

# INTED **2024**

18th International  
Technology, Education and  
Development Conference

4-6 March 2024  
Valencia (Spain)

## CONFERENCE PROCEEDINGS



*Sharing the Passion for Learning*

**INTED** **2024**

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PROCEEDINGS**

***Sharing the Passion for Learning***

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## Preface

The INTED2024 Conference Proceedings contain the papers presented at the 18th International Conference of Technology, Education and Development, held in Valencia, Spain, from the 4th to the 6th of March 2024. INTED takes place annually and its aim is to bring together academics and researchers to continue the exchange of innovative ideas and research. Participants from over 78 countries joined INTED2024 to learn about the changing world of education and learning technologies.

INTED's focus is on Education and Educational research. Since many international education experts attended the conference, participants were able to network and collaborate with other delegates from around the world, participating in thematic sessions, networking activities, workshops and interactive sessions. The keynote speeches are available at IATED Talks: [iated.org/talks](http://iated.org/talks).

The INTED2024 Proceedings, exclusively in English, are included in the IATED Digital Library: [library.iated.org](http://library.iated.org). The INTED2024 International Program Committee was composed of lecturers and researchers from multiple countries. A blind peer review process was followed to guarantee the quality of the final publication, in which the following points were evaluated: information content, relevance to the educational field, general structure, clarity of contents, originality, and relation to the conference topics and disciplines.

IATED endeavors to publish original and high-quality research papers. Following the expected ethical standards, all authors that published their papers in the INTED2024 Proceedings signed the IATED copyright transfer form. More information about the publication ethics of IATED is available at [iated.org/publication\\_ethics](http://iated.org/publication_ethics).

We wish to extend our most sincere thanks to all who contributed to the INTED2024 Proceedings. Thanks for your dedication and for sharing your passion for learning.

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## INTED2024 Keynote Speakers

### Mike Sharples – The Open University (UK)



**Keynote speech:**

***Social Generative AI: A Future for International Education***

Development of Generative Artificial Intelligence is following the same path as the World Wide Web: research, breakthrough, integration into workplace tools, development of apps. For the Web, the next major development was social media and services. I suggest we will soon see the emergence of “Social Generative AI” – AI systems interacting with humans and with other AI tools in complex social networks. Social Generative AI will have profound implications. In education it will offer new roles for AI as a conversational partner and collaborator; it will break down language barriers and connect people across cultures. However, Social Generative AI may also erode trust in information and create networks of interacting machines beyond human control. In my talk, I will propose we develop social AI for education that is not only effective and ethical but also caring and founded on good pedagogy. The result could be a future for international education that merges human empathy and experience with social artificial intelligence.

**Biography:**

Mike Sharples is Emeritus Professor of Educational Technology at The Open University, UK. He gained a PhD from the Department of Artificial Intelligence, University of Edinburgh on Cognition, Computers and Creative Writing. His expertise involves human-centred design and evaluation of new technologies and environments for learning. He provides consultancy for institutions worldwide including UNESCO, UNICEF, universities and companies. As Academic Lead for FutureLearn.com he led pedagogy-informed design of the open learning platform. He is an Associate Editor of the International Journal of Artificial Intelligence in Education. He is author of over 300 published papers in the areas of educational technology, learning sciences, science education, human-centred design of personal technologies, artificial intelligence and cognitive science. His recent books are *Practical Pedagogy: 40 New Ways to Teach and Learn* and *Story Machines: How Computers Have Become Creative Writers*, both published by Routledge, and *An Introduction to Narrative Generators*, published by Oxford University Press.

**Sarah Newman – Harvard University (USA)****Keynote speech:*****Facing this Moment Critically & Creatively: AI Pitfalls & Opportunities for Educators***

Many educators are intimidated and overwhelmed by the rapid availability and uptake of AI tools like ChatGPT. How do these tools change the value of skills we've held dear to learning — and expression — such as writing? How do they exacerbate inequities between learners? What do they mean for the role of educators? And what can, and should, we do right now?

New technologies have always changed how we learn, and how we teach. As an educator and AI researcher who leads the AI Pedagogy Project, I will offer recommendations (and some warnings) about how to best face this moment. We need to be both critical and creative. We need to separate AI hype from reality. As overwhelming as it feels, the introduction of these AI technologies offers a chance to revisit and revise what hasn't been working in education, while protecting what is most important. Centered on the value of interdisciplinarity, informed by technology ethics, and leveraging the opportunity that this indeed is, this talk will offer pitfalls to avoid, and concrete recommendations that educators can apply immediately.

***Biography:***

Sarah Newman is Director of Art & Education at metaLAB at Harvard University, a project of the Berkman Klein Center for Internet & Society. Her work explores the social, ethical, and pedagogical dimensions of artificial intelligence and other emerging technologies through research, art, and teaching. Newman leads the AI Pedagogy Project, a resource to provide educators materials for responsible engagement with AI technologies. Newman's research focuses on data transparency. She co-founded and serves as Research Lead of the Data Nutrition Project, which aims to mitigate bias in data-driven systems through tools and educational practices. Newman holds a BA in Philosophy from Washington University in St. Louis and an MFA in Imaging Arts from the Rochester Institute of Technology. She is also an installation artist who has exhibited work in New York, Miami, Berlin, London, and Rome, and has attended artist residencies in Germany, Italy, and Sweden. Previous honors include: AI Grant, Harvard Assembly Fellow, Harvard Berkman Klein Fellow, a Rockefeller AI Resident, Artist-in-Residence at Northeastern School of Law, and a grantee of the Notre Dame Tech Ethics Lab, a grantee of the National Endowment of the Arts, and winner of the 2022 Ars Electronica Award for Digital Humanity.

## Conference Tracks & Sessions

The INTED2024 conference program is available online at <https://iated.org/inted2024>

### ORAL SESSIONS MONDAY

Fostering Critical Thinking  
 Virtual Reality  
 Learning Analytics & Data Science Experiences  
 Post-Pandemic Scenarios in Education  
 Exchange & Mobility Programmes  
 Barriers to Learning & Inclusive Practices  
 Science Popularization and STEM Education  
 English as a Medium of Instruction  
 Challenge and Problem-Based Learning  
 Augmented Reality  
 Digital Assessment  
 From COVID to Construction: Creating a Sense of Belonging  
 Intercultural and Multicultural Education  
 Inclusive Education Teacher Training  
 Learning Factories & Remote Laboratories  
 AI and Chatbots in Language Learning  
 Game-Based Learning  
 Extended Reality  
 Feedback and Assessment  
 Technology Enhanced Learning  
 Employability Trends and Challenges  
 Equality, Diversity and Inclusion  
 Teaching STEM  
 English for Special Purposes  
 Active Learning Experiences  
 e-Learning Experiences  
 Assessment in the Era of Generative AI  
 21st Century Skills  
 Tales from the trenches of Entrepreneurship Education and Innovation in HEIs  
 Special Education  
 Computer Science and Cybersecurity Education  
 Online and Technology-Enhanced Language Learning

### POSTER SESSIONS MONDAY

Emerging Technologies in Education  
 Pedagogical Innovations in Education

### ORAL SESSIONS TUESDAY

Making Learning Accessible to Diverse Students  
 Students' and Teachers' Perceptions of AI  
 Virtual Learning Environments  
 Digital and AI Skills for Educators  
 Workplace & Lifelong Learning 1  
 Curriculum Design Experiences  
 Mathematics in Higher Education  
 English as a Foreign Language  
 Service Learning & Community Engagement  
 Generative AI in Education  
 Mentoring & Tutoring

Pre-service Teachers' Experiences  
 Workplace & Lifelong Learning 2  
 Quality in Education  
 Promoting STEM Careers  
 Student Wellbeing  
 Pedagogical Innovations  
 Generative AI Chatbots  
 MOOCs & Open Educational Resources  
 Professional Development of Teachers  
 Entrepreneurship Education  
 Educational Management and Digitization  
 Science Outreach and Communication  
 Student Safety and Protection  
 Collaborative & Team-Based Learning  
 Research on Generative AI in Education  
 Blended and Hybrid Learning  
 ICT Skills among Teachers  
 University-Industry Cooperation  
 Leadership in Education  
 STEM in Schools  
 Health Sciences Education  
 Student Engagement  
 Application of AI in Education  
 Mobile Learning  
 Unlocking the Potential: Quality and Growth in Initial Teacher Education  
 Education for Sustainability  
 Institutional Cooperation in Education  
 Architecture & Civil Engineering Education  
 Transnational Medical Education: AIWMU Joint Medical Education Program

## **POSTER SESSIONS TUESDAY**

Educational Trends and Experiences  
 Challenges in Education and Research

## **VIRTUAL SESSIONS**

### **DIGITAL & DISTANCE LEARNING**

MOOCs & Open Educational Resources  
 Blended & Mobile Learning  
 LMS & VLEs  
 e-Learning Experiences  
 Distance Education in COVID-19 Times

### **DIGITAL TRANSFORMATION OF EDUCATION**

Data Science & AI in Education  
 Learning Analytics & Educational Data Mining  
 Digital Transformation  
 21st Century Skills

### **INNOVATIVE EDUCATIONAL TECHNOLOGIES**

Virtual & Augmented Reality  
 Social Media in Education  
 Videos for Learning  
 Technology Enhanced Learning

### **TEACHER TRAINING & ED. MANAGEMENT**

ICT & Digital Skills  
 Teacher Training and Support  
 Professional Development of Teachers  
 Educational Management

**ACTIVE & STUDENT-CENTERED LEARNING**

Gamification & Game-based Learning  
Flipped Learning  
Problem & Project-Based Learning  
Pedagogical Innovations  
Active & Experiential Learning  
Cooperative & Team-Based Learning

**ASSESSMENT, MENTORING & STUDENT SUPPORT**

Assessment & Evaluation  
Mentoring & Tutoring  
Student Support & Motivation  
Student Wellbeing  
Developing Soft and Transversal Skills

**EDUCATIONAL STAGES & LIFE-LONG LEARNING**

From Pre-school to Secondary Education  
Vocational Training  
Transition to the Job Market  
Developing Entrepreneurship in Education  
Life-Long & Workplace Learning

**QUALITY & IMPACT OF EDUCATION**

Quality in Education  
Learning Space Design  
Service Learning & Community Engagement  
Social Impact of Education

**INCLUSION & MULTICULTURALITY**

Inclusive Education  
Diversity Issues  
Special Educational Needs  
Multicultural Education

**LANGUAGE LEARNING AND TEACHING**

Foreign Languages  
New Technologies in Language Learning  
Intercultural & Sociocultural Competences

**DISCIPLINE-ORIENTED SESSIONS**

Architecture & Interior Design  
Health Sciences Education  
Sustainable Development Goals in Education  
Business & Tourism Education

**STEM EDUCATION**

Mathematics & Statistics  
Engineering Education  
Computer Science Education  
STEM Experiences

## Table of Contents

|  |     |
|--|-----|
| <b>FIELD ESCAPE GAMES WITH QR CODES TO LIVEN UP THE CLASSES IN SECONDARY SCHOOLS</b>   | 1   |
| <i>L. Benediktova, A. Hruby</i>  |     |
| <b>EMPOWERING E-TUTORS: AN ITERATIVE DEVELOPMENT OF AN E-TUTOR SELF-EVALUATION TOOL</b>  | 7   |
| <i>L.M. Langesee, N. Hobe, S. Schmidt</i>  |     |
| <b>PLURI-TEAL AS A HYBRID PEDAGOGICAL FRAMEWORK: REVISITING THE PEDAGOGICAL VALUES OF ZOOM AND MOODLE</b>  | 17  |
| <i>K. Haseyama</i>   |     |
| <b>USING AN EARLY CHILDHOOD LEARNING COMMUNITY IN AN EFFORT TO RETAIN ONLINE STUDENTS</b>  | 21  |
| <i>M. Simecek, H. Lopez, S. Heald</i>  |     |
| <b>TELAGOY: NEW LEARNING IN SOCIETY 5.0 AND BEYOND</b>   | 22  |
| <i>T. Pitso</i>  |     |
| <b>THE VIEWS OF EARLY CAREER PRIMARY TEACHERS ON THE IMPACT OF AN UNDERGRADUATE SPECIALISM IN SPECIAL EDUCATION ON THEIR WORK AS CLASS TEACHERS</b>                    | 31  |
| <i>T. O'Brien</i>  |     |
| <b>VIRTUAL WORLD DESIGN FOR CAPACITY BUILDING</b>  | 32  |
| <i>L. Cassar, M. Montebello</i>  |     |
| <b>LEARNING FOREIGN LANGUAGES FOR SPECIFIC PURPOSES IN THE DIGITAL AGE IN PORTUGAL, AND THE PROBLEMATICS OF SKILLS FOR SOCIAL AND ECONOMIC CHALLENGES</b>              | 43  |
| <i>V. Delplanq, A.M. Costa Lopes, S. Fidalgo</i>   |     |
| <b>EDUCATION BASED ON THE CHANGING ROLES OF TEACHER AND STUDENT</b>  | 51  |
| <i>R. Gámez Belmonte, M.J. Zarzuelo Romero, C. Zarzuelo Romero</i>   |     |
| <b>PROJECT-BASED LEARNING IN THE FIELD OF SCIENCE AND ENGINEERING</b>  | 55  |
| <i>R. Gámez Belmonte, C. Zarzuelo Romero, M.J. Zarzuelo Romero</i>   |     |
| <b>GIFTEDNESS FOR BIOLOGY IN THE CROATIAN EDUCATIONAL SYSTEM</b>   | 60  |
| <i>D. Vrbanović Lisac, N. Marangunić</i>   |     |
| <b>MOVING IN, MOVING THROUGH, MOVING BEYOND INITIAL TEACHER EDUCATION – REPORT ON THE TRANSITIONS OF STUDENT TEACHERS</b>  | 68  |
| <i>J. Rens</i>   |     |
| <b>INTEGRATED THINKING AS A TEACHING STYLE OR PROCESS FOR TEACHING BUSINESS</b>  | 69  |
| <i>A. Barclay, C. White</i>  |     |
| <b>TEACHING SYNERGY THROUGH DIGITAL RESOURCES AND PROFESSIONAL WORKSHOPS IN THE MASTER OF INDUSTRIAL ENGINEERING</b>   | 70  |
| <i>J. Ferreiro-Cabello, E. Fraile-García, J. Los Santos-Ortega, F. Somovilla Gomez</i>   |     |
| <b>THERE'S AN APP FOR THAT: DESIGN, DEVELOPMENT, AND EVALUATION OF EDUCATIONAL APPS</b>  | 76  |
| <i>J. Hughes, L. Morrison, D. Petrarca</i>   |     |
| <b>PERCEPTIONS OF ORGANIZATIONAL READINESS FOR CHANGE IN THE CONTEXT OF LEARNING MANAGEMENT SYSTEM PROJECTS: INSIGHTS FROM HIGHER EDUCATION INSTITUTIONS IN KOSOVO</b> | 84  |
| <i>A. Veseli, P. Hasanaj, A. Bajraktari</i>  |     |
| <b>OPTIMIZING THE OPERATION OF EDUCATIONAL INSTITUTIONS: VARIABLES, CATEGORIES AND TOOLS TO MONITOR ITS PERFORMANCE</b>  | 85  |
| <i>J. Villagrana, C. Donaldson, A. Soler, F. Sánchez</i>   |     |
| <b>ENTREPRENEURIAL COMPETENCE OF HIGH SCHOOL STUDENTS</b>  | 94  |
| <i>N. Othman, L. Sapudin</i>   |     |
| <b>ATMOSPHERIC RESEARCH METHODOLOGIES: A PROPOSAL IN METEOROLOGY LESSONS</b>   | 100 |
| <i>M. Vázquez Domínguez, P. Coll Hidalgo, L. Gimeno Sotelo, R. Sorí Gomez, R. Nieto, L. Gimeno</i>   |     |
| <b>THE PLAY PARADOX: AN IPA STUDY WHICH EXPLORED PLAYFUL PRACTICE AS A MEANS TO IMPROVING PSYCHOLOGICAL WELLBEING</b>  | 101 |
| <i>R. Rylance-Graham</i>   |     |

|   |     |
|---|-----|
| <b>PREPARING FACULTY TO USE GENERATIVE ARTIFICIAL INTELLIGENCE IN THEIR WORK AND CLASSROOM</b><br><i>C. Ormsbee</i>   | 102 |
| <b>ORAL COMMUNICATION CLASSES DURING THE COVID-19 PANDEMIC: EXAMINING STUDENTS' EXPERIENCES, BENEFICIAL FOR SPEAKING CLASSES IN THE POST PANDEMIC ERA</b><br><i>J. Aliponga, Y. Koshiyama</i>               | 103 |
| <b>DIGITAL SOLUTIONS FOR GAMIFICATION AND GAME-BASED LEARNING FROM THE PERSPECTIVE OF EDUCATORS</b><br><i>E. Sarva, E. Grāvelsiņa, L. Daniela</i>   | 109 |
| <b>ONLINE MICROLEARNING EVENTS: FOSTERING EDUCATORS' PROFESSIONAL GROWTH THROUGH PEDAGOGICAL PRACTICE EXCHANGE</b><br><i>E. Sarva, L. Daniela</i>   | 119 |
| <b>THE ROLE OF AI CODING ASSISTANTS: REVISITING THE NEED FOR LITERATE PROGRAMMING IN COMPUTER AND DATA SCIENCE EDUCATION</b><br><i>M. Birkenkrahe</i>   | 127 |
| <b>SELF-REGULATION OF STUDENT LEARNING AND TEAMWORK: THE ROLE OF VIDEO FEEDBACK, SELF-REFLECTION AND LECTURER FEEDBACK</b><br><i>A. Lavric</i>  | 133 |
| <b>NO-COST TWO-YEAR ASSOCIATE DEGREE AT A PWI</b><br><i>B. Hannafin</i>   | 138 |
| <b>LEVERAGING INSTRUCTIONAL DESIGN FOR EQUITABLE OUTCOMES</b><br><i>B. Hannafin</i>   | 139 |
| <b>FIXCAMPUS: A WEB APPLICATION FOR EXPLOITING COLLECTIVE EFFORT TOWARDS A WELL-PRESERVED CAMPUS ENVIRONMENT</b><br><i>M. Kordas, E. Papaioannou, C. Kaklamanis</i>   | 140 |
| <b>AN ONLINE WEB APPLICATION FOR DATA ANALYSIS AND VISUALIZATION ON GENDER ASPECTS OF COMPUTER SCIENCE AND ENGINEERING ALUMNI</b><br><i>D. Assimakopoulos, E. Papaioannou, C. Kaklamanis</i>                | 151 |
| <b>INFLUENCE OF DIDACTIC, AUDIOVISUAL, AND JOURNALISTIC DESIGN ELEMENTS ON LEARNING SUCCESS AND LEARNING MOTIVATION IN VIDEOS MADE FOR TEACHING AND LEARNING</b><br><i>R. Fleck</i>                         | 161 |
| <b>STRENGTHEN KNOWLEDGE IN TOXICOLOGY THROUGH A PRACTICAL EXPERIENCE</b><br><i>E. Ramos, C. de los Ríos, J. Egea, A. Romero</i>   | 162 |
| <b>UTILIZING DIGITAL SOLUTIONS IN THE IMPLEMENTATION OF UNIVERSAL DESIGN FOR LEARNING: EDUCATOR PERSPECTIVES</b><br><i>E. Sarva, A. Rektina</i>   | 163 |
| <b>DEVELOPMENT OF UNIVERSITY EDUCATION FIELD STUDENT DIGITAL COMPETENCES - OVERVIEW OF PRACTICE</b><br><i>E. Sarva, A. Lastovska, A. Olesika, Z. Zalite-Supe, Z. Rubene, A. Abolina</i>                     | 173 |
| <b>USING WIKIPEDIA AS A KNOWLEDGE TRANSFER TOOL AND TO ENHANCE SPANISH SCIENCE DISSEMINATION</b><br><i>E. Ramos, R.M. Garcia-Garcia, M. Arias-Alvarez</i>   | 181 |
| <b>PARENTAL AND ACADEMIC SELF-EFFICACY AMONG STUDENT-MOTHERS AND THEIR ASSOCIATIONS WITH MOTHER-CHILD RELATIONS: THE MEDIATING ROLE OF PERCEIVED STRESS AND PARENTING STYLE</b><br><i>G. Levi, Y. Yaffe</i> | 188 |
| <b>PREPARING TEACHERS TO EDUCATE DIVERSE LEARNERS</b><br><i>M. Milian, A.O. Davidson</i>  | 189 |
| <b>ARTIFICIAL INTELLIGENCE BASED DIAGNOSTIC SUPPORT SYSTEM FOR DENTAL RESIDENTS</b><br><i>A. Vistoso Monreal, N. Veas, G. Loeb, G. Clark</i>  | 190 |
| <b>ANCESTRAL KNOWLEDGE IN THE PRODUCTION OF CRAFTS IN THE MUNICIPALITY OF RÁQUIRA (COLOMBIA)</b><br><i>J.A. Segura Osuna</i>  | 198 |
| <b>EMPOWERING TOMORROW'S LEADERS: A FACILITATOR-LED EXPLORATION OF CURRICULUM DESIGN FOR DEVELOPING GENERIC SKILLS</b><br><i>I. Chohan</i>  | 202 |



|  |     |
|--|-----|
| <b>AN INNOVATIVE FRAMEWORK FOR DIGITALISATION IN PUBLIC ADMINISTRATION IN GERMANY</b><br><i>R. Wang, C. Merten</i>   | 211 |
| <b>A NEW VUCA-APPROPRIATE FRAMEWORK FOR THE NEW WORK IN THE IT INDUSTRY AND EDUCATION</b><br><i>R. Wang, G. Contino</i>  | 217 |
| <b>DEVELOPMENT AND EVALUATION OF IMAGE PROCESSING-BASED KINESTHETIC LEARNING SYSTEM</b><br><i>D. Yıldız, U. Fidan, M. Yıldız, B. Er, G. Ocak, F. Güngör, I. Ocak, Z. Akyıldız</i>  | 232 |
| <b>EDUCATIONAL STOPLIGHT</b><br><i>M. Burt</i>   | 233 |
| <b>NON-TRAINED INDIGENOUS ORANG ASLI TEACHERS' ROLE IN THE DEVELOPMENT OF EMERGENT READING SKILLS</b><br><i>M.K. Mehar Singh</i>   | 240 |
| <b>ORGANIZATIONAL MODEL OF A LEARNING FACTORY FOR INTEGRATED ENGINEERING TECHNOLOGY AND BUSINESS EDUCATION</b><br><i>M. Vaz, B. Baetz, T. Wanyama</i>  | 248 |
| <b>REFINING THE STUDENT EXPERIENCE IN INDUSTRY-UNIVERSITY COLLABORATIONS: STRATEGIES FOR SATISFACTION, ENGAGEMENT, AND EFFECTIVE LEARNING</b><br><i>X. Xu, S. Zhang</i>  | 256 |
| <b>CONSIDERING GENERATIVE AI FOR ACCESSIBILITY IN INTELLIGENT EDUCATIONAL SYSTEMS</b><br><i>T. Mehigan</i>   | 260 |
| <b>PROTOTYPE OF A SELF-STUDY WEB APPLICATION SUITE FOR PARALLEL PROGRAMMING EDUCATION</b><br><i>A. Wakatani, T. Maeda</i>  | 261 |
| <b>SHORT VIDEO-DRIVEN LEARNING: ENHANCING PARTICIPATION AND MOTIVATION IN ELECTRICAL ENGINEERING DEGREES</b><br><i>R. Boluda-Ruiz, I. Moreno-González, B. Castillo-Vázquez, A. García-Zambrana, P. Salcedo-Serrano</i>             | 271 |
| <b>DESIGN AND IMPLEMENTATION OF A BOARD GAME FOR CHEMICAL ENGINEERING COURSES</b><br><i>I. Diaz, M. González-Miquel, M. Rodríguez, E. González</i>   | 279 |
| <b>VOCATIONAL TRAINING AND LANGUAGE LEARNING. A PERFECT MATCH FOR TODAY'S GLOBAL WORKFORCE</b><br><i>M. Pace</i>   | 280 |
| <b>THE STRENGTHENING OF SOCIOEMOTIONAL SKILLS IN SCHOOLS</b><br><i>D. Otálora-Gallego</i>  | 285 |
| <b>VIRTUAL TEACHING AND LEARNING IN VISUAL ARTS AND STEAM EDUCATION</b><br><i>S.L. Wong</i>  | 286 |
| <b>PROBLEM-ORIENTED LEARNING AS AN ALTERNATIVE TO REGULATORY CHANGES IN TECHNICAL STUDIES</b><br><i>F. Magdalena-Layos, S. González-Rodrigo, N. López Sánchez, A. Bosqued Navarro, P. Bautiste-Villanueva, B. González-Rodrigo</i> | 287 |
| <b>REFLECTION ON ASSESSMENT PRACTICES WITHIN A COMPUTER SECURITY MODULE AT HONOURS LEVEL</b><br><i>L. Drevin</i>   | 291 |
| <b>ATTITUDES OF UNIVERSITY STUDENTS OF TOURISM TOWARD DISTANCE TEACHING OF LANGUAGE FOR SPECIFIC PURPOSES IN AN ONLINE ENVIRONMENT: THE CASE OF TWO SLOVENIAN FACULTIES DURING THE COVID-19 PANDEMIC</b><br><i>T. Smajla</i>       | 301 |
| <b>ARE OUTREACH ACTIONS EFFECTIVE IN INCREASING THE REPRESENTATION OF WOMEN IN STEM FIELDS?</b><br><i>C. Clausell-Terol, J. Beltrán-Arandes, A. Gómez-Cadenas</i>  | 313 |
| <b>HOW DO STUDENTS DEMONSTRATE ELEMENTARY ARITHMETIC PROPERTIES AT THE BEGINNING OF THEIR UNIVERSITY STUDIES?</b><br><i>M. Burgos, B. Milanesio, N. Tizón-Escamilla</i>  | 319 |
| <b>PROBLEM-POSING MEGA-PROCESS IN TEACHER EDUCATION. DEVELOPING ALGEBRAIC REASONING IN THE PROBABILISTIC CONTEXT</b><br><i>M. Burgos, N. Tizón-Escamilla, J. Chaverri</i>  | 329 |

|  |     |
|--|-----|
| <b>HEARING THE STUDENT VOICE: UNIVERSAL DESIGN FOR LEARNING AS A FRAMEWORK FOR PEDAGOGICAL REFORM IN HIGHER EDUCATION</b><br><i>A. Power, E. Whewell</i>   | 338 |
| <b>THE PEDAGOGY OF AN INTRODUCTORY LEVEL DESIGN COURSE</b><br><i>J. O'Brien</i>  | 339 |
| <b>KAHOOT! IN HIGHER EDUCATION: A SMALL-SCALE STUDY WITH STUDENTS ATTENDING A SECOND LANGUAGE ACQUISITION COURSE</b><br><i>M.T. Barberán-Recalde, M. Martínez-Adrián</i>   | 348 |
| <b>ASSESSMENT OF UNIVERSITY STUDENTS' ATTITUDES IN THE CONTEXT OF SUSTAINABILITY AND ETHICAL PRINCIPLES OF PRODUCTION</b><br><i>M. Navrátilová, M. Beranová</i>  | 356 |
| <b>ROBOTICS AS A TOOL TO IMPROVE RECEPTIVE COMMUNICATION IN AUTISTIC STUDENTS</b><br><i>G. Lorenzo, J.A. López-Nuñez, E. Andreu-Cabrera, J.M. Romero, J.A. Marín, S. Alonso, F.J. Hinojo</i>   | 364 |
| <b>A PILOT STUDY OF TELEPRESENCE IN CLASS WITH MIXED REALITY</b><br><i>F. Escalona, B. Dominguez-Dager, F. Gomez-Donoso, A. Belmonte-Baeza, E. Martinez-Martin, M. Cazorla</i>   | 370 |
| <b>USING AI GENERATED TESTS FOR STUDYING AND EVALUATION</b><br><i>F. Gomez-Donoso, M. Pina-Navarro, F. Morillas-Espejo, L. Marquez-Carpintero, F. Escalona, M. Cazorla</i>   | 374 |
| <b>VIRTUAL EMERGENT TECHNOLOGIES FOR INCREASING RECEPTIVE COMMUNICATION IN AUTISTIC LEARNERS</b><br><i>G. Lorenzo, J.A. López-Nuñez, E. Andreu-Cabrera, F. Doviigo, I. Gómez-Barreto, M.T. Bejarano-Franco, G. Herrera-Gutierrez</i> | 378 |
| <b>NAVIGATING THE NEW NORMAL: ENSURING SUCCESS FOR EDUCATIONAL TECHNOLOGY SUPPORT TEAMS IN THE POST-COVID ERA</b><br><i>Y. Piller, R. Dorough</i>  | 384 |
| <b>MATCHING PEDAGOGY TO PRACTICE : ADAPTING TO COVID 19 AND BEYOND; MOVING A PHYSIOLOGY MOOC TO ON DEMAND STATUS</b><br><i>T. Gleave, S. Canning, D. Prescott</i>  | 392 |
| <b>EDUCATIONAL INITIATIVE ON INSTAGRAM TO ENHANCE UNIVERSITY STUDENTS' SCIENTIFIC WRITING SKILLS AND SELF-EFFICACY</b><br><i>S. Collado, R. Rodríguez-Rey, C. Fidalgo, M. Sorrel, M. Carballo</i>                                    | 393 |
| <b>HOW THE USE OF AI IS CHANGING THE ROLE OF EDUCATORS AT UNIVERSITIES - AND WHY THIS IS BY NO MEANS A BAD THING</b><br><i>N. Weimann-Sandig</i>   | 394 |
| <b>DIGITALISATION OF PRACTICAL CONTENTS IN ELECTRONICS TO PROMOTE BLENDED LEARNING WITH AN INVERTED APPROACH</b><br><i>D. Valiente, F. Rodríguez-Mas, A. Ruiz, A. Hortal, A. Peidro</i>  | 401 |
| <b>EXPLORING SOCIAL CONNECTEDNESS AND EMPATHY WITH POSTGRADUATE PSYCHOLOGY STUDENTS AND THE IMPACT OF THE COVID-19 PANDEMIC: THE VALUE OF THE HIDDEN CURRICULUM</b><br><i>A.J. Viljoen, T.A. Adonis</i>                              | 402 |
| <b>THE IMPACT OF ARTIFICIAL INTELLIGENCE (AI) CONTENT ON EDUCATION AND STUDENT LEARNING</b><br><i>J. Dosky</i>   | 408 |
| <b>A NEW UNIVERSITY LEARNING EXPERIENCE WITH IMAGINATIVE EDUCATION</b><br><i>L. Vargas, V. Tena, F. Sandoval, R. Ruiz</i>  | 422 |
| <b>REIMAGINING STUDENT CENTEREDNESS IN HIGHER EDUCATION: ENTERPRISE CAPABILITY THEORETICAL PERSPECTIVE</b><br><i>P. Msweli</i>   | 429 |
| <b>MULTIMODAL CONTEXTUALIZING AND TARGETING EXERCISES IN ICAPT SYSTEMS</b><br><i>E. Pyshkin, J. Blake, V. Khaustova, V. Khaustov, I. Lezhenin, R. Svechnikov, D. Efimov, N. Bogach</i>   | 438 |
| <b>EDUCATION OF MANAGERS IN THE AREA OF PROCESS RISK ASSESSMENT</b><br><i>M. Hudakova, P. Kardoš, K. Buganová</i>  | 449 |
| <b>HOW TO PROMOTE FEMALE ENTREPRENEURSHIP: A GENDER-SENSITIVE APPROACH TO HIGHER ENTREPRENEURIAL EDUCATION</b><br><i>J. Villagrana, S. Enrique, C. Donaldson</i>   | 458 |
| <b>TECHNOLOGICAL RESOURCE FOR TEACHING AND LEARNING OF CONDUCTING FOR BLIND STUDENTS</b><br><i>E. Lima</i>   | 463 |

