchers shared their scientific advances in this tenth edition. Some of them were new, but most of them were regular participants in this conference, which reinforces the original idea of forming a solid scientific community.

It is also important to say that this TEEM tenth edition was within the European Campus of City-Universities (EC2U) Alliance (<https://ec2u.eu/>), co-funded by the Erasmus+ Programme of the European Union. The EC2U is a multi-cultural and multi-lingual Alliance consisting of seven long-standing, education- and research-led, locally and globally engaged universities from four diverse regions of the European Union: the University of Coimbra, the University of Iași, the University of Jena, the University of Pavia, the University of Poitiers (Coordinator), the University of Salamanca and the University of Turku.

TEEM 2022 has had 210 submissions from which 145 full papers were accepted; that is, there is a 30% rejection rate. These papers have involved 424 authors from 26 countries.

The TEEM 2022 was organized in 16 thematic tracks that covers research areas such as Educational Assessment and Orientation, Human–Computer Interaction, Computers in Education, Communication Media and Education, Medicine and Education, Learning Analytics, Engineering Education, Robotics in Education, Diversity in Education, Gamification and Games for Learning, Smart Learning and Laboratory-Based Education.

In addition to the regular sessions, the TEEM 2022 edition featured three prestigious guest speakers. Firstly, Gema Parreño Piqueras, Developer Advocate at Iterative, gave the inaugural keynote entitled “Alignment of language agents in video games.” Dr. Oriol Borrás Gené, Professor at Universidad Rey Juan Carlos (Spain), gave a keynote entitled

“3 years escaping from a room, learned lessons.” The closing lecture was given by Dr. Ricardo Colomo-Palacios, Full Professor at the Østfold University College (Norway), with the title “Academia-Industry collaboration: a view from IT.”

We would like to thank the members of the Steering Committee for their counsel and the International Scientific Committee for their accurate and timely reviewing. We would also like to thank the Track Chairs for their efforts in organizing the academic issues related to each track and the Organizing Committee for their huge effort in all the associated tasks that an international conference involves. We would like to do a special mention for the Editors-in-Chief of the linked journals that have offered special issues or slots in their regular issues for those selected and extended papers of TEEM 2022 conference that will have another in-depth review following the guidelines of each journal. Last, but not least, we would like to thank the participating organizations: University of Salamanca, Research Institute for Educational Sciences at the University of Salamanca, GRIAL Research Group and European Campus of City-Universities (EC2U) Alliance for their support.

Next year, we will continue with eleventh edition of TEEM Conference that will be held at Bragança, Portugal, organized by Instituto Politécnico de Bragança.

October 2022

Francisco José García-Peñalvo
Alicia García-Holgado
TEEM 2022 Conference Chairs

Program Committee

Adriana Gamazo	University of Salamanca, Spain
Adriana Segura Mariño	Pontificia Universidad Católica del Ecuador Sede Santo Domingo, Ecuador
Agustín Carlos Caminero-Herráez	Universidad Nacional de Educación a Distancia, Spain
Agustín Pérez Martín	Miguel Hernández University, Spain
Alberto Ardèvol Abreu	Universidad de La Laguna, Spain
Alberto Ortiz López	University of Salamanca, Spain
Alberto Prats Galino	University of Barcelona, Spain
Alberto Sánchez Rojo	Universidad Complutense de Madrid, Spain
Alejandra Martínez-Monés	Universidad de Valladolid, Spain
Alejandro Rabasa Dolado	Miguel Hernández University, Spain
Alessandro Ruggiero	University of Salerno, Italy
Alexander Kist	University of Southern Queensland, Australia
Alexandre da Silva Pinto	Escola Superior de Educação do Porto, Portugal
Alicia García-Holgado	University of Salamanca, Spain
Alicia Murciano Hueso	Universidad de Salamanca, Spain
Alicia Triviño	Universidad de Málaga, Spain
Álvaro Luis Rojas Zamorano	Universidad Tecnológica Metropolitana, Chile
Amílcar Oliveira	Universidade Aberta, Portugal
Amparo Camacho Díaz	Universidad del Norte, Colombia
Ana Belén González Rogado	University of Salamanca, Spain
Ana García Valcárcel	University of Salamanca, Spain
Ana María Balbín	Pontifical Catholic University of Peru, Peru
Ana María González Ramos	Universidad Pablo de Olavide de Sevilla, Spain
Ana María Pinto-Llorente	University of Salamanca, Spain
Ana Pavani	PUC-Rio, Brazil
André Fidalgo	Instituto Superior de Engenharia do Porto, Portugal
Andrea Vázquez-Ingelmo	University of Salamanca, Spain
Ángel Fidalgo	Technical University of Madrid, Spain
Ángel Hernández-García	Universidad Politécnica de Madrid, Spain
Angela Rees	Pontydysgu, Welsh educational research institute, UK
Ángeles Domínguez Cuenca	Tecnológico de Monterrey, Mexico
Anita Tabacco	Politecnico di Torino, Italy
Anna Puig	Universitat de Barcelona, Spain
Anna Puigdellívol-Sánchez	Universidad de Barcelona, Spain
Antonio Fernández Martínez	University of Almería, Spain
Antonio Fumero-Reverón	Universidad Politécnica de Madrid, Spain

Antonio Jimeno Morenilla	University of Alicante, Spain
António Pedro Dias da Costa	University of Aveiro, Portugal
Antonio Robles-Gómez	Universidad Nacional de Educación a Distancia, Spain
Aruquia Peixoto	CEFET/RJ, Brazil
Bahar Kutun	Technische Hochschule Ingolstadt, Germany
Baltasar Fernández-Manjón	Universidad Complutense de Madrid, Spain
Bárbara Mariana Gutiérrez Pérez	Universidad de Salamanca, Spain
Beatriz Legeren	University of Vigo, Spain
Belén Curto Diego	University of Salamanca, Spain
Bernardino Lopes	Universidade de Trás-os-Montes e Alto Douro, Portugal
Bertil Marques	Instituto Superior de Engenharia do Porto, Portugal
Bianca Thoilliez Ruano	Universidad Autónoma de Madrid, Spain
Blanca Ruth Orantes de Pineda	Universidad Tecnológica de El Salvador, El Salvador
Camino Fernández-Llamas	University of León, Spain
Carina S. González-González	University of La Laguna, Spain
Carlos Alberola López	University of Valladolid, Spain
Carlos Arcila Calderón	Universidad de Salamanca, Spain
Carlos Arguedas Matarrita	Universidad Estatal a Distancia, Costa Rica
Carlos Cuenca-Enrique	Universidad Politécnica de Madrid, Spain
Carlos Felgueiras	Instituto Superior de Engenharia do Porto, Portugal
Carlos Vaz de Carvalho	Instituto Politecnico do Porto, Portugal
Carlos Villagrà Arnedo	University of Alicante, Spain
Carol Rivero Panaqué	Pontifical Catholic University of Peru, Peru
Cassia Gonçalves Isac	IFRJ, Brazil
Catalina Cerquera Arbeláez	Antioquia Institute of Technology, Colombia
Catalina Rus Casas	Universidad de Jaén, Spain
Celina Leão	Universidade Minho, Portugal
Clara Viegas	Polytechnic Institute of Porto, Portugal
Claudia Gomes	Universidade Aberta Lisbon, Portugal
Claudius Terkowsky	TU Dortmund University, Germany
Cristina Frade Martínez	University of Salamanca, Spain
Cristina Mesuita	Instituto Politécnico de Bragança, Portugal
Cristina Pereira	Polytechnic Institute of Castelo Branco, Portugal
Daniel Amo	La Salle, University of Ramon Llull, Spain
Daniel Aranda	Universitat Oberta de Catalunya, Spain
Daniel Gonçalves	INESC-ID, Portugal
Daniel Riera	Universitat Oberta de Catalunya, Spain

Daniela Reimann	Karlsruhe Institute of Technology KIT, Germany
David Fonseca	La Salle, Ramon Llull University, Spain
David Griffiths	Universidad Internacional de La Rioja, Spain
David López Álvarez	Polytechnic University of Catalonia, Spain
Diego González Rodríguez	University of León, Spain
Diogo Ribeiro	Instituto Superior de Engenharia do Porto, Portugal
Dominik May	University of Georgia, USA
Doris Meza Bolaños	Central del Ecuador University, Ecuador
Edith Soria Valencia	Pontifical Catholic University of Peru, Peru
Eduardo Herranz	Universidad Carlos III de Madrid, Spain
Eduardo Vila Merino	Universidad de Málaga, Spain
Elisabete Nogueira	Instituto Superior de Engenharia do Porto, Portugal
Elise Lavoue	Université Jean Moulin, France
Elvira Rincón-Flores	Tecnológico de Monterrey, Mexico
Emilia López Iñesta	Universitat de València, Spain
Emiliano Acquila-Natale	Universidad Politécnica de Madrid, Spain
Encarnación Gimeno Nieves	Universidad de Alicante, Spain
Enric Mor	Universitat Oberta de Catalunya, Spain
Enrique Soriano Heras	University of Carlos III, Spain
Erla M. Morales Morgado	University of Salamanca, Spain
Euan Lindsay	Aalborg University, Denmark
Eva María Torrecilla Sánchez	University of Salamanca, Spain
Faraon Llorens	Universidad de Alicante, Spain
Faraón Llorens	University of Alicante, Spain
Faraón Llorens	Largo University of Alicante, Spain faraon.llorens@ua.es
Federico Simmross Wattenberg	University of Valladolid, Spain
Felipe Marañón Lazcano	Universidad Autónoma de Nuevo León, México
Félix Ortega Mohedano	Universidad de Salamanca, Spain
Fermín Viejo Tirado	Complutense University of Madrid, Spain
Fernando Blaya Haro	Universidad Politécnica de Madrid, Spain
Fernando Gil Cantero	Universidad Complutense de Madrid, Spain
Fernando Martínez Abad	University of Salamanca, Spain
Ferrán Prados Carrasco	Centre for Medical Image Computing, UK
Flavio Escribano	GECON, Fundación Iberoamericana del Conocimiento, Spain
Francisco Álvarez	Universidad Autónoma de Aguascalientes, Mexico
Francisco Esteban Bara	Universidad de Barcelona, Spain
Francisco Gallego	Universidad de Alicante, Spain

Francisco Gutiérrez	Universidad de Granada, Spain
Francisco Javier Tejedor	University of Salamanca, Spain
Francisco José Gallego Durán	University of Alicante, Spain
Francisco José García Peñalvo	University of Salamanca, Spain
Francisco Pastor Vázquez	University of Valladolid, Spain
Francisco Revuelta	Universidad de Extremadura, Spain
Francisco Xavier Valverde Alulema	Central del Ecuador University, Ecuador
Gabriela Marín	University of Costa Rica, Costa Rica
Germania del Rocio Rodriguez Morales	Universidad Técnica Particular de Loja, Ecuador
Gina Susana Mejía Madrid	Central del Ecuador University, Ecuador
Gisela Oliveira	Universidade Fernando Pessoa, Portugal
Graciela Carnevali	National Technological University, Argentina
Guadalupe Soria Rodríguez	University of Barcelona, Spain
Gustavo Ribeiro Alves	Instituto Superior de Engenharia do Porto, Portugal
Héctor Barbosa León	Instituto Politécnico de Colima, Mexico
Hernán Gil Ramírez	Technological University of Pereira, Colombia
Higinio Rubio Alonso	University of Carlos III, Spain
Ignacio González López	University of Córdoba, Spain
Ilkka Jormanainen	School of Computing, University of Eastern Finland, Finland
Inés González-González	Universidad Pública de Navarra, Spain
Inma Rodríguez	Universitat de Barcelona, Spain
Isabel Soares	University of Porto, Portugal
J. P. Cravino	Universidade de Trás-os-Montes e Alto Douro, Portugal
Jaime Ricardo Valenzuela González	Tecnológico de Monterrey, Mexico
Javier Alfonso-Cendón	Universidad de León, Spain
Javier Bravo	Universidad de Distancia de Madrid, Spain
Javier Garcia-Zubia	Universidad de Deusto, Spain
Javier Vidal García	University of León, Spain
Jenny Hughes	Pontydysgu, Welsh educational research institute, UK
Jens Vermeersch	GO! Onderwijs van de Vlaamse Gemeenschap, Belgium
Jesús Ruedas Caletrio	Universidad de Salamanca, Spain
Jimena Pascual	Pontificia Universidad Católica de Valparaíso, Chile
Joan Arnedo Moreno	Universitat Oberta de Catalunya, Spain
Joan San Molina	Universidad de Girona, Spain

Joaquim Alves	Instituto Superior de Engenharia do Porto, Portugal
Joaquim Armando Pires Jorge	University of Lisboa, Portugal
Joe O'Hara	Dublin City University, Ireland
Jorge Cerqueiro Pequeño	University of Vigo, Spain
Jorge Joo Nagata	Universidad Metropolitana de Ciencias de la Educación, Chile
Jorge Simoes	Instituto Superior Politécnico Gaya, Portugal
José Antonio Cordón García	University of Salamanca, Spain
José Antonio Jerónimo	UNAM, Mexico
José Antonio Merlo Vega	University of Salamanca, Spain
José Carlos Sánchez-Prieto	University of Salamanca, Spain
José Gonçalves	Instituto Politécnico de Bragança, Portugal
José Lima	Instituto Politécnico de Bragança, Portugal
José Luis Martín Núñez	Technical University of Madrid, Spain
José M Martins Ferreira	University of South-Eastern Norway, Norway
José Manuel Muñoz-Rodríguez	University of Salamanca, Spain
Josep Petchamé Sabartés	La Salle, University of Ramon Llull, Spain
Juan A. Juanes-Méndez	University of Salamanca, Spain
Juan Cruz-Benito	IBM Research, USA
Juan David Cano Moreno	University of Politécnica de Madrid, Spain
Juan García Gutiérrez	Universidad Nacional de Educación a Distancia, Spain
Juan José Igartua	Universidad de Salamanca, Spain
Juan Pablo Hernández Ramos	University of Salamanca, Spain
Juarez Bento da Silva	Universidade Federal de Santa Catarina, Brazil
Judith Martin Lucas	University of Salamanca, Spain
Julián Chaparro-Peláez	Universidad Politécnica de Madrid, Spain
Karina Arrambide	University of Waterloo, Canada
Kay Margarethe Berkling	Duale Hochschule Baden-Württemberg Karlsruhe, Germany
Kheng Lee Koay	University of Hertfordshire, UK
Koen DePryck	Vrije Universiteit Brussel, Belgium
Laura Calvet	Universitat Oberta de Catalunya, Spain
Laura García Ruesgas	University of Sevilla, Spain
Laura-Del-Río-Carazo	Universidad Politécnica de Madrid, Spain
Leidy Maritza García Toro	University of Antioquia, Colombia
Leonardo Glasserman	Tecnológico de Monterrey, Mexico
Lourdes Moreno	University Carlos III of Madrid, Spain
Lourdes Villalustre	Universidad de Oviedo, Spain
Luciano Carlos Mendes de Freitas Filho	Universidade Federal do Rio de Janeiro, Brazil