|  |     |
|--|-----|
| <b>IS IT POSSIBLE TO TEACH CONDUCTING TO BLIND STUDENTS?</b>   | 464 |
| <i>E. Lima</i>   |     |
| <b>USING SMARTPHONE-BASED MICROSCOPY FOR INNOVATIVE BIOLOGY TEACHING</b>   | 465 |
| <i>V. Lang, A. Šorgo</i>   |     |
| <b>RESEARCH TRENDS WITH THE USE OF EDUCATIONAL TECHNOLOGY</b>  | 469 |
| <i>M.E. Cipagauta Moyano</i>   |     |
| <b>LEADING THE RETURN TO THE HIGHER EDUCATION UNIVERSITY CLASSROOM AFTER THE COVID-19 PANDEMIC</b>   | 470 |
| <i>A. Fernandez, G. Shaw</i>   |     |
| <b>SMARTPHONE SENSORS: A VALUABLE TOOL FOR SCIENTIFIC EXPERIMENTS</b>  | 471 |
| <i>V. Lang, A. Šorgo</i>   |     |
| <b>EXPLORING FACTORS INFLUENCING ADULTS' ENGAGEMENT IN SECONDARY EDUCATION AND TRAINING PROGRAMMES IN PORTUGAL</b>                           | 477 |
| <i>M.J. Antunes, A.R. Luz, O. Tavares, C. Sá</i>   |     |
| <b>EXPLORING DROPOUT AND RETENTION TRENDS IN PORTUGUESE HEIS DURING TRANSFORMATIVE PERIODS</b>   | 484 |
| <i>A.R. Luz, M.J. Antunes, C. Sá, O. Tavares</i>   |     |
| <b>EXPLORATION AND INTEGRATION OF METAVERSE OPPORTUNITIES AND THE CDIO METHODOLOGY IN BLENDED TEACHING OF TECHNICAL ENGINEERING SUBJECTS</b> | 492 |
| <i>J. Herrera Herbert, R. Arranz Revenga, J.A. Ramírez Masferrer</i>   |     |
| <b>ENHANCING SCIENCE EDUCATION THROUGH ROBOTIC INSTRUMENT EXPERIMENTATION IN JUNIOR HIGH SCHOOL</b>  | 500 |
| <i>N. Papadimitropoulos</i>  |     |
| <b>THE INFLUENCE ON CONCEPTUAL DEVELOPMENT WITHIN ARITHMETIC AND MATHEMATICS VIA APPLICATION OF VIRTUAL REALITY</b>                          | 506 |
| <i>N. Fanchamps</i>  |     |
| <b>EVOLUTION OF TEACHING IN THE METAVERSE FROM 2011 TO 2024</b>  | 516 |
| <i>J.A. Ramírez Masferrer, J. Herrera Herbert, R. Arranz Revenga</i>   |     |
| <b>INTERNATIONAL STUDENT VIEW ON INTEGRATION TO WORKING LIFE IN THE HOST COUNTRY</b>   | 526 |
| <i>L. Hongell, S. Fabricius, M. Halmén</i>   |     |
| <b>UNLOCKING TEACHERS' DIGITAL COMPETENCE: THE CONTRIBUTION OF A MOOC DESIGNED FOR ENHANCING DIGITAL ASSESSMENT</b>                          | 532 |
| <i>M. Lucas, S. Senos</i>  |     |
| <b>BUILDING FUTURE ENGINEERS THROUGH TEAMWORK: WHAT WE NEED TO IMPROVE IN HIGHER EDUCATION</b>   | 534 |
| <i>I. Ortiz-Marcos, R. Garcia-Galan, A. Zarzo Altarejos, E. Caro Huertas</i>   |     |
| <b>TEACHER'S PERSPECTIVE ON COMMUNICATION BETWEEN PARENTS OF SPECIAL NEEDS CHILDREN AND THEIR TEACHERS IN THE TECHNOLOGICAL AGE</b>          | 542 |
| <i>E. Wasserman, H. Berkowitz</i>  |     |
| <b>THE TRANSFORMATIVE POTENTIAL OF GENERATIVE AI IN EDUCATION</b>  | 543 |
| <i>M. Muhic</i>  |     |
| <b>INTERNATIONAL COOPERATION AS A DRIVER FOR STUDENT DEVELOPMENT – A CASE STUDY BASED IN GEOSPATIAL INFORMATION TECHNOLOGY APPLICATION</b>   | 548 |
| <i>F. Sanchez Iglesias, M.A. Grande Ortiz, A. Serrano Iglesias, M.J. Garcia Garcia, L.C. Echavarría Caballero</i>                            |     |
| <b>THE AGONY OF WORKPLACE DISCRIMINATION ON WOMEN IN EDUCATION LEADERSHIP: A CASE OF WATERBERG DISTRICT IN LIMPOPO PROVINCE</b>              | 555 |
| <i>S.J. Madela, E. Ngobeni, P. Sepeng</i>  |     |
| <b>USE OF PYTHON PROGRAMMING LANGUAGE FOR SOLVING PRACTICAL PROBLEMS RELATED TO ELECTRICAL ENGINEERING</b>                                   | 562 |
| <i>J. Jimenez-Ruiz, A. Honrubia-Escribano, E. Gómez Lázaro</i>   |     |
| <b>ABSTRACT THINKING OF ENGINEERING STUDENTS IN HIGH-SCHOOL AND HIGHER EDUCATION</b>   | 570 |
| <i>A. Gero</i>   |     |
| <b>PEER LEARNING: NURSING STUDENTS' EXPERIENCE</b>   | 575 |
| <i>C. Pinto, A. Pinto, A. Veríssimo, I. Ribeiro, F. Segadães, R. Pires, P. Oliveira, S. Costa</i>  |     |
| <b>USE OF MOBILE DEVICES IN UNDERGRADUATE NURSING STUDENTS</b>   | 583 |
| <i>C. Pinto, A. Pinto, A. Veríssimo, I. Ribeiro, F. Segadães, R. Pires, S. Costa, P. Oliveira</i>  |     |

|  |     |
|--|-----|
| <b>PARENTING EDUCATION IN SLOVAKIA: A CONTENT ANALYSIS OF PARENTING EDUCATION COURSES</b><br><i>S. Dončevová, Z. Hrcán</i>   | 588 |
| <b>MANAGERIAL ETHICS FOR SUSTAINABLE BUSINESS – A CASE OF IMPLEMENTATION OF ACTIVE LEARNING STRATEGIES</b><br><i>E. Švejdarová</i>   | 597 |
| <b>IDENTIFYING THRESHOLD CONCEPTS TO IMPROVE THE LEARNING AND TEACHING PROCESS: APPLICATION IN THE SUBJECT OF PROJECT ENGINEERING</b><br><i>D. Uribe Rodríguez, S. Lopez Garcia-Vaquero, B. Quílez Fernandez</i> | 606 |
| <b>AI-DRIVEN STUDENT ASSISTANCE: CHATBOTS REDEFINING UNIVERSITY SUPPORT</b><br><i>S. Martínez-Requejo, E. Jiménez García, S. Redondo Duarte, J. Ruiz Lázaro, E. Puertas Sanz, G. Mariscal Vivas</i>              | 617 |
| <b>IMPROVING COMPETITION PERFORMANCE TO MIDDLE SCHOOL ROBOTIC TEAMS BY TEACHING PRODUCT DEVELOPMENT SKILLS</b><br><i>E. Sudano, G. Avvento</i>   | 626 |
| <b>TURBOCHARGING DOCTORAL RESEARCHERS' TRAINING: BLENDING TEXT, XERTE LEARNING OBJECTS AND AI INDIVIDUALISATION</b><br><i>P. Trowler</i>   | 637 |
| <b>DOES TRAUMA EFFECT IDENTIFICATION IN SPECIAL EDUCATION? WORDS FROM THE FIELD</b><br><i>J. Finn</i>  | 638 |
| <b>TECHNICAL CHANGE IN HIGHER EDUCATION SYSTEM</b><br><i>V. Giménez, G. Pérez-López, D. Prior, J. Zafra-Gómez</i>  | 639 |
| <b>EMPOWERING PRE-SERVICE TEACHERS: LEVERAGING QUANTITATIVE ETHNOGRAPHY TO ENHANCE ONLINE EDUCATION</b><br><i>M. Phillips, T. McDougall</i>  | 640 |
| <b>BIASED EDUCATION - TEACHING DIGITAL DESIGN THROUGH FEMALE PROTAGONISTS: A CASE STUDY</b><br><i>L. Bollini</i>   | 648 |
| <b>INTERDISCIPLINARY, AI-BASED CYBERSECURITY AWARENESS TRAINING IN SMES</b><br><i>I. Hamburg</i>   | 657 |
| <b>PRIVATE AVATAR GOES HOME, TEACHER OBSERVATIONS</b><br><i>M. Beňo, D. Čagáňová, N. Horňáková</i>   | 662 |
| <b>A TEACHING EXPERIENCE ON THE USE OF CHATGPT FOR LEARNING AND CRITICAL REASONING</b><br><i>J.A. Aledo, P. Bermejo</i>  | 670 |
| <b>ACTIVE LEARNING METHODOLOGIES IN HIGHER EDUCATION: REFLECTIONS ON THE PERCEPTIONS OF PORTUGUESE TEACHERS AND TRAINING OPPORTUNITIES</b><br><i>G. Reses, V. Carlos, S. Soares</i>                              | 675 |
| <b>MEASURING THE IMPACT OF 21ST CENTURY SKILLS EXPERIENTIAL LEARNING ON INTERNATIONALLY TRAINED PROFESSIONALS' (ITPS) WORKPLACE READINESS IN CANADA</b><br><i>G. Grant, J. Staples</i>                           | 676 |
| <b>ASSESSVR: ENHANCING RISK ASSESSMENT SKILLS THROUGH SERIOUS GAMES WITH EMBEDDED PRIMING FOR OCCUPATIONAL HAZARDS</b><br><i>N. Keren, J. Wright</i>   | 686 |
| <b>TRAINING TEACHERS AND TRAINERS TO DESIGN TECHNOLOGY-BASED AND PROBLEM-ORIENTED EXAMINATION TASKS</b><br><i>S. Seeber, E. Wuttke</i>   | 687 |
| <b>CHILDREN'S WELLBEING: CONCEPTUALIZATION OF CHILDHOOD AMONG ANGLOPHONES AND FRANCOPHONES IN CAMEROON</b><br><i>A. Rita Veghessi</i>  | 694 |
| <b>ONE EFFECT ON PRE-SERVICE TEACHERS' SELF-EFFICACY SCORES LINKED TO CHANGES IN ANTI-COVID-19 MEASURES AS THE PANDEMIC PROGRESSED IN SCHOOLS IN THE NORTHWEST OF ENGLAND</b><br><i>R. Tynan, A. Mallaburn</i>   | 695 |
| <b>USING THE SCHOOL PLAYING FIELD TO MEET THE PRACTICAL REQUIREMENTS ASSOCIATED WITH ECOLOGY SUBSTANTIVE KNOWLEDGE IN CURRENT BIOLOGY EXAMINATION SPECIFICATIONS IN ENGLAND</b><br><i>R. Tynan</i>               | 705 |

|   |     |
|---|-----|
| <b>TECNO-CONCIENCIA: ECO-FRIENDLY STRATEGY TO ENCOURAGE STEAM LEARNING</b><br><i>M. Martinez</i>  | 715 |
| <b>LET'S RESIST A RETURN TO PRE-PANDEMIC HIGHER EDUCATION</b><br><i>A. Fernandez, G. Shaw</i>   | 716 |
| <b>LEARNING, UNDERSTANDING AND RECOGNIZING THE IMPORTANCE OF FORMAL AND SEMANTIC CONGRUENCE BETWEEN MUSIC AND SPORTS ROUTINES</b><br><i>F.C. Loo, F.Y. Loo</i>  | 717 |
| <b>TEACHING NATIONAL MUSIC IDENTITY IN A MULTIRACIAL MALAYSIA: DIVERSITY, COMPLEXITY, AND CONTINGENCY</b><br><i>F.Y. Loo, F.C. Loo</i>  | 722 |
| <b>THE POTENTIAL CONTRIBUTION OF LI JINHUI'S COMPOSITIONS AND PRESCHOOL MUSIC TEXTBOOKS TO PRESCHOOL MUSIC EDUCATION IN CONTEMPORARY CHINA</b><br><i>Y. Huang, F.C. Loo</i>   | 723 |
| <b>A DECADE OF EXPERIENCE: ADVANCES AND REFLECTIONS IN THE MANAGEMENT OF INTERNATIONAL GROUPS AT THE FACULTY OF VETERINARY MEDICINE OF THE UNIVERSITY CEU CARDENAL HERRERA</b><br><i>C. de Brito, I. Tadeo, E. Bataller</i> | 727 |
| <b>EXPLORING TEACHERS' REQUIREMENTS FOR EDUCATIONAL RESOURCES: DIVERSE USER TYPES AND COMMON NEEDS</b><br><i>M. Kastner, B. Simon</i>   | 732 |
| <b>ENGAGING MEDIA APPROACH IN THE INSTITUTIONALIZATION OF PUZHOU OPERA</b><br><i>L.L. Pang, F.C. Loo</i>  | 742 |
| <b>A PRELIMINARY STUDY OF SPOC FOR MEDICAL IMAGING TECHNOLOGIST EDUCATION IN RURAL CHINA UNDER THE COVID-19 PANDEMIC</b><br><i>S. Chow, D. Zhong</i>  | 746 |
| <b>REPURPOSING THE FUTURE SCHOOL TEACHER THROUGH A FOUCAULDIAN LENS</b><br><i>M. Harpham, J. Patterson</i>  | 755 |
| <b>EVEN BETTER THAN THE REAL THING? HOW NEW FORMS OF POLICE TRAINING PROGRAMS CHALLENGE ESTABLISHED EDUCATIONAL STRUCTURES</b><br><i>D. Skog</i>  | 763 |
| <b>DIGITAL EDUCATIONAL RESOURCES IN TRAINING OF OIL AND GAS SPECIALISTS</b><br><i>K. Makayev, G. Makayeva, L. Ibatulina, E. Bilguzovna, I. Kuznetsova</i>   | 764 |
| <b>CONSIDERATION OF DIFFERENCES OF RUSSIAN AND ENGLISH TERMS BY THEIR USE AND TRANSLATION</b><br><i>K. Makayev, G. Makayeva, L. Ibatulina, E. Bilguzovna, I. Kuznetsova</i>   | 769 |
| <b>ONE-TO-ONE CONVERSATIONAL STUDY PARTNERS FOR CHILDREN USING AI: A USER EXPERIENCE ANALYSIS OF TEDDYAI</b><br><i>P. Otermans, A. Sharma, M. Singh, D. Aditya</i>  | 777 |
| <b>A STUDY EXPLORING THE EFFECTIVENESS OF A VIRTUAL COACH TO UPSKILL UNDERSERVED WOMEN</b><br><i>P. Otermans, D. Aditya</i>   | 784 |
| <b>INFLUENCE OF EDUCATION LEVEL, GENDER, AGE AND SENIORITY OF TEAM MEMBERS ON THEIR JOB SATISFACTION AND ORGANISATIONAL BEHAVIOUR</b><br><i>S. Silberg, L. Stehlik, M. Silberg</i>  | 796 |
| <b>USING DOCUMENTARIES IN THE ONLINE CLASSROOM TO TEACH MEDIA LITERACY AND BUSINESS ETHICS</b><br><i>D. Pearce</i>  | 807 |
| <b>GASTRONOMIC EVENT AS A DRIVER FOR DEVELOPING LANGUAGE SKILLS - ADVANTAGES AND LIMITATIONS OF PROJECT-BASED LEARNING</b><br><i>M.N. Perez Santos, B. Costa</i>  | 817 |
| <b>THE USE OF PROMOTIONAL TOURISM VIDEOS TO DEVELOP FOREIGN LANGUAGE SPEAKING SKILLS</b><br><i>M.N. Perez Santos</i>  | 822 |
| <b>OBSERVING FROM A DISTANCE: DIGITAL ETHNOGRAPHY TO INVESTIGATE AUTISTIC CHILDREN'S DIGITAL INTERACTION IN THE HOME</b><br><i>I. Siloa</i>   | 828 |

|  |     |
|--|-----|
| <b>THE USAGE OF DEPTH AND COMPLEXITY ICONS WHEN WORKING WITH INTELLECTUALLY GIFTED STUDENTS</b><br><i>G. Ereemeeva, N. Sigacheva, R. Bikbulatov</i>  | 829 |
| <b>DIGITAL RECORD OF STUDENT ATTENDANCE IN UNIVERSITY CLASSES</b><br><i>C. Lerma, J. Vercher, J.G. Borràs, Á. Mas, E. Gil</i>  | 837 |
| <b>ELABORATION OF TRAINING COMPLEMENTS BY RECORDING VIDEOS WITH CHROMA KEY</b><br><i>C. Lerma, J. Vercher, J.G. Borràs, Á. Mas, E. Gil</i>   | 844 |
| <b>DECODING LEARNER RESPONSES: AN ANALYSIS OF COMMENTS ON TIKTOK VIDEOS</b><br><i>Y. Zhang, M. Lucas, L. Pedro</i>   | 853 |
| <b>RETHINKING EDUCATION: UNLEASHING THE POWER OF DIGITAL INNOVATION - PARADIGM SHIFT IN EXAMINATION CULTURE - DIGITAL MEDIA AND INNOVATIVE FORMS OF EXAMINATION</b><br><i>E. Benedik, A. Gruber</i>  | 854 |
| <b>READING NON-LINEAR DIGITAL NARRATIVES: A SYSTEMATIC REVIEW</b><br><i>C. Vanhees, M. Simons, V. Joosen</i>   | 861 |
| <b>EMPOWERING YOUNG MINDS: A JOURNEY INTO MAKING IN PRIMARY SCHOOLS - THE MAKERSPACE OF THE UNIVERSITY COLLEGE OF TEACHER EDUCATION UPPER AUSTRIA</b><br><i>E. Benedik, A. Gruber</i>  | 871 |
| <b>VALUE ORIENTATION AND ATTITUDES OF POLICE OFFICERS IN PREVENTION OF DISCRIMINATORY ETHNIC PROFILING AND FURTHER POLICE EDUCATION</b><br><i>Š. Strnad, Z. Freitinger-Skalická, L. Michalcová, Š. Kavan</i>   | 875 |
| <b>INNOVATION, PRODUCTION, QUALITY AND INTERNAL COMMUNICATION FACTORS THAT CONTRIBUTE TO AN ORGANISATION'S SUCCESS</b><br><i>R. Caldeira, A. Infante Moro</i>  | 879 |
| <b>PAPER VOLCANOES LAB: ENGAGING YOUNG CHILDREN WITH EARTH SCIENCE IN KENYA. WHAT WE HAVE ACCOMPLISHED SO FAR</b><br><i>S. Amici, A. Bertoli, J.T. Ng'asike, M. Tesar, R. Sulpizio, S. Eleman, P. Emase</i>  | 886 |
| <b>DESIGN AND IMPLEMENTATION OF LEARNING ANALYTICS IN HIGHER EDUCATION. A PILOT CASE STUDY</b><br><i>F. Pelizzari, C. Sala, E. Tassalini</i>   | 896 |
| <b>TRANSPAVET: INNOVATING IN VETERINARY LEARNING USING AUGMENTED AND VIRTUAL REALITY</b><br><i>M. García-Roselló, E. García-Roselló, J.A. Solves, B. Ballester, J. López, A. Navarro, M. Muñoz, C. de Brito</i>  | 905 |
| <b>AN EXPLORATION OF FOREIGN LANGUAGE CLASSROOM ANXIETY IN YOUNG ADOLESCENTS IN FRENCH-SPEAKING SWITZERLAND</b><br><i>D. Bosmans</i>   | 912 |
| <b>BRIDGING THEORY AND PRACTICE: EMPOWERING COMMUNITIES THROUGH RECIPROCAL LEARNING</b><br><i>M. Castrillon Toro</i>   | 921 |
| <b>DIGITAL TWIN AS A TOOL FOR SOCIAL PARTICIPATION IN ENVIRONMENTAL IMPACT ASSESSMENT</b><br><i>L.I. Hojas Hojas, E.M. García-Del-Toro, I. Más López</i>   | 928 |
| <b>TACTICAL ENVIRONMENT IN CIVIL ENGINEERING: ENVIRONMENTAL SPECIALIZATION IN CIVIL ENGINEERING WITH A HIGH SOCIAL PARTICIPATION</b><br><i>L.I. Hojas Hojas, E.M. García-Del-Toro, I. Más López</i>  | 934 |
| <b>EMBRACING THE TRANSFORMATIVE SHIFT OF 3D TECHNOLOGY: COLLABORATIVE PATHWAYS BETWEEN SUSTAINABLE DIGITAL INNOVATION AND FASHION DESIGN EDUCATION</b><br><i>X. Lin, M.O. Ingaramo</i>   | 943 |
| <b>INFORMATION AND COMMUNICATION TECHNOLOGIES AS FACILITATORS IN THE TEACHING AND LEARNING PROCESS: AN ANALYSIS OF MUNICIPALITIES IN THE SEMIARID REGION OF RIO GRANDE DO NORTE, BRAZIL</b><br><i>E. Sant'anna, R. Silva, J. Mendes de Araujo, M. Aguirre, B. Lima, A.A.S. Fontoura, J. Ribeiro de Oliveira, P. Medeiros</i> | 951 |

|  |      |
|--|------|
| <b>GENERATING KNOWLEDGE CONTENT AND KNOWING IN THE AGE OF ARTIFICIAL INTELLIGENCE</b>  | 957  |
| <i>S. Dugal, S. Singh, M. Troiano, R. Singh, E. Sillat, M. Hanna, M. Vancouyghen, N. Gamache, G. Daddio, C. Calise, M. Goeller, M. Sundwall, J. Castro, L. Joseph, A. Ryder, J. Morley, S. Boyer, J. Keeler, E. Papa, A. Merlo, J. Campbell, S. Schindlar, H. Brown, A. Bacik, N. Januario, B. Swajger, O. Surette, P. Gudas, T. Tobin, A. Doran, J. Romero, T. Renzi, M. Lessard, A. Gomez, E. Piel, S. Cardoso, N. Carlino, M. Harmon, G. Isaacson, V. Jones, M. Torres, M. Lasky, N. Debarros, S. Rodriguez, P. Smith</i> |      |
| <b>L2 VIRTUAL EXCHANGES AND LABORATORY EXPERIMENTS IN ENGINEERING EDUCATION: NEW HORIZONS FOR SUSTAINABLE, TRANSVERSAL AND LINGUISTIC DEVELOPMENT</b>  | 959  |
| <i>O. Polyakova, E. Klyatskina</i>   |      |
| <b>CONNECTIONS BETWEEN READING COMPREHENSION AND SCIENCE FAMILIARITY FOR SCIENCE TEACHERS IN TRAINING</b>  | 965  |
| <i>E. Ortega Torres, E. Gamero Sandemetrio</i>   |      |
| <b>DESIGNING A CHATBOT TO SUPPORT PROBLEM-SOLVING IN A PROGRAMMING COURSE</b>  | 966  |
| <i>C. Martínez-Araneda, M. Gutiérrez, D. Maldonado, P. Gómez, A. Segura, C. Vidal-Castro</i>   |      |
| <b>PROJECT-BASED LEARNING FOR THE ANALYSIS AND MANAGEMENT OF RURAL SPACES: PROPOSAL FOR ADAPTATION MEASURES AGAINST CLIMATE CHANGE</b>   | 976  |
| <i>N. Dávila Cabanillas, I. Aguado Moralejo, J. Aranbarri Erkiaga</i>  |      |
| <b>INNOVATIVE TEACHING FOR CLIMATE CHANGE AND SOCIAL VULNERABILITY: RESTRUCTURING LEARNING IN GEOGRAPHY</b>  | 983  |
| <i>N. Dávila Cabanillas, I. Aguado Moralejo, J. Aranbarri Erkiaga</i>  |      |
| <b>UNLOCKING SCIENCE FOR ALL: FOSTERING COMMUNITY EMPOWERMENT THROUGH EUROPEAN RESEARCHERS' NIGHT IN RURAL TERRITORIES OF PORTUGAL</b>   | 991  |
| <i>R. Branquinho, I. Duarte, C. Sarabando, S. Ambrósio, P. Cruz, C. Damião, J. Duarte, X. Sá Pinto</i>   |      |
| <b>YOU'VE GOT MAIL! EMPOWERING STUDENTS TOWARD SUCCESS THROUGH THE USE OF UPLIFTING MESSAGES AND LIVE, VIRTUAL CONNECTIONS - THE MISSING LINK TO STUDENT RETENTION AND SUCCESS?</b>  | 1001 |
| <i>S. Rebeor, C. McMahon, S. Stubbs, M. Rosser-Majors</i>  |      |
| <b>LEARNING BY DOING AND EXPERIENCING THE WORLD THROUGH OUTDOOR EDUCATION</b>  | 1002 |
| <i>K. Kasowska, M. Kowalski</i>  |      |
| <b>ACTION RESEARCH: OPTIMIZING IDEATION AND DIGITAL PREPRESS WORKFLOWS WITH AI INTEGRATION</b>   | 1006 |
| <i>A. Bridges, C. Blue</i>   |      |
| <b>CAPTURING THE PERSONAL AND PEDAGOGICAL EXPERIENCES OF FACULTY DURING EMERGENCY RESPONSE TEACHING (COVID 19) AT A RESEARCH UNIVERSITY IN ABU DHABI</b>   | 1013 |
| <i>D. Dalton</i>   |      |
| <b>PROMOTING ATTITUDINAL CHANGE AND IMPROVING KNOWLEDGE OF INSECTS THROUGH COOPERATIVE LEARNING AMONG SECONDARY SCHOOL STUDENTS</b>  | 1014 |
| <i>M. Ferrer Suay, J.J. Asensi, J. Selfa, J. Pérez-Rodríguez, T. Pina</i>  |      |
| <b>INTERCONNECTION BETWEEN THEORY AND PRACTICE FOR PROBLEM SOLVING: ANALYSING THE POINT OF VIEW OF THE STUDENTS</b>  | 1023 |
| <i>E. Segredo-Morales, O. Díaz, E. González</i>  |      |
| <b>THE PROBLEM-BASED TEACHING METHODOLOGY APPLIED TO THE REFORMULATION OF LABORATORY PRACTICES</b>   | 1027 |
| <i>E. Segredo-Morales, O. Díaz, E. González</i>  |      |
| <b>ELEARNING MOTIVATION ACROSS UNIVERSITY AND RURAL YOUNG ADULTS IN WINNOVATOR SPACE</b>   | 1031 |
| <i>M. Zapušek, K. Pata, K. Jüristo, V. Devedzić, S. Radenkovic, M. Devedzić, D. Milošević, M. Blagojevic, S. Popovic-Pantic</i>  |      |
| <b>THE EFFECTIVENESS OF CRITIQUES AS WRITING TOOLS IN A GRAPHIC COMMUNICATIONS CLASSROOM</b>   | 1038 |
| <i>A. Bridges</i>  |      |
| <b>DIGITAL TRANSITION AND HOME EDUCATION: CHALLENGES AND OPPORTUNITIES FOR PSYCHOLOGICAL INTERVENTION</b>  | 1044 |
| <i>F. Oliveira, G. Castanheira, R. Fidalgo de Oliveira, L. Cunha, C. Costa-Lobo</i>  |      |

|   |      |
|---|------|
| <b>EXPLORING THE ELECTRONIC INTERACTIONAL COMPETENCE THROUGH CONVERSATION ANALYSIS: A CASE STUDY OF TWO PHILIPPINE K-12 SYNCHRONOUS ONLINE CLASSES</b><br><i>N. Lyu</i>   | 1053 |
| <b>EDUCATION FOR SUSTAINABILITY: NURTURING GLOBAL COMPETENCY AND CHANGEMAKERS THROUGH INTERDISCIPLINARY LEARNING</b><br><i>P. Holanchock, S. Davis</i>  | 1060 |
| <b>RIC: A CHATGPT-BASED MODEL TO DEVELOP STUDENTS' CRITICAL THINKING SKILLS</b><br><i>N. Rizk</i>   | 1065 |
| <b>DEVELOPING AN INNOVATIVE FRAMEWORK TO EXPLORE THE RELATIONSHIP BETWEEN IN-TEXT CITATIONS AND ACADEMIC WRITING SKILLS AMONG OMANI UNIVERSITY UNDERGRADUATES</b><br><i>J. Issa, F. Al-Dhahli</i>   | 1071 |
| <b>ENHANCING STUDENT ENGAGEMENT AND LEARNING OUTCOMES THROUGH RESEARCH-BASED LEARNING STRATEGIES IN BIOCHEMISTRY AND MOLECULAR BIOLOGY</b><br><i>C. Martín, R. Montes, K.B. Uribe</i>   | 1079 |
| <b>CONTINUOUS VERSUS DISCONTINUOUS TEXTS: PROCESSING DIFFERENCES IN UNIVERSITY STUDENTS</b><br><i>A. Rubio-Peñarrubia, A.C. Llorens-Tatay</i>   | 1085 |
| <b>A GAME BASED PHYSICAL EXERCISE LEARNING SUPPORT SYSTEM FOR HEALTHCARE OF THE ELDERLY</b><br><i>N. Uchiyama, Y. Yamahira, N. Iwane, S. Kitano, M. Yamaguchi</i>   | 1086 |
| <b>BURNOUT AND WELL-BEING OF PARENTS OF CHILDREN WITH AND WITHOUT NEURODEVELOPMENTAL DISABILITIES</b><br><i>E. Hassanein</i>  | 1092 |
| <b>FOSTERING CRITICAL THINKING IN VOCATIONAL EDUCATION AND TRAINING</b><br><i>B. Vignjević Korotaj, I. Buchberger</i>   | 1093 |
| <b>PLURICENTRIC APPROACH IN LEARNING GERMAN IN A SCHOOL ENVIRONMENT IN SLOVAKIA</b><br><i>E. Stranovská, I. Haringa</i>   | 1094 |
| <b>ADVANCING THE DISCOURSE ON SERVANT LEADERSHIP IN SCHOOLS: AN EXPLORATION OF INTERPRETATIONS</b><br><i>C.B. Swart</i>   | 1102 |
| <b>THE IMPACT OF GAMIFICATION AND ONLINE QUIZZES ON PRE-CLASS PREPARATION FOR AN ENGINEERING DESIGN COURSE. AN ACTIVE LEARNING APPROACH</b><br><i>A.Z. Salem</i>  | 1112 |
| <b>A RIGOROUS ASSESSMENT OF A PROPOSED CONCEPTUAL FRAMEWORK FOR FACILITATING SCHOOL LEADERSHIP IN ESTABLISHING A POSITIVE TEACHING AND LEARNING ENVIRONMENT IN SOUTH AFRICAN SCHOOLS</b><br><i>C.B. Swart</i>   | 1117 |
| <b>SERVICE LEARNING AND INTERDISCIPLINARY TEAMWORK FOR MEDICAL STUDENTS</b><br><i>M. Alonso-Chamorro, M.P. Rodríguez Gabriel</i>  | 1127 |
| <b>BIM EDUCATION FOR QATAR'S CONSTRUCTION INDUSTRY: A LIFECYCLE VISION</b><br><i>A. Hammi, D. Ouahrani, A. Bouras, K. Naji</i>  | 1135 |
| <b>STUDY OF THE HABITS OF EQUALITY, INCLUSION AND SUSTAINABILITY IN THE UNIVERSITY COMMUNITY</b><br><i>M.J. Alférez, A. Molinero García, B. Clares Naveros, A. Conejo García, O. Cruz López, E. García Fernández, R.J. Giménez Martínez, M.C. González García, J.A. González Vera, A.I. Del Moral García, C. Monteagudo Sánchez, R. Navarrete Casas, F. Ocaña Peinado, J.M. Paredes Martínez, M. Romero Pérez, B. Rubio Ruiz, M.J. Ruedas Rama, M. Sánchez Polo, E.M. Talavera Rodríguez, J. Valverde Pozo, R. Castilla Ríos, C.F. García Jiménez, A. Lozano Ortega, A. Martínez Avilés, A. González Muñoz, L. González Robles, J. Sepúlveda Villodres, E. González Muñoz</i> | 1144 |



|   |      |
|---|------|
| <b>INNOVATIVE STRATEGIES: A CASE STUDY ON EMPLOYMENT TRAINING AT THE UNIVERSITY OF GRANADA</b>  | 1149 |
| <i>M.J. Alférez, A. Lozano Ortega, B. Clares Naveros, A. Conejo García, O. Cruz López, E. García Fernández, R.J. Giménez Martínez, M.C. González García, J.A. González Vera, A. Molinero García, A.I. Del Moral García, C. Monteagudo Sánchez, R. Navarrete Casas, F. Ocaña Peinado, J.M. Paredes Martínez, M. Romero Pérez, B. Rubio Ruiz, M.J. Ruedas Rama, M. Sánchez Polo, E.M. Talavera Rodríguez, J. Valverde Pozo, R. Castilla Ríos, C.F. García Jiménez, A. Martínez Avilés, A. González Muñoz, L. González Robles, J. Sepúlveda Villodres, E. González Muñoz</i> |      |
| <b>COMPUTATIONAL TOOLS FOR DEALING WITH ENERGY SYSTEMS. A NECESSARY DIDACTIC APPROACH</b>   | 1157 |
| <i>L. García-Pérez, M. Santos</i>   |      |
| <b>DIVERSE PERSPECTIVES IN STEM EDUCATION</b>   | 1162 |
| <i>M. Day</i>   |      |
| <b>BUILDING SCHEDULES TO SUPPORT COMPLETION: ENGAGING STUDENTS IN GUIDED PATHWAYS</b>   | 1163 |
| <i>M. Perry</i>   |      |
| <b>EDUCATOR PERSPECTIVES OF PROFESSIONAL COMMUNICATION IN PRIMARY SCHOOL ENVIRONMENTS</b>   | 1164 |
| <i>N. Maras, B. Nemet, D. Tot</i>   |      |
| <b>ENHANCING DIGITAL DESIGN: INVESTIGATING PROMISING PEDAGOGICAL PRACTICES FOR ONLINE LEARNING IN HIGHER EDUCATION</b>  | 1174 |
| <i>L. Morrison, R. Kay</i>  |      |
| <b>EMPOWERING NONTRADITIONAL STUDENTS IN TARRANT COUNTY COLLEGE: STUDENT ENGAGEMENT STRATEGIES TO FACILITATE STUDENT COMPLETION AND TRANSFERRING</b>  | 1175 |
| <i>A. Garza</i>   |      |
| <b>MATHEMATICS COMPETITION BY TEAMS (COMATEQ): AN OPPORTUNITY TO COMPETE INTERNATIONALLY</b>  | 1176 |
| <i>L. Cáceres, O. Colón</i>   |      |
| <b>GRAPHIC DESIGN STUDENTS DESIGN, DEVELOP AND DELIVER FOR CLIENTS</b>  | 1177 |
| <i>L. Frear, C. Phillip, K. Dirisio</i>   |      |
| <b>THE CONCEPT OF MULTICULTURALISM - THE ROLE OF LIBRARIES AND THE IMPORTANCE OF FOREIGN LANGUAGE LEARNING</b>  | 1178 |
| <i>D. Pavlovic, Z. Stanisavljevic Petrovic</i>  |      |
| <b>RESEARCH SKILLS DEVELOPMENT OF POSTGRADUATE PSYCHOLOGY STUDENTS: THE INTEGRATION OF LEARNING, TEACHING, RESEARCH, AND COMMUNITY ENGAGEMENT</b>   | 1186 |
| <i>T.A. Adonis, M. Florence, S. Isaacs, K. Jackson</i>  |      |
| <b>EMERGING TRENDS IN HIGHER EDUCATION IN PORTUGAL</b>  | 1193 |
| <i>M. Varela, A. Infante Moro</i>   |      |
| <b>SPIRAL TEACHING METHODOLOGY IN MATHEMATICS COMPETITIONS</b>  | 1201 |
| <i>L. Cáceres, V. Reyes</i>   |      |
| <b>EDUCATIONAL TRANSFORMATION THROUGH AI: PREPARING FOR A NEW ERA OF LEARNING</b>   | 1202 |
| <i>G. Zootzky, A. Pfeiffer</i>  |      |
| <b>LEVERAGING ARTIFICIAL INTELLIGENCE FOR ENHANCING READING SPEED, VOCABULARY, AND COMPREHENSION: AN INTEGRATED APPROACH</b>  | 1208 |
| <i>I. Kondrateva, A. Makhmutova, A. Zinnatullina</i>  |      |
| <b>GATHER 'ROUND FOR I HAVE A STORY: ENGAGING STUDENTS IN A COMMON READER PROGRAM</b>   | 1218 |
| <i>C. Savant</i>  |      |
| <b>VIRTUAL CLASSROOMS: THE CHANGE OF ONLINE EDUCATION</b>   | 1219 |
| <i>D. Garcia</i>  |      |
| <b>DICTION PRACTICE ENHANCED BY ARTIFICIAL INTELLIGENCE: A MODERN APPROACH TO LANGUAGE LEARNING</b>   | 1225 |
| <i>A. Makhmutova, I. Kondrateva, A. Zinnatullina</i>  |      |
| <b>A HYBRID APPROACH TO ENGINEERING EDUCATION: INTEGRATING ONLINE AND IN-PERSON LEARNING</b>  | 1233 |
| <i>M. Tomovic, C. Tomovic, S. Bawab</i>   |      |

|   |      |
|---|------|
| <b>VET TEACHERS: FACING THE CHANGES IMPLEMENTED IN VET EDUCATION IN SPAIN</b>   | 1240 |
| <i>L. Gómez Estrada, L. Gómez Estrada, C. Zoli, S. Randaccio, L. Pietra, R. Sixto Iglesias, R. Navarro Cerveró, J.S. Nunes, P. Karampelas, J.B. Tornos Capilla, L. Miltiadis, J.L. Gómez Ribelles</i> |      |
| <b>GRADUATE TRACE STUDIES (GTS) IN ARCHITECTURAL AND PLANNING FACULTY, KAU: INVESTIGATING THE EXTENT OF SKILLS MATCHING BETWEEN THE PROGRAM OF URP AND NEEDED SKILLS FOR THE LABOR MARKET</b>         | 1248 |
| <i>W. Salem</i>   |      |
| <b>LEARNING BY INNOVATING AND PLAYING IN DIFFERENT AREAS</b>  | 1258 |
| <i>M.I. Rodríguez, M.J. Álvarez, M. Cuadros, S. García-Rodríguez, V. Ayllon, V. Sánchez, L.J. Martínez, P. Sánchez, C. Torres</i>   |      |
| <b>RURAL STUDENTS' EMPOWERMENT: FOSTERING SCIENTIFIC CURIOSITY THROUGH MICROBIOLOGY</b>   | 1262 |
| <i>R. Branquinho, C. Sarabando, L. Queijo, C. Damião, J. Duarte</i>   |      |
| <b>A MOTIVATIONAL LEARNING BY DOING ERASMUS+ INTERNSHIP: BUILDING A WIND TURBINE</b>  | 1275 |
| <i>S. Esteban San Román, M. Santos Peñas</i>  |      |
| <b>AN EXPLORATORY ASSESSMENT OF THE USABILITY AND POTENTIAL OF GENERATIVE PRETRAINED TRANSFORMERS (GPTS) AS FEEDBACK ASSISTANTS FOR LONG-FORMAT ACADEMIC WRITING TASKS</b>                            | 1280 |
| <i>J. Lievens</i>   |      |
| <b>IMPLEMENTATION OF APPLIED RESEARCH PROJECTS IN STUDENTS OF THE BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT AS INNOVATIVE METHODOLOGIES WITHIN PROJECT-BASED LEARNING</b>        | 1287 |
| <i>J. Ivorra-Martínez, D. García-Sanoguera, O. Fenollar, N. Montanes, R. Balart, L. Quiles-Carrillo</i>   |      |
| <b>USE OF FORMAL COOPERATIVE LEARNING IN THE SUBJECT OF POLYMERIC MATERIALS ENGINEERING</b>   | 1293 |
| <i>V. Moreno-García, J. Gomez-Caturla, T. Boronat, L. Quiles-Carrillo, L. Sanchez-Nacher, D. Garcia-García</i>  |      |
| <b>RESILIENCE AND EMOTIONAL INTELLIGENCE IN UNIVERSITY EDUCATION STUDENTS</b>   | 1298 |
| <i>A. Izquierdo, N. Perez-Soto, T. Pozo-Rico, R. Gilar-Corbi</i>  |      |
| <b>FINOPTIMISE: A COMPREHENSIVE USER EXPERIENCE METHODOLOGY FOR ASSESSING A STOCK TRADING SIMULATION</b>  | 1304 |
| <i>C. Power, D. Kneeshaw, R. Kelly, W. Kavanagh, J. Corcoran, B. Byrne, A. Curley, D. Gordon, P. Kelly</i>  |      |
| <b>USE OF NEW TECHNOLOGIES IN THE CLASSROOM TO REFLECT ON SUSTAINABILITY IN PERSONAL MOBILITY</b>   | 1312 |
| <i>I. Villalba Sanchis, M.R. Arroyo López, V.G. Lo Iacono Ferreira</i>  |      |
| <b>THE BL-5D MODEL: THE DEVELOPMENT OF A MODEL OF INSTRUCTIONAL DESIGN FOR BLENDED LEARNING ACTIVITIES</b>  | 1318 |
| <i>D. Gordon, P. Doyle, A. Becevel, J. Vilafranca Molero, C. Gascon, A. Vitiello, T. Baloh</i>  |      |
| <b>ADVANCING E-TUTOR TANDEM: QUALITATIVE INSIGHTS AND A MATRIX FOR COLLABORATIVE PRACTICE</b>   | 1327 |
| <i>L.M. Langesee, N. Ukhova, M. Altmann</i>   |      |
| <b>JOURNALISM AS AN ARTICULATOR OF KNOWLEDGE. A PROPOSAL OF CURRICULAR DESIGN IN THE PROFESSIONAL TRAINING OF COMMUNICATORS</b>   | 1338 |
| <i>C. García-Hernández</i>  |      |
| <b>POETRY AND LITERATURE AS TEACHING STRATEGIES IN SCHOOL BULLYING PREVENTION</b>   | 1346 |
| <i>T.G. Fernández Guayana</i>   |      |
| <b>USE OF THE IMPLICIT ASSOCIATION TEST IN QUALITATIVE RESEARCH FOCUSED ON INVESTIGATING UNCONSCIOUS CONTENT IN MOTIVATION TO LEARN ENGLISH AS A FOREIGN LANGUAGE</b>                                 | 1355 |
| <i>W. de Lima, M.R. Bambirra</i>  |      |
| <b>FOSTERING RESILIENCE AND UNITY: NURTURING A SENSE OF BELONGING IN THE FACE OF UNCERTAINTY</b>  | 1364 |
| <i>L. Benedetti</i>   |      |
| <b>THE POTENTIAL OF BLENDED ESP ASSIGNMENTS IN THE AGE OF AI-GENERATED STUDENTS' LANGUAGE PRODUCTION</b>  | 1365 |
| <i>P. Brebera, Z. Bezdicikova</i>   |      |
| <b>STEM TRAINING FOR PRIMARY SCHOOL TEACHERS WITH REMOTE LABS</b>   | 1371 |
| <i>M. Haack, D.M. Jozefiak</i>  |      |

|  |      |
|--|------|
| <b>REAL OR VIRTUAL? ENSURING AUTONOMOUS LEARNING IN BLENDED HIGHER EDUCATION CLASSROOMS</b><br><i>L. Zizka, G. Probst, N. Sarrasin</i>   | 1379 |
| <b>USE OF PROTONATION CONSTANTS TO FACILITATE MATHEMATICAL TREATMENT IN ACID-BASE EQUILIBRIUM</b><br><i>M.J. Ruiz-Ángel, S. Carda-Broch, J. Peris-Vicente</i>  | 1386 |
| <b>STRATEGIES FOR THE ACADEMIC PERFORMANCE IMPROVEMENT OF THE STUDENTS IN THE ADVANCED CHEMISTRY SUBJECT (CHEMICAL ENGINEERING DEGREE)</b><br><i>S. Carda-Broch, J. Peris-Vicente, M.J. Ruiz-Ángel, R. Castillo-Solsona</i>                                      | 1391 |
| <b>USABILITY OF A SIMULATION-BASED TEACHING TASK: EVALUATION THROUGH EYE TRACKING</b><br><i>P. Tekeli, Ş. Çağlar Özhan, A. Altun</i>   | 1396 |
| <b>TRANSFORMATIVE APPROACH FOR ENHANCING EXPERIMENTAL LEARNING IN THE DESIGN OF IRRIGATION SYSTEMS</b><br><i>A. Román, F. Sanfèlix, P. Martí</i>   | 1405 |
| <b>REIMAGINING SCIENCE EDUCATION: STUDENT PERCEPTIONS AND THE POTENTIAL OF THE GAMIFIED DIGITAL BOOK</b><br><i>F. Sanfèlix, A. Román, P. Martí</i>   | 1411 |
| <b>SELF-ANALYSIS WORKSHOPS IN MANTEIGAS (PORTUGAL) USING THE RECIPROCAL MAIEUTIC APPROACH UNDER THE PROJECT OUR DIGITAL VILLAGE: CO-DESIGNED DIGITAL EDUCATION IN RURAL AREAS</b><br><i>A. Ribeiro</i>   | 1420 |
| <b>DUCK GRIPPER: A MODULAR PARALLEL JAW GRIPPER FOR EDUCATION AND RESEARCH</b><br><i>G. Espinoza, N. Fernandez, R. Barber</i>  | 1430 |
| <b>REDEFINING GAMIFICATION IN EDUCATIONAL CONTEXTS: INTEGRATING DATA ASSESSMENT AND EVALUATION INTO PLAYFUL LEARNING ENVIRONMENTS</b><br><i>A. Pfeiffer, T. Wernbacher, S. Bezzina, A. Dingli</i>  | 1438 |
| <b>DEVELOPING A CURRICULUM FOR TEACHING ARTIFICIAL INTELLIGENCE LITERACY TO EDUCATORS</b><br><i>S. Schallert-Vallaster, K. Papageorgiou, J. Buchner</i>  | 1444 |
| <b>LEAF: RESULTS AND IMPACT ASSESSMENT OF THE THREE-YEAR EUROPEAN RESEARCHERS NIGHT PROJECT FOCUSED ON GREEN DEAL TOPICS</b><br><i>E. Diociaiuti, G. Burzachechi, D. Chiti, A. Della Ceca, G. Ciocca, R. Donghia, V. Guglielmotti, M. Martini, S. Pierangeli</i> | 1449 |
| <b>UNVEILING THE IMPACT OF AI CHATBOTS ON HIGHER EDUCATION: INSIGHTS FROM STUDENTS</b><br><i>C. Bjelland, K. Ludvigsen, A. Møgelvang</i>   | 1458 |
| <b>CROATIAN-ITALIAN LANGUAGE CONTACTS AND INTERCULTURAL EDUCATION OF CHILDREN IN CROATIA</b><br><i>D. Drandić, L. Lazarić, E. Šegon</i>  | 1466 |
| <b>TRANSFORMING POSTGRADUATE CYBERSECURITY EDUCATION: A CYBERSECURITY BODY OF KNOWLEDGE CASE STUDY</b><br><i>A. Wilde, B. Sanders</i>  | 1474 |
| <b>STUDENTS' PERCEPTION OF AI GENERATED EXAM QUESTIONS</b><br><i>V. Juričić, M. Obrvan</i>   | 1480 |
| <b>DOES ONLINE TEACHING/LEARNING PROMOTE INCLUSIVITY?</b><br><i>U. Jahn</i>  | 1488 |
| <b>ENHANCING ENGLISH LANGUAGE SKILLS THROUGH MOTIVATION: A CASE STUDY USING THE WANDER APP FOR VIRTUAL DIRECTION-GIVING TASKS</b><br><i>Y. Satake</i>  | 1493 |
| <b>BENEFITS OF USING THE LBD MODEL IN MASTER'S LEVEL DIGITAL ACCESSIBILITY COURSES</b><br><i>J. Lahti, R. Beenen</i>   | 1503 |
| <b>CYBERSECURITY AWARENESS AMONG YOUNG LEARNERS – A CASE STUDY</b><br><i>G. Kozieł, M. Dziuba-Kozieł, E. Łukasik</i>   | 1508 |
| <b>THE IMPACT OF USER EDUCATION AND EXPERIENCE ON ACCESS PROTECTION WHEN USING NETWORK SERVICES</b><br><i>M. Dziuba-Kozieł, G. Kozieł, M. Pańczyk</i>  | 1514 |

|   |      |
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| <b>FROM IVORY TOWERS TO RURAL POWERS: HIGHER EDUCATION INSTITUTIONS AS KNOWLEDGE PARTNERS IN DIGITAL TRANSFORMATION</b>   | 1521 |
| <i>P. Weber, A. Wyczisk, M. Patalon, I. Borowicz</i>  |      |
| <b>WORK BASED LEARNING: THE ROLE OF NOVEL ASSESSMENT IN PERSONALISED STUDENT LEARNING EXPERIENCES FROM A HIGHER EDUCATION PERSPECTIVE</b>                       | 1531 |
| <i>J. Gilchrist</i>   |      |
| <b>DEFYING ZOOM FATIGUE – HOW TO BOOST THE EFFECTIVENESS AND SUSTAINABILITY OF ONLINE COMMUNICATION</b>   | 1538 |
| <i>F. Kempf, M. Krauss, M. Aßfalg</i>   |      |
| <b>TRANSFORMING LEARNING: HOW EMOTIONS AND TECHNOLOGY COULD ENHANCE STUDENT SUCCESS</b>   | 1546 |
| <i>M.L. Mocé, M.D. Soler Sanchís, C. Garcés Narro, E. García-Roselló</i>  |      |
| <b>A CONCISE VIEW OF CURRICULUM DESIGN AND LEARNING OUTCOMES: VIRTUAL REALITY TECHNIQUE IN SAUDI ARABIA</b>   | 1551 |
| <i>A. Alraddadi, S. Alghamdi</i>  |      |
| <b>DIGITAL EDUCATIONAL CONTENT - THE CONCEPT OF HISTORY INTERACTIVE VIDEO LESSONS</b>   | 1556 |
| <i>M. Glučina, T. Pleić</i>   |      |
| <b>EDUCATIONAL REVOLUTION IN THE METAVERSE: TEC VIRTUAL CAMPUS'S FIRST FULL-CLASS IMPLEMENTATION</b>  | 1562 |
| <i>A. Juárez</i>  |      |
| <b>OPTIMIZING LEARNING ENVIRONMENTS: A MICROCLIMATE STUDY OF A SCHOOL CAMPUS IN SINGAPORE USING AN INTEGRATED ENVIRONMENT MODELLER SIMULATION TOOL (IEMSIM)</b> | 1569 |
| <i>I.J.E. Lim, A.L.Y. Low, K.Y.T. Lim</i>   |      |
| <b>FROM A PICTUREBOOK TO A READING CULTURE OF EARLY-AGED CHILDREN</b>   | 1578 |
| <i>M. Verdonik, V. Katić</i>  |      |
| <b>STUDENT READINESS FOR CO-CREATION: ENHANCING ACTIVE LEARNING FOR STUDENT-STAFF PARTNERSHIP IN HIGHER EDUCATION</b>   | 1587 |
| <i>A. Ko, S. Sabapathy, W.W.L. Chiu</i>   |      |
| <b>STUDENT SATISFACTION DURING TEMPORARY COLLEGE RELOCATION – THE CASE OF THE FACULTY OF MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE IN ZAGREB</b>            | 1592 |
| <i>I. Čavar, N. Dubreta, F. Miškić</i>  |      |
| <b>THE PROMOTION OF DIGITAL HEALTH LITERACY IN GERMANY: CENTRAL LINES OF DEVELOPMENT AND KEY SUCCESS FACTORS AS A RESULT OF A DELPHI PRE-STUDY</b>              | 1602 |
| <i>J. Ullbrich</i>  |      |
| <b>INTEGRATING CHATGPT IN FOREIGN LANGUAGE EDUCATION</b>  | 1607 |
| <i>Z. Vasiljevic</i>  |      |
| <b>INTERNATIONAL INTERNSHIPS FOR NON-MEDICAL STUDENTS AS A TOOL TO ENHANCE CULTURALLY SENSITIVE PATIENT CARE</b>  | 1612 |
| <i>A. Lochmannová</i>   |      |
| <b>FACE-TO-FACE VS REMOTE LEARNING</b>  | 1613 |
| <i>S. Alles, P. Ranasinghe Mudiyansele</i>  |      |
| <b>VIRTUAL SICKNESS AS A LIMITATION OF EDUCATION AND TRAINING IN VIRTUAL REALITY: USERS' PERCEPTIONS</b>  | 1621 |
| <i>A. Lochmannová, M. Dvořák, M. Bakeš, B. Kopová, J. Jeníkovský</i>  |      |
| <b>AI EDUCAMP: A CREATIVE APPROACH TO ENVISIONING THE FUTURE OF AI-BASED HIGHER EDUCATION</b>   | 1629 |
| <i>D. Casiraghi, S. Sancassani</i>  |      |
| <b>NATIONAL SCIENCE FOUNDATION – EXPERIENTIAL LEARNING FOR EMERGING AND NOVEL TECHNOLOGIES (EXLENT): A RESPONSE TO EMTECH WORKFORCE SHORTAGES</b>               | 1639 |
| <i>C. Tomovic, M. Tomovic, M. Yang, S. Bawab</i>  |      |
| <b>GENDER AND AGE AS FACTORS AFFECTING THE DIGITAL SKILLS OF PRIMARY SCHOOL PRINCIPALS</b>  | 1643 |
| <i>G. Kalogeratos, K. Lourida, E. Anastasopoulou, D. Tsogka, C. Pierrakeas</i>  |      |
| <b>INFORMATION SYSTEMS USAGE IN THE GREEK PRIMARY SCHOOL. THE CASE OF THE PREFECTURE OF ACHAIA</b>  | 1652 |
| <i>G. Kalogeratos, K. Lourida, E. Anastasopoulou, D. Tsogka, C. Pierrakeas</i>  |      |

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| <b>THE IMPACT OF COIL COLLABORATIONS WITHIN THE CONSTRUCTION OF INVESTMENT PORTFOLIOS</b><br><i>A. Uribe Rocha</i>   | 1658 |
| <b>RETOOLING DIALOGIC PEDAGOGY AS A UNIVERSAL LANGUAGE FOR EQUITABLE AND INCLUSIVE TRANSFORMATIVE TEACHING AND LEARNING</b><br><i>C. Fort</i>  | 1663 |
| <b>ADAPTING WRITING PROMPTS AND CORRECTING RUBRICS: AVOIDING AI GENERATED STUDENT WRITING ASSIGNMENTS</b><br><i>H. McCune Bruhn</i>  | 1664 |
| <b>EXPLORING AI'S ROLE IN BILINGUAL BIBLE EDUCATION: OVERCOMING LANGUAGE BARRIERS – A CASE STUDY OF SIXTH GRADE BIBLE STORY READING AT SANKUANG ELEMENTARY SCHOOL IN NEW TAIPEI CITY</b><br><i>P.J. Wang</i> | 1671 |
| <b>IMPLEMENTING READING STRATEGY INSTRUCTION IN TEACHING UNIVERSITY STUDENTS A FOREIGN LANGUAGE</b><br><i>E. Schmidt, M. Bolina, K. Bolshakova, E. Chelpanova, L. Naumenko</i>                               | 1681 |
| <b>PROGRAMMING TEACHING IN A VIRTUAL ENVIRONMENT USING THE ROS INTERFACE</b><br><i>C. Lecon, S. Soeser, A. Stegmaier</i>   | 1686 |
| <b>PROBLEMATIZATION IN TEACHING FOREIGN LANGUAGE SPEAKING</b><br><i>E. Chelpanova, M. Bolina, K. Bolshakova, L. Naumenko, E. Schmidt</i>   | 1695 |
| <b>EXPLORING PERCEPTIONS IN THE MATH TEACHER-STUDENT RELATIONSHIP THROUGH GAMIFICATION</b><br><i>S. Rizzo, A. Cavallaro</i>  | 1702 |
| <b>EXPLORING THE POTENTIAL AFFORDANCES OF AUGMENTED REALITY (AR) GAME-BASED LEARNING IN CAMPUS HERITAGE PRESERVATION</b><br><i>Q. Ying, P.B.A. Vu, K.Y.T. Lim</i>  | 1707 |
| <b>FACING CONTEMPORARY CHALLENGES: ABOUT THE UNCONSCIOUS RESOURCE THAT CAN BE USED IN EDUCATION - TACIT KNOWLEDGE</b><br><i>M. Bielecki</i>  | 1715 |
| <b>PERSPECTIVES ON THE PROGRESS OF NURSING EDUCATION: INSIGHTS FROM ESTONIAN NURSES</b><br><i>U. Kõrgemaa, J. Sepp, K. Puusepp</i>   | 1716 |
| <b>HOW IS AI BEING APPLIED IN HIGHER EDUCATION? EXAMINING THE STATE-OF-THE-ART</b><br><i>J.M. Aguado-García, S. Alonso-Muñoz, R. González-Sánchez, C. De-Pablos-Heredero</i>                                 | 1721 |
| <b>THE ROLE OF THE UNIVERSITY IN SUSTAINABLE DEVELOPMENT GOALS (SDGS) ACHIEVEMENT.</b><br><i>J.M. Aguado-García, R. González-Sánchez, S. Alonso-Muñoz</i>  | 1729 |
| <b>EDUCATIONAL EMPOWERMENT FOR SUSTAINABLE PRACTICES: ENHANCING FOOD SECTOR PERSONNEL THROUGH ADVANCED WASTE MANAGEMENT PROFICIENCY</b><br><i>G. Grinberga-Zalite, A. Zvirbule</i>                           | 1730 |
| <b>DEVELOPING A COURSE IN ACADEMIC COMMUNICATION FOR MASTER'S STUDENTS: CASE STUDY</b><br><i>A. Astanina, V. Kareva, N. Sazonova, S. Ivanova</i>   | 1736 |
| <b>THE POTENTIAL OF DIGITAL LEARNING PLATFORMS IN TRAINING FUTURE TEACHERS TO IMPLEMENT ADAPTIVE TEACHING</b><br><i>N. Valiakhmetova, R. Akhmadullina, I. Yarmakeev, E. Gimadieva, Y. Hismatullina</i>       | 1744 |
| <b>DESIGN AND INFORMATION COMPETENCE FORMATION OF FUTURE TEACHERS BASED ON DIGITAL STORYTELLING</b><br><i>R. Akhmadullina, N. Valiakhmetova, I. Yarmakeev, E. Gimadieva, Y. Hismatullina</i>                 | 1752 |
| <b>A COMPARATIVE STUDY OF FUNCTIONALITY OF AVAILABLE VIDEO-CONFERENCING PLATFORMS FOR TEACHING ENGLISH</b><br><i>N. Sazonova, S. Ivanova, V. Kareva, A. Astanina</i>   | 1759 |
| <b>PRESCHOOL TEACHERS' EXPERIENCES IN TEACHING/LEARNING IN THE WORKPLACE (THE CONTEXT OF LITHUANIA)</b><br><i>J. Smilgienė, E. Masiliauskienė</i>  | 1764 |
| <b>SUMMER SCHOOL: USING MATHEMATICS FOR SUSTAINABLE DEVELOPMENT</b><br><i>E. Safiulina, O. Panova, A. Vintere</i>  | 1772 |