Lucy Esther Garcia Ramos	Universidad del Norte, Colombia
Luis Guilherme Augsburguer	Universidade do Estado de Santa Catarina, Brazil
Luis Manuel Casas García	University of Extremadura, Spain
Luis Panizo-Alonso	Universidad de León, Spain
Luis Schlichting	Instituto Federal de Santa Catarina, Brazil
Luis Tomás Gallego Morales	University of Autónoma de Madrid, Spain
Luiz Lizasoain Hernández	University of País Vasco, Spain
Lynn Alves	Universidade Federal da Bahia, Brazil
M ^a Cruz Sánchez-Gómez	University of Salamanca, Spain
M ^a Jesús Perales Montolio	University of Valencia, Spain
M ^a José Rodríguez Conde	University of Salamanca, Spain
M ^a María del Mar Lorenzo Moledo	Universidad de Santiago de Compostela, Spain
M ^a Teresa Anguera Argilaga	Universidad de Barcelona, Spain
M ^a Teresa Del Moral Marcos	Pontifical University of Salamanca, Spain
M ^a Victoria Martín Cilleros	University of Salamanca, Spain
Mabel Calderín Cruz	Universidad Católica Andrés Bello, Venezuela
Maddalena Taras	University of Sunderland, UK
Maire Tuul	Institute of Educational Sciences, Tallinn University, Estonia
Manuel Caeiro-Rodríguez	Universidade de Vigo, Spain
Manuel Castro	UNED, Spain
Manuel Rodríguez Martín	Universidad de Salamanca, Spain
Marc Alier	Barcelona Tech, Spain
Marcela Cavallo	National University of Rosario, Argentina
Marcela Isabel Prieto Ferraro	University of Antofagasta, Chile
Marcelo Zannin	Universidade Federal de Santa Catarina, Brazil
Marcos Cabezas-González	University of Salamanca, Spain
Margarida Lucas	Universidade de Aveiro, Portugal
Margarida Ribeiro	Instituto Superior de Engenharia do Porto, Portugal
María Amparo Verdú Vázquez	Technical University of Madrid, Spain
Maria Arcelina Marques	Instituto Superior de Engenharia do Porto, Portugal
Maria Correia Duarte	Instituto Superior de Engenharia do Porto, Portugal
María do Rosário Pinheiro	Universidade de Coimbra, Portugal
María Elena Rodríguez Benito	Universidad Pontificia de Salamanca, Spain
María Esther Del Moral	Universidad de Oviedo, Spain
María Isabel Pozzo	National University of Rosario, Argentina
María José Hernández Serrano	Universidad de Salamanca, Spain
María José Rodríguez-Conde	University of Salamanca, Spain

María José Vieira Aller	University of León, Spain
María Luisa Sein-Echaluce	University of Zaragoza, Spain
Maria Rosa Fernández	Universidad de Extremadura, Spain
María Sánchez Canales	Technical University of Madrid, Spain
María Soledad Ramírez-Montoya	Tecnológico de Monterrey, Mexico
Mariana Hare	Pontifical Catholic University of Peru, Peru
Marílio Cardoso	Instituto Politécnico do Porto, Portugal
Mariluz Guenaga	Universidad de Deusto, Spain
Maristela Holanda	University of Brasilia, Brazil
Marjo Virnes	Aalto University, Finland
Mark Johnson	University of Liverpool, UK
Marta Martín del Pozo	University of Salamanca, Spain
Martin Brown	Dublin City University, Ireland
Martín Oller Alonso	Università degli Studi di Milano, Italia
Matteo de Notaris	San Pio Hospital, Italy
Mervi Heikkinen	University of Oulu, Finland
Miguel Ángel Conde	University of León, Spain
Miguel Ángel Gómez Ruiz	University of Cadiz, Spain
Miguel Castelo Branco Sousa	Universidade da Beira Interior, Portugal
Miguel Hernández	Catholic University of Valencia, Spain
Miguel Vicente Mariño	Universidad de Valladolid, Spain
Mikel Larrañaga	Euskal Herriko Unibertsitatea, Spain
Miloš Milovanović	University of Belgrade, Serbia
Miroslav Minović	University of Belgrade, Serbia
Natércia Lima	Polytechnic Institute of Porto, Portugal
Nic Nistor	Ludwig Maximilians Universität München, Germany
Nikolaos Vryzas	Aristotle University of Thessaloniki, Greece
Noemí Merayo Álvarez	University of Valladolid, Spain
Noura Aknin	Abdelmalek Essaâdi University, Morocco
Nuria Medina	Universidad de Granada, Spain
Oriol Borrás	Universidad Rey Juan Carlos, Spain
Oscar Garcia-Pañella	ENTI-UB/Cookie Box/IEBS, Spain
Óscar José Martín Sánchez	Pontifical University of Salamanca, Spain
Pablo Rodríguez-Gonzálvez	Universidad de León, Spain
Pablo Ruisoto Palomera	University of Navarra, Spain
Pablo Vicente Torres	Universidad Técnica Particular de la Loja, Ecuador
Patricia Jimenez	Pontificia Universidad Católica de Valparaíso, Chile
Patricia Paderewski	University of Granada, Spain
Patricia Sánchez-Holgado	University of Salamanca, Spain

Patricia Torrijos Fincias	University of Salamanca, Spain
Pedro Corcho Sánchez	University of Extremadura, Spain
Pedro José Muñoz-Merino	Universidad Carlos III, Spain
Pedro Plaza	UNED, Spain
Peter Sloep	OUNL, The Netherlands
Petr Valášek	Czech University of Life Sciences, Czech Republic
Piedade Barros	Polytechnic of Porto, Portugal
Pierre Bourdin	Universitat Oberta de Catalunya, Spain
Pino Caballero-Gil	University of La Laguna, Spain
Purificación Sánchez Delgado	University of Valencia, Spain
Rafael Molina-Carmona	University of Alicante, Spain
Rafael Pastor	Universidad Nacional de Educación a Distancia, Spain
Raul Cordeiro Correia	Instituto Politécnico de Setúbal, Portugal
Ricardo Castedo	Technical University of Madrid, Spain
Ricardo Costa	Instituto Superior de Engenharia do Porto, Portugal
Ricardo Morais	Universidade da Beira Interior, Portugal
Rina Wehbe	University of Waterloo, Canada
Rita Peñabaena	Universidad del Norte, Colombia
Robert Clarisó	Universitat Oberta de Catalunya, Spain
Robert Tennyson	University of Minnesota, USA
Roberto D'Amato	Universidad Politécnica de Madrid, Spain
Roberto Therón	Universidad de Salamanca, Spain
Rocael Hernandez-Rizzardini	Galileo University, Guatemala
Rodrigo de Luis García	University of Valladolid, Spain
Rosa Cabrales	Universidad de Oriente, Cuba
Rosa Gil-Iranzo	University of Lleida, Spain
Rosa María Guilleumas García	Technological University of Pereira, Colombia
Rosana Satorre	University of Alicante, Spain
Ruth Cobos	Universidad Autónoma de Madrid, Spain
Salvador Ros-Muñoz	Universidad Nacional de Educación a Distancia, Spain
Samuel Marcos-Pablos	University of Salamanca, Spain
Sandra Cano	Universidad San Buenaventura de Cali, Colombia
Santiago Iglesias-Pradas	Universidad Politécnica de Madrid, Spain
Sara García Cuesta	University of La Laguna, Spain
Sara Serrate González	Universidad de Salamanca, Spain
Silvia Rueda Pascual	University of Valencia, Spain
Simone M. Biléssimo	Universidade Federal de Santa Catarina, Brazil
Sonia Casillas-Martín	University of Salamanca, Spain

Sonia Concari	Universidad Tecnológica Nacional, Argentina
Sonia Labrada	Universidad de Oriente, Cuba
Sónia Pizarro	Instituto Superior de Engenharia do Porto, Portugal
Sonia Verdugo-Castro	University of Salamanca, Spain
Susana Olmos Migueláñez	University of Salamanca, Spain
Susana Sastre Merino	Technical University of Madrid, Spain
Tania Alonso Sainz	Universidad Autónoma de Madrid, Spain
Tapani Toivonen	School of Computing, University of Eastern Finland, Finland
Teresa Alzás García	University Isabel I, Spain
Teresa Gonçalves	Polytechnic Institute of Castelo Branco, Portugal
Teresa Pessoa	Universidade de Coimbra, Portugal
Teresa Sancho	Universitat Oberta de Catalunya, Spain
Teresa Sena Esteves	Instituto Superior de Engenharia do Porto, Portugal
Thorsten Händler	Vienna University of Economics and Business, Austria
Trevor Spratt	Trinity College Dublin, Ireland
Valeriano Piñeiro-Naval	Universidad de Salamanca, Spain
Vanessa Izquierdo Álvarez	University of Salamanca, Spain
Veronica Basilotta Gomez Pablos	University of Salamanca, Spain
Veronica Rossano	University of Bari Aldo Moro, Italy
Vicente Martínez	Universitat Jaume I de Castellón, Spain
Vicente Matellán Olivera	University of León, Spain
Vicente Matellán-Olivera	Universidad de León, Spain
Vidal Moreno Rodilla	University of Salamanca, Spain
Xabier Martínez Rolán	Universidade de Vigo, Spain

Organization



European Campus
of City-Universities



Cofinanciado por
la Unión Europea



Collaborators



Contents

Trends on Computational Thinking, Engineering Education, Technology in Medicine, Qualitative and Mixed Methods, Diversity in STEM, Lab-Based Education, Technology and Education, Gamification and Games for Learning and Smart Learning at TEEM 2022	1
<i>Gustavo Alves, Joan Arnedo-Moreno, Juarez Bento da Silva, Miguel Á. Conde, António Pedro Costa, Angeles Dominguez, Alicia García-Holgado, Francisco José García-Peñalvo, Carina Soledad González-González, Juan A. Juanes-Méndez, Natércia Lima, Samuel Marcos-Pablos, Arcelina Marques, Judith Martín-Lucas, Rafael Molina-Carmona, José Manuel Muñoz-Rodríguez, Aruquia Peixoto, Teresa Pessoa, Ana María Pinto-Llorente, Joaquim Armando Pires Jorge, M. Isabel Pozzo, M^a Cruz Sánchez-Gómez, Clara Viegas, and Carlos Villagrà-Arnedo</i>	
Computational Thinking and Robotics in Education	
Vocabulary Enrichment in Mother Language After Preschoolers' Interaction with a Social Robot	25
<i>Nicoleta Laura Popa, Oana Alexandra Clim, Adina Boaca, Cristian-Tiberius Axinte, Robert-Gabriel Lupu, and Georgiana Juravle</i>	
The Way for Learning Initial Programming: Activities, Feedback, and Predict Model	33
<i>José Figueiredo and Francisco José García-Peñalvo</i>	
Educational Robotics and Dyslexia: Investigating How Reinforcement Learning in Robotics Can Be Used to Help Support Students with Dyslexia	43
<i>Sarah-May Mcvey, Eysin Chew, and Fiona Carroll</i>	
Designing Exercises for Block-Based Languages: The Case of ScratchJr	50
<i>J. Ángel Velázquez-Iturbide</i>	
An Overview of European Projects About Computational Thinking	60
<i>Tannya Andreina Tene-Tenempaguay, Alicia García-Holgado, Francisco José García-Peñalvo, and Juan Pablo Hernández-Ramos</i>	

Engineering Education: Teachers' and Students' Competences Recent Developments

Digital Competence in Educators Through Interaction with a Virtual Learning Environment	77
<i>Eduard de Torres and Xavier Canaleta</i>	
SDART Software: A Novel Tool Designed to Enhance Learning in Adjustment Computation in Surveying	86
<i>Pablo Rodríguez-González, Manuel Rodríguez-Martín, and Paula García-Osorio</i>	
Software Alternatives to Design Learning Activities for Lean Six Sigma in e-learning	96
<i>Manuel Rodríguez-Martín, Pablo Rodríguez-González, and María del Rosario Domingo</i>	
Following Up on the Examination of Accesses to Educational Resources in a Blended Learning Flipped Classroom Controls Course	106
<i>Ana Pavani and Vivian S. Medeiros</i>	
Roleplay Ethical Debates, An Activity to Learn to Apply Ethical Theories to Dilemmas and Improve Critical Thinking	116
<i>María José Casañ and Marc Alier Forment</i>	
Understanding Engineering Real Projects as an Innovative Learning Activity: A Case Study in the Bachelor's Degree in Electrical Engineering	126
<i>Cristina Sáez Blázquez, Ignacio Martín Nieto, Miguel Ángel Maté-González, Natalia Nuño Villanueva, and Arturo Farfán Martín</i>	
Team-Based Learning to Enhance Student' Competencies in a Fluid Mechanics Module	135
<i>M. Teresa Sena-Esteves, Margarida Ribeiro, Cristina Morais, Isabel Brás-Pereira, Anabela Guedes, Filomena Soares, and Celina P. Leão</i>	
The Internship Subject in a CTeSP Course	144
<i>Frederico L. Jacob, António Silveira D. P. Alberto, and Pedro M. S. Guimarães</i>	

Technological Applications in Medical Training and Practice

The Metaverse in Medical Education and Clinical Practice	157
<i>Juan A. Juanes Méndez, Samuel Marcos-Pablos, and Santiago González Izard</i>	
Students' Assessment of the Use of 3D Vision Technology Resources for Independent Learning	165
<i>Manuela Martín Izquierdo, Marcelo F. Jiménez López, and Juan A. Juanes Méndez</i>	
Embedded Mobile App Prototyping	173
<i>Júlia Carneiro de Almeida Nogueira, Alex Sandro Gomes, Amadeu Sá de Campos Filho, and Fernando Moreira</i>	
Private Health Record System: Improving the Patient's Medical Knowledge with an e-Learning Approach	182
<i>Ali Azadi and Francisco José García-Peñalvo</i>	
Analysis of Ergonomic Aspects in the Surgery Field: Surgeons' Appraisals	192
<i>Jaime Solleiro Rodríguez, Juan A. Juanes Méndez, and Fernando Blaya Haro</i>	
A Production Workflow for Healthcare Educational Dashboards Using Clinical Data	201
<i>Félix Buendía-García, Joaquín Gayoso-Cabada, and José-Luis Sierra-Rodríguez</i>	
Testing and Improvements of KoopaML: A Platform to Ease the Development of Machine Learning Pipelines in the Medical Domain	210
<i>Andrea Vázquez-Ingelmo, Alicia García-Holgado, Francisco José García-Peñalvo, Rubén Fraile-Sanchón, Esther Andrés-Fraile, Pablo Pérez-Sánchez, Pablo Antúnez-Muiños, Antonio Sánchez-Puente, Víctor Vicente-Palacios, Pedro Ignacio Dorado-Díaz, Ignacio Cruz-González, and Pedro Luis Sánchez</i>	
Creating Virtual Models of a Flexible Endoscope in Unity	218
<i>Adrián Lugilde-López, Fernando A. Mikic-Fonte, Manuel Caeiro-Rodríguez, Martín Llamas-Nistal, and Luis Emilio Fernández-Santiago</i>	