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| <b>IDENTIFICATION OF MOTIVATING AND DEMOTIVATING FACTORS IN TEACHERS' WORK AS A GUARANTEE OF THE SUCCESS OF THE LEADERSHIP ACTIVITIES OF THE HEAD OF THE EDUCATIONAL INSTITUTION</b><br><i>J. Smilgienė, E. Masiliauskienė</i>   | 1781 |
| <b>EDUCATIONAL INNOVATIONS: A CASE STUDY ON THE PRACTICAL IMPLEMENTATION OF STEAM IN FORMAL EDUCATION AT PRIMARY AND PRESCHOOL LEVELS</b><br><i>M. Abramishvili, M. Apakidze</i>   | 1788 |
| <b>TOWARDS THE DESIGN AND EVALUATION OF CLICKBAIT EDUCATION CONTENT: LEVERAGING USER MENTAL MODELS AND LEARNING SCIENCE PRINCIPLES</b><br><i>A. Shrestha, A. Flood, B. Hackler, A. Behfar, M.N. Al-Ameen</i>   | 1794 |
| <b>TEACHING PRACTICES WITH DIGITAL AFTER TRAINING WORKSHOPS: THE IMPACT ON SCHOOLS IN THE SAME GEOGRAPHICAL AREA</b><br><i>M.L. Neves, J. Silveira, A. Amaro</i>   | 1805 |
| <b>THE CONTRIBUTION OF THE ORCHESTRA IN THE CONSTRUCTION OF AN AUTHENTIC SCHOOL</b><br><i>M.L. Neves, M. Ângelo Gomes Fialho, A. Amaro</i>   | 1814 |
| <b>THE RELATIONSHIP BETWEEN THE PERSONAL EXPERIENCES OF FUTURE CHILDHOOD PEDAGOGUES AND THEIR PREPARATION FOR CHILDREN'S CITIZENSHIP EDUCATION AT SCHOOL</b><br><i>S. Kovienė, N. Bražienė</i>   | 1827 |
| <b>CONTEMPORARY PARENTS' CULTURAL TRANSFORMATION IN TERMS OF CHILDREN'S EDUCATION</b><br><i>S. Kovienė, N. Bražienė</i>  | 1834 |
| <b>PERCEPTION AND USAGE OF CHAT GPT IN THE EDUCATION SYSTEM</b><br><i>K. Aleksić-Maslač, F. Borović, Z. Biočina</i>  | 1842 |
| <b>INCORPORATING POST-QUANTUM CRYPTOGRAPHY (PQC) INTO COMPUTER SCIENCE AND INFORMATION SYSTEMS EDUCATION</b><br><i>T.A. Yang, A. Yang</i>  | 1849 |
| <b>INNOVATING MIDDLE EAR ANATOMY LEARNING: THE IMPACT OF A NEW VIRTUAL REALITY SCENARIO – A PILOT STUDY</b><br><i>J. Plane, N. Sepúlveda, M. Acosta, V. Rayo, D. Morales, C. Meza, M. Rojas</i>  | 1854 |
| <b>INTRODUCTION OF A REAL-TIME COMMUNICATION TOOL FOR ONLINE ENGINEERING EXPERIMENTS</b><br><i>K. Sugimoto, Y. Teshima, A. Sakaguchi</i>   | 1862 |
| <b>STUDENT PREFERENCES IN LABORATORY LEARNING MODALITIES: FACE-TO-FACE VS. REMOTE INSTRUCTION IN PHYSIOLOGY AND PHYSIOPATHOLOGY EDUCATION</b><br><i>J. Olloquequi, R. Martin-Venegas, T. Cambras, M.C. Moran, M.P. Vinardell, R. Ferrer, J. Del Valle, M.E. Juan, M.J. Rodríguez-Lagunas, M. Riba, C. Casanova, A. García-Vara, C. Pelegrí, A.S. Maddaleno, M.L. Miro, A. Pérez-Bosque, M. Mitjans</i> | 1871 |
| <b>INTERMEDIATE PHASE TEACHERS' MOTIVATION AND JOB SATISFACTION AMID THE COVID-19 PANDEMIC</b><br><i>S. Sibanda, A. Rambuda</i>  | 1873 |
| <b>OPPORTUNITIES FOR PUBLIC RELATIONS SPECIALISTS TO ENHANCE THEIR KNOWLEDGE IN MANAGING NEGATIVE UGC</b><br><i>T. Limba, E. Juozėnaitė</i>  | 1874 |
| <b>STRATEGIES FOR ADDRESSING CHALLENGES FOUNDATION PHASE TEACHERS EXPERIENCE WHEN IMPLEMENTING INCLUSIVE EDUCATION IN SOUTH AFRICA</b><br><i>Y. Qhala, A. Rambuda, P. Serero</i>   | 1884 |
| <b>STUDENTS DEVELOPING RESEARCH: LIFE-CYCLE ASSESSMENT IN THE PIG SECTOR</b><br><i>F. Sánchez, G. Cervantes</i>  | 1885 |
| <b>REFRAMING MYOPIA IN TEACHING REFUGEE AND IMMIGRANT STUDENTS</b><br><i>L. Kajee</i>  | 1891 |
| <b>RESILIENCE IN TROUBLING TIMES: REFUGEE YOUTH VULNERABILITIES</b><br><i>L. Kajee</i>   | 1892 |
| <b>UNDERSTANDING ENTREPRENEURIAL BEHAVIOUR AMONG INDUSTRIAL TECHNOLOGY ENGINEERING STUDENTS IN BILBAO</b><br><i>I. Bidauren, D. Boullosa-Falces, I. Albaina, U. Izquierdo, G.A. Esteban, A. Sarrionandia-Ibarra</i>  | 1893 |

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| <b>THE USE OF FLIPPED CLASSROOMS METHODOLOGY IN DEGREE OF MARINE ENGINEERING TO INCREASE STUDENT MOTIVATION</b><br><i>D. Boullosa-Falces, I. Bidaguren, E. Urtaran-Lavin, A. Peña, E. Madrazo, J.M. Blanco, A. Gamarra</i>  | 1901 |
| <b>PEER-COACHING WITH GENERATIVE AI: AN EXPERIMENT</b><br><i>M. Leiss</i>   | 1909 |
| <b>THE EVOLUTION OF AN INDIGENOUS LANGUAGE LEARNING SPACE IN THE IRISH GAELTACHT</b><br><i>C. Dawson</i>  | 1915 |
| <b>EMPOWERING PROFESSIONAL SKILLS: A MOBILE LEARNING CONCEPT IN SOFTWARE ENGINEERING EDUCATION</b><br><i>S. Schefer-Wenzl, I. Miladinovic</i>   | 1916 |
| <b>UNIVERSITY-INDUSTRY COLLABORATIONS IN DOCTORAL EDUCATION PROGRAMMES: A GLIMPSE OF THE PORTUGUESE CONTEXT</b><br><i>S. Santos, S. Diogo, M.J. Rosa</i>  | 1917 |
| <b>ADJUSTMENTS FOR STUDENTS WITH DISABILITIES IN TERTIARY EDUCATION</b><br><i>V. Vidaček-Hainš, K. Kokot, M. Kláčmer Čalopa</i>   | 1927 |
| <b>HEI STAKEHOLDER ENGAGEMENT: WHAT IS THE IMPACT OF PROXIMITY?</b><br><i>R. Vancelee, R. Kelly</i>   | 1934 |
| <b>ELIMINATING THE BARRIERS TO CREATING AND SHARING 3D INTERACTIVE MEDIA FOR ENHANCED LEARNING MATERIALS</b><br><i>M. Hennelly, A. Kelly, V. Hargaden, K. Nolan</i>   | 1935 |
| <b>ECOSYSTEM LEARNING: AN INTEGRATED LEARNING THEORY?</b><br><i>H.K. Simonsen</i>   | 1946 |
| <b>DESIGN MEETS IMPLEMENTATION: A CHATBOT PROJECT FOR FIRST-YEAR STUDENTS IN STEM PROGRAMS</b><br><i>G. Socher, T. Weisser</i>  | 1954 |
| <b>A DECADE OF SUCCESSFUL UNIVERSITY-INDUSTRY COOPERATION: A TRIPLE WIN SITUATION</b><br><i>R. Groß, C. Cartwright, K. Freudenthaler, T. Ulrich</i>   | 1960 |
| <b>TEACHING ENTREPRENEURSHIP AND INNOVATION THROUGH A UNIVERSITY INCUBATOR</b><br><i>A. Zvirbule, A. Auzina, G. Grinberga-Zalite</i>  | 1970 |
| <b>THEORETICAL-METHODOLOGICAL PRECONDITIONS AT THE BASE OF MIXED MODE LABORATORY TEACHING</b><br><i>R. Vegliante, A. Marzano, S. Miranda</i>  | 1976 |
| <b>AN EVALUATION OF A COMMUNITY OF PRACTICE AND ITS EFFECTIVENESS IN BUILDING LECTURER CONFIDENCE IN AN ONLINE TEACHING ENVIRONMENT</b><br><i>D. Doran</i>  | 1982 |
| <b>CHATGPT AS A TOOL TO FOSTER CRITICAL THINKING IN A HUMAN PHYSIOLOGY COURSE FOR STUDENTS OF THE DEGREE OF HUMAN NUTRITION AND DIETETICS</b><br><i>M.E. Juan, M.P. Vinardell</i>   | 1991 |
| <b>FROM NEEDS ANALYSIS TO FORMATIVE DESIGN FOR PRIMARY SCHOOL TEACHERS</b><br><i>R. Vegliante, S. Miranda, A. Marzano</i>   | 1999 |
| <b>LEARNING AND QUALITY ASSURANCE IN THE SAME PACKAGE</b><br><i>L. Aggestam, I. Elison</i>  | 2006 |
| <b>CHATGPT IN EDUCATION – AN EDUCATOR-DRIVEN UNDERSTANDING OF PROMISE AND THE PATH FORWARD</b><br><i>D. Amiel, C. Blitz</i>   | 2012 |
| <b>UNDERSTANDING THE INFLUENCE OF INTERCULTURAL COMMUNICATION IN CONSTRUCTION MANAGEMENT CURRICULUM AND PRACTICE</b><br><i>A. Bhattacharya, V. Kretzschmar</i>  | 2013 |
| <b>EDUCATIONAL RESOURCES FOR PHYSICS 101 INSTRUCTION WITHIN HEALTH SCIENCES DEGREES</b><br><i>V. Gonzalez-Fernandez, A. Gonzalez-Cano, J. Alda Serrano, M.E. Piedrahita Alonso, S. Fernández Núñez, N. Díaz Herrera, M.C. Navarrete Fernández, L. Ares Santos, A. Orenes Plankova</i> | 2021 |
| <b>PLANET EARTH, SUSTAINABILITY AND CLIMATE CHANGE FROM ITALIAN ELEMENTARY SCHOOL DRAWINGS</b><br><i>G. D'Addezio, N. Besker</i>  | 2029 |

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| <b>EXPLORING DIGITAL EPISTEMOLOGY WITHIN CONSTRUCTIONIST LEARNING IN THE AGE OF ARTIFICIAL INTELLIGENCE</b><br><i>M. Marom, I. Levin</i>  | 2037 |
| <b>DEVELOPING DIGITAL TEACHING MATERIALS SUITABLE FOR BOTH FACE-TO-FACE AND DISTANCE TEACHING IN THE PANDEMIC ERA</b><br><i>C.C. Yang</i>   | 2041 |
| <b>ON THE USE OF EDUCATIONAL SIMULATORS FOR ROCKET PROPULSION IN AEROSPACE ENGINEERING UNDERGRADUATE COURSES</b><br><i>J. Gomez-Soriano, M. Carreres, J. García-Tiscar, P.M. Quintero-Igeño</i>   | 2048 |
| <b>SECOND LANGUAGE ACQUISITION THROUGH INTERPERSONAL COMMUNICATION WITH ARTIFICIAL INTELLIGENCE</b><br><i>A. Nessel, G. Kamilar, K. Gaugler, C. Matheus</i>   | 2054 |
| <b>DIGITAL READING AS THE RESULT OF CHANGING READING PRACTICES: POSSIBLE DIFFICULTIES AND IMPLICATIONS</b><br><i>A. Gilmanova, L. Yuzmukhametova, T. Marsheva, I. Gimaeova, G. Zakirova</i>   | 2062 |
| <b>ENHANCING STAFF WEEK ORGANISATION THROUGH SERVICE ACTION RESEARCH</b><br><i>O. Polyakova</i>   | 2067 |
| <b>NAVIGATING THE ARTIFICIAL INTELLIGENCE FRONTIER IN HEALTHCARE ENTREPRENEURSHIP EDUCATION: INTEGRATION, IMPACTS, AND CONSIDERATIONS</b><br><i>J. Sepp, U. Kõrgemaa, K. Puusepp</i>  | 2072 |
| <b>COMPUTER GAMES AS MOTIVATION FOR LEARNING ENGLISH</b><br><i>T. Marsheva, A. Gilmanova, G. Zakirova, L. Yuzmukhametova, I. Gimaeova</i>   | 2080 |
| <b>FOSTERING STRATEGIC INNOVATION AND COLLABORATION THROUGH GAMIFICATION: A CASE STUDY BASED ON LEGO SERIOUS PLAY IN AN MBA MASTER'S PROGRAM</b><br><i>J.V. Tomás-Miquel, J. Capó-Vicedo, J. Capó-I-Vicedo</i>  | 2085 |
| <b>USE OF AN INDIVIDUAL CONTRIBUTIONS DESIGN AS AN INNOVATIVE PEDAGOGICAL METHOD FOR MEASURING COLLABORATIVE LEARNING UPON COMPLETION OF A GROUP PROJECT</b><br><i>R. Branch, H. Lee</i>  | 2094 |
| <b>SOFT SKILLS DEVELOPED IN BUSINESS SIMULATION MODELS FOR ACCOUNTING - STUDENTS' PERCEPTION</b><br><i>S. Bastos, H. Costa Oliveira, T. Barros, M. de Sá</i>  | 2095 |
| <b>PROMOTING ENVIRONMENTAL AWARENESS: A STUDY ON THE IMPACT OF ADOPTING DESIGN THINKING APPROACHES THROUGH THE DEVELOPMENT OF MULTIMEDIA PRODUCTS</b><br><i>J. Cartaxo da Silva, M. Aresta, P. Beça</i>   | 2106 |
| <b>A SYSTEMATIC REVIEW: FREE ALTERNATIVES FOR VIDEO CREATION AND PROCESSING IN ACADEMIC ENVIRONMENTS</b><br><i>O. Labanova, N. Maksimova, E. Safiulina</i>  | 2116 |
| <b>COMPARATIVE ANALYSIS OF CHATGPT-4 AND CO-PILOT IN CLINICAL EDUCATION: INSIGHTS FOR MEDICAL TEACHING AND LEARNING</b><br><i>V. Rajaratnam, S. Tan, F. Omar</i>  | 2123 |
| <b>THE PROBLEM OF VIOLENCE IN GEORGIAN PUBLIC EDUCATION: IMPLEMENTING STRATEGIES FOR A SAFE SCHOOL POLICY</b><br><i>L. Tavidgiridze, N. Sherozia, I. Khasaia</i>  | 2124 |
| <b>ENHANCING THE PEDAGOGICAL CLIMATE IN SCHOOLS: A CRUCIAL FACTOR IN MITIGATING TEACHER BURNOUT (ILLUSTRATED BY GEORGIAN SCHOOLS)</b><br><i>L. Tavidgiridze, N. Sherozia, K. Beridze, S. Meskhidze, I. Khasaia</i>  | 2132 |
| <b>ENROLLMENT AND SCHOOL DROPOUT DUE TO THE PANDEMIC IN MEXICO: A CASE STUDY OF THE STATE OF JALISCO</b><br><i>M. Morfín Otero, C.A. González Quintanilla, H.M. Rodríguez Gómez, V. Peña Guzmán</i>   | 2138 |
| <b>THE EFFECTIVENESS OF USING "GO TALK NOW" APP THROUGH GROUP PLAY STRATEGY IN ENHANCING INTERACTIVE INITIATIVE SKILL AMONG STUDENTS WITH INTELLECTUAL DISABILITY</b><br><i>W. Alzahrani</i>  | 2143 |
| <b>APPLICATION OF COMPUTATIONAL FLUID DYNAMICS (CFD) SIMULATIONS FOR LEARNING THERMAL ENGINEERING IN HEAT EXCHANGERS PROBLEMS</b><br><i>F.D. Molina-Aiz, M.N. Honoré, A. López-Martínez, A.J. Álvarez-Martínez, R.M. Oliva-Molina, M.A. Moreno-Teruel</i> | 2144 |



|  |      |
|--|------|
| <b>PROMOTING WATER EFFICIENCY IN A STUDENT RESIDENCE AS A CONTRIBUTION TO SUSTAINABILITY: HYDROSAAP INNOVATION PROJECT</b><br><i>F. Silva, J. Barros, M.J. Afonso, G. Oliveira, I. Fachada, A.M. Antão-Geraldes</i>  | 2153 |
| <b>EXPLORING HISTOLOK AS A GAMIFIED LEARNING TOOL IN MEDICAL HISTOLOGY</b><br><i>J. Vázquez-Flores, R. Pantoja-Vázquez, V. Menéndez-Domínguez, H. Rubio-Zapata</i>   | 2163 |
| <b>ENHANCING ENGLISH LEARNING EXPERIENCE WITH AN INNOVATIVE INTERPRETATION TRAINING MOBILE APP: A SELF-DETERMINATION THEORY PERSPECTIVE ON AUTONOMOUS MOTIVATION</b><br><i>Y.L. Chen, C.C. Hsu</i>   | 2170 |
| <b>EXPANDING THE HYFLEX APPROACH IN INTERPROFESSIONAL EDUCATION (IPE)</b><br><i>K. Hoggatt Krumwiede</i>   | 2175 |
| <b>NAVIGATING THE NEXUS OF AI LITERACIES: A STUDY ON GENERATIVE AI PRACTICES AMONG NTU STUDENTS</b><br><i>S.H.S. Ng, H.Y. Chan</i>   | 2176 |
| <b>KNOWLEDGE MANAGEMENT APPLIED TO ENTERPRISE AND SUPPLY CHAIN RESILIENCE. A TEACHING CASE</b><br><i>M. Arias-Vargas, R. Sanchis, R. Poler</i>   | 2186 |
| <b>THE ROLE OF TUTOR IN MASSIVE SOCIAL LANGUAGE LEARNING: A CASE STUDY OF AN ACADEMIC ITALIAN MOOC</b><br><i>A. Pakula</i>   | 2195 |
| <b>CRITICAL SUCCESS FACTORS (CSFS) – AN IMPORTANT ANALYTICAL TOOL</b><br><i>L. Aggestam, A. Svensson, A.K. Holmqvist</i>   | 2204 |
| <b>EDUCATIONAL LEADERSHIP FOR ACADEMIC DEVELOPMENT: PRACTICES AND REFLECTIONS AT UNIVERSITY OF TRENTO</b><br><i>A. Serbati, D. Agostini, S. Maniero, F. Picasso, P. Venuti, E. Felisatti</i>   | 2212 |
| <b>EMPLOYING SOCIAL MEDIA PLATFORMS DURING CRISIS IN PRIVATE SCHOOLS</b><br><i>A. Alanezi</i>  | 2218 |
| <b>FROM LABS TO LECTURE HALLS: UNDERSTANDING THE CROSSROADS OF EU R&amp;D PROJECTS AND MARKETING EDUCATION AT UNIVERSITIES</b><br><i>J.C. Serrano-Ruiz, J. Mula, R. Poler</i>  | 2223 |
| <b>LOOKING TO THE FUTURE: DEVELOPING A DIGITAL EDUCATION AND INNOVATION STRATEGY WHICH PREPARES AND EQUIPS THE NEXT GENERATION OF HEALTHCARE PRACTITIONERS</b><br><i>D. Prescott, S. McKinnell, S. Canning</i>   | 2232 |
| <b>SUPPORT FOR INNOVATIVE METHODOLOGY, APPROACHES AND TOOLS FOR TEACHING THROUGH THE MEDIUM OF ENGLISH IN ORDER TO IMPROVE EDUCATIONAL YIELD, SUSTAINABILITY, AND INTERNATIONALIZATION - THE SMARTI PROJECT</b><br><i>L. Oliveira, E.L. Cardoso</i>  | 2237 |
| <b>BLENDED LEARNING AND STUDENT TEACHERS' EXPERIENCES OF PRESENCES IN A MULTI-CAMPUS UNIVERSITY</b><br><i>A.G. Nilsen, J.E. Ølnheim, A.G. Almås</i>  | 2238 |
| <b>PRACTICAL EXAMPLES OF IMPLEMENTING CHALLENGE-BASED LEARNING IN ENGINEERING EDUCATION FOR STUDENTS, LIFE-LONG LEARNERS AND EDUCATORS – EXPERIENCE AT THE UNIVERSITY OF STAVANGER, NORWAY</b><br><i>M. Shahverdi, Y. Xing, C. Ren</i>   | 2239 |
| <b>BOOSTING THE UTILIZATION OF RESEARCH AND DEVELOPMENT OUTCOMES IN LIFELONG LEARNING IN HIGHER EDUCATION</b><br><i>L. Kuismala, R. Hämäläinen</i>   | 2247 |
| <b>ON THE ROLE OF EDUCATION IN SOCIETY</b><br><i>J. Loeckx</i>   | 2252 |
| <b>USE OF VIDEOS FOR THE INTERCONNECTION OF BIOCHEMISTRY WITH PHYSIOTHERAPEUTIC THERAPIES</b><br><i>P. Sánchez, M.I. Rodríguez, C. Torres, V. Sánchez, S. García-Rodríguez, L.J. Martínez, M.J. Álvarez, R.M. Tapia-Haro, A. Casas-Barragán, E. Aguilar-Ferrándiz, L. Chica-Redecillas, C.M. Morales-Álvarez, M. Cuadros</i> | 2257 |
| <b>ENTREPRENEURSHIP HUB- A WAY TO SUPPORT ENTREPRENEURIAL DREAMS</b><br><i>L. Hongell, S. Fabricius, M. Hernberg, C.J. Rosenbröijer, F. Sirén</i>  | 2261 |
| <b>WHAT TEACHERS THINK: WHAT KIND OF COMPETENCE AND SUPPORT DO TEACHERS NEED IN DESIGN OF LEARNING?</b><br><i>J.E. Olmheim, E. Rogne</i>   | 2267 |

|   |      |
|---|------|
| <b>GENDER AND TEAMWORK: CASE STUDY IN A SUBJECT IN AN ENGINEERING DEGREE</b>  | 2268 |
| <i>R. Martín Cabezuolo, J.M. Meseguer Dueñas, J. Molina Mateo, A. Vidaurre Garayo, N. Navajas Pertegás, J.A. Gómez Tejedor, S. Quiles Casado, J. Riera, M.A. Serrano Jareño, I. Tort Ausina</i> |      |
| <b>EVALUATING A REMOTE ROBOTIC LABORATORY ACROSS DIFFERENT UNIVERSITY SYSTEMS</b>   | 2274 |
| <i>S. Prohaska, L.N. Kennes</i>   |      |
| <b>EXPLORING STEM EDUCATION IN GEORGIA: UNDERSTANDING THE DYNAMICS OF IMPLEMENTATION</b>  | 2281 |
| <i>M. Abramishvili, M. Tabidze, L. Tavdgiridze</i>  |      |
| <b>SUPPORTING FACULTY DEVELOPMENT IN ENGLISH AS A MEDIUM OF INSTRUCTION (EMI): INSIGHTS FROM A FACULTY CERTIFICATE PROGRAM IN TAIWAN</b>  | 2289 |
| <i>M. Doran, J. Rieker</i>  |      |
| <b>VESTLAND-CLASS IN FOOD AND HEALTH: AN EXAMPLE ON HOW TO IMPLEMENT A PRACTICAL SUBJECT AS A PARTIALLY WEB-BASED SUBJECT</b>   | 2297 |
| <i>J. Meinseth Vatne, I. Veka</i>   |      |
| <b>TEACHING FUNDAMENTALS OF BUSINESS PROCESS MANAGEMENT IN THE CONTEXT OF GENERATIVE ARTIFICIAL INTELLIGENCE</b>  | 2298 |
| <i>E. Ponick</i>  |      |
| <b>SIMULATION OF CAM MECHANISMS: UNVEILING MATHEMATICAL METHODS THROUGH THE MODELING OF ARBITRARILY SHAPED CAM DISKS</b>  | 2305 |
| <i>U. Zwiers</i>  |      |
| <b>ACTIVE LEARNING OF PROGRAMMING BY COLOUR CODING</b>  | 2310 |
| <i>K. Czakoóová</i>   |      |
| <b>QUALITY INDICATORS OF ELEMENTARY EDUCATION FOR THE DEVELOPMENT OF SYNTROPIC ENVIRONMENTAL EDUCATION: A STUDY IN PUBLIC SCHOOLS IN THE INLAND OF THE STATE OF SÃO PAULO</b>                   | 2315 |
| <i>M.L. Spazziani, N.N. Rumemos, P.N. Pereira, C. Gheler-Costa, G.C. Stipkovic, F. Toqueti</i>  |      |
| <b>THE ROLE OF THE ENGLISH LANGUAGE IN THE PROCESS OF MASTERING ENGINEERING SPECIALTIES BY UNIVERSITY STUDENTS</b>  | 2323 |
| <i>N. Plotnikova, T. Usmanov, L. Gizyatova, F. Sitdikova</i>  |      |
| <b>UNDERSTANDING ASYNCHRONOUS LEARNING: A CASE STUDY AT AARHUS UNIVERSITY HERNING</b>   | 2327 |
| <i>J.H. Hire, H. Slavensky</i>  |      |
| <b>"PROVOTYPES" EXPLORING HOW TEACHERS VALUE AI IN EDUCATION</b>  | 2333 |
| <i>J. Lundin, T. Leino Lindell, M. Utterberg Modén, M. Tallvid</i>  |      |
| <b>TEACHERS' PERSPECTIVES OF ASSESSMENT PRACTICES IN THE AGE OF LARGE LANGUAGE MODELS</b>   | 2334 |
| <i>E. Winerö, J. Lundin</i>   |      |
| <b>STUDENT EXPERIENCES WITH USING CHATGPT IN HISTORY CLASSES</b>  | 2335 |
| <i>A. Lazareva, S. Vindbo, A. Spanos</i>  |      |
| <b>ARTIFICIAL INTELLIGENCE FOR STUDENT LEARNING: PERCEPTIONS AND REVIEW</b>   | 2343 |
| <i>J.J. Suñol</i>   |      |
| <b>TEAMWORK IN PHYSICS SUBJECTS: PERCEPTION OF THE STUDENTS</b>   | 2348 |
| <i>J.J. Suñol</i>   |      |
| <b>FROM CONCEPT TO SOLUTION: A PROJECT-BASED LEARNING CASE STUDY IN ENGINEERING</b>   | 2354 |
| <i>R. Sanchis, M. Díaz-Madroñero, J. Mula, R. Poler</i>   |      |
| <b>FACE MASK DETECTION AS A LABORATORY EXERCISE IN A COMPUTER VISION COURSE</b>   | 2361 |
| <i>K. Hendija, M. Mikac, R. Logožar, E. Dumić</i>   |      |
| <b>EXPLORING PRIMARY SCHOOL PUPILS' NAÏVE CONCEPTIONS ABOUT SCIENCE</b>   | 2367 |
| <i>B. Borovicza, K. Szarka, K. Paulíková, R. Madarász</i>   |      |
| <b>INNOVATIVE APPROACHES TO PEDAGOGICAL DESIGN: A TRANS-EDUCATIONAL FRAMEWORK FOR STUDY PLAN DEVELOPMENT AND EVALUATION</b>   | 2373 |
| <i>J. Aguirre, P. Casado</i>  |      |
| <b>FORMATIVE EVOLUTION IN ENGINEERING: KEY EXPERIENCES IN CURRICULAR RENEWAL BY COMPETENCES</b>   | 2374 |
| <i>C. Bañados, K. García</i>  |      |

|  |      |
|--|------|
| <b>GENDER AND SES DIFFERENCES IN THE AGE OF ENTERING STEM-RELATED ACADEMIC EDUCATION</b>   | 2381 |
| <i>S. Lissitsa, S. Chachashvili-Bolotin</i>  |      |
| <b>TEACHERS' AND STUDENTS' MOTIVATION TO ENGAGE IN ROBOTICS ACTIVITIES IN STEM EDUCATION</b>   | 2382 |
| <i>D. Saad, I. Verner, B. Rosenberg-Kima</i>   |      |
| <b>TEACHING DESIGN AND ACTIVELY APPLYING IT THROUGH PROJECT-BASED LEARNING FORMAT: A PRACTICAL CASE STUDY OF A COLLABORATION BETWEEN A UNIVERSITY COURSE AND A COMPANY</b>   | 2391 |
| <i>G. Carella, F. Colombo</i>  |      |
| <b>PRIOR LEARNING ASSESSMENT FOR COLLEGE LEVEL CREDIT</b>  | 2399 |
| <i>M. Walker</i>   |      |
| <b>TRANSLATION AND VALIDATION INTO PORTUGUESE OF THE TEAM MEETING EFFECTIVENESS QUESTIONNAIRE</b>  | 2403 |
| <i>M. Varela, L. Neves</i>   |      |
| <b>STUDY-BUDDY FOR IMPROVING INTERNATIONAL COOPERATION</b>   | 2408 |
| <i>D. Stepanova, V. Grytsai</i>  |      |
| <b>PRESCHOOL EDUCATION AND THE ACADEMIC PERFORMANCE OF FIRST-GRADERS</b>   | 2412 |
| <i>N. Mamuladze, L. Turmanidze, I. Khasaia, K. Shotadze</i>  |      |
| <b>EXPERIENCES INTEGRATING TELEWORKING TOOLS IN FACE-TO-FACE TEACHING: SATISFACTION OF STUDENTS</b>  | 2419 |
| <i>C. Vereda-Alonso, M.M. Cerrillo-Gonzalez, C. Gomez-Lahoz, R.A. Garcia-Delgado, J.M. Rodriguez-Maroto, C. Vereda-Alonso</i>  |      |
| <b>FOOTT PRINTTS - AN INTERNATIONAL RESEARCH PROJECT WITH THE AIM OF DEVELOPING PRACTICAL GUIDELINES FOR IN-SERVICE TEACHER TRAINERS</b>   | 2426 |
| <i>C. Rudloff, A. Efstathiades</i>   |      |
| <b>CHALLENGES IN COLLABORATIVE PARTNERSHIP BETWEEN PRESCHOOL EDUCATIONAL INSTITUTIONS AND CHILDREN'S FAMILIES</b>  | 2432 |
| <i>N. Makaradze, M. Gurgenidze, N. Makaradze, A. Diasamidze, I. Khasaia</i>  |      |
| <b>EXPERIENCES INTEGRATING TELEWORKING TOOLS IN FACE-TO-FACE TEACHING: ACADEMIC RESULTS</b>  | 2441 |
| <i>C. Vereda-Alonso, M.M. Cerrillo-Gonzalez, C. Gomez-Lahoz, M. Villen-Guzman, J.M. Paz-Garcia, C. Vereda-Alonso</i>   |      |
| <b>DIGITAL COMPETENCE ENHANCEMENT THROUGH DISTANCE MOODLE-BASED BUSINESS ENGLISH COURSE</b>  | 2447 |
| <i>Z. Vincela, J. Selivanova</i>   |      |
| <b>VALUES, NARRATIVES AND CONSERVATION DILEMMAS: AN EIGHT-YEAR SURVEY ON UNDERGRADUATE BIOLOGY STUDENTS AT THE UNIVERSITY OF VALENCIA, SPAIN</b>   | 2455 |
| <i>F.J. Aznar, I. Álvarez-Rodríguez, M. Barreda-Llorens, R. Beltrí, M. Bernal-Ripollés, D. Buendía-Martín, L. Carretero-Arias, B.G. Chianese-Blanco, E. Espín-Ferrando, M. Castelló-Martínez, M. Díaz-Escudero, M. Estornell-Boscá, I. Fernández-Cabello, N. Fraija-Fernández, O. García-Casado, A. García-Gallego, M.L. Gaude, L. López-Gil, M. Martínez-Carrancho, A.B. Martínez-Santaella, M.X. Medrano-Montoya, J. Mendivil-Odériz, I. Moreno-Valle, F. Mortarini, C. Navarro-Pérez, I. Ortolá-Medina, A. Perales-Guzmán, C. Peralta-Aranda, M. Pérez-Pascual, C. Pons-Bordas, R. Pool, M. Puchades-Bartí, J.P. Torres-Da Silva, S. Tórtola-Utiel, A. Trigo-Viéitez, P. Ubiedo Evangelio, A. Van Calster Rolin, S. Ten, R. Ortells</i> |      |
| <b>POWERING UP POWERPOINT WITH GPT-4 FOR ENGAGING LANGUAGE INSTRUCTION</b>   | 2463 |
| <i>J.E. Suazo Zepeda</i>   |      |
| <b>DETERMINATION OF ANTHROPIC POLLUTANTS IN RABBITS' FAECES AS A PROPOSAL FOR A FINAL MASTER OF SCIENCE'S DEGREE PROJECT</b>   | 2470 |
| <i>V. León-Pérez, S.J. Álvarez-Méndez, F.J. Díaz-Peña, S. Gómez-Escabia, J. González-Sálamo, J. Hernández-Borges</i>   |      |
| <b>BRANDY, A GAME DEVELOPED BY 10 EUROPEAN UNIVERSITIES TO TEACH BRANDING: MEASURING MARKETING AND INTERCULTURAL LEARNING, ENGAGEMENT AND LEARNING STYLES WITH STUDENTS FROM 4 EUROPEAN COUNTRIES</b>  | 2479 |
| <i>S. Emad, F. Suay Perez</i>  |      |
| <b>ACTIVE AND EXPERIENTIAL LEARNING – ENVIRONMENT TRANSFORMATION INITIATIVE</b>  | 2480 |
| <i>D. Garcia</i>   |      |

|  |      |
|--|------|
| <b>INTERDISCIPLINARY SCIENTIFIC DISSEMINATION IN EDUCATIONAL TALKS AND EVENTS: AN ENRICHING THREE-YEARS EXPERIENCE</b>   | 2485 |
| <i>C. Villanova-Solano, C. Domínguez-Hernández, C. Hernández-Sánchez, C. Ortega-Zamora, G. Jiménez-Skrzypek, C. Socas-Hernández, A.M. Afonso-Álvarez, S.J. Álvarez-Méndez, J. González-Sálamo, J. Hernández-Borges</i> |      |
| <b>EMPOWERING OF INFORMAL CAREGIVERS THROUGH IMPROVED KNOWLEDGE AND SKILLS OF PROVIDING CARE AT HOME</b>   | 2493 |
| <i>M. Varik, E.M. Sooväli, J. Pael</i>   |      |
| <b>TEACHER TRAINING IN SYNTROPIC ENVIRONMENTAL EDUCATION AT A BASIC EDUCATION SCHOOL IN THE INTERIOR OF THE STATE OF SÃO PAULO, BRAZIL</b>   | 2497 |
| <i>F. Toqueti, M.L. Spazziani, N. Novello Rumenos, F. Freitas dos Santos, E.A. Toledo Pinto, C. Gheler-Costa</i>   |      |
| <b>THE DESIGN PROCESS OF A MATHEMATICS TEACHER EDUCATION TASK FOR INTER-INSTITUTIONAL USE</b>  | 2504 |
| <i>R. Tomás Ferreira, M.H. Martinho, F. Delgado</i>  |      |
| <b>HIGHER EDUCATION DIDACTICS FACING NEW CHALLENGES</b>  | 2514 |
| <i>M. Ivanuš Grmek, M. Mithans, S. Ograjšek</i>  |      |
| <b>BUILDING GLOBAL CITIZENS: UNVEILING THE POWER OF EXCHANGE PROGRAMS IN EDUCATION</b>   | 2520 |
| <i>M. Alvarez Barba</i>  |      |
| <b>IMPLEMENTING PROBLEM-BASED LEARNING AND CASE STUDIES IN HIGHER EDUCATION USING ARTIFICIAL INTELLIGENCE</b>  | 2527 |
| <i>A. Lavric</i>   |      |
| <b>WHY DID NEW DISTANCE LEARNING STUDENTS DROP OUT? PRELIMINARY FINDINGS FROM INDONESIA</b>  | 2533 |
| <i>R. Budiman, A. Afriani, W. Widiasari, Y. Efendi</i>   |      |
| <b>TEACHING A FOREIGN LANGUAGE IN THE INCLUSIVE EDUCATIONAL ENVIRONMENT OF A DIGITAL SCHOOL</b>  | 2540 |
| <i>N. Sigal, A. Zabolotskaya, E. Gutman</i>  |      |
| <b>FLIPPED LEARNING MODEL IMPLEMENTATION IN A LEXICOLOGY COURSE</b>  | 2547 |
| <i>N. Sigal, A. Zabolotskaya, E. Gutman</i>  |      |
| <b>COMPELLING EDUCATIONAL OFFERINGS: A STUDY ON THE EFFICACY OF SKILLS IDENTIFICATION PLATFORMS WITH COURSE DESCRIPTIONS</b>   | 2553 |
| <i>J.W. Lai, L. Zhang, Y.S. Chan, C.C. Sze, F.S. Lim</i>   |      |
| <b>EXAMINING FACTORS AFFECTING STUDENTS' PREPAREDNESS FOR AI TECHNOLOGY</b>  | 2562 |
| <i>Y.Y. Wang, Y.W. Chuang</i>  |      |
| <b>EMPOWERING EDUCATORS: FOSTERING DIALOGIC TEACHING</b>   | 2563 |
| <i>K. Ludvigsen</i>  |      |
| <b>EXPLORING PERCEPTIONS AND USAGE OF LARGE LANGUAGE MODELS AMONG UNIVERSITY OF ANDORRA STUDENTS</b>   | 2564 |
| <i>M. Bleda Bejar, A. Dorca Josa, B. Oliveras Prat</i>   |      |
| <b>AUTOMATED ANALYSIS AND GRADING OF PRIVACY POLICIES: AI-DRIVEN APPROACH FOR USER-CENTRIC DASHBOARD</b>   | 2573 |
| <i>A. Ahmad, P. Raman</i>  |      |
| <b>ARTIFICIAL INTELLIGENCE AND THE DEVELOPMENT OF METACOGNITIVE STRUCTURES INVOLVED IN PROBLEM SOLVING</b>   | 2574 |
| <i>M. Maier, Z. Triff</i>  |      |
| <b>CHATGPT AS A TOOL TO ANALYZE CHEMISTRY TEXTBOOKS</b>  | 2583 |
| <i>R. Maršálek, K. Trčková, R. Opěla</i>   |      |
| <b>PROMPT ENGINEERING IN IT MANAGEMENT EDUCATION</b>   | 2590 |
| <i>O. Resch</i>  |      |
| <b>ARE YOU MORE INTELLIGENT THAN ARTIFICIAL INTELLIGENCE? THE CRITICAL APPRAISAL OF CHATGPT AS AN EFFECTIVE LEARNING MEDIUM</b>  | 2598 |
| <i>N. Tran, A. Kan, S. Spencer, M. Lin, H. Zhang, B. Shulruf, A. Agar</i>  |      |
| <b>A MOOC ON DATA JOURNALISM: THE BEGINNING OF A JOURNEY INTO DATA</b>   | 2599 |
| <i>C. Silvestre, F. Bonacho, S. Araújo, H.F. Pina</i>  |      |
| <b>TRANSFORMING HIGHER EDUCATION TEACHING THROUGH THE INTEGRATION OF VIRTUAL AND AUGMENTED REALITY</b>   | 2604 |
| <i>P. Kosmas, E. Nisiforou, C. Vrasidas</i>  |      |

|  |      |
|--|------|
| <b>COMPETENCES AND SKILLS: TEACHING AND LEARNING AT SCHOOL</b>   | 2613 |
| <i>P. Paolini, N. Diblas</i>   |      |
| <b>ASSESSING DIGITAL LITERACIES: AN ETHNOGRAPHIC STUDY OF TEACHERS' ASSESSMENT LITERACIES IN THE DIGITAL AGE</b>                                     | 2620 |
| <i>H.Y. Chan</i>   |      |
| <b>IMPACT OF GENERATIVE ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION: STUDENT PERCEPTIONS</b>   | 2631 |
| <i>V. Roger-Monzó</i>  |      |
| <b>INTEGRATING SDGS INTO THE OPERATIONS MANAGEMENT COURSE</b>  | 2636 |
| <i>M.J. Oltra-Mestre, C. García Palao</i>  |      |
| <b>EXPLORING NEW REALITIES: UNIVERSITY STUDENTS' VIEWS ON IMMERSIVE TECHNOLOGY IN EDUCATION</b>  | 2637 |
| <i>K. Varadharajulu, M. Lara</i>   |      |
| <b>A CASE STUDY OF PROMOTING K12 STEM EDUCATION THROUGH HACKATHONS</b>   | 2645 |
| <i>E. Lazarou, R. Brezoaie, T.M. Ursachi, M.I. Dascalu, I.C. Stanica</i>   |      |
| <b>A FRAMEWORK TO DESIGN AND ANALYZE GAMES FOR CULTIVATING CREATIVE LITERACY</b>   | 2654 |
| <i>J. Raimundo</i>   |      |
| <b>CREATING A COMPUTER ADAPTIVE ASSESSMENT FOR USE IN SCHOOLS</b>  | 2662 |
| <i>C. Jellis</i>   |      |
| <b>TEACHER EDUCATOR IN A MULTI-CAMPUS UNIVERSITY</b>   | 2670 |
| <i>A.G. Almás</i>  |      |
| <b>ASSESSMENT OF THRESHOLD MATH CONCEPTS FOR SECOND YEAR STUDENTS WITHIN A MATERIALS SCIENCE COURSE</b>  | 2671 |
| <i>A.I. Pruna, F. Salas, A. Vicente-Escuder, E.M. Sánchez-Orgaz, S. Martínez Sanchis</i>   |      |
| <b>TEACHING REDUNDANCY RESOLUTION IN REDUNDANT PARALLEL MANIPULATORS WITH AN INTERACTIVE AND GRAPHICAL SIMULATION</b>                                | 2677 |
| <i>A. Peidró, M. Fabregat-Jaén, A. Gil, D. Valiente, O. Reinoso</i>  |      |
| <b>FROM THEORY TO PRACTICE: IMPROVING LEARNING THROUGH ACTION ORIENTATION IN ACADEMIC EDUCATION</b>  | 2687 |
| <i>T.N. Jambor</i>   |      |
| <b>IDEATION, BUSINESS MODELLING AND LEADERSHIP BY GAMIFICATION – USING DIGITAL PLAYFUL LEARNING IN NEXT GENERATION ENTREPRENEURSHIP</b>              | 2697 |
| <i>H. Fischer, M. Pippig, M. Arnold, Y. Farrand, S. Leducq, T. Köhler, M. Letonja, L. Mertens, J. Müller, R. Slingerland, P. Urgacz, R. Verhagen</i> |      |
| <b>SMART TOOLS, SMARTER STUDENTS: A STUDY ON CHATGPT'S EFFECTS ON LEARNING OUTCOMES AND EXERCISE QUALITY IN BUSINESS EDUCATION</b>                   | 2704 |
| <i>L. Meyer, A. Dannecker</i>  |      |
| <b>LEARNING NEURAL NETWORKS BY PLAYING WITH WIND TURBINE SIGNALS: A GREEN CHALLENGE-DRIVEN DIDACTIC PROPOSAL</b>                                     | 2714 |
| <i>J.E. Sierra-Garcia, M. Santos</i>   |      |
| <b>UNCONVENTIONAL EXECUTION OF CHEMICAL EXPERIMENTS IN CONTAINERS PRODUCED BY 3D PRINTING</b>  | 2722 |
| <i>K. Trčková, R. Maršálek</i>   |      |
| <b>BARRIERS TO SOCIAL ENTREPRENEURSHIP AMONG BUSINESS MANAGEMENT UNIVERSITY STUDENTS IN SPAIN: A FUZZY DEMATEL APPROACH</b>                          | 2728 |
| <i>O. Barbulescu, J. Capó-I-Vicedo, G. Maldonado-Gómez, J.V. Tomás-Miquel</i>  |      |
| <b>A CONCEPTUAL FRAMEWORK FOR ANALYSING THE EFFECTS OF QUALITY MANAGEMENT SYSTEM ON STUDENT PERFORMANCE IN ADULT EDUCATION</b>                       | 2737 |
| <i>M. Vučić, I. Dužević, T. Baković</i>  |      |
| <b>"LET'S SAVE OUR BEACHES": SDG-DRIVEN ROBOTIC CHALLENGE FOR SECONDARY EDUCATION</b>  | 2746 |
| <i>M. Sastre-Domenech, J.E. Sierra-Garcia, M. Santos</i>   |      |
| <b>PARTICIPATORY ACTIVITIES AND INDIVIDUAL STUDENT INTEREST IN THE MODULE OF EXPRESSION AND COMMUNICATION</b>  | 2754 |
| <i>Y. Martínez-Hierrezuelo, V. García-Aparicio, L. Lucio-González</i>  |      |
| <b>TEACHING EXPERIENCES SHARING AMONGST ACADEMICS IN SAUDI UNIVERSITIES: COMPUTER SCIENCE ACADEMICS' PERSPECTIVES</b>                                | 2759 |
| <i>M. Alharbi, M. Devlin, J. Warrender</i>   |      |

|   |      |
|---|------|
| <b>FOSTERING WHOLE INSTITUTION APPROACH TO SUSTAINABILITY IN HIGHER EDUCATION INSTITUTIONS THROUGH SYSTEMS THINKING</b>   | 2769 |
| <i>S. Armenia, E. Franco, O. Christou, J. Papathanasiou</i>   |      |
| <b>INTEGRATING UNIVERSAL LEARNING DESIGN AND INNOVATIVE TECHNOLOGIES FOR THE EFFECTIVE INCLUSION OF STUDENTS WITH HEARING LOSS IN COMPULSORY SECONDARY EDUCATION</b>                            | 2778 |
| <i>V. García-Aparicio, Y. Martínez-Hierrezuelo, D. Gil-Pareja</i>   |      |
| <b>FLIPPED CLASSES BASED ON FREE ACCESS TO INDUSTRIAL DOCUMENTS TO KEEP THE STUDENTS ENGAGED</b>  | 2786 |
| <i>J. Lario Femenia, M.J. Verdecho, M.P. Conesa</i>   |      |
| <b>RESPONSIBLE BUSINESS MANAGEMENT EDUCATION: INTEGRATION OF SUSTAINABLE DEVELOPMENT GOALS INTO A BUSINESS PLAN</b>   | 2793 |
| <i>J. Lario Femenia, M.J. Verdecho, M.P. Conesa</i>   |      |
| <b>LONGITUDINAL LINKS BETWEEN HOME NUMERACY ENVIRONMENT AND CHILDREN'S MATH ADJUSTMENT IN LITHUANIAN ELEMENTARY SCHOOL</b>  | 2799 |
| <i>G. Silinskas, S. Raiziene</i>  |      |
| <b>PREDICTORS OF ADOLESCENTS' FINANCIAL LITERACY: EVIDENCE FROM PISA 2018</b>   | 2800 |
| <i>G. Silinskas, K. Laine, A. Ahonen</i>  |      |
| <b>DEPLOYMENT OF ARTIFICIAL INTELLIGENCE IN EDUCATION: RESULTS OF EMPIRICAL RESEARCH</b>  | 2801 |
| <i>Z. Konecna, J. Budik</i>   |      |
| <b>EDTECH AND GAMIFICATION: EFFECTIVE TOOLS IN EDUCATIONAL PROCESS AT HEIS. A CASE OF RE-DESIGNING OF A COURSE FOCUSED ON THE DEVELOPMENT OF MANAGERIAL SKILLS</b>                              | 2806 |
| <i>Z. Konecna, J. Budik</i>   |      |
| <b>CURRENT SITUATION AND CHARACTERISTICS OF THE USE OF VISUAL TEACHING MATERIALS IN DEAF SCHOOLS IN JAPAN</b>   | 2811 |
| <i>I. Chung, A. Yamamoto, S. Ganmaru, Y. Ishida, H. Aoyama</i>  |      |
| <b>ANALYSIS OF TEACHERS' DIDACTIC PRACTICES IN RELATION TO STUDENTS' LEARNING</b>   | 2817 |
| <i>M. Vaclavik, I. Cervenkova, T. Barot</i>   |      |
| <b>BUILDING A SENSE OF LEARNING COMMUNITY ONLINE: STRATEGIES TO FOSTER INTERACTION WITH AND AMONG STUDENTS IN DISTANCE ARTS EDUCATION</b>   | 2821 |
| <i>A. Aurelio Castro-Varela, V. Pavlou</i>  |      |
| <b>ANALYSIS OF THE PROCESS AND SUCCESS RATE IN THE DEVELOPMENT OF MASTER DISSERTATIONS IN DISTANCE LEARNING DEGREES. COMPARISON WITH OFFICIAL FACE-TO-FACE DEGREES IN THE SAME SUBJECT AREA</b> | 2822 |
| <i>R. Del Teso, E. Gómez, E. Estruch-Juan, J. Soriano</i>   |      |
| <b>ACCESS TO BASIC EDUCATION FOR PERSONS WITH DISABILITIES - AN ANALYSIS OF THE MUNICIPALITIES OF RIO GRANDE DO NORTE (BRAZIL) USING EDUCATIONAL CENSUS DATA FROM THE YEAR 2022</b>             | 2828 |
| <i>B. Lima, J. Oliveira, P. Medeiros, M. Aguirre, A.A.S. Fontoura, E. Sant'anna, J. Silva, J. Araújo</i>  |      |
| <b>ENGAGEMENT PRACTICES IN CROSS-UNIVERSITY OPEN KNOWLEDGE-BUILDING ACTIVITIES</b>  | 2834 |
| <i>K. Kori, K. Pata</i>   |      |
| <b>SERVICE-LEARNING AS A TEACHING METHODOLOGY FOR BRAND DESIGN IN HIGHER EDUCATION</b>  | 2842 |
| <i>O. Ampuero-Canellas, J. González Del Río, N. Tarazona-Belenguer</i>  |      |
| <b>THE MEANING OF THE GAME IN EARLY CHILDHOOD EDUCATION</b>   | 2850 |
| <i>V. Padgurskytė</i>   |      |
| <b>INFOGRAPHICS AND ICTS: UPDATING CONTENT IN A SUBJECT OF THE DEGREE IN AUDIOVISUAL COMMUNICATION</b>  | 2856 |
| <i>N. Tarazona-Belenguer, M. Rodrigo-Sánchez, B. Jordá-Albiñana</i>   |      |
| <b>THE ROLE OF THE FAMILY IN THE EARLY EDUCATION OF A CHILD</b>   | 2865 |
| <i>V. Padgurskytė</i>   |      |
| <b>PYTHIA - AI SUGGESTED INDIVIDUAL LEARNING PATHS FOR EVERY STUDENT</b>  | 2871 |
| <i>S. Röhrh, S. Staufer, V.K. Nadimpalli, F. Bugert, F. Hauser, L. Grabinger, D. Bittner, T. Ezer, J. Mottok</i>  |      |
| <b>INVESTIGATING THE EFFECTS OF THE DISTRIBUTION OF CLASSROOM POWER ON THE QUALITY OF CLASSROOM INTERACTION</b>   | 2881 |
| <i>S. Bouchene</i>  |      |

|   |      |
|---|------|
| <b>WHAT DO UNIVERSITY STUDENTS EXPECT FROM AN EDUCATIONAL APPLICATION DESIGNED TO DEVELOP SKILLS?</b>   | 2889 |
| <i>M. Lara, T. Lutzenkirchen</i>  |      |
| <b>NATURBUILD PROJECT. NATURE-BASED SOLUTIONS: GREEN ROOFS TRAINING FOR URBAN AND BUILDING SUSTAINABILITY</b>   | 2897 |
| <i>B. Oliete Galiano, E. Rodríguez Arévalo, M. Pérez Ríos</i>   |      |
| <b>SUSTAINABLE EDUCATIONAL LEADERS: FACING CHALLENGES OR CREATING OPPORTUNITIES?</b>  | 2906 |
| <i>L. Snellman</i>  |      |
| <b>POLITECNICO CALZATURIERO SCARL AND THE TRAINING OF THE FUTURE: AN IMMERSIVE EXPERIENCE IN A FOOTWEAR FACTORY</b>   | 2914 |
| <i>C. Biancotto</i>   |      |
| <b>TEACHER EMPOWERMENT TO OPTIMIZE STUDENT MONITORING AND ASSESSMENT: A HOLISTIC APPROACH TO LEARNING ANALYTICS IN DIGITAL ENVIRONMENTS</b>                       | 2920 |
| <i>M. Guitert Catasús, T. Romeu Fontanillas, J.P. Cerro Martínez</i>  |      |
| <b>DEVELOPING GRADUATE STUDENTS' CRITICAL THINKING ABILITIES THROUGH EAP COURSES: AN SEEI APPROACH</b>  | 2927 |
| <i>Y. Dong</i>  |      |
| <b>TRAINING DOCTORAL SUPERVISORS TO TRAIN RESEARCHERS OF TOMORROW – A SWEDISH EXAMPLE</b>   | 2928 |
| <i>L. Reneland-Forsman, A. Forsman</i>  |      |
| <b>INTERPROFESSIONAL AND INTERDISCIPLINARY COLLABORATION IN THE NURSING AND CARE WORKER CURRICULUM</b>  | 2933 |
| <i>K. Puusepp, U. Kõrgemaa, J. Sepp</i>   |      |
| <b>THE INFLUENCE OF CURRICULUM CHANGES ON TEACHERS' EXPERIENCES OF TEACHING ACCOUNTING: A CASE STUDY OF SOUTH AFRICAN SECONDARY SCHOOLS</b>                       | 2934 |
| <i>N. Sithole</i>   |      |
| <b>EXPLORING SUSTAINABLE PRACTICES IN DIGITAL SCREEN USE BY CHILDREN AND ADOLESCENTS</b>  | 2935 |
| <i>T. Romeu Fontanillas, M. Guitert Catasús, D. Español Fernández</i>   |      |
| <b>NAVIGATING NEW FRONTIERS IN EDUCATION: THE ROLE OF CHATGPT IN ALGORITHMIC LEARNING AND ITS CHALLENGES</b>  | 2943 |
| <i>D. Palla, A. Slaby</i>   |      |
| <b>PHYSICS TEACHERS' CONCEPTIONS OF GAMIFICATION AND THE USE OF GAMIFICATION IN PHYSICS LESSONS</b>   | 2949 |
| <i>M. Gaurina, J. Paolin</i>  |      |
| <b>EYE TRACKING AS TECHNOLOGY IN EDUCATION: FURTHER INVESTIGATION OF DATA QUALITY AND IMPROVEMENTS</b>  | 2955 |
| <i>T. Ezer, L. Grabinger, F. Hauser, S. Staufer, J. Mottok</i>  |      |
| <b>OVER-RELIANCE ON TECHNOLOGY IN FOREIGN LANGUAGE LEARNING: CASE STUDY OF LLB UNDERGRADUATES</b>   | 2962 |
| <i>P. Novikov, A. Kiseleva</i>  |      |
| <b>USING COLOUR IN THE CLASSROOM TO LEARN DIFFERENT CALIBRATIONS IN ANALYTICAL CHEMISTRY</b>  | 2967 |
| <i>R. Sáez-Hernández, I. Adam-Cervera, K.U. Antela, M.L. Cervera, Á. Morales-Rubio</i>  |      |
| <b>USE OF A MARINE AQUARIUM AS A CORE MULTIDISCIPLINARY PLATFORM TO DEVELOP LINKED ACTIVE AND COOPERATIVE LEARNING STRATEGIES IN CHEMICAL ENGINEERING COURSES</b> | 2973 |
| <i>C. Quijada, S.C. Cardona Navarrete, M.F. López-Pérez, V.G. Lo Iacono Ferreira, R. Sanchis</i>  |      |
| <b>INSTRUMENTAL LABORATORY PRACTICES IN A VIRTUAL ENVIRONMENT: AN APPLICATION IN ANALYTICAL CHEMISTRY</b>   | 2983 |
| <i>R. Sáez-Hernández, K.U. Antela, I. Adam-Cervera, M.J. Luque, M.L. Cervera, Á. Morales-Rubio</i>  |      |
| <b>AI-POWERED TOOLS FOR ENHANCING ENGAGEMENT AND ACADEMIC PERFORMANCE OF ENGINEERING STUDENTS</b>   | 2990 |
| <i>R. Yakhina, K. Grigorieva, N. Batrova, M. Lukoyanova</i>   |      |
| <b>PEDAGOGICAL PREDICTION OF LEARNING OUTCOMES BASED ON AUTOREGRESSIVE INTEGRATED MOVING AVERAGE MODEL</b>  | 2997 |
| <i>M. Lukoyanova, N. Batrova, K. Grigorieva, R. Yakhina</i>   |      |