INOVSAFECARE Tools for the Training of Practitioners	227
<i>Amaia Yurrebaso, Juan A. Juanes Méndez, Raquel Guzmán-Ordaz, and Eva Picado-Valverde</i>	
Proposal and Definition of a Novel Methodology for Improving the Design and Manufacturing of 3D Printed Prosthetic Hands in Developing Countries	237
<i>Manuel Casal-Guisande, Jorge Cerqueiro-Pequeño, Elena Piñón-Fraga, Daniel Rey-Castro, and Alberto Comesaña-Campos</i>	
Design of a Methodology Based on Analysis of Vibrations for an Efficient Minimally Invasive Remote Monitoring of the Evolution of Parkinson's Disease	246
<i>Manuel Casal-Guisande, Jorge Cerqueiro-Pequeño, Katelynn Rooney, Habeeb Busairi, and Alberto Comesaña-Campos</i>	
Development of Mobile Interactive E-tools in Clinical Guidance for Nurse Practitioners	255
<i>Félix Buendía-García, Meritxell Leal Ferrandis, and Jorge Casaña Mohedo</i>	
Design of a Novel Respiratory Device for Neonatal Patients	264
<i>Manuel Casal-Guisande, Jorge Cerqueiro-Pequeño, Antía Álvarez-Pazó, Ainhoa Álvarez-Álvarez, Andrea García-Vázquez, Mario González-Quintas, and Alberto Comesaña-Campos</i>	
Hyperthermia by Low Intensity Focused Ultrasound	273
<i>Manuel Vielma, David Wahl, and François Wahl</i>	
Piloting the Willingness to Use a Didactic Robot in Health Sciences Education on the Basis of the UTAUT Model	283
<i>Samuel Marcos-Pablos, Rebeca Cordero-Gutiérrez, Rubén Martín-García, and Juan A. Juanes Méndez</i>	
Mobile Application Development for Human Veterinary Resources Management in a Low Density Population Context: Promoting Students Engagement by Working with the Community	292
<i>Paulo Matos, Helena Velasco, and José Gonçalves</i>	
3D Technology Applied on Complex Abdominal Wall Pathologies	304
<i>Jose A. Torres Villachica, Álvaro Sánchez Tabernero, Tiago Coelho Morais, Beatriz Montejo Mailló, and Juan A. Juanes Mendez</i>	

Implementation of Qualitative and Mixed Methods Researches

The Opinion of the Spanish University Population on the Existence of Studies and Professions According to Gender 315
Sonia Verdugo-Castro, M^a Cruz Sánchez-Gómez, and Alicia García-Holgado

Trends in Techno-Social Environments and Gerontechnological Innovation: A Systematic Mapping and European Initiatives 325
Sonia Verdugo-Castro, M^a Cruz Sánchez-Gómez, and M^a Victoria Martín-Cilleros

Towards an Initial Teacher Training in Comprehensive Sexuality Education (CSE): Theoretical Scopes and Presentation of Categories 335
Daniela Dinamarca-Figueroa, Alicia García-Holgado, and M. Cruz Sánchez-Gómez

Evaluation of Learning Attributes in Higher Education: A Methodological Guide Validation 345
Mónica Hernández-Campos, Antonio Gonzalez-Torres, Martha Quesada-Sánchez, Giannina Ortiz-Quesada, and Francisco José García-Peñalvo

Qualitative Analysis of the Transition and Learning Needs of Front-Line Refinery Leaders 355
Patrick Voorhies, Harold Tinoco-Giraldo, and Mark Veary

Accompaniment Methodology of Open Innovation in Local Universities After COVID-19 366
Hilda Angélica Del Carpio Ramos, Pedro Antonio Del Carpio Ramos, Francisco José García-Peñalvo, Jose Carlos Montes Ninaquispe, Haydeé Ysabel del Pilar Chirinos Cuadros, and Eduardo Alberto Martín Zárate Aguinaga

Digital Qualitative and Mixed Methods Research in the Transformation of Higher Education 375
Noé Abraham González-Nieto, Margarita Espinosa-Meneses, and Caridad García-Hernández

Bridging the Diversity Gap in STEM

Analysis of Gender and STEM in Secondary School Students 387
Alba Ayuso and Noemí Merayo

Design of Didactic Units Focused on Improving Diversity Gaps Within New Multidisciplinary Spaces: The STEAM-Labs	397
<i>David Fonseca, Mónica Sanchez-Sepulveda, Roger Olivella, Daniel Amo-Filva, Alicia García-Holgado, Francisco José García-Peñalvo, Giuseppe Maffeo, Yasin Keskin, Kirsten Quass, Christian Hofmann, Gülay Sevinç, and Ömer Yiğit</i>	
Implementing Mentoring Communities Under the TEC21 Educational Model to Ensure the Resilience of Female Students in STEM Areas	406
<i>María Gabriela Ortiz-Martínez, Mónica Delgado-Fabián, Verónica Mayve González-Alemán, and Jorge Membrillo-Hernández</i>	
A Pilot Experience to Raise Awareness Among Computer Science Undergraduates About the Gender Biases of Algorithms	414
<i>Carmen Lacave and Ana Isabel Molina</i>	
A Grey Web Analysis of Existing STEAM Diversity Initiatives	424
<i>Henry Hasti, Daniel Amo-Filva, David Fonseca, Mónica Sánchez-Sepúlveda, Roger Olivella, Alicia García-Holgado, Francisco José García-Peñalvo, Giuseppe Maffeo, Yasin Keskin, Kirsten Quass, Christian Hofmann, Gülay Sevinç, and Ömer Yiğit</i>	
Access and Dropout in Engineering and Architecture Studies. A Preliminary Study with a Gender Perspective	431
<i>Ana-Belén González-Rogado, Susana Nieto-Isidro, and Alicia García-Holgado</i>	
Cultural Differences in Complexity Reasoning in Higher Education	440
<i>Guillermo Rodríguez-Abitia, María Soledad Ramírez-Montoya, Sandra Martínez-Pérez, and Edgar Omar López-Caudana</i>	
Gender Roles and Gender Stereotypes in Childhood Education: A Pilot Study	448
<i>Carina Soledad González-González, Verónica Violant-Holz, and José María del Castillo-Olivares Barberán</i>	
 Lab-Based Education in STEM	
Didactic Analysis of Olive Mill Wastewaters Antimicrobial Activity	457
<i>Inês S. Afonso, Cristina Duarte, António Ribeiro, Joana S. Amaral, and João Ribeiro</i>	

Perceptions of Mechanical Engineering Students Regarding Flipped Laboratory Activities	466
<i>Marina Isabel Felizardo Correia Duarte and Maria de Fátima Coelho Monteiro</i>	
Augmented Reality for Self-management of Learning in Manufacturing Laboratories (AR-ManufacturingLab)	478
<i>Felipe Hernández-Rodríguez</i>	
GeOrder Simulator as Provocator of Semiotic Representations for Statistics Learning in STEM	487
<i>Claudia Orozco-Rodríguez and Abel Palafox González</i>	
 Identity, Technology and Education. Identity Construction Processes in Hyperconnected Ecosystems	
Technology and Teaching Space: A Pedagogical Approach to the Classroom of the Future	499
<i>Judith Martín-Lucas and Alberto Sánchez-Rojo</i>	
Daily Life of Elderly: An Approach to the Use of Gerontechnology	509
<i>Alicia Murciano-Hueso, Judith Martín-Lucas, Sara Serrate-González, Patricia Torrijos-Fincias, and Bárbara-Mariana Gutiérrez-Pérez</i>	
Combating Screens with School Gardens: The Innovative 21st Century Tool Against Nature Deficit	516
<i>David Caballero Franco</i>	
Students as Creators of Online Newspapers: A Tool’s User-Interface Proposal	523
<i>Diogo Miguel Carvalho, Luísa Júlio, and Telmo Silva</i>	
The Subjective Perception of Internet Use Among Protected Minors and Young Offenders in the Childhood Protection Scheme in the Spanish Region of Castilla y León	531
<i>Jesús Ruedas-Caletrio, Sara Serrate-González, and José Manuel Muñoz-Rodríguez</i>	
Social Construction of Learning: Analysis from the Participants of an Energy Sustainability xMOOC	540
<i>Ruth-Elizabeth Minga-Vallejo and María-Soledad Ramírez-Montoya</i>	

The Anthropological Dynamics Revealed in the Use of Social Networks and What We Can Do from Pedagogy	550
<i>Tania Alonso-Sainz</i>	
Video Games as a Form of Youth Leisure: Socialization Practices and Self-perception Among Young University Students	556
<i>Luis E. Andrade Silva</i>	
Gamification and Games for Learning (GAMILEARN)	
Tales from the Future: Exploring Game Design Strategies for Creativity and Play	565
<i>Anna O. Meshcheryakova and Fabian Hemmert</i>	
Design and Implementation of Serious Games on Extended Reality: A Use Case in Construction Safety	575
<i>María Jesús Bopp Ibar, Felipe Muñoz La Rivera, Javier Mora Serrano, and Miguel Valero García</i>	
Urban Exploration Game – An EPS@ISEP 2022 Project	586
<i>Lina Blaschke, Bram Blauw, Chloé Herlange, Anita Pyciak, Jakob Zschocke, Abel J. Duarte, Benedita Malheiro, Cristina Ribeiro, Jorge Justo, Manuel F. Silva, Paulo Ferreira, and Pedro Guedes</i>	
Tangible Application of Gamification for Teaching Spatial Topics to Blind People Based on Universal Design for Learning	597
<i>Luis Roberto Ramos Aguiar, Francisco Javier Álvarez Rodríguez, Julio César Ponce Gallegos, and César Eduardo Velázquez Amador</i>	
Coding is Fun: Engaging Adult On-Line Learners Using Programming Games	606
<i>Joan Arnedo-Moreno and David García-Solórzano</i>	
Gameful English: How Playing Vernacular Video Games May Enhance ESL Learning in an Extra-Mural Educational Context	615
<i>Francesca D’Adamo</i>	
Pervasiveness for Learning in Serious Games Applied to Older Adults	624
<i>Johnny Alexander Salazar Cardona, Jeferson Arango López, and Francisco Luis Gutiérrez Vela</i>	
Examples of Games for Learning in Erasmus+	633
<i>María Goretti Alonso de Castro and Francisco José García-Peñalvo</i>	

Unplugged Gamification: Towards a Definition 642
Carina Soledad González-González

Smart Learning

Smart Schools: Inclusion and Participation of Vulnerable Students
 During at Distance Learning 653
Caterina Bembich and Michelle Pieri

Students’ Acceptance and Efficiency of Virtual Reality in French
 Language Learning at Higher Education 662
Claire Babin, Raphaël Jamard, and Celia Paola Sarango-Lapo

Students’ Performance and Academic Success Study Using Self
 Directed Based Learning Methodology 671
Maria Alsina, Xavier Canaleta, and Ricardo Torres

TEmaps for Designing Courses Based on Smart Learning 682
*Alberto Real-Fernández, Rafael Molina-Carmona,
 and Faraón Llorens-Largo*

Identifying Demotivation Patterns in Students of Subjects Related
 to Data Science at College 690
*Alejandro Rabasa, Kristina Polotskaya, Agustín Pérez-Martín,
 Nuria Mollá, and Patricia Compañ*

Trends on Communication, Educational Assessment, Sustainable
 Development, Educational Innovation, Mechatronics and Learning
 Analytics at TEEM 2022 699
*Ana María Balbín, Nidia S. Caetano, Miguel Á. Conde,
 Paulo Costa, Carlos Felgueiras, Ángel Fidalgo-Blanco,
 David Fonseca, Adriana Gamazo, Alicia García-Holgado,
 Francisco José García-Peñalvo, José Gonçalves,
 Ángel Hernández-García, José Lima, Nicolae Nistor,
 Joe O’Hara, Susana Olmos-Migueláñez, Valeriano Piñeiro-Naval,
 María-Soledad Ramírez-Montoya, Patricia Sánchez-Holgado,
 and María Luisa Sein-Echaluze*

Communication, Education and Social Media

Fact-Checking: A Journalistic Movement yet to Be Discovered?
 Audience Attitudes and Familiarity Levels in Portugal 719
*João Pedro Baptista, Anabela Gradim, Marlene Loureiro,
 and Fábio Ribeiro*

Opportunities, Challenges, and Risks of Clickbait in the Scientific Communication	728
<i>Ana María Zaharía and Jesús Miguel Flores-Vivar</i>	
Signs of Culture in Computer Games: Assumption for Education	738
<i>Gintare Vaitonyte, Eugenija Valiene, and Dalia Senvaityte</i>	
Women in Front of and Behind the Camera. Analysis of the Representation of Society in Contemporary Spanish Cinema	747
<i>David Blanco-Herrero, María Marcos Ramos, and Teresa Martín García</i>	
Chatbot to Provide Initial Assistance to Erasmus Students in Case of Emergency	755
<i>Roberto Fermín García Mena, Antonio Balderas, Milagros Huerta, Juan Manuel Dodero, and Nestor Mora Nuñez</i>	
New Technologies to Quit Smoking. Analysis of Mobile Applications Available for iPhone	764
<i>Laura Rodríguez-Contreras and Juan-José Igartua</i>	
Are Intercultural Competencies the Key to International Collaboration?: A Systematic Review	772
<i>Nicia Guillén-Yparrea and María-Soledad Ramírez-Montoya</i>	
Profiles of Smartphone Use and Consumption in Spanish Students of Generations Y and Z	782
<i>Diego Ramos Méndez and Félix Ortega-Mohedano</i>	
The Censorship of Nudes on Instagram: The Female and Male Body and Its Sexualization	790
<i>María del Carmen Tomás-Jiménez, Patricia Sánchez-Holgado, and María-Elena Rodríguez-Benito</i>	
Education Through Organizations with a Purpose in Social Networks	798
<i>Laura Pacheco Barriga</i>	
Museums and Heritage Education on Instagram: An Analysis of the Actions of the “Museus Conectam” Network	806
<i>Rafaela Silva Thomaz</i>	
The Association of Internet Use with Subjective Well-Being: An Empirical Study Based on CGSS 2017	814
<i>Yurong Yan, Yuying Deng, Juan-José Igartua, and Xiagang Song</i>	