|  |      |
|--|------|
| <b>EYE TRACKING METRICS FOR DISTINGUISHING GLOBAL AND FOCAL GAZE PATTERNS: A SYSTEMATIC LITERATURE REVIEW</b><br><i>T. Ezer, L. Grabinger, F. Hauser, S. Stauffer, J. Mottok</i>   | 3005 |
| <b>PLAYING FOR THE FUTURE. ENRICHING DESIGN STUDENTS' USER RESEARCH SKILLS FOR SUSTAINABLE TOY DESIGN</b><br><i>L. Sossini, M. Italia, F. Costa, B. Del Curto, S. Banfi, E. Sadolfo</i>                                      | 3015 |
| <b>DESIGN THINKING AS AN ENABLER OF CHANGE IN THE TECHNOLOGICAL MARKET: A PRACTICAL CASE STUDY OF COMPANY'S INNOVATION AND DIFFERENTIATION</b><br><i>G. Carella, F. Colombo, S. Migliozzi, V. Arquilla</i>                   | 3025 |
| <b>UNIVERSITY STUDENTS WITH SPECIAL EDUCATIONAL NEEDS - AN EXAMPLE FROM SLOVAKIA</b><br><i>V. Michvočíková, M. Sirotoová</i>   | 3034 |
| <b>INTERACTIVITY AND SCAFFOLDING IN PRACTICE BASED LEARNING WITH DISRUPTIVE TECHNOLOGIES</b><br><i>T. Väljataga, K. Pata</i>   | 3039 |
| <b>PERCEPTION OF INCLUSION OF SPECIAL NEEDS CHILDREN AMONG PUPILS, PARENTS, EDUCATORS AND STAFF IN INCLUSIVE AND NON-INCLUSIVE PRIVATE AND PUBLIC SCHOOLS IN LEBANON</b><br><i>S. Emad, M. Kosremelli Asmar, M. Dubosson</i> | 3048 |
| <b>CHALLENGES OF DIVERSITY-SENSITIVE RESEARCH WITH YOUNG CHILDREN – A CASE STUDY OF MEDIA USE AND POLITICAL EDUCATION</b><br><i>J. Lategahn, R. Tkotzyk, G. Marci-Boehncke</i>   | 3054 |
| <b>STUDENTS' ATTITUDES, PERCEPTIONS AND INTENTIONS TO LEARN WITH DIFFERENT TYPES OF SERIOUS GAMES AND SERIOUS GAMES FOR OPIOID EDUCATION</b><br><i>C. Anyinam, S. Coffey</i>   | 3061 |
| <b>DEVELOPMENT OF A CHATGPT WEB-BASED EDUCATIONAL CHATBOT FOR CIRCUIT THEORY TEACHING</b><br><i>J. Parra, P. Sanchis</i>   | 3062 |
| <b>HEI SOCIAL MEDIA ANALYSIS - A CASE STUDY OF FIVE PRIVATE UNIVERSITIES IN CROATIA</b><br><i>L. Opačić, P. Vranešić, K. Aleksić-Maslač</i>  | 3063 |
| <b>STUDENTS' PERCEPTIONS OF GENERATIVE AI USAGE AND RISKS IN A FINNISH HIGHER EDUCATION INSTITUTION</b><br><i>M. Suonpää, J. Heikkilä, A. Dimkar</i>   | 3071 |
| <b>INTEGRATED EVALUATION OF MOTIVATION AND LEARNING IN CIRCUIT THEORY LABORATORY: A QUALITATIVE AND QUANTITATIVE STUDY</b><br><i>J. Parra, P. Sanchis</i>  | 3078 |
| <b>DEVELOPING DIDACTIC PROPOSALS FOR SCIENCE EDUCATION WITH STS ORIENTATION, PROMOTING CRITICAL THINKING: A SYSTEMATIC LITERATURE REVIEW</b><br><i>L.F. Torres Moreira</i>   | 3079 |
| <b>CAN SMARTWATCHES WITH STRESS DETECTION LOWER STUDENTS' ANXIETY? AN EXPLORATORY PILOT STUDY USING WEARABLES</b><br><i>I. Nicolaidou</i>  | 3080 |
| <b>INTRODUCTION OF BIOLUMINESCENCE IN SCIENCE FOR FIFTH GRADE PRIMARY SCHOOL STUDENTS</b><br><i>L. Fortuna, M. Slapničar, J. Pavlin</i>  | 3084 |
| <b>LINKING GREAT PARTNERS FOR ENTREPRENEURSHIP EDUCATION</b><br><i>G. Gonçalves</i>  | 3090 |
| <b>ENGLISH FOR THE EDI GENERATION: PREDICTING AND TRACKING THE ROLE OF ENGLISH AND DIGITAL/MOBILE TECHNOLOGIES IN HIGHER EDUCATION ACROSS EAST AND SOUTH ASIA</b><br><i>S. Dawadi, A. Kukulska-Hulme, S. Seargeant</i>       | 3091 |
| <b>HOW DEEP TECH CAN PROMOTE INNOVATION AND ENTREPRENEURSHIP IN HIGHER EDUCATION INSTITUTIONS</b><br><i>G. Gonçalves, J. Miranda</i>   | 3092 |
| <b>A PROCESS FOR INFORMAL EVALUATION OF AFTER SCHOOL STEM (SCIENCE, TECHNOLOGY, ENGINEERING, MATHEMATICS) PROGRAMS FOR GIRLS</b><br><i>M. Larson</i>   | 3101 |



|  |      |
|--|------|
| <b>THE LAW PROJECT: THE IMPORTANCE OF LEGAL LITERACY IN THE EVERYDAY LIFE OF KIDS AND YOUNG PEOPLE</b>   | 3102 |
| <i>A. Ribeiro, M. Rodrigues</i>  |      |
| <b>MAKING GENDER EQUALITY VISIBLE IN HIGHER EDUCATION. AN APPROACH FROM CUBA AND ROMANIA</b>   | 3111 |
| <i>C. Correa García, B. Tescasiu</i>   |      |
| <b>ADDRESSING CHALLENGES AND ENHANCING PROSPERITY: THE OREN PROJECT'S INNOVATIVE APPROACH TO RURAL ENTREPRENEURIAL EDUCATION</b>   | 3119 |
| <i>G. Tsaples, S. Armenia, T. De Angelis</i>   |      |
| <b>UNLOCKING INSIGHTS: NATURAL LANGUAGE PROCESSING ANALYSIS OF CASE STUDIES IN THE OREN PROJECT</b>  | 3125 |
| <i>G. Tsaples</i>  |      |
| <b>MIND THE (TECHNOLOGY) GAP: USING ARTICULATE STORYLINE TO BUILD A SERIOUS GAME FOR OPIOID EDUCATION</b>  | 3126 |
| <i>C. Anyinam, S. Coffey, L. Graham, C. Da Silva, P. Munro-Gilbert, A. De La Rocha, D. Chorney</i>   |      |
| <b>THE SUCCESSFUL IMPLEMENTATION OF A CREDIT BEARING READINESS ACTIVITY USED TO ENHANCE PERSONAL LEARNING ENVIRONMENTS</b>   | 3131 |
| <i>R. Branch, H. Lee, A. Morris, C. De Beer</i>  |      |
| <b>CONCEPTUAL KNOWLEDGE IN FINANCIAL LITERACY</b>  | 3132 |
| <i>J. Helus</i>  |      |
| <b>ARTIFICIAL INTELLIGENCE IN THE TEACHING-LEARNING PROCESS IN PHARMACOLOGY</b>  | 3139 |
| <i>M. Arribas Blazquez, M.V. Barahona Gomariz, A. Rodríguez Artalejo, M.I. San Andrés Larrea, J.J. de Lucas Burneo, J.A. Gilabert Santos, M.R. Gómez Villafuertes, F. Ortega de la O, E. García Delicado, R. Pérez Sen, S. Sánchez Fortún, A. D'Ors de Blas, E. De Lago Fernia, I. Lastres-Becker, S. Santander Ballestín, M.J. Luesma Bartolomé, A. García Barrios, B. López Bouzo, P. Morón Elorza, C. Llorente Sáez, J. Serrano López, A. Sánchez Fortún, A. Quintero Pérez, M. Arias Mosquera, I. Belloso Melcon, O. Licerias de Bernardo, M.J. Muelas González, L.A. Olivos-Oré</i> |      |
| <b>MOBILE AUGMENTED REALITY GAMES FOR AUTHENTIC SCIENCE LEARNING: PERSPECTIVES OF STUDENTS (FUTURE TEACHERS) ON THE EDUCITY ACTIVITY</b>   | 3145 |
| <i>L. Pombo, R. Rodrigues</i>  |      |
| <b>DIGITAL HUMANITIES: NEW RESEARCH TRAJECTORIES, NEW CHALLENGES, NEW INTERPRETATION</b>   | 3155 |
| <i>M. Novikova, P. Novikov</i>   |      |
| <b>DIFFERENT ROLES OF ARTIFICIAL INTELLIGENCE IN THE TEACHING-LEARNING PROCESS IN PHARMACOLOGY</b>   | 3160 |
| <i>L.A. Olivos-Oré, M.V. Barahona Gomariz, A. Rodríguez Artalejo, M.I. San Andrés Larrea, J.J. de Lucas Burneo, J.A. Gilabert Santos, M.R. Gómez Villafuertes, F. Ortega de la O, E. García Delicado, R. Pérez Sen, S. Sánchez Fortún, A. D'Ors de Blas, E. De Lago Fernia, I. Lastres-Becker, S. Santander Ballestín, M.J. Luesma Bartolomé, A. García Barrios, B. López Bouzo, P. Morón Elorza, C. Llorente Sáez, J. Serrano López, A. Sánchez Fortún, A. Quintero Pérez, M. Arias Mosquera, I. Belloso Melcon, O. Licerias de Bernardo, M.J. Muelas González, M. Arribas Blazquez</i> |      |
| <b>CAN THE SDGS INSPIRE TOMORROW'S BUSINESS LEADERS?</b>   | 3166 |
| <i>L. Guitart Tarrés, A. Núñez-Carballosa, N. Jaría Chacón, F. Achcaoucaou, P. Miravittles, C. Cruz-Cázares</i>  |      |
| <b>CHATGPT IN EDUCATION - USE CASES IN AN INTRODUCTORY WEB PROGRAMMING COURSE</b>  | 3173 |
| <i>M. Mikac, M. Horvatić, R. Logožar, E. Dumić</i>   |      |
| <b>SERVICE-LEARNING AND SDGS: EDUCATIONAL APPLICATION IN THE FIELD OF INFORMATION AND COMMUNICATION IN THE CONTEXT OF ISCHOOLS</b>   | 3183 |
| <i>S. Martínez-Cardama, F. García-López, M. Caridad-Sebastián, A.R. Pacios-Lozano</i>  |      |
| <b>ATTITUDES OF HUNGARIAN STUDENTS IN SLOVAKIA IN VOCATIONAL SECONDARY SCHOOLS AND GRAMMAR SCHOOLS TOWARDS THE USE OF REGIONAL LANGUAGE VARIETIES</b>  | 3192 |
| <i>D. Illés, I. Vančo</i>  |      |
| <b>THE APPROACH OF FIRE RESCUE OFFICERS TO ETHICAL ASPECTS OF FIREFIGHTING</b>   | 3198 |
| <i>L. Michalcová, Z. Freitinger-Skalická, Š. Strnad</i>  |      |
| <b>ATTITUDES TOWARDS THE USE OF STANDARD LANGUAGE AMONG HUNGARIAN SECONDARY SCHOOL STUDENTS IN SLOVAKIA</b>  | 3204 |
| <i>D. Illés, I. Vančo</i>  |      |

|  |      |
|--|------|
| <b>MANIFESTO OUTFITS: CREATIVE AND COMMUNICATIVE TOOLS, GREEN TECHNOLOGIES AND MATERIALS</b>   | 3210 |
| <i>A. Violano, S. Ottieri, R. Liberti, M. Cannaviello, G. Savarese</i>   |      |
| <b>INTEGRATING VIDEO GAMES IN BUSINESS EDUCATION: A BARRIER-FREE APPROACH</b>  | 3220 |
| <i>H. Pérez Moure, J. Lampón, P. Cabanelas</i>   |      |
| <b>TEACHER TRAINING AND EDUCATIONAL MANAGEMENT FOR THE DEVELOPMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY SKILLS AT THE UNIVERSIDAD DEL QUINDÍO</b> | 3221 |
| <i>A.M. Ramírez Agudelo, L.M. Castro Benavides</i>   |      |
| <b>SIMULATION-BASED LEARNING FACILITATION USING THE HELPERS MODEL</b>  | 3227 |
| <i>S. Coffey, L. Graham, A. de la Rocha, D. Chorney, A. Cope, P. Munro-Gilbert, C. Anyinam, C. Da Silva</i>  |      |
| <b>STUDENT PERCEPTION OF THE ACADEMIC TRANSITION FROM TECHNICAL CAREERS TO ENGINEERING AT UCSC</b>   | 3235 |
| <i>K. Roberts, M. Basso, H. Abarca</i>   |      |
| <b>A UNIFIED AESTHETIC APPROACH TO ACADEMIC AND EDUCATIONAL WEB DESIGN</b>   | 3240 |
| <i>A. Giannakouloupoulos, A. Lamprogeorgos, M. Pergantis</i>   |      |
| <b>USER EXPERIENCE DESIGN FOR ACADEMIC CONTENT EDITORS IN A MULTISITE ENVIRONMENT</b>  | 3247 |
| <i>A. Giannakouloupoulos, M. Pergantis, A. Lamprogeorgos</i>   |      |
| <b>EMPOWERING EDUCATION: THE STEAME PROJECT'S VISION FOR TEACHER COMPETENCE AND INNOVATION IN STEM LEARNING ENVIRONMENTS</b>                             | 3256 |
| <i>P. Escudeiro, N. Escudeiro, M. Campos</i>   |      |
| <b>INTEGRATING LARGE LANGUAGE MODELS FOR REAL-WORLD PROBLEM MODELLING: A COMPARATIVE STUDY</b>   | 3262 |
| <i>C.M. Lorenzo</i>  |      |
| <b>MOTIVATION OF EDUCATIONAL INSTITUTION EMPLOYEES IN THE GENERATIONAL CONTEXT</b>   | 3273 |
| <i>A. Auzina, A. Zvirbule, G. Grinberga-Zalite</i>   |      |
| <b>UNIVERSITY STUDENTS' PERCEPTION OF TEACHING AS A GUIDE IN THEIR LEARNING PROCESS AND ITS IMPACT ON THE QUALIFICATIONS</b>                             | 3274 |
| <i>A.M. Martínez-Martínez, R.I. Herrada-Valverde, M.C. López-Berlanga</i>  |      |
| <b>THE DIDACTIC GAME AND ITS SIGNIFICANCE IN TEACHING CHEMISTRY AT PRIMARY SCHOOLS</b>   | 3280 |
| <i>Z. Jenisová, L. Simon, K. Hotová, K. Szarka</i>   |      |
| <b>EXPLORING THE ROLE OF SOCIAL ROBOTS IN ELDERLY CARE: A CASE STUDY</b>   | 3288 |
| <i>C. Tigerstedt, K. Kuvaja-Adolfsson, D. Biström</i>  |      |
| <b>PROMOTING THE ENTREPRENEURIAL MINDSET IN ENGINEERING COURSES AT THE UNIVERSITY OF AVEIRO, PORTUGAL</b>  | 3296 |
| <i>B. Gabriel, R. Valente</i>  |      |
| <b>REFLEXIVE MONITORING FOR HIGHER EDUCATION IN TRANSITION</b>   | 3297 |
| <i>E. Devries</i>  |      |
| <b>UNIVERSITY STUDENTS' PERCEPTION OF THE PRACTICAL-COLLABORATIVE EXPERIENCE IN THE CLASSROOM</b>  | 3298 |
| <i>M.C. López-Berlanga, R.I. Herrada-Valverde, A.M. Martínez-Martínez</i>  |      |
| <b>CONTEXT-ADAPTIVE E-LEARNING CONCEPT IN A SMART HOME SCENARIO</b>  | 3305 |
| <i>F. Fischer, M. Fischer</i>  |      |
| <b>HIGHER EDUCATION PROFESSORS' AND STUDENTS' PERSPECTIVES AND EXPERIENCES CONCERNING THE USE OF UNIVERSAL DESIGN FOR LEARNING: A SCOPING REVIEW</b>     | 3315 |
| <i>M.A. Santos, R. Teles</i>   |      |
| <b>TEACHING CONDITIONS FOR THE INTEGRATION OF ICT MEDIATED GAMIFICATION</b>  | 3324 |
| <i>M. Perdomo Vargas, Z. Chinchilla Ruedas</i>   |      |
| <b>PERSONALIZED GAMIFICATION TO PROMOTE USER ENGAGEMENT: A CASE STUDY</b>  | 3330 |
| <i>F. Fischer, M. Fischer</i>  |      |

|  |      |
|--|------|
| <b>MOTIVATIONS BEHIND BULLYING FROM THE PERSPECTIVE OF TEACHERS: VALIDATION OF A NEW QUESTIONNAIRE AND FIRST RESULTS ON THE ASSOCIATION WITH MORAL DISENGAGEMENT</b><br><i>S. Siddiqui, A. Schutlze-Krumbholz</i>  | 3341 |
| <b>A ROPE OF MANY STRANDS; BUILDING EFFECTIVE TEACHING TEAMS TO SUPPORT WORK-INTEGRATED DELIVERY OF VOCATIONAL EDUCATION</b><br><i>S. Hexamer, H. Cadzow</i>   | 3342 |
| <b>WHICH MEASURES OF EMOTIONAL INTELLIGENCE HAVE BEEN ADOPTED IN EMPIRICAL RESEARCH THAT EXPLORES ITS VALUE FOR HIGHER EDUCATION EDUCATORS?</b><br><i>A. Youde, W. Bailey, A. Armitage</i>   | 3343 |
| <b>RESULTS OF AWARENESS WORKSHOP ON SAVING ENERGY AND NATURAL RESOURCES IN A SECONDARY CLASSROOM IN ALMERIA (SPAIN)</b><br><i>M.N. Honoré, F.D. Molina-Aiz, M.J. Salazar-Rumí, I.M. Ruiz-Serna</i>   | 3353 |
| <b>EMBEDDING SUSTAINABILITY IN SUPPLY CHAIN DECISION-MAKING: AN EDUCATIONAL APPROACH</b><br><i>P. Cortés-Pellicer, F. Castelló-Sirvent</i>   | 3360 |
| <b>USING GENERATIVE AI FOR STRATEGIC ANALYSIS? A STUDY ON PERCEIVED UTILITY AMONG INDUSTRIAL ORGANIZATION ENGINEERING STUDENTS</b><br><i>F. Castelló-Sirvent, P. Cortés-Pellicer</i>   | 3365 |
| <b>BREAKING BOUNDARIES: ASSESSING THE IMPACT OF A CROSS-CULTURAL LEARNING ACTIVITY ON STUDENTS' GLOBAL PERSPECTIVES</b><br><i>J. Kwon</i>  | 3373 |
| <b>PROJECT BASED LEARNING IN DESIGN: PERSONAL BRANDING THROUGH PLASTIC TECHNIQUES</b><br><i>T. Magal-Royo, J. Armijo Tortajada, B. Jordá-Albiñana</i>  | 3374 |
| <b>BRIDGING GENDER GAPS GLOBALLY: EDUCATIONAL TRANSFORMATION AND CULTURAL HERITAGE RESTORATION THROUGH THE WOMEN'S LEGACY RESOURCE BANK</b><br><i>A. López-Navajas, L. Medea-García</i>  | 3380 |
| <b>VALIDATION OF THE MOTHERS' SENSITIVITY SCALE (MSS) DURING CHILDREN'S TRANSITION FROM HOME TO KINDERGARTEN</b><br><i>S. Tatalović Vorkapić, I. Mihić</i>   | 3381 |
| <b>RETHINKING THE COURSE OBJECTIVES AND TEACHING METHODOLOGY IN ENGLISH FOR SPECIFIC PURPOSES (ESP) COURSES IN THE POST-PANDEMIC HIGHER EDUCATION CONTEXT</b><br><i>A. Knezovic</i>  | 3390 |
| <b>PROJECT-BASED APPLICATION OF ACTIVE LEARNING METHODOLOGY OF REAL CASES THROUGH THE INVOLVEMENT OF LOCAL COMPANIES</b><br><i>I. Domínguez-Candela, L. Sanchez-Nacher, R. Balart, D. Garcia-Sanoguera, O. Fenollar, J. Lora-Garcia, S.C. Cardona Navarrete, M.F. López-Pérez, V. Fombuena</i> | 3400 |
| <b>EARLY CHILDHOOD EDUCATORS' PERCEPTION ON THEIR COMPETENCIES FOR MENTAL HEALTH AND WELL-BEING</b><br><i>S. Tatalović Vorkapić, E. Pereša</i>   | 3406 |
| <b>AUTOMATION OF KAHOOT! BY THE HUMANOID ROBOT PEPPER – THE WAY PEPPER CAN ANSWER RUDELY</b><br><i>A. Dannecker</i>  | 3417 |
| <b>STRATEGIC IMPERATIVES FOR BRIDGING THE INNOVATION DIVIDE: THE OSEAN INITIATIVE IN EUROPEAN OUTERMOST REGIONS</b><br><i>E. Leite, A. Leite</i>   | 3426 |
| <b>A PROPOSAL TO INTEGRATE ARTIFICIAL INTELLIGENCE TOOLS IN CHEMISTRY TEACHING IN HIGHER EDUCATION</b><br><i>R. Perezzan, S. Montalvo-Quirós, R. Rama-Ballesteros, D. Herráez-Aguilar</i>  | 3435 |
| <b>RELEVANCE OF ARTIFICIAL INTELLIGENCE COMPONENTS IN WORKFLOW-BASED STUDENT PROJECTS</b><br><i>A. Dannecker, L. Meyer</i>   | 3442 |
| <b>SCHOOL SUPPORT TEAM IN INCLUSIVE EDUCATION IN SLOVAK SCHOOLS</b><br><i>M. Mikulcová, M. Matulčíková</i>   | 3451 |
| <b>DEVELOPMENT OF AN INTERACTIVE LEARNING RESOURCE BASED ON COMICS USING A DESIGN THINKING APPROACH</b><br><i>M. Mota, C. Manuela Sá, C. Guerra</i>  | 3461 |

|   |      |
|---|------|
| <b>COMMUNITY EDUCATION AS AN INNOVATION TO EDUCATION OF CHILDREN AND PUPILS IN EDUCATION IN SLOVAKIA</b><br><i>M. Mikulcová, A. Wiegerová</i>   | 3462 |
| <b>INTERNATIONAL COOPERATION PARTNERSHIPS IN SCHOOL EDUCATION TO PROMOTE YOUNG INNOVATORS FOSTERING CITIZEN ENGAGEMENT FOR SUSTAINABLE AND FAIR TRANSFORMATION AND INNOVATION</b><br><i>C. Calderón-Guerrero, R. Rupp, M. van Pul, I. Todorova, L.M. Ramírez-Benavides, M. Landaberea, P. van Der Hofstad</i> | 3472 |
| <b>NATURE-BASED SOLUTIONS FOR DRUG-DEPENDENT SHELTERS AND DAY CENTRES FOR WOMEN IN SITUATIONS OF SEVERE EXCLUSION THROUGH SERVICE-LEARNING IN MADRID (SPAIN): INFRAVERDE-2022/23</b><br><i>C. Calderón-Guerrero, L.M. Ramírez-Benavides, C. Arteaga-Bustamante</i>  | 3483 |
| <b>ERASMUS AND LATIN AMERICAN STUDENTS COIL COLLABORATION: GENERATING A MULTICULTURAL MINDSET THROUGH INTERNATIONAL COOPERATION</b><br><i>C. Martin</i>   | 3494 |
| <b>OPPORTUNITIES AND CHALLENGES PRESENTED BY GOOGLE CLASSROOM AS A LEARNING MANAGEMENT SYSTEM (LMS) IN ENGLISH FOR SPECIFIC PURPOSES (ESP) COURSES</b><br><i>A. Knezovic</i>  | 3498 |
| <b>INCENTIVIZING STUDENT WRITING THROUGH IMPROVEMENT-BASED GRADING</b><br><i>M. Sama, M. Shoura, L. Lewandowska</i>   | 3509 |
| <b>EVALUATING THE EFFICACY OF COLLABORATIVE TEST-TAKING IN UNDERGRADUATE STATISTICS COURSES</b><br><i>M. Shoura, M. Sama, D. Chan, O. Lewandowska</i>   | 3510 |
| <b>TEACHER PATHWAYS AND PERSPECTIVES ON EDUCATING DIVERSE LEARNERS AFTER MA-TDL</b><br><i>A.O. Davidson, M. Milian</i>  | 3511 |
| <b>ADVANCING ADULT EDUCATION WITH AI AT OPEN UNIVERSITY MALAYSIA: TAILORING LEARNING EXPERIENCES FOR COGNITIVE DEVELOPMENT</b><br><i>Z. Hamidon, M.L. Abdullah, Y. Yusoff, M.N. Ismail</i>  | 3512 |
| <b>ICT LEARNING SUPPORT FOR NEURODIVERSITY: A CASE STUDY</b><br><i>T. Takabayashi</i>   | 3523 |
| <b>ACTIVE LEARNING: A STORY-TELLING AND STORY-MAKING APPROACH TO EMBRACE STUDENT LEARNING STYLE FOR CLASSROOM ENGAGEMENT</b><br><i>A. Ko</i>  | 3529 |
| <b>MOBILE LEARNING FOR SOFT SKILLS ENHANCEMENT IN UNDERGRADUATE STUDENTS</b><br><i>M. Staboulis, M. Sytziouki, I. Lazaridou</i>   | 3530 |
| <b>TEACHING PARAMETRIC MODELLING SKILLS TO CIVIL ENGINEERING STUDENTS</b><br><i>B. Uremović, D. Šojat</i>   | 3541 |
| <b>USING DESCRIPTIVE GEOMETRY COMPETENCES FOR 3D PARAMETRIC MODELLING IN A MASTER THESIS PROJECT, A CASE STUDY</b><br><i>B. Uremović, D. Šojat</i>  | 3549 |
| <b>INVESTIGATING THE TRANSFORMATIVE POWER OF AI-DRIVEN INTELLIGENT TUTORING SYSTEMS IN ONLINE LANGUAGE LEARNING ENVIRONMENTS</b><br><i>T. Sbardella, A. Pakula</i>  | 3557 |
| <b>EMOTIONAL PROBLEMS AND SELF-EVALUATION OF HIGH SCHOOL STUDENTS WITH LEARNING DISABILITIES</b><br><i>B. Sender, K. Bielicikova, K. Kudlova</i>  | 3563 |
| <b>DEVELOPMENT OF A FRAMEWORK THAT INCLUDES THE NEEDS, VALUES, AND PREFERENCES OF INDIVIDUALS WITH COPD WITHIN THE DIGITAL HEALTHCARE SYSTEM: A META-SYNTHESIS</b><br><i>C. Schmidt, K. Borgnakke, A. Frölich, L. Kayser</i>  | 3569 |
| <b>ARTEPHYLETICS AS A CONSTRUCT OF SOCIAL-PSYCHOLOGICAL SUPPORT FOR STUDENTS WITH LEARNING DISABILITIES</b><br><i>B. Sender, K. Bielicikova, E. Zovinec</i>   | 3570 |
| <b>EMPOWERING GENERALIST TEACHERS: A CASE STUDY ON IN-SERVICE TEACHER TRAINING FOR DIGITAL PROFESSIONAL COMPETENCES IN ARTS LEARNING</b><br><i>V. Pavlou</i>  | 3577 |

|  |      |
|--|------|
| <b>FROM RATIONALISM TO EMPIRICISM IN EDUCATION OF SOFTWARE TESTING USING GAMIFICATION</b>  | 3586 |
| <i>N. Doorn, T.E.J. Vos, B. Marín</i>  |      |
| <b>THE POSITION OF THE UNIVERSITY TEACHER IN INCLUSIVE EDUCATION IN THE SLOVAK REPUBLIC</b>  | 3596 |
| <i>M. Sirotoová, V. Michvočíková</i>   |      |
| <b>WORKING SUSTAINABILITY IN A SUBJECT ABOUT PACKAGING DESIGN</b>  | 3604 |
| <i>O. Ampuero-Canellas, J. Gonzalez Del Rio, J. Armijo Tortajada</i>   |      |
| <b>TRAINING NEEDS FOR THE TUTORS OF RESILIENCE IN SOCIAL SERVICES ENVIRONMENTS</b>   | 3611 |
| <i>M.A. Tomiță, R. Ungureanu</i>   |      |
| <b>IMAGE, TEXT AND CONTEXT: COMMUNICATION TECHNIQUES IN THE PRESENTATION OF THE ARCHITECTURAL PROJECT</b>  | 3612 |
| <i>A.M. Capraru, S. Paduretu, L. Vultur</i>  |      |
| <b>LEARNING DEEP-TECHNOLOGIES THROUGH AN INTERGENERATIONAL SERVICE-LEARNING PROJECT</b>  | 3618 |
| <i>D. Facal, M.C. Gutierrez-Moar, L. Perez-Blanco, M. Gandoy-Crego, M.J. Diz-López, S. Valladares-Rodríguez</i>  |      |
| <b>EU DIGITAL FABLAB: A VIRTUAL SHOE FABLAB USING AR FOR PRACTICAL FOOTWEAR MANUFACTURING SKILLS</b>   | 3623 |
| <i>C. Biancotto, A. Marcato</i>  |      |
| <b>PROBABILITY OF CHEATING BETWEEN TWO STUDENTS USING THE COHEN'S KAPPA INDEX</b>  | 3629 |
| <i>R. Nalda-Molina, A. Ramon-Lopez, J.J. Perez-Ruixo</i>   |      |
| <b>APPLICATION OF ARTIFICIAL INTELLIGENCE DURING CONTINUOUS EVALUATION IN A PHARMACY DEGREE</b>  | 3634 |
| <i>A. Ramon-Lopez, R. Nalda-Molina., E. Barrajon-Catalan, J.J. Perez-Ruixo</i>   |      |
| <b>DEVELOPING PERSONAL LEADERSHIP AND LEADERSHIP SKILLS FOR BETTER IMPLEMENTATION IN THE JOB MARKET: INVOLVING STUDENTS IN REAL-LIFE PROJECT MANAGEMENT IN HIGHER EDUCATION</b>      | 3638 |
| <i>B. Petjärvo, H. Kiis, R. Juurikas</i>   |      |
| <b>FOSTERING LEARNING COMMUNITIES AMONG INTERNATIONAL STUDENTS IN HE FOR LANGUAGE COMPETENCE AND INTERCULTURAL COMMUNICATION</b>   | 3646 |
| <i>S.C. Munteanu, A.M. Capraru, S. Paduretu</i>  |      |
| <b>EXPERIENTIAL OUTDOOR INFORMAL LEARNING ACTIVITIES IN VILNIUS UNIVERSITY BOTANICAL GARDEN, LITHUANIA</b>   | 3650 |
| <i>R. Ryliskienė, D. Ryliskis, G. Jurkevičienė, I. Raubaitė</i>  |      |
| <b>A MODEL FOR ASSESSING THE EFFECTIVE INTEGRATION OF TECHNOLOGY INTO EDUCATIONAL PRACTICE FROM A PEDAGOGICAL PERSPECTIVE</b>  | 3651 |
| <i>P. Polymeropoulou, K. Potsis, A. Kameas</i>   |      |
| <b>BRIDGING THE GAP: ENHANCING GRADUATE ATTRIBUTES OF IT HONOURS STUDENTS THROUGH A COLLABORATIVE INDUCTION PROGRAMME</b>  | 3659 |
| <i>L. Drevin, D. Snyman, G. Drevin</i>   |      |
| <b>ANALYSIS AND VALIDATION OF THE APPLICATION OF PEER CO-EVALUATION AS A METHODOLOGY FOR THE EVALUATION OF A COLLABORATIVE WORK ACTIVITY IN A CHEMICAL ENGINEERING DEGREE COURSE</b> | 3669 |
| <i>B. Garcia-Fayos, J.M. Arnal, B. Ruwira, B. Garcia-Gimeno</i>  |      |
| <b>DESIGNING BY STUDENTS FOR STUDENTS: AN EDUCATIONAL ROADMAP IN THE DESIGN OF UNIVERSITY CAMPUSES</b>   | 3677 |
| <i>L. Sossini, F. Guarnieri, L. Grossi, L. Donvito, B. Del Curto, G. Gerosa</i>  |      |
| <b>ANALYSIS OF THE TEACHING-LEARNING METHODOLOGY FOR THE DEVELOPMENT OF FLOW DIAGRAMS IN THE CHEMICAL ENGINEERING DEGREE</b>   | 3687 |
| <i>B. Garcia-Fayos, J.M. Arnal, B. Ruwira, B. Garcia-Gimeno</i>  |      |
| <b>STUDENT ACCEPTANCE OF AI-BASED FEEDBACK SYSTEMS: AN ANALYSIS BASED ON THE TECHNOLOGY ACCEPTANCE MODEL (TAM)</b>   | 3695 |
| <i>D. Otto, V. Assenmacher, A. Bente, C. Gellner, M. Waage, R. Deckert, M. Siepermann, F. Kammer, J. Kuche</i>   |      |
| <b>ON DESIGN OF INCLUSIVE AND ENJOYABLE EDUCATIONAL GAMES - THE GAMING4CODING CONCEPT</b>  | 3702 |
| <i>L. Sällvojn, P. Mozelius, N. Humble, A. Calvo-Morata, B. Fernández-Manjón, R. Pechuel, T. Kreuzberg</i>   |      |

|   |      |
|---|------|
| <b>NAVIGATING NEW SPACES IN EDUCATION ENVIRONMENTS: A COMPARISON WITH EYE-TRACKING BETWEEN 360-DEGREE WALKS AND IMAGE-TEXT COMBINATIONS</b><br><i>D. Zaglmann, M. Haack</i>   | 3711 |
| <b>THE IMPACT OF ARTIFICIAL INTELLIGENCE ON THE PRODUCTION OF TEXTS FOR SPECIFIC PURPOSES: WRITING FOR THE WEB</b><br><i>D. Baptista</i>  | 3721 |
| <b>USING LARGE LANGUAGE MODELS (LLMS) TO DEVELOP AN EDUCATIONAL APP FOR GENDER BASED VIOLENCE</b><br><i>Z. Qureshi, I. Zualkernan</i>   | 3729 |
| <b>CO-OPERATIVE EDUCATION SYSTEM IMPROVEMENT FOR CREATIVE INDUSTRY EDUCATION</b><br><i>A. Kiratisin, B. Phichaikamjornwut, P. Rounpanyaraj, P. Rujinarong, K. Jaihan</i>  | 3736 |
| <b>EXPLORING THE IMPACT OF AI ON DIGCOMPEDU COMPETENCES FOR HIGHER EDUCATION TEACHING</b><br><i>A. Jantos, L.M. Langese, N. Volkmann, M. Lindner</i>  | 3742 |
| <b>EMPOWERING EDUCATION: DESIGN AND IMPLEMENTATION OF A WEB APP FOR MONITORING STUDENTS' PROFESSIONAL PRACTICE</b><br><i>T. Matijasic, L. Nacinovic Prskalo</i>   | 3752 |
| <b>"I AM HERE TO GUIDE YOU": A DETAILED EXAMINATION OF LATE 2023 GEN-AI TUTORS CAPABILITIES IN STEPWISE TUTORING IN AN UNDERGRADUATE STATISTICS COURSE</b><br><i>W. Qiu, C.L. Su, N.B. Jamil, S.S.H. Ng, C.M. Chen, F.S. Lim</i>  | 3761 |
| <b>ACADEMIC PERFORMANCE PREDICTION IN HIGHER EDUCATION THROUGH INTERACTION WITH EDUCATIONAL VIDEOS</b><br><i>G. López-Crespo, S. Escriche-Martínez, M.C. Blanco-Gandía, C. Ferrer-Pérez, N. Sánchez-Pérez, C. Fidalgo, S. Valdívia-Salas, T.I. Jiménez, C. León-Moreno, M. Alcaraz-Iborra, F. Guil-Reyes, I.C. García-Acedo</i>   | 3771 |
| <b>TOWARDS USING LARGE LANGUAGE MODELS TO AUTOMATICALLY GENERATE READING COMPREHENSION ASSESSMENTS FOR EARLY GRADE READING ASSESSMENT</b><br><i>I. Zualkernan, S. Shapsough</i>   | 3772 |
| <b>ENHANCING FUNDAMENTAL CONCEPTS IN ACADEMIC AND PROFESSIONAL PROJECTS</b><br><i>V.G. Lo Iacono Ferreira, A. Hilario Caballero, B. Micó Vicent, J. Jordán Núñez, V. Lerma Arce, P. Ferrer Gisbert, J.E. Solanes Galbis, I. Miró Orozco, J. Capó-Vicedo, J. Lora-García, M. Pérez Sánchez, J.A. Maestro Cano, R. Vercher, C. Quijada, L. Santos Juanes-Jordá, J.I. Torregrosa-López, A.M. García Bernabeu</i> | 3783 |
| <b>THE DIGICOMPASS TRAINING COURSE: A FLIPPED AND AI-BASED APPROACH TO CONTENT CREATION</b><br><i>P. Mazohl, A. Yeratziotis, C. Tsouris, C. Mettouris, G. Papadopoulos</i>  | 3791 |
| <b>FORMATIVE ASSESSMENT STRATEGY IN A VIRTUAL ENVIRONMENT. THE CASE OF IT GOVERNANCE SUBJECT</b><br><i>L. Cuenca, L. Osete, A. Boza</i>   | 3798 |
| <b>PSYCHOLOGICAL AND PEDAGOGICAL APPROACH TO THE MORAL SETTINGS OF PRIMARY SCHOOL TEACHERS</b><br><i>Z. Zacharová, Š. Ferková</i>   | 3806 |
| <b>THE NEEDS OF THE PRIMARY AND SECONDARY SCHOOL CLASS TEACHER IN THE FIELD OF PREVENTION IN THE CONTEXT OF MORAL EDUCATION</b><br><i>Š. Ferková, E. Tóblová, V. Zemančíková</i>  | 3814 |
| <b>MOBILE AUGMENTED REALITY APP WITH 3D MODELS: THE EDUCITY APP</b><br><i>R. Rodrigues, L. Pombo</i>  | 3824 |
| <b>GIRLS GO STEM: IMPLEMENTING THE GENDER PERSPECTIVES IN STEM EDUCATION</b><br><i>V. Čotić Poturić, A. Bašić-Šiško, I. Dražić</i>  | 3831 |
| <b>BRIDGING THE GAP: ENHANCING PARENT-EDUCATOR COMMUNICATION IN PRESCHOOLS WITH "KINDERGARTEN CONNECT" APPLICATION</b><br><i>M. Roža, L. Nacinovic Prskalo</i>  | 3836 |
| <b>MOTIVATION AS A PREDICTOR OF STUDENT SUCCESS IN UNIVERSITY MATHS COURSES</b><br><i>V. Čotić Poturić, A. Bašić-Šiško, I. Dražić</i>   | 3844 |

|  |      |
|--|------|
| <b>PRELIMINARY ASSESSMENT OF THRESHOLD CONCEPTS IN A FIRST-YEAR GENERAL GENETICS SUBJECT</b><br><i>M. Leiva-Brondo</i>   | 3851 |
| <b>A CRITICAL ANALYSIS OF OPEN EDUCATIONAL RESOURCES ASSESSMENT STRATEGIES</b><br><i>C. Serrat, G. Alsina, M.M. Bruguera, A. Uukkivi, O. Labanova, E. Safiulina, M.R. Estela, X. Marcote, J. Guardia, A.P. Lopes, F. Soares, S. Softic, E. Schirgi, Y. Andriichenko, V. Bocanet, F. Serdean, T. Tamberg, A. Seletski</i>   | 3860 |
| <b>DESIGN AND EVALUATION OF A MOOC ON THE INTERNET OF THINGS TO UPSKILL ADULT EDUCATORS</b><br><i>F. Lazarinis, T. Panagiotakopoulos, A. Kameas</i>  | 3870 |
| <b>IMMERSIVE TOPOGRAPHIC ENVIRONMENT USING 360-DEGREE PHOTOS</b><br><i>C. Carbonell-Carrera, J.L. Saorin</i>   | 3878 |
| <b>EXAMINING STUDENT DROPOUT IN ESTONIAN VOCATIONAL SCHOOLS: RISKS AND PREVENTIVE MEASURES</b><br><i>A. Uukkivi, N. Maksimova, O. Labanova</i>   | 3883 |
| <b>SHOULD WE USE A DIFFERENT METHODOLOGY WHEN TEACHING ESP (ENGLISH FOR SPECIAL PURPOSES) TO GENERATION AI (ARTIFICIAL INTELLIGENCE)?</b><br><i>O. Lomakina</i>  | 3889 |
| <b>THE VALUE OF SHORT-TERM STUDY TRIPS FOR UNDERGRADUATES IN THE POST PANDEMIC ERA</b><br><i>C. Sinclair, C. Botting</i>   | 3890 |
| <b>INTEGRATIVE VERSUS INSTRUMENTAL MOTIVATION AMONG FOREIGN LANGUAGE ONLINE LEARNERS</b><br><i>B. Ivanova, D. Kuzmanovska, A. Vitanova-Ringaceva, D. Marolova</i>  | 3895 |
| <b>THE NEED TO ADDRESS THE RAISE OF COMPLEXITY: RELAUNCHING SYSTEMS THINKING IN EDUCATION</b><br><i>P. Água, V. Conceição, A. Correia</i>  | 3902 |
| <b>STATIONS OF CREATIVITY</b><br><i>P. Lane, R. Lafferty</i>   | 3912 |
| <b>ENHANCING K-12 STUDENTS' PERFORMANCE IN CHEMISTRY THROUGH CHATGPT-POWERED BLENDED LEARNING IN THE EDUCATION 4.0 ERA</b><br><i>D. Ortiz de Zárate, R. Castañeda, L. Mercade, V.J. Gómez, A. Diaz Rubio, F.J. Díaz-Fernández, M. Sinusia Lozano, J. Navarro-Arenas, A. Barreda, M. Gomez Gomez, E. Pinilla-Cienfuegos</i> | 3920 |
| <b>DIGITAL APTITUDE TESTS IN HIGHER EDUCATION: HOW ARE THEY SUCCESSFULLY DESIGNED AND IMPLEMENTED?</b><br><i>M. Baume, E. Dörfler</i>  | 3930 |
| <b>STATE LANGUAGE AS A FOREIGN LANGUAGE AT A HIGHER EDUCATION INSTITUTION WITH A LANGUAGE OF INSTRUCTION OF A NATIONAL MINORITY</b><br><i>E. Prokopcová</i>  | 3941 |
| <b>DJANGO GIRLS IN SECONDARY SCHOOL: ENHANCING PROGRAMMING RESOURCES AND SKILLS THROUGH PROJECT-BASED LEARNING</b><br><i>R. Rama-Ballesteros, S. Montalvo-Quirós, R. Perezzan, D. Herráez-Aguilar, C. Fernández-Jiménez</i>  | 3949 |
| <b>IN SEARCH OF THE METHOD TO ASSESS JAPANESE STUDENTS' READINESS FOR GLOBAL CITIZENSHIP</b><br><i>K. Matsumoto, T. Takeuchi</i>   | 3959 |
| <b>BENCHMARKING AS PART OF MODERNIZATION OF BIOTECHNOLOGY EDUCATION AND TRAINING IN TUNISIA</b><br><i>S. Mubarak, J. Tuominen</i>  | 3960 |
| <b>TEAMWORK SKILLS IN A FACE-TO-FACE AND AN ONLINE CONTEXT: A COMPARISON AND CONTRIBUTION TO TEAMWORK EFFICIENCY</b><br><i>A. Polak, P. Gradišek</i>   | 3969 |
| <b>FROM THEORY TO PRACTICE: HOW TO USE MEDIA LITERACY AS TOOL FOR FOSTERING POLITICAL AWARENESS</b><br><i>R. Tkotzyk, J. Lategahn</i>  | 3970 |
| <b>SUMMATIVE EXAMS WITH THE USE OF CHATGPT: VISION OR REALISTIC ALTERNATIVE TO TRADITIONAL EXAMS?</b><br><i>M. Baume, E. Dörfler, M. Etchegaray Bello, C. Schauer</i>  | 3980 |
| <b>THE IMPACT OF INCLUSIVE EDUCATION ON THE INTELLECTUAL LEVEL OF ROMA PUPILS INVESTIGATED THROUGH THE ANALYSIS OF HUMAN FIGURE DRAWING</b><br><i>L. Horňák, L. Končeková</i>  | 3991 |

|  |      |
|--|------|
| <b>A HORIZONTAL CROSSDISCIPLINARY APPROACH TO SCIENCE TEACHING USING DIGITAL AND BLENDED LEARNING ENVIRONMENTS</b>   | 3999 |
| <i>Z. Asimakopoulos, Z. Smyrniou</i>   |      |
| <b>EAGLE PROJECT: COVERING THE TRAINING GAP IN DIGITAL SKILLS FOR EUROPEAN SMES MANPOWER</b>   | 4008 |
| <i>B. Baruque-Zanón, J.E. Sierra-García, H. Cogollos-Adrián, L. Keane</i>  |      |
| <b>LEARNING TOOL TO FACILITATE THE ON-SITE TRAINING OF PERSONAL ASSISTANTS</b>   | 4016 |
| <i>M. Santamaría-Vázquez, J.H. Ortiz-Huerta, A.M. Lara-Palma, B. Baruque-Zanón, J.E. Sierra-García</i>   |      |
| <b>INTEGRATING TECHNOLOGY IN EDUCATION TO ADDRESS CONCEPTUAL MISUNDERSTANDINGS: THE ARGUMENTATION-BASED DIGITAL STORYTELLING (DS) FLOW MODEL</b>                         | 4026 |
| <i>P. Köseoğlu, A. Altun, G. Mercan</i>  |      |
| <b>A CASE STUDY ABOUT FEEDBACK LITERACY: PROVIDING INFORMATION AND MANAGING AFFECT</b>   | 4033 |
| <i>R. Faria, D. Pedrosa, B. da Silva Lopes, F.C. Ribeiro Faria</i>   |      |
| <b>EQUALITY, DIVERSITY AND INCLUSION IN THE BUSINESS MANAGEMENT EDUCATION, TRAINING AND PROFESSIONS: A NATIONAL STUDY ABOUT THE STATE-OF-THE ART IN GREECE</b>           | 4039 |
| <i>P. Polymeropoulou, K. Mantzos, E. Georgakakou, A. Kameas</i>  |      |
| <b>EXPERIENTIAL LEARNING IN SCIENCE EDUCATION: AN INCLUSIVE APPROACH TO INDIGENOUS KNOWLEDGE AND PERSPECTIVES?</b>   | 4048 |
| <i>N. Louis, E. Lemaire</i>  |      |
| <b>ENABLING SELF-DETERMINED LEARNING SPEED IN UNDERGRADUATE CONTROL SYSTEMS LABS BY PROVIDING STUDENTS ACCESS TO VIRTUAL TWINS THAT RUN IN A CENTRALIZED ENVIRONMENT</b> | 4049 |
| <i>J.C. Kuhr, C. Tokaji</i>  |      |
| <b>ADVANCING VIRTUAL LEARNING: A REVIEW OF MOODLE FOR THE OPTIMIZATION OF ONLINE EDUCATION</b>   | 4056 |
| <i>I. Lanza-Cruz, R. Montoliu Colás, A. Martínez-Martínez, I. Remolar Quintana</i>   |      |
| <b>KNOWLEDGE OF VOCATIONAL SCHOOL PUPILS IN THE FIELD OF SEXUALITY AS A PREREQUISITE FOR BETTER PARTNER RELATIONSHIP</b>   | 4065 |
| <i>L. Horňák, B. Ulapová</i>   |      |
| <b>ENHANCING TEACHING INNOVATION THROUGH MENTORING AT REY JUAN CARLOS UNIVERSITY</b>   | 4066 |
| <i>M.C. De la Calle-Durán, A.J. Lopez-Galisteo, R. Montes-Diez</i>   |      |
| <b>INTEGRATING TECHNOLOGY TO CULTIVATE CRITICAL THINKING SKILLS AMONG STUDENTS</b>   | 4067 |
| <i>M. Mikeladze, T. Nakashidze-Makharadze, N. Sammidze, M. Diasamidze</i>  |      |
| <b>SUPPORT RESOURCES IN A RESEARCH LABORATORY: DESIGN AND INNOVATION</b>   | 4073 |
| <i>B. Nieto Rodríguez, J.C. García Vázquez, T. Lloret, M. G. Ramírez, I. Pascual, M. Morales Vidal</i>   |      |
| <b>INNOVATION AND EDUCATION: A CHALLENGING RELATIONSHIP</b>  | 4079 |
| <i>P. Dobrescu, L. Vladu, F. Durach</i>  |      |
| <b>ROLE OF INTERNATIONAL RESEARCH PROJECTS IN SHARING KNOWLEDGE AND IMPROVING EDUCATION QUALITY</b>  | 4086 |
| <i>M. Aroshidze, M. Loria, N. Aroshidze</i>  |      |
| <b>INSTRUCTIONAL DESIGN AND CO-REGULATION LEARNING STRATEGIES IN DISTANCE EDUCATION: A FRAMEWORK PROPOSAL</b>  | 4092 |
| <i>F.C. Ribeiro Faria, D. Pedrosa, B. da Silva Lopes, R. Faria</i>   |      |
| <b>USING A DIGITAL ENVIRONMENT TO FOSTER WRITING AS A LEARNING AND REFLECTIVE TOOL: THE ORWELL PROJECT</b>   | 4096 |
| <i>R. Villalon Molina, M. Gallardo Gómez, D. García Saiz, K. Tsadima</i>   |      |
| <b>TOOLS FOR ENHANCING EQUALITY, DIVERSITY AND INCLUSION IN HIGHER EDUCATION INSTITUTIONS: SUPPORTING GENDER &amp; LGBT+ INCLUSION IN TERTIARY EDUCATION</b>             | 4102 |
| <i>K. Mantzos, E. Georgakakou, A. Kameas</i>   |      |
| <b>COHERENCE BETWEEN TRAINING AND CONSCIOUS EVALUATION OF UNIVERSITY TEACHING</b>  | 4109 |
| <i>M. Martín-Lope, R. Montes-Diez, D. De Haro</i>  |      |
| <b>NEW CHALLENGES IN MATHS TEACHING - EXPLORING THE POTENTIAL OF CHATGPT</b>   | 4110 |
| <i>M. Štefan Trubić, N. Črnjarić</i>   |      |



|   |      |
|---|------|
| <b>PRIMARY SCHOOL TEACHERS' VIEWS ON THE MENTOR'S ROLE IN THE PROFESSIONAL-EDUCATIONAL DEVELOPMENT</b>  | 4119 |
| <i>P. Konstantopoulou, E. Zenakou, K. Koutrouba, S. Kasapi</i>  |      |
| <b>INNOVATIVE FORMS OF EDUCATION USING VIRTUAL AND AUGMENTED REALITY. SCENARIOS AND SIMULATIONS AND THEIR POSSIBILITY OF USE IN THE TEACHING PROCESS</b>                                      | 4128 |
| <i>A. Kuricová, S. Kočár, K. Hollá</i>  |      |
| <b>LEARNING COMMUNITIES AS INSTRUMENTS TO INTERTWINE WORKING, LEARNING AND INNOVATION 'ON THE JOB?': INSIGHTS FROM THE LOGISTICS AND TRANSPORT SECTOR</b>                                     | 4136 |
| <i>L. Woudstra, E. Rusman, J. de Jong, W. van Zwol, B. van Der Heijden</i>  |      |
| <b>COMPUTER SCIENCE ACADEMICS' PERSPECTIVES REGARDING THE SHARING OF THEIR TEACHING-RELATED KNOWLEDGE: QUALITATIVE STUDY</b>  | 4137 |
| <i>M. Alharbi, M. Devlin, J. Warrender</i>  |      |
| <b>ENGAGING STUDENTS AS PARTNERS IN THE CO-CREATION OF EXEMPLARS FOR AUTHENTIC PLACEMENT INTERVIEW ASSESSMENTS: A CASE STUDY IN THE MTU SCHOOL OF BUSINESS</b>                                | 4145 |
| <i>D. McSweeney, C. Murphy</i>  |      |
| <b>BUSINESS EDUCATION AND PLATFORM ECOSYSTEMS DEVELOPMENT: RUSSIAN EXPERIENCE</b>   | 4146 |
| <i>O. Molchanova, S. Shchelokova</i>  |      |
| <b>WORKING TOWARD SHARED GOALS ON A VIRTUAL INTERNATIONAL EXCHANGE: AUSTRALIAN-JAPANESE COLLABORATION</b>   | 4147 |
| <i>S. Sekiguchi</i>   |      |
| <b>FOUR STAGES OF IMPLEMENTING DIGITALIZATION IN SCHOOLS - A BEST PRACTICE APPROACH AT A GERMAN VOCATIONAL SCHOOL</b>   | 4148 |
| <i>N. Lemke, K.O. Tiburtius, J. Siemon</i>  |      |
| <b>AWARENESS-RAISING ON ENVIRONMENTAL SUSTAINABILITY THROUGH INTEGRATING THE SDGS INTO HIGHER EDUCATION</b>   | 4155 |
| <i>M.N. Rivas Márquez, P. Cabrera Reyes, M.C. Recio Ruiz, F.J. García Mateos, M.J. Valero Romero, J. Rodríguez Mirasol, T. Cordero, J.M. Rosas</i>  |      |
| <b>BLENDED ROTATION LEARNING MODEL TO REINVENT MAINSTREAM CLASSROOMS</b>  | 4161 |
| <i>N. Eteokleous, N. Kyriacou, A. Albanese, M.J. Guerreiro Figueiredo, M. Mitsiaki, S. Zammit Pulo, E. Xení</i>   |      |
| <b>INTERNATIONAL HIGHER EDUCATION STUDENTS: NEEDS, CHALLENGES, AND OPPORTUNITIES</b>  | 4169 |
| <i>A. van Der Meulen, S. Armenia, M. Bonsangue, C. Carlini, O. Casey</i>  |      |
| <b>RELATIONSHIP BETWEEN DYNAMIC LEARNING FOR CAREER AND EMPLOYABILITY</b>   | 4178 |
| <i>A. Valickas, V. Rapuano</i>  |      |
| <b>UNVEILING SCHOOL COMMUNITY DYNAMICS IN ENERGY TRANSITION: THE GREENGAGE INITIATIVE</b>   | 4183 |
| <i>N. Romero Herrera, A. Singh, M. Wellink, E. Doherty, E. Clifford, B. Arthur Delmonte, S. Smit, E. McLoughlin, N. Roudil, A. Hill</i>   |      |
| <b>FORMATIVE ASSESSMENT AS A SUPERIOR TOOL FOR THE TEACHERS TO AVAIL THE STUDENTS TO HAVE DEEPER INSIGHTS IN THEIR LEARNING PREFERENCES AND TO ENHANCE THEIR OVERALL ACADEMIC PERFORMANCE</b> | 4189 |
| <i>T. Dilaverova, S. Dumbadze, T. Kapanadze, N. Kharati, N. Dorofeeva</i>   |      |
| <b>TYCHE ALGORITHM: MARKOV MODELS FOR GENERATING LEARNING PATHS IN LEARNING MANAGEMENT SYSTEMS</b>  | 4195 |
| <i>S. Staufer, F. Bugert, F. Hauser, L. Grabinger, T. Ezer, V.K. Nadimpalli, D. Bittner, S. Röhr, J. Mottok</i>   |      |
| <b>PRE-SERVICE TEACHERS' PERSPECTIVES: EXPLORING THE INTEGRATION OF ARTIFICIAL INTELLIGENCE APPLICATIONS IN EDUCATION</b>   | 4206 |
| <i>H. Ciralí Sarica</i>   |      |
| <b>THE INFLUENCE OF INTERLOCUTORS' EXPERIENCE IN THE PERCEPTION OF NON-NATIVE SPEECH FOR ESTABLISHING SMOOTH GLOBAL COMMUNICATION AND THE ROLE OF VCL IN ESP CLASSES</b>                      | 4212 |
| <i>S. Dumbadze, T. Dilaverova</i>   |      |
| <b>AN INNOVATIVE METHODOLOGY FOR THE TRAINING OF ADULTS WITH OBSTACLES THROUGH UNDERTAKING AND EMPLOYABILITY IN THE THIRD SECTOR</b>  | 4219 |
| <i>R. Navarro Cerveró, R. Sixto Iglesias, L. Gómez Estrada, L. Gómez Estrada, J.L. Gómez Ribelles</i>   |      |

|  |      |
|--|------|
| <b>LEARNING ELEMENTS IN LMS - A SURVEY AMONG STUDENTS</b>  | 4224 |
| <i>S. Stauffer, F. Hauser, L. Grabinger, D. Bittner, V. K. Nadimpalli, F. Bugert, T. Ezer, S. Röhl, J. Mottok</i>  |      |
| <b>WOMEN IN ENGINEERING AND ARCHITECTURE: EVOLUTION IN THE NUMBER OF STUDENTS ENROLLED AND ACTIONS TO PROMOTE VOCATIONS IN THE UNIVERSITY OF ALICANTE</b>                | 4232 |
| <i>M.F. Gomez-Rico, E. Gimeno, A. Font, M. Sempere, C. Rizo, S. Spairani, V. Gilart, M.D. Andujar, M.J. Moya, R. Perez, S. Vazquez, J.A. Nescolarde, L. Aragonés</i>     |      |
| <b>IS ARTIFICIAL INTELLIGENCE A MOTIVATION ANGEL FOR LANGUAGE LEARNERS?</b>  | 4242 |
| <i>E. Pipia, E. Kintsurashvili, T. Gurgenshvili</i>  |      |
| <b>A DESIGN-DRIVEN APPROACH TO FOSTER SENSORIAL LEARNING IN EARLY CHILDHOOD EDUCATION</b>  | 4251 |
| <i>C. Regni</i>  |      |
| <b>THE ENGLISH-ONLY FALLACY AND GLOBAL COMPETENCE: RETHINKING LINGUISTIC DIVERSITY IN HIGHER EDUCATION</b>   | 4260 |
| <i>B. Kjellgren, T. Richter</i>  |      |
| <b>ENGINEERS OF THE FUTURE: STRATEGY TO CULTIVATE FEMALE TALENT THAT OPENS PATHS IN STEM</b>   | 4265 |
| <i>A. Font, C. Rizo, M. Sempere, E. Gimeno, M.F. Gomez-Rico, S. Spairani, V. Gilart, M.D. Andujar, M.J. Moya, R. Perez, S. Vazquez, J.A. Nescolarde, L. Aragonés</i>     |      |
| <b>BEST PRACTICES AND RECOMMENDATIONS IN EDUCATION TO ENABLE THE INTEGRATION OF REFUGEES INTO THE EUROPEAN UNION HEALTH CARE PROVISION SYSTEMS</b>                       | 4273 |
| <i>Z. Valero-Ramon, M. Segura, K. Karlgren, N. Stathakarou, M. Harjani, I. Dratsiou, A. Varella, P. Bamidis, S. Konstantinidis, V. Traver</i>                            |      |
| <b>COMPETENCY MODEL OF MANAGEMENT STUDENT: COMPLIANCE WITH THE EMPLOYER'S REQUEST (CASE OF LOMONOSOV MOSCOW STATE UNIVERSITY)</b>  | 4281 |
| <i>S. Shchelokova, I. Suslova</i>  |      |
| <b>EXPANSION OF THE ERASMUS+ PROGRAMS IN NON-EU COUNTRIES AND CHALLENGES: INTEGRATION OF PARTICIPANTS COMING FROM CONFLICTING COUNTRIES</b>                              | 4282 |
| <i>G. Teksöz, B. Akpınar</i>   |      |
| <b>TEACHING SCIENCE AND CREATIVITY THROUGH CHALLENGE-BASED LEARNING: A FORMATIVE PROPOSAL FOR PRE-SERVICE TEACHERS</b>   | 4287 |
| <i>E. Ribeiro, A. Rodrigues, J. Katz-Buonincontro</i>  |      |
| <b>ERASMUS+ PROGRAMS AND THEIR IMPACT ON THE PARTICIPANTS' INFORMATION AND AWARENESS OF THE EU</b>   | 4288 |
| <i>B. Akpınar</i>  |      |
| <b>AI LITERACY MEETS SOCIO-EMOTIONAL LEARNING: ASSESSING TRANSFORMATIVE EDUCATIONAL PRACTICES IN SLOVENIA</b>  | 4295 |
| <i>A. Lipovec, S. Gartner, M. Krašna</i>   |      |
| <b>DRIVERS AND BARRIERS TO THE ADOPTION OF GAMIFICATION TO SUPPORT LOCAL ADMINISTRATORS IN POSITIVE ENERGY DISTRICTS IMPLEMENTATION: AN ITALIAN CASE STUDY</b>           | 4300 |
| <i>G. Marinensi, B. Botte, S. Biancifiori, N. Caballero</i>  |      |
| <b>EXPLORING COMPLEX LANDSCAPE: CHALLENGES AND OPPORTUNITIES FOR INTERNATIONAL STUDENTS AND STARTUP ENTREPRENEURS WITH FOREIGN BACKGROUNDS IN FINLAND</b>                | 4301 |
| <i>O. Bogdanova, P. Rantanen</i>   |      |
| <b>STRATEGIES FOR SUCCESS: EXPLORING EFFECTIVE TEACHING APPROACHES TO DEVELOP COLLABORATION SKILLS IN HIGHER EDUCATION</b>   | 4307 |
| <i>R. Juurikas, B. Petjärvi, H. Kiis</i>   |      |
| <b>DEVELOPING DIGITAL LEARNING DESIGNS – THE DIGITAL TEACHING AND LEARNING LAB (DIGITELL)</b>  | 4314 |
| <i>S. Zeaiter</i>  |      |
| <b>AIED FOR BUILDING AN INDIVIDUAL LEARNING TRAJECTORY FOR STUDENTS IN THE ACQUISITION OF KNOWLEDGE AND FOR TEACHERS IN THE DEVELOPMENT OF PROFESSIONAL COMPETENCIES</b> | 4324 |
| <i>O. Tapalova, N. Zhiyenbayeva, S. Tapalov, K. Seitimbetova, S. Zhiyenbayeva, A. Seitmetov, Z. Zhiyenbayeva, Z. Yerkinaliyeva, Z. Utesheva</i>                          |      |