Educational Assessment and Guidance

- Application of the CIPP Model in the Structure of a Satisfaction Survey
for Elearning Training Activities 825

*Jessica Uribe Navarrete, María José Rodríguez Conde,
and Susana Olmos Migueláñez*

- Mentoring in Educational Innovation: Systematization in the Experience
of Teachers' Educational Experimentation and Research 838

May Portuguese-Castro

- Student's Awareness of the Environment in Mallorca (Spain)
on Education for Sustainable Development (ESD) 850

*Maneerat Sa-ngiemjit, María Antonia Manassero Mas,
and Ángel Vázquez Alonso*

- Comparing Students' Critical Thinking by Using the Revised Bloom's
Taxonomy in Online and Face-to-Face Class Formats of Organic
Chemistry 860

*Maneerat Sa-ngiemjit, María Antonia Manassero Mas,
and Ángel Vázquez Alonso*

- The Usefulness of a Mobile App in a Visual Literacy Blended Learning
Course for Educators 870

*Catalina Huilcapi-Collantes, Azucena Hernández Martín,
and Juan Pablo Hernández-Ramos*

- Competences of University Teaching Staff to Use New Learning
and Evaluation Resources 879

*Angélica González Arrieta, Guillermo Hernández González,
Juan Manuel Corchado Rodríguez, María Belén Pérez Lancho,
José Rafael García-Bermejo Giner, Iván Álvarez Navia,
Juan Andrés Hernández Simón, Ángel Luis Sánchez Lázaro,
and Pastora Isabel Vega Cruz*

Advances on Sustainable Development in Higher Education

- Learning Object as an Educational Innovation Tool for Energy
Management Systems Teaching Based on the ISO-50001 Framework:
An Interdisciplinary Descriptive Approach 891

*Josué Aarón López-Leyva, Sialia Karina Mellink-Méndez,
Gloria Janeth Murillo-Aviña, and Paola Monet Cañedo-Bobadilla*

Learning the Design of Geothermal Sustainable Systems Through the Analysis of Acceptable Outcomes	900
<i>Ignacio Martín Nieto, Cristina Sáez Blázquez, Miguel Ángel Maté-González, Natalia Nuño Villanueva, and Arturo Farfán Martín</i>	
Promoting Sustainability and Energy Efficiency in Higher Education Through the Optimized Management of Geothermal Resources	909
<i>Cristina Sáez Blázquez, Ignacio Martín Nieto, Miguel Ángel Maté-González, Natalia Nuño Villanueva, and Arturo Farfán Martín</i>	
Electronic Test Subjects and Sustainability	919
<i>Rúbem Sarmiento and Carlos Felgueiras</i>	
Insect Farming – An EPS@ISEP 2022 Project	925
<i>Benjamin Copinet, Finn Flügge, Leonie Christine Margetich, Marie Vandepitte, Paul-Luchian Petrache, Abel J. Duarte, Benedita Malheiro, Cristina Ribeiro, Jorge Justo, Manuel F. Silva, Paulo Ferreira, and Pedro Guedes</i>	
Form Follows Recyclability? Instruments for Dissipation-Aware Product Design	935
<i>Konrad Schoch, Fabian Hemmert, and Christa Liedtke</i>	
The Role of Engineering in Achieving the SDGs: A Case Study on Awareness-Raising Through Different Undergraduate Subjects at the Higher Polytechnic School of Zamora (Spain)	944
<i>Ana Belén Ramos-Gavilán, M^a Ascensión Rodríguez-Esteban, M^a Almudena Frechilla-Alonso, Aitor Cristiam Raposeiras, Diana Movilla-Quesada, Ana María Vivar-Quintana, Isabel Revilla, and Ana Belén González-Rogado</i>	
An Overview of the Evolution of Civil Engineering Education Towards Sustainability in Portugal	953
<i>Paulo Silva, Nídia S. Caetano, and Carlos Felgueiras</i>	
Towards Sustainable Living: Undergraduate Training Course Using AWORLD App as an Educational Resource	962
<i>Harold Tinoco-Giraldo, Catalina Huilcapi-Collantes, Aída Gándara-Tovar, and Sandy Antonio Gutiérrez</i>	

Educational Innovation

Didactic Strategies in Hybrid and Remote Learning Modalities to Promote Critical Thinking	973
<i>John Jairo Dominguez, Manuel Iván Ortiz Ramos, Alex Sandro Gomes, Fernando Moreira, Rossana Gaia, Miguel Ángel Vargas, and Rosane Alencar da Silva</i>	
Academic Analytics Applied in the Study of the Relationship Between the Initial Profile of Undergraduate Students and Early Drop-Out Rates. Defining the Variables of a Predictor Instrument	982
<i>Alba Llauro, David Fonseca, Daniel Amo-Filva, Susana Romero, Marian Alález, Jorge Torres Lucas, and María Martínez Felipe</i>	
Analysis, Progress and Comparative of the European Digital Competence Framework DIGCOMP	991
<i>María Collado-Sánchez, Francisco José García-Peñalvo, and Ana M. Pinto-Llorente</i>	
A Tool to Analyze the Satisfaction Impact of the MFT Method	998
<i>Marta Gómez-Gómez, José Tomás Alcalá-Nalvaiz, Inmaculada Gómez-Ibáñez, María Luisa Sein-Echaluze, and Ángel Fidalgo-Blanco</i>	
Digital Competence, Educational Innovation with ICT and Burnout in Tertiary Education Latin American Professors	1007
<i>Angel Deroncele-Acosta, Irma Milagros Carhuancho-Mendoza, Fernando Alexis Nolzco-Labajos, Helfer Molina-Quiñones, Jorge Ernesto Torres-Obleas, Susana Edita Paredes-Díaz, and Juanjo Mena</i>	
Perceptions of Future Teachers Experiencing Flipped Learning as Students in a Master's Course in Spain	1016
<i>Iciar Pablo-Lerchundi, Ana Jiménez Rivero, Gema Martí-Blanc, and Susana Sastre-Merino</i>	
Typology of Processes in the Shared Leadership of Academic Work Teams	1025
<i>Ángel Fidalgo-Blanco, María Luisa Sein-Echaluze, Ana María Balbín, and Francisco José García-Peñalvo</i>	
Personalized Flipped Classroom	1034
<i>María Luisa Sein-Echaluze, Ángel Fidalgo-Blanco, José Luis Martín-Núñez, Amparo Verdú Vázquez, and Laura García Ruesgas</i>	

Learning Design Using Mobile Technology in Visual Literacy Teacher Training	1044
<i>Catalina Huilcapi-Collantes, Azucena Hernández Martín, and Juan Pablo Hernández-Ramos</i>	
A Proposal for Innovative Higher Education in Archaeology Through the Use of Virtual Tours	1053
<i>Miguel Ángel Maté-González, Cristina Sáez Blázquez, Jesús Rodríguez-Hernández, and Jesús R. Álvarez-Sanchís</i>	
Digital Teaching Skills to Design Virtual Learning Classrooms with the 4PADAFE Methodology	1062
<i>Lena Ivanova Ruiz Rojas, Cristhian Castillo, and Santiago Cañizares</i>	
Synergies Between Geomatics and Biological Sciences for the Creation of New Virtual Materials for Teaching Taphonomy	1072
<i>Miguel Ángel Maté-González, Julia Aramendi, Cristina Sáez Blázquez, Mari Carmen Arriaza, and José Yravedra</i>	
Gamified Formative Assessment in Local Architectures	1082
<i>Ángel Hernández-García, Laura Del-Río-Carazo, Carlos Cuenca-Enrique, Santiago Iglesias-Pradas, Emiliano Acquila-Natale, and Julián Chaparro-Peláez</i>	
Enhancing Adaptive Teaching of Reading Skills Using Digital Technologies: The LATILL Project	1092
<i>Martina Kienberger, Alicia García-Holgado, Karen Schramm, Anne Raveling, Detmar Meurers, Bohdana Labinska, Tetiana Koropatnitska, and Roberto Therón</i>	
A Model for Learning with Focus on Social Responsibility, Problem Solving and Collaborative Work in Higher Education	1099
<i>Álvaro Rojas Zamorano, Emilio Castro Navarro, and Carolina Castro Pereira</i>	
Multi-stakeholder Perspective on the Gap Between Existing Realities and New Requirements for Online and Blended Learning: An Exploratory Study	1109
<i>Miguel Á. Conde, Sonsoles López-Pernas, Elitsa Peltekova, Katina Pancheva, Miroslava Raspopovic Milic, and Mohammed Saqr</i>	

Gamified Values Education for Fostering Migrant Integration at Schools 1117
Lucía García-Holgado, Andrea Vázquez-Ingelmo, Alicia García-Holgado, Francisco José García-Peñalvo, Ömer Yiğit, Cristina Ramón-Navarro, Dilek Gökçen Pasin, Canan Aktug, and Annette Greilich

New Trends in Mechatronics Engineering Education

Learning Mechatronics in the MacGyver Way 1127
João Paulo Coelho and Inês Seixas

Robot Development for Educational Purposes: Advances on Real and Simulation Environments 1135
Emanuel de Jesus Soares Marta, José Gonçalves, and José Lima

Towards a More Accurate Time of Flight Distance Sensor to Be Applied in a Mobile Robotics Application 1145
Laiany Brancalião, Mariano Alvarez, Miguel Á. Conde, Paulo Costa, and José Gonçalves

Automated Ceramics Tableware Finishing: A Laboratory Prototype for Concept Validation 1156
Mariano Alvarez, Laiany Brancalião, Jorge Carneiro, Paulo Costa, João Paulo Coelho, and José Gonçalves

Those Were the Days! Looking Back at Ten Years of Learning Analytics at TEEM

From Variables to States to Trajectories (VaSSTra): A Method for Modelling the Longitudinal Dynamics of Learning and Behaviour 1169
Sonsoles López-Pernas and Mohammed Saqr

A Revision of LMS Interaction Classifications for Learning Analytics 1179
Ángel Hernández-García, Carlos Cuenca-Enrique, Uchendu Nwachukwu, and Laura Del-Río-Carazo

Higher Education from a Learning Analytics Perspective: an Exploration of the Theory Choice in Doctoral Educational Research 1190
Siyu Jiang, Nicolae Nistor, and Dorin Stanciu

Learning Analytics' Privacy in the Fog and Edge Computing: A Systematic Mapping Review 1199
Daniel Amo-Filva, David Fonseca, Francisco José García-Peñalvo, Marc Alier Forment, and Maria José Casany Guerrero

Doctoral Consortium

Digital Transformation in Higher Education Institutions Implementation Model	1211
<i>Lina María Castro Benavides, Johnny Alexander Tamayo Arias, and Daniel Burgos</i>	
Get the Most Out of Erasmus+ Good Practices	1220
<i>María Goretti Alonso de Castro and Francisco José García-Peñalvo</i>	
Indigenous Women in Higher Education in STEM: A Case Study in Oaxaca	1229
<i>Erika García-Silva, Alicia García-Holgado, and M^a Cruz Sánchez-Gómez</i>	
Development of Algorithms and Methods for the Simulation and Improvement in the Quantum Natural Language Processing Area	1238
<i>David Peral-García, Juan Cruz-Benito, and Francisco José García-Peñalvo</i>	
Design, Development, and Evaluation of a Serious Game Aimed at Addressing Bullying and Cyberbullying with Primary School Students	1246
<i>Alejandro Martel-Santana and Marta Martín-del-Pozo</i>	
Teaching Processes Concerning the Production of TV with Portuguese Elderly – From the Gratifications Obtained by Consumption to the Expectancies of the Production Process	1255
<i>Luís Miguel Pato, Patricia Torrijos Fincias, Cristóvão Margarido, and Ricardo Pocinho</i>	
TAM, Assessment, and Mobile Technologies: A Study of Teachers' Acceptance in Higher Education	1263
<i>Alberto Ortiz-López, Susana Olmos-Migueláñez, and José Carlos Sánchez-Prieto</i>	
Validation and Implementation of a Training Course on Digital Competence and Cybersecurity in the Future Teachers of the Autonomous Community of the Canary Islands Using the Escape Room Technique	1272
<i>David Suárez-Suárez and Juan Pablo Hernández-Ramos</i>	
XR as a Forward-Looking Tool for Mathematics Learning of Secondary School Students with Dyslexia and ADHD: A Thesis Plan	1279
<i>Àlex Miró-Mediano, Marc Alier Forment, and Francisco Javier Mora Serrano</i>	

The Influence of Serious Games and Gamification in University Students of English as a Foreign Language	1289
<i>Julián Alberto López-Torres, Hernández-Ramos Juan Pablo, and Azucena Hernández Martín</i>	
Methodological Approach to the Evaluation of Scientific Journals	1296
<i>Valeria Montoya-Roncancio and José Antonio Merlo-Vega</i>	
Development of an Accompaniment Program for Women at Risk of Exclusion After Unintended Pregnancies	1304
<i>Eustasio Pérez Salido, Araceli Queiruga Dios, and Marián Queiruga Dios</i>	
The Maker Movement in Engineering Education: A Partial Literature Review of the Research Opportunities on Competency Development	1311
<i>Leonardo Saavedra Munar and Marc Alier Forment</i>	
Design, Development, and Evaluation of an Intervention in Terms of Teaching/Learning Practices of Curricular Units of Differential and Integral Calculus in Engineering Degrees	1320
<i>Maria Emília Bigotte de Almeida, Araceli Queirugas-Dios, and María José Cáceres</i>	
Research Plan and Development of the Thesis: Musical Preferences in Primary Education in the Nou Llevant/Sud Neighborhood of Mallorca	1329
<i>Aurora Ferrer Juan, Noemy Berbel Gómez, and Josep Lluís Oliver Torelló</i>	
Assess Informal Learning, Through Technology, in Science Centers or Science Museums	1337
<i>Ivone Fachada, Francisco José García-Peñalvo, and Ana Isabel Pereira</i>	
Jazz Standards: From the Manuscript to Multiple Possibilities Through Computation	1346
<i>Patricia García-Iasci and Javier Merchán Sánchez-Jara</i>	
Definition of a Reference Architecture for the Integration of Augmented Reality/Virtual Reality Techniques in Remote Experimentation Environments	1354
<i>Isabela Nardi da Silva, Javier García-Zubía, and Unai Hernández-Jayo</i>	

The Discourse Against the LGTB Community in Social Networks and Its Relationship with Hate Crimes in Spain	1362
<i>Marcos Barbosa and Carlos Arcila</i>	
Data Literacy for the Development of Learning Analytics in K-12 Environments	1370
<i>Belén Donate Beby, Francisco José García-Peñalvo, and Daniel Amo-Filvà</i>	
Grading Criteria in Technology Subject in Secondary Education Within the Framework of the LOMLOE	1377
<i>Aurora Pérez-Fonseca, María Dolores Merchán Moreno, and María Jesús Santos Sánchez</i>	
Author Index	1385



Mobile Application Development for Human Veterinary Resources Management in a Low Density Population Context: Promoting Students Engagement by Working with the Community

Paulo Matos^{1(✉)}, Helena Velasco², and José Gonçalves¹

¹ CeDRI-Research Centre in Digitalization and Intelligent Robotics,
Polytechnic Institute of Bragança, Bragança, Portugal
{pmatos,goncalves}@ipb.pt

² Câmara Municipal de Bragança, Bragança, Portugal
helena.velasco@cm-braganca.pt

Abstract. This paper describes a mobile application, developed in an educational context, by the students of the Degree in Computer Engineering of the Instituto Politécnico de Bragança, allowing them to develop skills, based on real-world community problems solving, promoting by this way its engagement, and, at the same time, provide a solution to an effective need of the local community. The developed application has as goal to support the Human Veterinary Resources Management in a Low Density Population Context.

1 Introduction

Bragança is a small town from the northwest of Portugal that struggles with dimension and scale problems, being the only district capital that do not has an Veterinary Hospital that can provide a service 24/7 service. The need for this application arises from this very specific, uncommon context, characterized by areas of low population density, where it is not sustainable to maintain a full-time public service. The solution found resorts to several private providers of veterinary services to, as a whole, ensure this service to the population on a full-time basis. The particularity and rarity of this scenario makes the creation and commercial exploitation of this type of product unfeasible. It was in this context that the challenge was posed to the students of the Degree in Computer Engineering at the Instituto Politécnico de Bragança, allowing them to develop skills with real problems and, at the same time, provide a solution to an effective need in the region, promoting by this way its engagement [1–3].

However, this requires considering unusual aspects in the development - which are related to the fact that students will not be available to meet future

administration or maintenance needs. First of all, avoid the existence of physical equipment, namely servers that, in addition to having a relevant acquisition cost, sooner or later, need updates - for example, security updates. Avoid having its own services that also require maintenance, such as HTTP/S or database servers.

The particularity of the present context results that there are no other references that can be directly compared with the work proposed by the authors. However, there are some projects that share the same position of contributing to the common well-being and developed in an academic environment.

The paper is structured as follows initially an introduction section will contextualize the problem, then the related work, followed by the application functional requirements will be introduced, then the proposed solution and its implementation will be described and finally some conclusions and future work will round up the paper.

2 Related Work

One of the most active areas is the surveillance systems for public health related to animal diseases. There are many projects that take place in the most diverse geographical realities, as a result of the need to identify potential pandemics in time, understand their evolution and the impact they may have [4,5,7,8]. A real-time disease surveillance enables awareness of practitioners, students and veterinary technicians with an increased awareness of state and regional livestock disease.

Among the many projects, the “Improving the Sustainability of Rural Veterinarians Through Mentoring, Targeted Education, Telemedicine and Monitoring of Disease Syndromes” project [6], funded by the U.S. Department of Agriculture National Institute of Food and Agriculture grant, led by the Texas A & M AgriLife faculty, through which it has developed the Veterinary Syndromic Surveillance System, which provides an app and website to track diseases - that allows veterinarians to check online if what they see in the field is unique to their area or part of a pattern.

Other related work was report by [9], seeking to expand a web-based system and smart device app that is used as a distance learning and a telemedicine tool to assist farmers in getting immediate support and reaching veterinary care professionals and extension agents.

In [10] the authors analyse the importance and impact of new technologies in supporting veterinary services. State that the digital technologies will have a profound effect on how animal health services are delivered and how animal health systems are managed. They classify the technologies into three different sets, one of them focuses precisely on the relevance of wireless and mobile technologies - for animal health monitoring, disease surveillance, reporting and information sharing.

At [11], the authors state the great advantages of serverless computing, part of the technical solution used in the present work, identifying some existing challenges and analysing the associated cutting-edge solutions. With these results,

the authors further investigate some typical open-source frameworks and study how they address the identified challenges.

On both [12, 13], the authors state the advantages, disadvantages, challenges and characteristics of the serverless architectures, namely to dispense with the need to have and manage hardware, servers and services; as well as allowing high availability, dynamically adjustable to needs, with reduced operating and maintenance costs.

3 Application Functional Requirements

The main functional requirements of the proposed application is the following to provide a quick way to contact the veterinarian who is actually on duty. This is the ultimate motivation of the entire solution, to ensure that there is a place where interested parties, like firefighters, police, civil security and others, know that can find the contact information of the veterinary on duty; that the information available there is correct and up to date; and that from there they can easily contact the veterinarian on duty.

It also has to allow for simplified management of shift allocation. The distribution of days by veterinarians (duty shift) is, according to the current procedure, agreed for extended periods, typically for a calendar year. Entering this data for each day of the year, one by one, is not an acceptable solution. It is important to supply a solution that allows to insert/updated this data at once, for example, uploading a CSV file. The possibility of this procedure being repeated for full or partial updates of the shift schedule should be considered.

The application must allow the exchange of schedules between veterinarians. As the duty shift is scheduled for an extended period of time, and despite being agreed in advance by everyone, it is very natural and common that unforeseen circumstances arise that prevent the shift from being carried out exactly as stipulated. The problem is usually overcome by mutual agreement between the veterinarians themselves - normally, faced with the impossibility of fulfilling the service, they contact their colleagues to see if there is anyone available for the day in cause, in exchange for another one. As these unforeseen events are common among all, in which sooner or later, all veterinarians end up needing to make an exchange, there is a natural understanding and cooperation to resolve situations.

However, the motivation of this project is effectively related to these exchanges, which, when agreed between veterinarians, are not always widely known to the interested parties. Even when the exchange is formalized in the person who coordinates the process, its dissemination is not always effective, this is because many of the interested entities have the practice of printing on paper this data, to facilitate and ensure that the information is easily accessible, but with that, neither care is always taken to update these physical documents, when for some reason the data is changed.

Hence, it is essential to ensure a solution that allows for the exchange of shifts/scales of service, ensuring that this information is updated to the interested parties. If possible, without requiring the involvement of a central

management entity, that is, as long as the veterinarians involved in the exchange agree, it must be possible to do this by themselves.

Some complementary functionalities emerged in a later state, as a way to further enhance the usefulness of the solution and also as a result of the chosen technical options, in the belief that it will be able to support more features.

The basic idea is to collect elements about the interventions of veterinarians, elements that may be useful for the purposes of contacting animal owners, disseminating information, among others.

The registration must allow:

- Safeguard the intervention site, if possible, using GPS coordinates.
- Collect photos of the animal.
- If possible, register the identification of the animal.
- And, eventually, register additional information that may be useful to the entities involved.

4 Proposed Solution

For widespread access by the different parties involved, it was immediately clear that the solution would have to be a smartphone application. It is a common device, to which practically the entire population has access, in particular the elements of the interested parties, such as the police, civil security and the like. It adapts to the intended use and even have a set of technical options that support new features - it was even the decision to use the smartphone, which resulted in the FRO3 - taking advantage of the GPS and camera that most of the smartphones have.

The second decision concerned the development technology. The option by an smartphone app creates a problem - there are two major players in terms of operating systems: Android and iOS. Ensuring specific application development for both platforms was out of the question due to time constraints. The risk of not being able to complete both was also greater, so most likely only part of the users would have access to the solution - making it not a solution.

The decision fell on the use of React Native ensuring that with only one line of development it was possible to produce applications for both platforms: Android and iOS. Also enabling the possibility of having a web version, namely with the information about the veterinarian on duty.

The third technical decision was about application support services. In a more traditional model, it would be necessary to have a database server and a server to host REST/SOAP or equivalent services. From the explanation given for the NFR01 requirement, this was to be avoided. Thus, a serverless solution was chosen. Not that this means there is no server, but that the server belongs to a third party and works for simply as a place in the cloud where the the back-end services are hosted. There are thus no worries about installing, configuring and maintenance of services and servers.

Figure 1 illustrates the architecture of the solution, where the three types of users (actors) can also be identified:

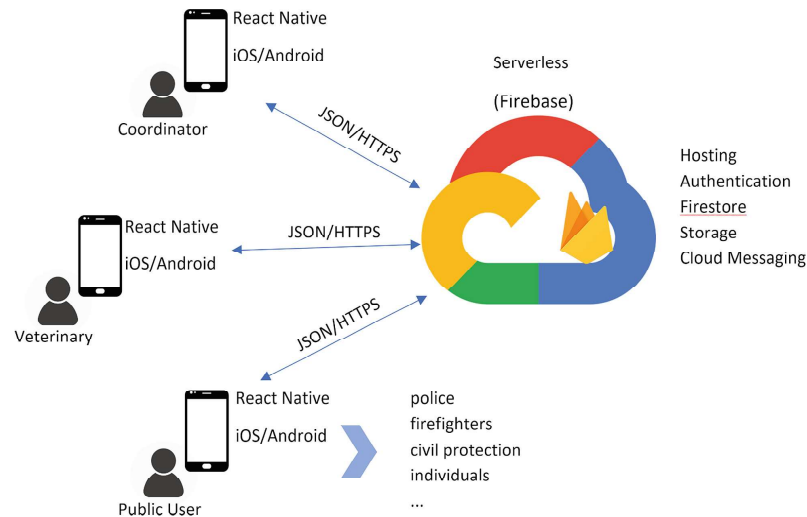


Fig. 1. Solution architecture.

Public User - Named for having access only to the public component of the application. Represents any person who needs to contact the veterinarian on duty, it can be a police officer, civil security officer or any other person.

Veterinarian - They are the ones who provide veterinary services. Access requires registration and subsequent acceptance by the Coordinator. The veterinarian can request to change shifts with a colleague and register the services provided.

Coordinator - Entity that admitted/removes veterinarians and that can upload the file with the duty shifts.

Only the last two can consult the entire schedule. The Public User only sees the contact of the veterinarian on duty for the day in question (the day he uses the app to request support from the on-call veterinarian).

All usage profiles are ensured through a single application - which, depending on the profile, provides more or less functionalities.

4.1 Veterinary Registration

Figure 2 illustrates the procedure for registering veterinarians. Anyone can register as a veterinarian. However, access to the veterinary features is impossible until the Coordinator admits him/her. The idea is that the person makes a registration, providing the name, email and telephone contact. A code is sent to

the email to verify email ownership. Later, the user can enter more data, such as the business name of the company he represents and the like.

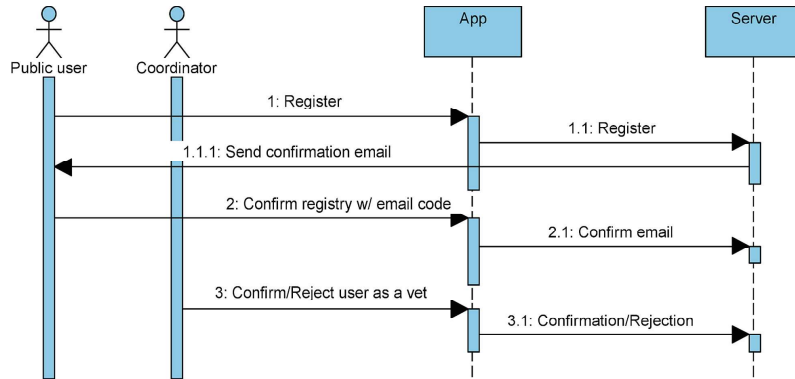


Fig. 2. Sequence diagram of the vet registry and acceptance.

Once the email has been verified, the candidate appears on the Coordinator's dashboard - The Coordinator can view the registration data to confirm their veracity and can accept or reject the registration. If rejected, all information from the veterinarian candidate's record is removed. If accepted, the veterinarian will be able to access the features of this profile.

4.2 Shift Exchange

The veterinary should have access to a calendar showing their duty shifts, as well as information on who is assigned to the other days. Trading for the purpose of exchange is extra-application, that is, it is the interested party who contacts the colleagues to find out if anyone is available to exchange and thus ensure the service for the day in question. Once agreed, anyone involved can go to the application, choose the days between which the exchange will take place. User can only do it for days that are allocated to him and always for future dates. The veterinarian on duty for the day to be changed receives a notification that can be viewed in detail in the application itself, signaling the change request. He can reject or accept. Upon acceptance, the exchange takes place between both and becomes visible to all others involved. The Coordinator also has access to this information on the exchange list, but only to be aware of. If the exchange is rejected, the applicant receives this indication by notification and can consult the status of the request on the application (that will appear as rejected).

5 Implementation

The implementation is not yet in the desired state, but it already provides almost all the intended features. In Fig. 3 it is possible to visualize the layout of the

public screen - when opening the application, the user (regardless of the profile) sees which veterinarian is on duty for the day in question. By clicking on the mobile number, the call is immediately initiated.

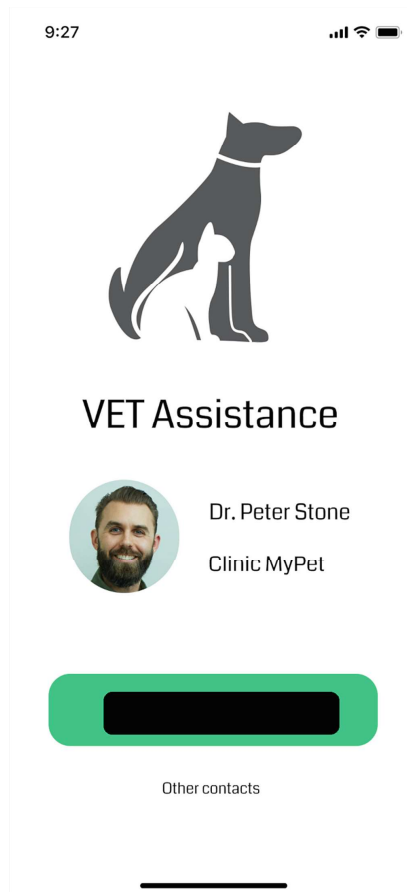


Fig. 3. Public screen

The long press on the application's logo allows access to authenticated functions, that is, those intended for veterinarians and coordinator. If there is no previous registration, the user is sent to the screen Fig. 4a, where he/she must fill in his/her data. From here, an email is sent with a confirmation code that should be introduced on the app (see Fig. 4b) - this way the email is validated as belonging to the user in question.

The user, a potential veterinarian, will stay on a pending condition - not being able to do anything else until the coordinator effectively admits him as a veterinarian.

If the user is already registered and confirmed by the coordinator, he goes directly to screen of Fig. 4c, where he can view past and present shift change requests, namely those awaiting by response. On the leftmost side of each request it is the veterinary that have requested the exchange. On the right, it appears

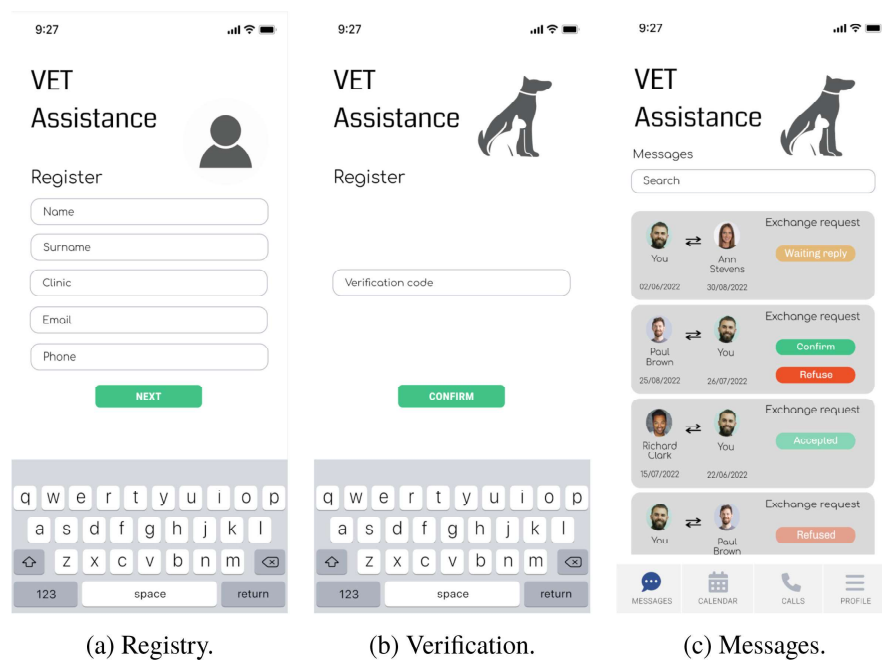


Fig. 4. Screens 1

to whom the request was done. In both cases, with the respective date (days for the exchange). Note that the user can either appear on the leftmost side, requesting the exchange to a colleague; or more to the right, in case a colleague has requested him to change shifts.

When the request is made by the user to a colleague, the indication of Waiting Reply appears. On the side of the colleague, there is the possibility of accept or reject.

The screen of Fig. 5a (Calendar) allows the user to know which days he has a shift (signalled in light blue); and consult who is on duty for a given day, simply by selecting the day. Whenever this is done, for the veterinarian on duty it appears the respective telephone contact and the possibility of requesting the change for the selected day. The idea is that user uses the contact to speak personally with the colleague to arrange the exchange. Then through the application formalizes this exchange.

When making Request change, it is possible to select a second day (the day to change) - Figure 5b - circled in red. Once this is done, user can then definitively request the exchange (Request). The process proceeds as previously explained. The days with pending trade requests are indicated by the small red dot and the detailed information shows Waiting reply (see Fig. 5c).

The veterinarian can also register the services performed through the Call option (Fig. 6a). Here you have the possibility to view records already made or to be filled in, as well as request the creation of a new record. In the latter case, it is automatically sent to the cell phone camera, in order to register the service through a photo of the animal in question (see Fig. 6b). Once the photo is taken,

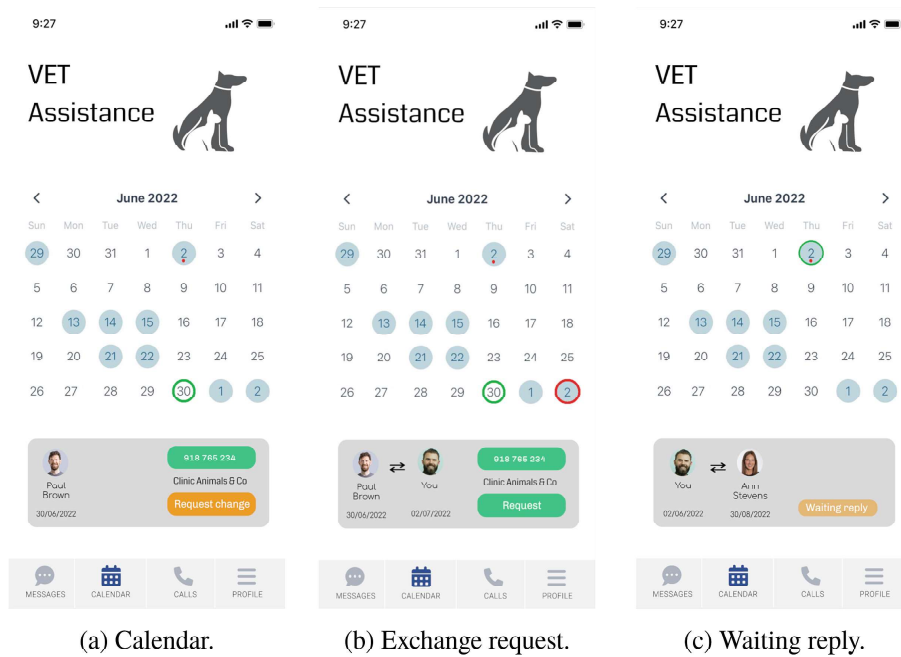


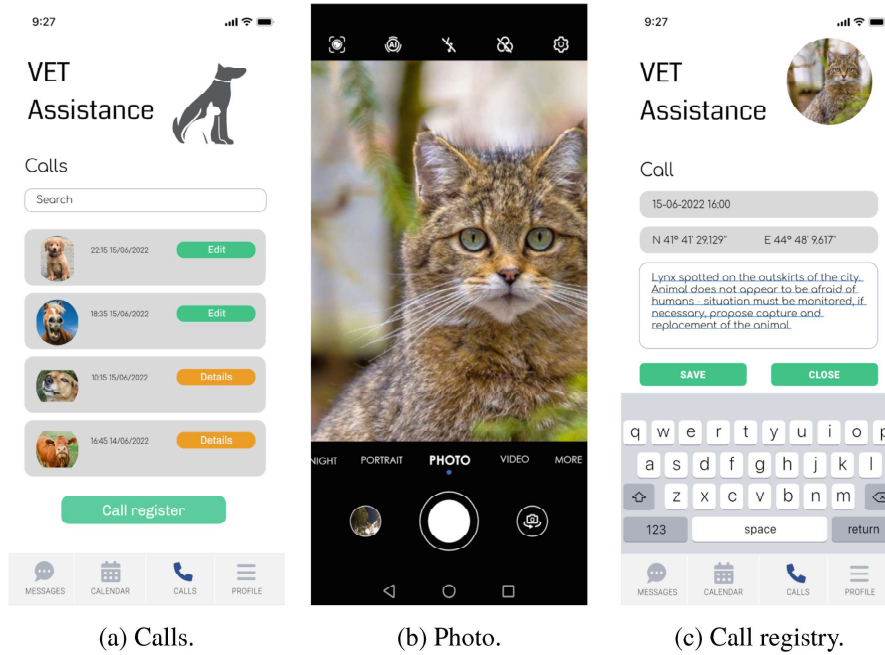
Fig. 5. Screens 2

the date, time and GPS coordinates of the location are also obtained. The record can be left in edit mode to be finished later or finished immediately (Fig. 6c).

According to Fig. 7a, the vet also has the Profile option available to edit their data (name, clinic, cell phone contact and photo).

The coordinator accesses the private part in the same way - but it is supposed to already be registered, which is done directly on the back-end (Firebase console). The coordinator has the option to view messages, for now only regarding requests for admission of users on the platform as veterinarians. For this purpose, he has access to the name, clinic, email, mobile phone and, eventually, photo (see Fig. 7b). He can accept or decline the request. Note that for each request an identifier is generated - which is essential to identify veterinaries in the upload option.

In the upload option, the coordinator can upload the file with the shift assignments. The file must be in CSV format, containing, for each day assigned, the user ID and the day (in YYYYMMDD format). Figure 1 illustrates one of these files. With this solution, the administrator makes the planning, namely for extended periods of time, and then easily makes that information available. This service assignment is normally carried out with the prior consent of the veterinarians. In any case, the objective of the solution is precisely to provide the possibility for veterinarians to exchange days of service and that this is reflected in the information provided to the common user.

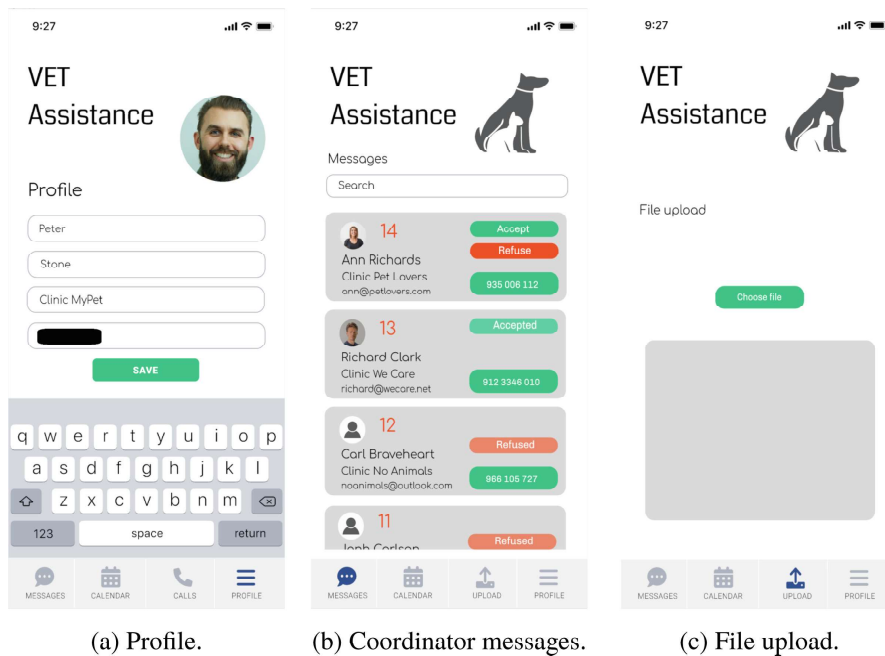


(a) Calls.

(b) Photo.

(c) Call registry.

Fig. 6. Screens 3



(a) Profile.

(b) Coordinator messages.

(c) File upload.

Fig. 7. Screens 4

Table 1. CSV file format

Day	ID
20220615	5
20220616	3
20220617	1

6 Conclusions and Future Work

In functional terms, the created solution complies with the defined and the necessary goals - although there are already more ideas and improvements identified. For this purpose, a serverless service was used, Firebase, which is a Platform As A Service - PaaS (more precisely a Back-End As Service - BeaS) - with this, the need for servers, services (HTTP and database), configuration and maintenance were significantly reduced.

Thus, a solution was obtained that can be immediately made available to the community, fully manageable by the community itself and that does not require the continued involvement of students for its maintenance. The production of an application that is effectively necessary and that will be used for the benefit of the community, namely veterinarians, but also of all those who use their services as public service providers, is undoubtedly a way to put students in practical situations, with the natural demands of the applications for effective use, promoting the experience, the acquisition of competences and even the professional curriculum of the students. The authors believe that the experience should be extended, bringing new challenges, namely for situations like the present, where it is possible to build in the available time and with the skills that students have, functional solutions that can be effectively used and for a long time.

Acknowledgements. This work has been supported by FCT - Fundação para a Ciência e Tecnologia within the Project Scope: UIDB/05757/2020.

References

1. Mebert, L., et al.: Fostering student engagement through a real-world, collaborative project across disciplines and institutions. In: Higher Education Pedagogies, vol. 5, no. 1, pp. 30–51. Routledge (2020). <https://doi.org/10.1080/23752696.2020.1750306>
2. Ferreira, D., Ambrosio, A., Melo, T.: Application of real-world problems in computer science education: teachers' beliefs, motivational orientations and practices. *Int. J. Inf. Commun. Technol. Educ.* **14**, 15–28 (2018). <https://doi.org/10.4018/IJICTE.2018070102>
3. Pirttinen, N.: Crowdsourcing in computer science education, pp. 421–422 (2021). <https://doi.org/10.1145/3446871.3469781>
4. Dórea, F.C., Sanchez, J., Revie, C.W.: Veterinary syndromic surveillance: current initiatives and potential for development. *Prevent. Veter. Medi.* **101**(1–2), 1–17 (2011). ISSN 0167–5877, <https://doi.org/10.1016/j.prevetmed.2011.05.004>

5. Dórea, F.C., Lindberg, A., Elvander, M.: Veterinary syndromic surveillance in practice: costs and benefits for governmental organizations. *Infect. Ecol. Epidemiol.* **5**(1) (2015). <https://doi.org/10.3402/iee.v5.29973>
6. Hairgrove, T.: Improving the sustainability of rural veterinarians through mentoring, targeted, education, telemedicine, and monitoring of disease syndromes. Texas A&M University (2020). <https://portal.nifa.usda.gov/web/crisprojectpages/1023718-improving-the-sustainability-of-rural-veterinarians-through-mentoring-targeted-education-telemedicine-and-monitoring-of-disease-syndromes.html>. Accessed 13 July 2022
7. Dórea, F.C., Vial, F.: Animal health syndromic surveillance: a systematic literature review of the progress in the last 5 years (2011–2016). *Vet. Med. (Auckl)*. **7**, 157–170 (2016). <https://doi.org/10.2147/VMRR.S90182>
8. Rodolphe, M., et al.: On behalf of EU-JAMRAI. Building the european antimicrobial resistance surveillance network in veterinary medicine (EARS-Vet). *Euro Surveill.* **26**(4), pii=2001359 (2021). <https://doi.org/10.2807/1560-7917.ES.2021.26.4.2001359>
9. Johnson, P., et al.: An innovative new approach to animal care. In: *IEEE Global Humanitarian Technology Conference (GHTC) 2018*, pp. 1–5 (2018). <https://doi.org/10.1109/GHTC.2018.8601912>
10. El Idrissi A.H., Larfaoui, F., Dhingra, M., Johnson, A., Pinto, J., Sumption, K.: Digital technologies and implications for Veterinary Services. *Rev Sci Tech.* **40**(2), 455–468 (2021). PMID: 34542102. <https://doi.org/10.20506/rst.40.2.3237>
11. Li, Y., Lin, Y., Wang, Y., Ye, K., Xu, C.-Z.: Serverless computing: state-of-the-art, challenges and opportunities. *IEEE Trans. Serv. Comput.* (2022). <https://doi.org/10.1109/TSC.2022.3166553>
12. Chaudhary, D.S.: Scientific study of serverless architecture, implementation and pros and cons. *Math. Stat. Eng. Appl.* **71**(1), 21–25 (2022). <https://doi.org/10.17762/msea.v71i1.33>
13. Ivan, C., Vasile, R., Dadarlat, V.: Serverless computing: an investigation of deployment environments for web APIs. *Computers* **8**(2), 50 (2019). <https://doi.org/10.3390/computers8020050>
14. Google Developers: *Firestore Documentation - Learn the fundamentals* (2020). <https://firebase.google.com/docs>. Accessed 14 July 2022



Mobile Application Development for Human Veterinary Resources Management in a Low Density Population Context: Promoting Students Engagement by Working with the Community

Paulo Matos^{1(✉)}, Helena Velasco², and José Gonçalves¹

¹ CeDRI-Research Centre in Digitalization and Intelligent Robotics,
Polytechnic Institute of Bragança, Bragança, Portugal
{pmatos,goncalves}@ipb.pt

² Câmara Municipal de Bragança, Bragança, Portugal
helena.velasco@cm-braganca.pt

Abstract. This paper describes a mobile application, developed in an educational context, by the students of the Degree in Computer Engineering of the Instituto Politécnico de Bragança, allowing them to develop skills, based on real-world community problems solving, promoting by this way its engagement, and, at the same time, provide a solution to an effective need of the local community. The developed application has as goal to support the Human Veterinary Resources Management in a Low Density Population Context.

1 Introduction

Bragança is a small town from the northwest of Portugal that struggles with dimension and scale problems, being the only district capital that do not has an Veterinary Hospital that can provide a service 24/7 service. The need for this application arises from this very specific, uncommon context, characterized by areas of low population density, where it is not sustainable to maintain a full-time public service. The solution found resorts to several private providers of veterinary services to, as a whole, ensure this service to the population on a full-time basis. The particularity and rarity of this scenario makes the creation and commercial exploitation of this type of product unfeasible. It was in this context that the challenge was posed to the students of the Degree in Computer Engineering at the Instituto Politécnico de Bragança, allowing them to develop skills with real problems and, at the same time, provide a solution to an effective need in the region, promoting by this way its engagement [1–3].

However, this requires considering unusual aspects in the development - which are related to the fact that students will not be available to meet future

administration or maintenance needs. First of all, avoid the existence of physical equipment, namely servers that, in addition to having a relevant acquisition cost, sooner or later, need updates - for example, security updates. Avoid having its own services that also require maintenance, such as HTTP/S or database servers.

The particularity of the present context results that there are no other references that can be directly compared with the work proposed by the authors. However, there are some projects that share the same position of contributing to the common well-being and developed in an academic environment.

The paper is structured as follows initially an introduction section will contextualize the problem, then the related work, followed by the application functional requirements will be introduced, then the proposed solution and its implementation will be described and finally some conclusions and future work will round up the paper.

2 Related Work

One of the most active areas is the surveillance systems for public health related to animal diseases. There are many projects that take place in the most diverse geographical realities, as a result of the need to identify potential pandemics in time, understand their evolution and the impact they may have [4,5,7,8]. A real-time disease surveillance enables awareness of practitioners, students and veterinary technicians with an increased awareness of state and regional livestock disease.

Among the many projects, the “Improving the Sustainability of Rural Veterinarians Through Mentoring, Targeted Education, Telemedicine and Monitoring of Disease Syndromes” project [6], funded by the U.S. Department of Agriculture National Institute of Food and Agriculture grant, led by the Texas A & M AgriLife faculty, through which it has developed the Veterinary Syndromic Surveillance System, which provides an app and website to track diseases - that allows veterinarians to check online if what they see in the field is unique to their area or part of a pattern.

Other related work was report by [9], seeking to expand a web-based system and smart device app that is used as a distance learning and a telemedicine tool to assist farmers in getting immediate support and reaching veterinary care professionals and extension agents.

In [10] the authors analyse the importance and impact of new technologies in supporting veterinary services. State that the digital technologies will have a profound effect on how animal health services are delivered and how animal health systems are managed. They classify the technologies into three different sets, one of them focuses precisely on the relevance of wireless and mobile technologies - for animal health monitoring, disease surveillance, reporting and information sharing.

At [11], the authors state the great advantages of serverless computing, part of the technical solution used in the present work, identifying some existing challenges and analysing the associated cutting-edge solutions. With these results,

the authors further investigate some typical open-source frameworks and study how they address the identified challenges.

On both [12, 13], the authors state the advantages, disadvantages, challenges and characteristics of the serverless architectures, namely to dispense with the need to have and manage hardware, servers and services; as well as allowing high availability, dynamically adjustable to needs, with reduced operating and maintenance costs.

3 Application Functional Requirements

The main functional requirements of the proposed application is the following to provide a quick way to contact the veterinarian who is actually on duty. This is the ultimate motivation of the entire solution, to ensure that there is a place where interested parties, like firefighters, police, civil security and others, know that can find the contact information of the veterinary on duty; that the information available there is correct and up to date; and that from there they can easily contact the veterinarian on duty.

It also has to allow for simplified management of shift allocation. The distribution of days by veterinarians (duty shift) is, according to the current procedure, agreed for extended periods, typically for a calendar year. Entering this data for each day of the year, one by one, is not an acceptable solution. It is important to supply a solution that allows to insert/updated this data at once, for example, uploading a CSV file. The possibility of this procedure being repeated for full or partial updates of the shift schedule should be considered.

The application must allow the exchange of schedules between veterinarians. As the duty shift is scheduled for an extended period of time, and despite being agreed in advance by everyone, it is very natural and common that unforeseen circumstances arise that prevent the shift from being carried out exactly as stipulated. The problem is usually overcome by mutual agreement between the veterinarians themselves - normally, faced with the impossibility of fulfilling the service, they contact their colleagues to see if there is anyone available for the day in cause, in exchange for another one. As these unforeseen events are common among all, in which sooner or later, all veterinarians end up needing to make an exchange, there is a natural understanding and cooperation to resolve situations.

However, the motivation of this project is effectively related to these exchanges, which, when agreed between veterinarians, are not always widely known to the interested parties. Even when the exchange is formalized in the person who coordinates the process, its dissemination is not always effective, this is because many of the interested entities have the practice of printing on paper this data, to facilitate and ensure that the information is easily accessible, but with that, neither care is always taken to update these physical documents, when for some reason the data is changed.

Hence, it is essential to ensure a solution that allows for the exchange of shifts/scales of service, ensuring that this information is updated to the interested parties. If possible, without requiring the involvement of a central

management entity, that is, as long as the veterinarians involved in the exchange agree, it must be possible to do this by themselves.

Some complementary functionalities emerged in a later state, as a way to further enhance the usefulness of the solution and also as a result of the chosen technical options, in the belief that it will be able to support more features.

The basic idea is to collect elements about the interventions of veterinarians, elements that may be useful for the purposes of contacting animal owners, disseminating information, among others.

The registration must allow:

- Safeguard the intervention site, if possible, using GPS coordinates.
- Collect photos of the animal.
- If possible, register the identification of the animal.
- And, eventually, register additional information that may be useful to the entities involved.

4 Proposed Solution

For widespread access by the different parties involved, it was immediately clear that the solution would have to be a smartphone application. It is a common device, to which practically the entire population has access, in particular the elements of the interested parties, such as the police, civil security and the like. It adapts to the intended use and even have a set of technical options that support new features - it was even the decision to use the smartphone, which resulted in the FRO3 - taking advantage of the GPS and camera that most of the smartphones have.

The second decision concerned the development technology. The option by an smartphone app creates a problem - there are two major players in terms of operating systems: Android and iOS. Ensuring specific application development for both platforms was out of the question due to time constraints. The risk of not being able to complete both was also greater, so most likely only part of the users would have access to the solution - making it not a solution.

The decision fell on the use of React Native ensuring that with only one line of development it was possible to produce applications for both platforms: Android and iOS. Also enabling the possibility of having a web version, namely with the information about the veterinarian on duty.

The third technical decision was about application support services. In a more traditional model, it would be necessary to have a database server and a server to host REST/SOAP or equivalent services. From the explanation given for the NFR01 requirement, this was to be avoided. Thus, a serverless solution was chosen. Not that this means there is no server, but that the server belongs to a third party and works for simply as a place in the cloud where the the back-end services are hosted. There are thus no worries about installing, configuring and maintenance of services and servers.

Figure 1 illustrates the architecture of the solution, where the three types of users (actors) can also be identified:

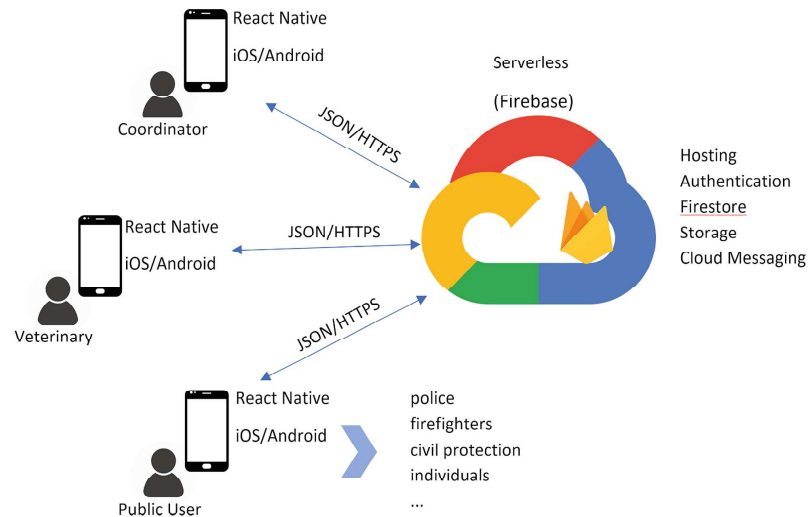


Fig. 1. Solution architecture.

Public User - Named for having access only to the public component of the application. Represents any person who needs to contact the veterinarian on duty, it can be a police officer, civil security officer or any other person.

Veterinarian - They are the ones who provide veterinary services. Access requires registration and subsequent acceptance by the Coordinator. The veterinarian can request to change shifts with a colleague and register the services provided.

Coordinator - Entity that admitted/removes veterinarians and that can upload the file with the duty shifts.

Only the last two can consult the entire schedule. The Public User only sees the contact of the veterinarian on duty for the day in question (the day he uses the app to request support from the on-call veterinarian).

All usage profiles are ensured through a single application - which, depending on the profile, provides more or less functionalities.

4.1 Veterinary Registration

Figure 2 illustrates the procedure for registering veterinarians. Anyone can register as a veterinarian. However, access to the veterinary features is impossible until the Coordinator admits him/her. The idea is that the person makes a registration, providing the name, email and telephone contact. A code is sent to

the email to verify email ownership. Later, the user can enter more data, such as the business name of the company he represents and the like.

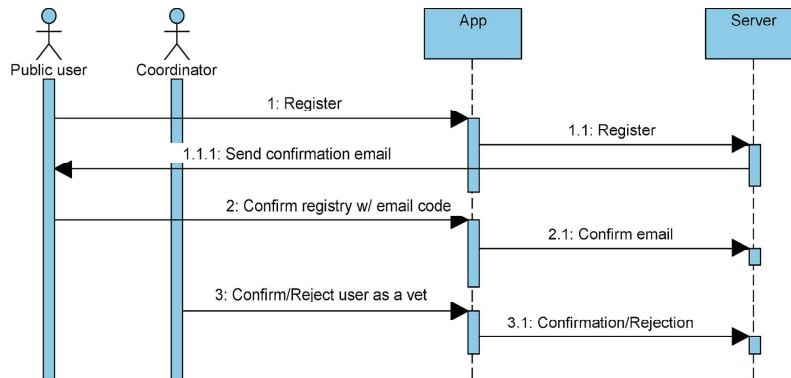


Fig. 2. Sequence diagram of the vet registry and acceptance.

Once the email has been verified, the candidate appears on the Coordinator's dashboard - The Coordinator can view the registration data to confirm their veracity and can accept or reject the registration. If rejected, all information from the veterinarian candidate's record is removed. If accepted, the veterinarian will be able to access the features of this profile.

4.2 Shift Exchange

The veterinary should have access to a calendar showing their duty shifts, as well as information on who is assigned to the other days. Trading for the purpose of exchange is extra-application, that is, it is the interested party who contacts the colleagues to find out if anyone is available to exchange and thus ensure the service for the day in question. Once agreed, anyone involved can go to the application, choose the days between which the exchange will take place. User can only do it for days that are allocated to him and always for future dates. The veterinarian on duty for the day to be changed receives a notification that can be viewed in detail in the application itself, signaling the change request. He can reject or accept. Upon acceptance, the exchange takes place between both and becomes visible to all others involved. The Coordinator also has access to this information on the exchange list, but only to be aware of. If the exchange is rejected, the applicant receives this indication by notification and can consult the status of the request on the application (that will appear as rejected).

5 Implementation

The implementation is not yet in the desired state, but it already provides almost all the intended features. In Fig. 3 it is possible to visualize the layout of the

public screen - when opening the application, the user (regardless of the profile) sees which veterinarian is on duty for the day in question. By clicking on the mobile number, the call is immediately initiated.

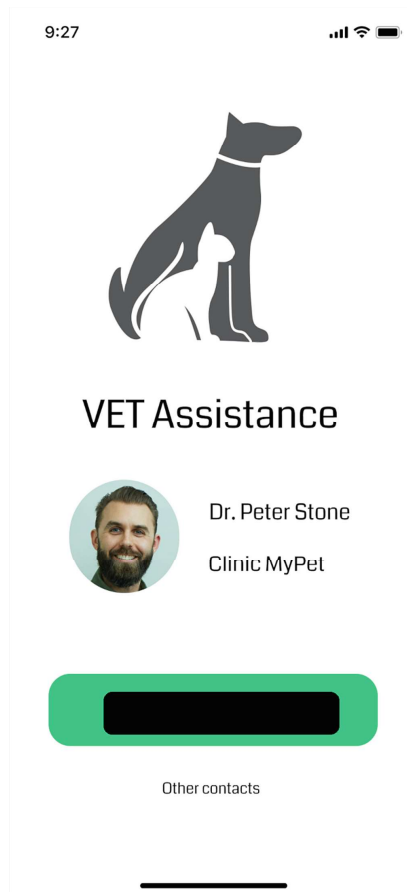


Fig. 3. Public screen

The long press on the application's logo allows access to authenticated functions, that is, those intended for veterinarians and coordinator. If there is no previous registration, the user is sent to the screen Fig. 4a, where he/she must fill in his/her data. From here, an email is sent with a confirmation code that should be introduced on the app (see Fig. 4b) - this way the email is validated as belonging to the user in question.

The user, a potential veterinarian, will stay on a pending condition - not being able to do anything else until the coordinator effectively admits him as a veterinarian.

If the user is already registered and confirmed by the coordinator, he goes directly to screen of Fig. 4c, where he can view past and present shift change requests, namely those awaiting by response. On the leftmost side of each request it is the veterinary that have requested the exchange. On the right, it appears

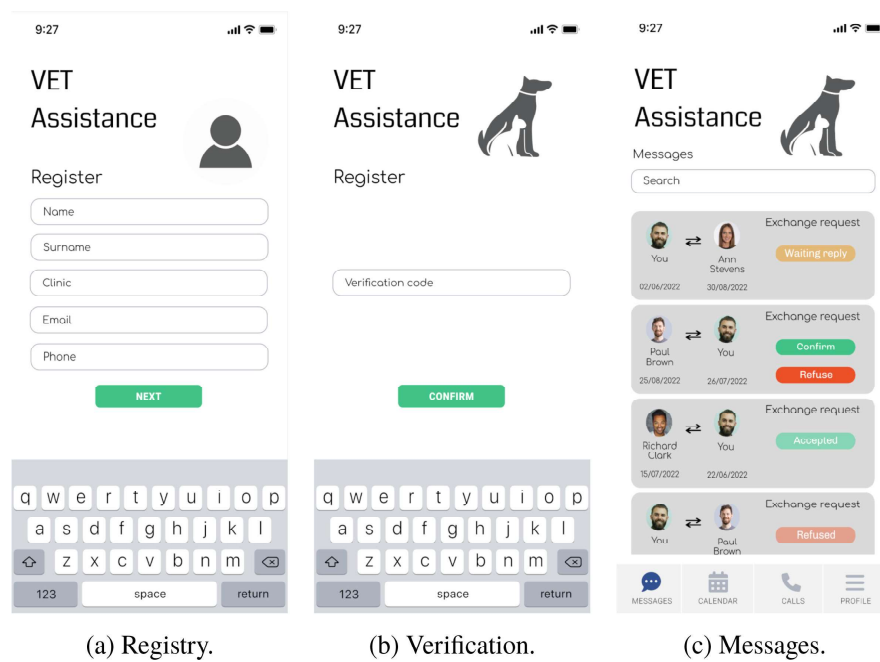


Fig. 4. Screens 1

to whom the request was done. In both cases, with the respective date (days for the exchange). Note that the user can either appear on the leftmost side, requesting the exchange to a colleague; or more to the right, in case a colleague has requested him to change shifts.

When the request is made by the user to a colleague, the indication of Waiting Reply appears. On the side of the colleague, there is the possibility of accept or reject.

The screen of Fig. 5a (Calendar) allows the user to know which days he has a shift (signalled in light blue); and consult who is on duty for a given day, simply by selecting the day. Whenever this is done, for the veterinarian on duty it appears the respective telephone contact and the possibility of requesting the change for the selected day. The idea is that user uses the contact to speak personally with the colleague to arrange the exchange. Then through the application formalizes this exchange.

When making Request change, it is possible to select a second day (the day to change) - Figure 5b - circled in red. Once this is done, user can then definitively request the exchange (Request). The process proceeds as previously explained. The days with pending trade requests are indicated by the small red dot and the detailed information shows Waiting reply (see Fig. 5c).

The veterinarian can also register the services performed through the Call option (Fig. 6a). Here you have the possibility to view records already made or to be filled in, as well as request the creation of a new record. In the latter case, it is automatically sent to the cell phone camera, in order to register the service through a photo of the animal in question (see Fig. 6b). Once the photo is taken,

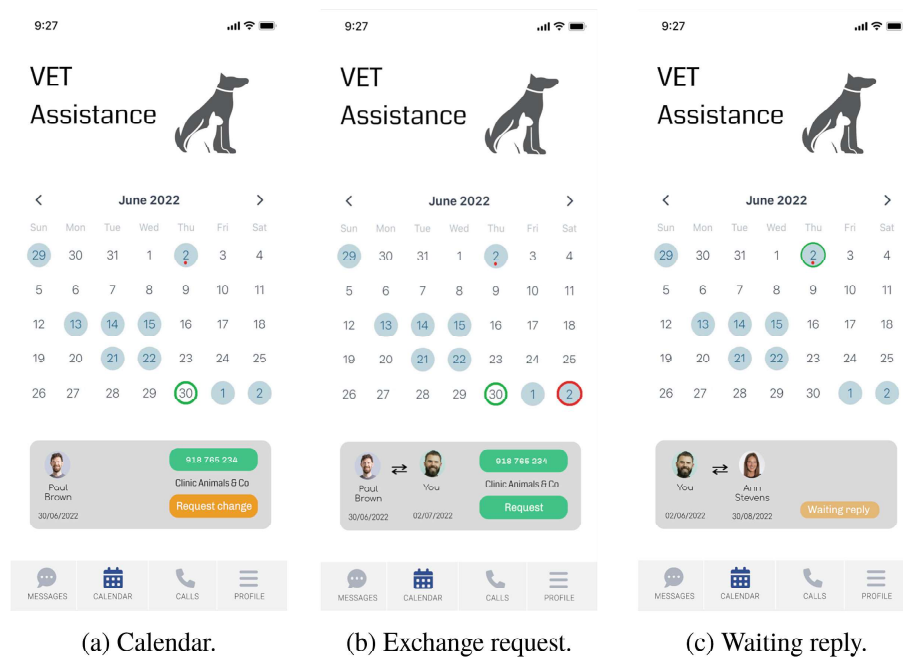


Fig. 5. Screens 2

the date, time and GPS coordinates of the location are also obtained. The record can be left in edit mode to be finished later or finished immediately (Fig. 6c).

According to Fig. 7a, the vet also has the Profile option available to edit their data (name, clinic, cell phone contact and photo).

The coordinator accesses the private part in the same way - but it is supposed to already be registered, which is done directly on the back-end (Firebase console). The coordinator has the option to view messages, for now only regarding requests for admission of users on the platform as veterinarians. For this purpose, he has access to the name, clinic, email, mobile phone and, eventually, photo (see Fig. 7b). He can accept or decline the request. Note that for each request an identifier is generated - which is essential to identify veterinaries in the upload option.

In the upload option, the coordinator can upload the file with the shift assignments. The file must be in CSV format, containing, for each day assigned, the user ID and the day (in YYYYMMDD format). Figure 1 illustrates one of these files. With this solution, the administrator makes the planning, namely for extended periods of time, and then easily makes that information available. This service assignment is normally carried out with the prior consent of the veterinarians. In any case, the objective of the solution is precisely to provide the possibility for veterinarians to exchange days of service and that this is reflected in the information provided to the common user.

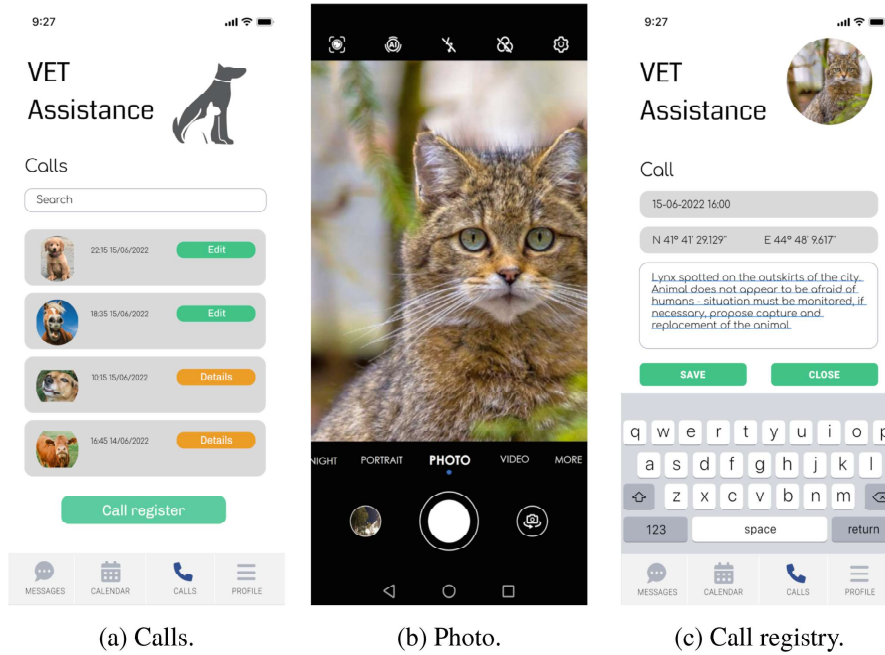


Fig. 6. Screens 3

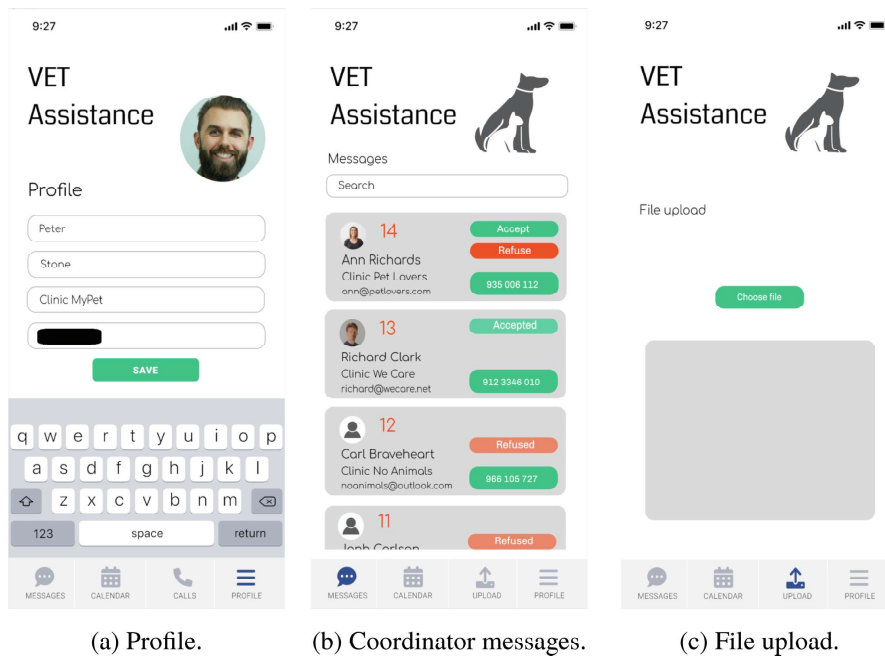


Fig. 7. Screens 4

Table 1. CSV file format

Day	ID
20220615	5
20220616	3
20220617	1

6 Conclusions and Future Work

In functional terms, the created solution complies with the defined and the necessary goals - although there are already more ideas and improvements identified. For this purpose, a serverless service was used, Firebase, which is a Platform As A Service - PaaS (more precisely a Back-End As Service - BeaS) - with this, the need for servers, services (HTTP and database), configuration and maintenance were significantly reduced.

Thus, a solution was obtained that can be immediately made available to the community, fully manageable by the community itself and that does not require the continued involvement of students for its maintenance. The production of an application that is effectively necessary and that will be used for the benefit of the community, namely veterinarians, but also of all those who use their services as public service providers, is undoubtedly a way to put students in practical situations, with the natural demands of the applications for effective use, promoting the experience, the acquisition of competences and even the professional curriculum of the students. The authors believe that the experience should be extended, bringing new challenges, namely for situations like the present, where it is possible to build in the available time and with the skills that students have, functional solutions that can be effectively used and for a long time.

Acknowledgements. This work has been supported by FCT - Fundação para a Ciência e Tecnologia within the Project Scope: UIDB/05757/2020.

References

1. Mebert, L., et al.: Fostering student engagement through a real-world, collaborative project across disciplines and institutions. In: Higher Education Pedagogies, vol. 5, no. 1, pp. 30–51. Routledge (2020). <https://doi.org/10.1080/23752696.2020.1750306>
2. Ferreira, D., Ambrosio, A., Melo, T.: Application of real-world problems in computer science education: teachers' beliefs, motivational orientations and practices. *Int. J. Inf. Commun. Technol. Educ.* **14**, 15–28 (2018). <https://doi.org/10.4018/IJICTE.2018070102>
3. Pirttinen, N.: Crowdsourcing in computer science education, pp. 421–422 (2021). <https://doi.org/10.1145/3446871.3469781>
4. Dórea, F.C., Sanchez, J., Revie, C.W.: Veterinary syndromic surveillance: current initiatives and potential for development. *Prevent. Veter. Medi.* **101**(1–2), 1–17 (2011). ISSN 0167–5877, <https://doi.org/10.1016/j.prevetmed.2011.05.004>

5. Dórea, F.C., Lindberg, A., Elvander, M.: Veterinary syndromic surveillance in practice: costs and benefits for governmental organizations. *Infect. Ecol. Epidemiol.* **5**(1) (2015). <https://doi.org/10.3402/iee.v5.29973>
6. Hairgrove, T.: Improving the sustainability of rural veterinarians through mentoring, targeted, education, telemedicine, and monitoring of disease syndromes. Texas A&M University (2020). <https://portal.nifa.usda.gov/web/crisprojectpages/1023718-improving-the-sustainability-of-rural-veterinarians-through-mentoring-targeted-education-telemedicine-and-monitoring-of-disease-syndromes.html>. Accessed 13 July 2022
7. Dórea, F.C., Vial, F.: Animal health syndromic surveillance: a systematic literature review of the progress in the last 5 years (2011–2016). *Vet. Med. (Auckl)*. **7**, 157–170 (2016). <https://doi.org/10.2147/VMRR.S90182>
8. Rodolphe, M., et al.: On behalf of EU-JAMRAI. Building the european antimicrobial resistance surveillance network in veterinary medicine (EARS-Vet). *Euro Surveill.* **26**(4), pii=2001359 (2021). <https://doi.org/10.2807/1560-7917.ES.2021.26.4.2001359>
9. Johnson, P., et al.: An innovative new approach to animal care. In: *IEEE Global Humanitarian Technology Conference (GHTC) 2018*, pp. 1–5 (2018). <https://doi.org/10.1109/GHTC.2018.8601912>
10. El Idrissi A.H., Larfaoui, F., Dhingra, M., Johnson, A., Pinto, J., Sumption, K.: Digital technologies and implications for Veterinary Services. *Rev Sci Tech.* **40**(2), 455–468 (2021). PMID: 34542102. <https://doi.org/10.20506/rst.40.2.3237>
11. Li, Y., Lin, Y., Wang, Y., Ye, K., Xu, C.-Z.: Serverless computing: state-of-the-art, challenges and opportunities. *IEEE Trans. Serv. Comput.* (2022). <https://doi.org/10.1109/TSC.2022.3166553>
12. Chaudhary, D.S.: Scientific study of serverless architecture, implementation and pros and cons. *Math. Stat. Eng. Appl.* **71**(1), 21–25 (2022). <https://doi.org/10.17762/msea.v71i1.33>
13. Ivan, C., Vasile, R., Dadarlat, V.: Serverless computing: an investigation of deployment environments for web APIs. *Computers* **8**(2), 50 (2019). <https://doi.org/10.3390/computers8020050>
14. Google Developers: *Firestore Documentation - Learn the fundamentals* (2020). <https://firebase.google.com/docs>. Accessed 14 July 2022