|  |      |
|--|------|
| <b>ENHANCING ENGLISH EDUCATION IN JAPAN: GIGA SCHOOL CONCEPT, ICT TRAINING, AND INNOVATIVE APPROACHES FOR ASPIRING ENGLISH TEACHERS</b><br><i>S. Sekiguchi</i>   | 4330 |
| <b>DEMO LESSONS OBSERVATION, REFLECTION, AND IMPROVEMENT TO DEVELOP PROFESSIONAL COMPETENCY IN THE ENGLISH LANGUAGE TEACHING (ELT) TRAINING PROGRAM AT THE NATIONAL UNIVERSITY OF EDUCATION (UNAE) IN ECUADOR</b><br><i>U. Recino</i>  | 4331 |
| <b>INNOVATIVE TECHNOLOGIES IN MUSEUMS: A REVIEW OF GAMIFIED AUGMENTED REALITY EXPERIENCES</b><br><i>B. Botte, G. Marinensi, V. Malakuczi, W. Vitaletti</i>   | 4338 |
| <b>ONLINE LITERACY ASSESSMENT ALSO AS A LEARNING STRATEGY: A PROPOSAL FOR ASTRONOMY</b><br><i>I.A. Costa, P. Jadhav, N. Murthy</i>   | 4346 |
| <b>USING MYTHOLOGICAL IDIOMATIC EXPRESSIONS IN A FOREIGN LANGUAGE CLASSROOM - BRIDGING THE PAST AND THE PRESENT</b><br><i>V. Kocceva, D. Kuzmanovska, A. Vitanova-Ringaceva, T. Ullanska</i>   | 4351 |
| <b>VIRTUAL PRODUCTION: A CLOSER LOOK AT DIGITAL INNOVATION AND HEALTH</b><br><i>G. Cruz, J. Raimundo, M. Madureira</i>   | 4358 |
| <b>ENHANCING SUPPORT STRATEGIES FOR PROFESSORS AND QUALITY ASSURANCE IN DESIGNING AND FACILITATING ONLINE MASTER'S DEGREE COURSES</b><br><i>R.A. Pozo Rocha, M. Nuñez, E. Ramirez</i>  | 4367 |
| <b>FORMATION OF TEACHER'S ELECTORAL CULTURE</b><br><i>I. Baykhanov, V. Pisarenko</i>   | 4375 |
| <b>EXPLORING THE IMPACT OF HAPTIC FEEDBACK ON LEARNING IN VIRTUAL AND AUGMENTED REALITY ENVIRONMENTS: A (COMPREHENSIVE) LITERATURE REVIEW</b><br><i>P. Varney, D. May, A. Richert</i>  | 4385 |
| <b>PARTICIPATION IN REMEDIAL ACTIVITIES TO OVERCOME A LACK OF BASIC SKILLS IN MATHEMATICS: ANALYSIS OF THE EVOLUTION OF THE STUDENT'S RESULTS INVOLVED IN AN ASSESSMENT DEVICE IN A PSYCHOLOGICAL AND EDUCATIONAL SCIENCES PROGRAM</b><br><i>J. Liemans, L. Lacourt, L. Santoro, D. Cauchie, M. Bruyninckx</i> | 4390 |
| <b>RACIAL MICROAGGRESSIONS EXPERIENCED BY UNIVERSITY STUDENTS FROM IMMIGRANT BACKGROUNDS IN FRENCH-SPEAKING BELGIUM: ANALYSIS OF THE EFFECTS OF RACISM ON THEIR WELL-BEING, ACCULTURATION ORIENTATIONS AND SOCIAL INTEGRATION</b><br><i>D. Cauchie, O. Ezzemami</i>  | 4398 |
| <b>A POLY CRISIS IN CACAO</b><br><i>P. Lane, E. Gomez, W. Chavez</i>   | 4406 |
| <b>STACT - A RESEARCH PROJECT WITH AND BY SCHOOL PUPILS</b><br><i>C. Rudloff, S. Zauchner, R. Bauer, C. Baum</i>   | 4414 |
| <b>BLENDED LEARNING IN TEACHING A FOREIGN LANGUAGE TO MULTICULTURAL GROUPS OF PHARMACY STUDENTS</b><br><i>I. Nalimova, K. Sakhbullina, N. Soboleva</i>   | 4421 |
| <b>EVIDENCE-BASED EDUCATIONAL POLICY IN SPAIN: STATE OF THE ART</b><br><i>J.L. Arco-Tirado, F.D. Fernández-Martín, L. Moral-Soriano</i>  | 4427 |
| <b>DESTABILISING STEREOTYPES TO CREATE BELONGING FOR COMPUTING STUDENTS</b><br><i>R. Awan</i>  | 4428 |
| <b>MEANINGFUL USE OF GENERATIVE AI IN VISUAL ARTS EDUCATION</b><br><i>A. Korepanova, A. Annus, T. Våljataga</i>  | 4433 |
| <b>CULTURAL EXCHANGE PROGRAM AS A WAY OF LEARNING LANGUAGE AND TEACHING PRACTICE</b><br><i>K. Sakhbullina, I. Nalimova, N. Soboleva</i>  | 4442 |
| <b>INCORPORATING PROJECT-BASED X-REALITIES INTO STUDENTS' REALITIES</b><br><i>L. Müller, V. Varney, T. Keller, N. Buck, J.N. Terschüren</i>  | 4446 |
| <b>DEEP TECHNOLOGIES ENTREPRENEURSHIP FOR PHD STUDENTS. CASE STUDY: SUPPORTING NEW LONGEVITY MODELS</b><br><i>S. Valladares-Rodríguez, D. Facal, C. Dosil-Díaz, R. Iglesias-Rodríguez</i>  | 4451 |

|   |      |
|---|------|
| <b>DESIGN OF A SPECIAL EDUCATIONAL ENVIRONMENT FOR THE FORMATION OF TEACHERS ELECTORAL CULTURE</b><br><i>I. Baykhanov</i>   | 4456 |
| <b>THE CLASSROOM IS NOT DESIGNED FOR ME: A STUDY ON THE EMOTIONAL IMPACT AND PREFERENCE OF FOUR CONTEMPORARY ARCHITECTURAL STYLES</b><br><i>J. Figueroa-Castillo, W. Rondero-Palestino, C. Llinares Millán, J.L. Higuera-Trujillo</i> | 4466 |
| <b>PRIORITIZING AFRICENTRIC EDUCATION FOR HEALTHCARE: HOW WE DID IT AND WHAT WE LEARNED</b><br><i>M. Brown, B. Hamilton-Hinch</i>   | 4472 |
| <b>PHYSICS MATERIALS FOR STUDENTS AND TEACHERS, EVALUATED BY DIFFERENT STAKEHOLDERS</b><br><i>K. Susman, S. Dolenc, J. Pavlin</i>   | 4473 |
| <b>EXPLORING LARGE LANGUAGE MODELS FOR THE EDUCATION OF INDIVIDUALS WITH COGNITIVE IMPAIRMENTS</b><br><i>A. Fiora, F. Piferi, P. Crovari, F. Garzotto</i>   | 4479 |
| <b>THE DESIGN FOR CIRCULARITY WORKSHOP. MERGING CONSTRUCTION INDUSTRY CHALLENGES WITH EDUCATIONAL GOALS</b><br><i>L. Daglio, E. Ginelli</i>   | 4488 |
| <b>MOTIVATIONS FOR CHOOSING REMOTE TEACHING/LEARNING TOOLS AT A UNIVERSITY OF HEALTH SCIENCES IN THE POST-PANDEMIC PERIOD: THE TEACHERS' ATTITUDES</b><br><i>E. Butrime, D. Gudaityte, L. Dulksniene, V. Tuomaite</i>                 | 4494 |
| <b>TEACHERS' ENGAGEMENT AND STUDENTS' ACADEMIC PERFORMANCE</b><br><i>J. Calleja-Blanco, A. Núñez-Carballosa</i>   | 4502 |
| <b>STUDENT-CENTRED TEACHING IN THE NATURAL SCIENCE VISITS COURSE</b><br><i>K. Susman, M. Vošnjak, J. Pavlin</i>   | 4508 |
| <b>WORDLE IN THE CLASSROOM: A GAME-CHANGING APPROACH TO ACTIVE LEARNING</b><br><i>S. Cavero, E. G. Pardo, M. González de Lena</i>   | 4513 |
| <b>USING HARDWARE TO SUPPORT ARTIFICIAL INTELLIGENCE IN EDUCATION</b><br><i>R. Fojtik</i>   | 4519 |
| <b>MOOC-ENHANCED LEARNING IN AN UNDERGRADUATE ENGINEERING COURSE</b><br><i>J.A. Pow-Sang, D. Corta</i>  | 4525 |
| <b>ASSESSMENT OF STUDENTS' ACHIEVEMENTS USING DIGITAL TOOLS</b><br><i>E. Mesic, A. Pongrac Paulina, K. Pavlina</i>  | 4530 |
| <b>EUROPEAN UNIVERSITY ALLIANCES: A CASE STUDY OF PORTUGAL</b><br><i>N. Gogadze, E. Cunha, J. Aguiar, T. Carvalho</i>   | 4537 |
| <b>RESPONDING TO THE CHALLENGES OF MODERN LANGUAGE TUITION THROUGH INTER-UNIVERSITY COOPERATION BETWEEN FOUR UNIVERSITIES IN THE HELSINKI METROPOLITAN AREA</b><br><i>P. Kudel, J. Viinanen</i>                                       | 4547 |
| <b>AI IN EDUCATION: A COMPARATIVE STUDY OF RHIZOMATIC AND CONNECTIVISM PEDAGOGICAL THEORIES</b><br><i>A. Correia, P. Água, V. Conceição</i>   | 4548 |
| <b>IMPROVING LEARNING OUTCOMES BY LABELING SLIDES BASED ON THE COMPLEXITY OF THEIR CONTENT</b><br><i>D. Ortega Del Campo, V. Ruiz Parrado, M. González de Lena, S. Cavero, J. Vélez</i>   | 4556 |
| <b>ADOLESCENCE AND CYBERBULLYING: A RESTORATIVE APPROACH</b><br><i>V. Guardabassi, P. Nicolini</i>  | 4562 |
| <b>COMMUNICATING SCIENCE THROUGH A PODCAST: THE CASE OF "POD'ISTO?"</b><br><i>G. Reses, E. Lima, R. Rodrigues, M. Lucas</i>   | 4571 |
| <b>APPROACHING SUSTAINABLE DEVELOPMENT FROM A FINANCIAL ACCOUNTING PERSPECTIVE</b><br><i>D. Gallardo Vázquez, J. Vega Cervera</i>   | 4572 |
| <b>ADAPTIVE LEARNING THROUGH AI: REINFORCEMENT LEARNING IN TEACHING MULTIPLICATION TABLES</b><br><i>L. Droždek, I. Pesek</i>  | 4576 |
| <b>TEACHERS' OPINION ABOUT THE APPLICATION OF AI IN THE EDUCATION</b><br><i>M. Krašna, B. Arcet, S. Gartner, A. Lipovec</i>   | 4581 |
| <b>SUPPORT FOR ASYNCHRONOUS DISTANCE LEARNING</b><br><i>R. Fojtik</i>   | 4590 |

|   |      |
|---|------|
| <b>DEVELOPING EDUCATIONAL LEADERSHIP IN THE SCHOOL SYSTEM: ANALYSIS OF CASE STUDIES</b><br><i>G. Moretti, A. Morini, P. Giovane</i>   | 4596 |
| <b>USING DIGITAL TECHNOLOGY TO PROMOTE COLLABORATION AND TEAMWORK AMONG UNIVERSITY STUDENTS: A CASE STUDY</b><br><i>P. Gradišek, A. Polak</i>   | 4605 |
| <b>TEACHING MODERN PERSPECTIVES ON ATOMIC STRUCTURE IN JUNIOR HIGH SCHOOL</b><br><i>D. Tounazatos, N. Papadimitropoulos</i>   | 4606 |
| <b>ARE B2 LEARNERS' WRITTEN PERFORMANCES ASSESSED AS B2?</b><br><i>J. Bérešová</i>  | 4611 |
| <b>EDUCATIONAL ROBOTICS RESOURCES FOR THE DEVELOPMENT OF DIGITAL SKILLS OF PRESERVICE TEACHERS</b><br><i>S. Cruz-Naranjo, J. Encalada, M. Arboleda, J. Chamba</i>   | 4616 |
| <b>THE IMPACT OF AI ON IMPROVING WRITTEN PERFORMANCES</b><br><i>J. Bérešová</i>   | 4625 |
| <b>THE RADIOLAB PROJECT FOR THE MEASUREMENT OF ENVIRONMENTAL RADIOACTIVITY IN THE CLASSROOM: THE EXPERIENCE IN THE SARDINIA REGION</b><br><i>V. Fanti, D. Barrale</i>   | 4630 |
| <b>OUTDOOR EDUCATION AS AN INCLUSIVE PRACTICE</b><br><i>D. Chiuseroli</i>   | 4635 |
| <b>BEYOND INFORMATION: CREATING AN EXPERIENCE TO DEVELOP EMPATHETIC CONNECTIONS USING IMMERSIVE VIRTUAL REALITY</b><br><i>M. Harris, K. Moody</i>   | 4640 |
| <b>SERVICE-LEARNING EXPERIENCE IN GEOLOGICAL ENGINEERING PROGRAM, UCSC, CHILE</b><br><i>M. Basso, K. Roberts, H. Abarca</i>   | 4641 |
| <b>THE CONTEMPORARY SCHOOL IN THE DIGITAL AGE: DIFFERENCES BETWEEN TEACHERS AND SCHOOL LEADERS IN THE ASSESSMENT OF DIGITAL COMPETENCE WITHIN THE FRAMEWORK OF DIGCOMP2.2</b><br><i>M. Vičič Krabonja, A. Flogie, B. Aberšek, D. Zemljak</i>              | 4646 |
| <b>INNOVATIONS IN THE TEACHING OF ARCHITECTURAL PROJECTS: THE ASSESSMENT OF STUDENTS TO NEW METHODOLOGIES BASED ON A SCIENTIFIC-TECHNOLOGICAL APPROACH</b><br><i>I. Estrada-Frías, F. Aguirre-Ponce, C. Llinares Millán, J.L. Higuera-Trujillo</i>        | 4652 |
| <b>THE CONCEPT OF SELF-EFFICACY IN ASSISTANT TEACHERS AND ITS RELEVANCE IN THE EDUCATIONAL PROCESS: A SCIENTIFIC LITERATURE REVIEW IN THE FIELD OF EDUCATION SCIENCES</b><br><i>K. Grigaitė-Bliūmienė</i>   | 4657 |
| <b>BLENDED INTENSIVE COURSES ERASMUS: NEW SUCCESSFUL EXPERIENCES IN EUROPEAN UNIVERSITIES NETWORKS</b><br><i>M. Fumo, V. Vitiello, A. Racolta, D. Psychogyios, G. D'Angelo</i>  | 4665 |
| <b>ACTIVE METHODOLOGIES THROUGH THE "EXTREME GAME EVENT" EXPERIENCE TO ENHANCE RESILIENCE</b><br><i>M.S. Medina-Salgado, C. Paredes-Bartolomé, V. Ramírez-Herrero, M. Ortiz-de-Urbina-Criado, M. Llorente-Isidro, J.A. Medina-Merodio, L. Bernal-Sanz</i> | 4675 |
| <b>FOSTERING MEDIA LITERACY IN EDUCATION: CONSIDERING THE CHILD DEVELOPMENT APPROACH</b><br><i>M. Lozar, I. Pesek, D. Šimunović</i>   | 4685 |
| <b>CURRICULAR DYNAMICS IN SECOND-CHANCE EDUCATION: A DOCUMENT ANALYSIS OF SCHOOL CURRICULA FOR AT-RISK STUDENTS IN ESTONIAN VET</b><br><i>L. Roos, K. Trasberg</i>  | 4690 |
| <b>ENVISIONING EDUCATION IN 2064: PRE-SERVICE TEACHERS' PERSPECTIVES ON TEACHING SKILLS IN NATURAL AND SOCIAL STUDIES</b><br><i>D. Zemljak, U. Martinc, M. Kerneža</i>  | 4698 |
| <b>ARTIFICIAL INTELLIGENCE THROUGH THE EYES OF UNIVERSITY STUDENTS FOR THE SECOND TIME</b><br><i>K. Kilianova, P. Kockova, M. Zavodna, L. Klubal, K. Kostolanyova</i>   | 4705 |
| <b>EXAMINING THE INDUCTIVE REASONING OF PRIMARY AND SECONDARY SCHOOL CHILDREN</b><br><i>R. Madarász</i>   | 4713 |

|   |      |
|---|------|
| <b>COMPARING ONLINE AND FACE-TO-FACE LEARNING THROUGH THE EYES OF PRIMARY AND SECONDARY SCHOOL TEACHERS</b>   | 4722 |
| <i>M. Závodná, K. Kiliánová, P. Kočková, K. Kostolányová</i>  |      |
| <b>LEARNING WITHIN UNESCO CULTURAL LANDSCAPES: ERASMUS MUNDUS MASTER'S EXPERIENCES IN COMPARISON</b>  | 4730 |
| <i>G. D'Angelo, M. Fumo, G. Gugg, G. Trinchese</i>  |      |
| <b>METHODOLOGY AND ACTIVE LEARNING ASSESSMENT: CRITICAL THINKING IN TECHNICAL HIGHER EDUCATION</b>  | 4735 |
| <i>M.D. Reyes Tolosa, Y. E-Martin, L.D. Sánchez Diana</i>   |      |
| <b>REFLECTING ON THE PARTICIPATORY APPROACH USED DURING EXTERNAL QUALITY ASSURANCE TO IMPROVE STAKEHOLDER PARTICIPATION IN INTERNAL QUALITY ASSURANCE</b> | 4741 |
| <i>R. Matshoba, E. Johannes</i>   |      |
| <b>CHALLENGES FOR TODAY'S CONSTRUCTION: FOSTERING CRITICAL THINKING AND SUSTAINABILITY IN BUILDING</b>  | 4748 |
| <i>D. Ferrández, M. Alvarez, A. Zaragoza, C. Morón</i>  |      |
| <b>COGNITIVE TOPOLOGY-IMAGERY IN SECOND LANGUAGE ACQUISITION: A THEORETICAL INVESTIGATION</b>   | 4754 |
| <i>J. Jia</i>   |      |
| <b>CHALLENGE-BASED LEARNING IN PHYSICAL PRINCIPLES OF STRUCTURES: A 3D EXPERIENCE</b>   | 4764 |
| <i>M. Alvarez, D. Ferrández, C. Morón, A. Morón</i>   |      |
| <b>NAVIGATING CHANGE – EXPLORING THE MANDATORY USE OF AI/CHATBOTS IN MANAGEMENT ESSAYS</b>  | 4771 |
| <i>J. Kirch, K. Böttcher</i>  |      |
| <b>HOW TO COUNTERACT THE DROP IN ADULT READERS: VALIDATION IN THE ITALIAN CONTEXT OF THE LITERARY RESPONSE QUESTIONNAIRE</b>                              | 4778 |
| <i>A. Morini, G. Moretti</i>  |      |
| <b>EXPLORING POSSIBILITIES OF IMPLEMENTING BLOCKCHAIN FOR SECURE, DECENTRALIZED EDUCATIONAL RECORDS</b>   | 4786 |
| <i>A. Minchev, M. Karabaliev, V. Stoykova</i>   |      |
| <b>THE ROLE OF SCHOOLS IN SHAPING SUSTAINABLE DEVELOPMENT COMPETENCIES IN PRE-UNIVERSITY STUDENTS</b>   | 4787 |
| <i>R. Simut, C. Simut</i>   |      |
| <b>“DISCOVERING COSMIC RAYS”: A HIGH SCHOOL PHYSICS TEACHERS’ COURSE AS A LINK BETWEEN EDUCATION AND RESEARCH</b>   | 4795 |
| <i>R. Antolini, C. Aramo, A. Candela, N. D'Ambrosio, M. De Deo, A. Giampaoli, S. Hemmer, A. Iuliano, I. Veronesi</i>                                      |      |
| <b>THE PERSPECTIVES OF DISCLOSING INTELLECTUAL CAPITAL IN LEADING RUSSIAN UNIVERSITIES</b>  | 4803 |
| <i>M. Ulyanova, V. Gerasimenko</i>  |      |
| <b>SOCIAL PEDAGOGUES AND THEIR PROFESSIONAL APPLICATION IN CZECH SCHOOLS</b>  | 4811 |
| <i>J. Šmída, T. Čech, T. Hormandlová, V. Balaban</i>  |      |
| <b>HEALTH AND WELL-BEING IN EDUCATION: WHAT HEALTH CHALLENGES DO TODAY'S EDUCATIONAL LEADERS FACE?</b>  | 4817 |
| <i>L. Snellman</i>  |      |
| <b>CEURS: PROGRAM FOR THE CREATION OF A NATIONAL NETWORK OF AGENTS FOR THE MUNICIPALIZATION OF AGENDA 2030</b>  | 4828 |
| <i>A. Amin, R. Pacheco, M. Carneiro, F. Gauthier</i>  |      |
| <b>STUDYING METACOGNITIVE LEARNING PROCESSES WITH THE USE OF EYE-TRACKING TECHNOLOGY</b>  | 4835 |
| <i>Z. Jurikova, N. Dostalova, L. Juhanak, V. Jurik</i>  |      |
| <b>RE.MA.C.: AN INTERCULTURAL EDUCATIONAL INITIATIVE</b>  | 4836 |
| <i>A. Albanese, N. Eteokleous, N. Kyriacou, M.J. Guerreiro Figueiredo, M. Mitsiaki, E. Xenii, S. Zammit Pulo</i>  |      |
| <b>CHILDREN AS GUARDIANS OF THEIR ONLINE ENVIRONMENT</b>  | 4844 |
| <i>P. Kockova, K. Kilianova, K. Kostolanyova</i>  |      |
| <b>AN INTERNATIONAL RESEARCH AND DESIGN WORKSHOP: UNPRECEDENTED DYNAMICS OF LEARNING AND RESEARCH</b>   | 4849 |
| <i>G. Trinchese, P. Villoria, A. Verniero, M. Del Rio Merino</i>  |      |

|  |      |
|--|------|
| <b>DOUBLE MEANINGS: DISCOVERING THE GEOSCIENCE MEANING OF DAILY LIFE WORDS IN A FUNNY WAY</b><br><i>S. Amici, M. Dinezza</i>   | 4859 |
| <b>THE QUEEN DIDO: ARTISTIC, MUSICAL, LITERARY AND MATHEMATICAL GEOMETRIES - AN INTERDISCIPLINARY EDUCATIONAL PATH FOR HIGH SCHOOL STUDENTS</b><br><i>I. Veronesi</i>  | 4864 |
| <b>MOTIVATION TO STUDY IN CONTEXTS OF ORGANIZED CRIME</b><br><i>C.L. Moccia, F. Sabatano</i>   | 4873 |
| <b>INSIGHT INTO OPEN BOOK MANAGEMENT IN TRANSPARENT INTERNAL PERFORMANCE REPORTING</b><br><i>D. Šteffko, D. Trubač, J. Papula</i>  | 4878 |
| <b>THE ART OF BEING AN ARCHITECT: ARCHITECTURAL EDUCATION IN THE CONTEXT OF THE 21ST CENTURY</b><br><i>I. Voronkova</i>  | 4886 |
| <b>EXPLORING THE POTENTIAL OF LARGE LANGUAGE MODELS FOR ENHANCED VIRTUAL NON-PLAYER CHARACTER INTERACTIONS</b><br><i>A. Anand, E. Polyak</i>   | 4895 |
| <b>LEARNING BY DOING: PARTICIPATORY DESIGN AND ADAPTIVE REUSE TO REVITALISE AN OLD HAMLET</b><br><i>A. Violano, M. Fumo, G. D'Angelo, M. Merola, G. Trinchese, R.G. Aenoai</i>   | 4899 |
| <b>EVIDENCE FOR IMPROVING EDUCATION FOR SUSTAINABILITY IN CHILE: AN APPLIED PERSPECTIVE ON LEARNING INTERACTIONS</b><br><i>L.M. Cerdá Suárez</i>   | 4909 |
| <b>INTRODUCTION OF PROBLEM BASED LEARNING FOR TRANSFORMATION MANAGERS IN THE AUTOMOTIVE INDUSTRY</b><br><i>U. Kaschka, J. Kirch</i>  | 4916 |
| <b>IMPORTANCE OF TUTORIALS IN LEARNING THE SUBJECT OF ANALOG ELECTRONICS</b><br><i>J.J. Galiana-Merino, B.Y.N. Benabdeloued, J.A. Jornet-Monteverde</i>  | 4925 |
| <b>DEVELOPING STUDENTS' ENTREPRENEURIAL MINDSET</b><br><i>A. Soler-Domínguez, J.C. Matallín-Sáez, L. Morales, L. Pop</i>   | 4931 |
| <b>DEVELOPING A METHODOLOGICAL APPROACH AND FRAMEWORK TO ASSESS STUDENTS' ETHICAL APPROACHES TO GENERATIVE AI UTILISATION FOR ASSESSMENTS</b><br><i>D. Pike, A. Bajgrowicz</i>   | 4937 |
| <b>TEACHER COUNSELLING SKILLS IN PROFESSIONAL COMMUNICATION WITH PARENTS</b><br><i>T.D. Wendler, R. Čepić, S. Skočić Mihić</i>   | 4944 |
| <b>ENHANCEMENT OF UNDERGRADUATE EMPLOYABILITY BY AD HOC FINAL DEGREE PROJECT</b><br><i>L. Vera, L. Rodríguez-Gómez, M.C. Marrero, J. Rodríguez-Sevilla, J.J. Macías</i>  | 4952 |
| <b>BLENDED INTENSIVE COURSE (BIP), VERNACULAR CONSTRUCTION IN EUROPE AND ENVIRONMENTAL SUSTAINABILITY. HIGHLIGHTS</b><br><i>G. García López de la Osa, P. Izquierdo Gracia, D. Gawryluk, A. Dudzinski, G. D'Angelo, G. Rodonò, M. Mosoarca, O. Banescu, V. Vitiello, K. Misiuk, S. González-Rodrigo, J. García Muñoz</i> | 4957 |
| <b>ACCREDITATION AND QUALITY IN EDUCATION OF NON-MEDICAL HEALTH PROFESSIONS AND ETHICAL ASPECTS</b><br><i>Z. Freitinger Skalická, L. Michalcová, S. Strnad, S. Kavan</i>   | 4958 |
| <b>TEACHING, LEARNING AND INTERACTING IN A CONSTANTLY EVOLVING DIGITAL ENVIRONMENT: THE 2DIGI2 PROJECT AND ITS OPEN ACCESS, MULTILINGUAL RESOURCES FOR LANGUAGE CENTRE TEACHERS</b><br><i>D. Erent, S. Vuonokari-Kämäräinen</i>  | 4963 |
| <b>DESIGNRESEARCHSLAM. ENABLING ACTIVE LEARNING AMONG DESIGN STUDENTS</b><br><i>U. Lagger</i>  | 4964 |
| <b>TEACHERS' SOCIO-EMOTIONAL AND INTERCULTURAL COMPETENCIES IN THE CONTEXT OF INCLUSIVE EDUCATION</b><br><i>S. Skočić Mihić, M. Butković, N. Mrvić</i>   | 4971 |
| <b>THE IMPACT OF ARTIFICIAL INTELLIGENCE ON PERSONALIZED LEARNING IN STEM EDUCATION</b><br><i>N. Barkoczi, M.L. Maier, A. Horvat-Marc</i>  | 4980 |

|   |      |
|---|------|
| <b>VRET ENVIRONMENTS ARCHITECTURE: ADJUSTING IMMERSIVE VIRTUAL ENVIRONMENTS FOR PSYCHOTHERAPEUTIC TRAINING</b><br><i>V. Juřík, K. Varšová, J. Chmelík, O. Janoušek</i>  | 4990 |
| <b>FOSTERING SCHOOL INCLUSION: THE ROLE OF THE CONTACT EXPERIENCE WITH VISUAL DISABILITY</b><br><i>D.C. Di Gennaro, A. Amadoro</i>  | 5001 |
| <b>WEB ACCESSIBILITY OF INFORMATION SERVICES AT UNIVERSITIES IN MERCOSUR AND THE ECONOMIC COMMUNITY OF AFRICAN STATES: A COMPARATIVE STUDY</b><br><i>P. Nso-Mangue, T. Acosta, S. Luján-Mora</i>  | 5006 |
| <b>SOLVE MATH PROBLEMS STEP BY STEP WITH AI SUPPORT</b><br><i>O.E. Horváthné Hadobás, V. Stoffova</i>   | 5015 |
| <b>MEETING THE SUSTAINABILITY CHALLENGES: AN ASSESSMENT OF ENTREPRENEURIAL EDUCATION</b><br><i>A. Zherdeva, I. Madi, A. Alzankawi, L. Pop, A. Soler-Domínguez, J.C. Matallín-Sáez, L. Morales</i>   | 5024 |
| <b>ACTIVE TEACHING AND LEARNING METHODOLOGIES: THE DEMOLA PROJECT AT THE POLYTECHNIC INSTITUTE OF BEJA</b><br><i>E. Rodrigues, P. Cravo, M. Tavares, S. Bailoa, M.J. Silva, A. Carloto, F. Teixeira, M. Amaral, F. Silva, A. Canhestro, A. Horta, J. Rodrigues, D. Morais, H. Martins</i> | 5035 |
| <b>RETHINKING PEDAGOGY IN THE 4IR AND INNOVATION-DRIVEN ECONOMY: CHALLENGES AND OPPORTUNITIES</b><br><i>R. Tsephe, L. Makoele</i>   | 5042 |
| <b>EXPLORING BLOCKCHAIN'S HORIZONS IN EDUCATIONAL GAMING</b><br><i>G. Jaferian, D. Ramezani, E. Polyak, M. Wagner</i>   | 5050 |
| <b>WEB ACCESSIBILITY OF TOP-10 UNIVERSITIES OF AFRICA, AMERICA, ASIA, EUROPE, AND OCEANIA: 2023 SNAPSHOT</b><br><i>P. Nso-Mangue, T. Acosta, S. Luján-Mora</i>  | 5059 |
| <b>IMPLEMENTATION OF EXPERIENTIAL LEARNING FOR ENTREPRENEURSHIP BACHELOR PROGRAM AT TEC DE MONTERREY</b><br><i>J. Rehak, V.M. Jiménez Rodríguez, P.E. Alonso Galicia</i>  | 5069 |
| <b>SETU: SAFETY IN EXCAVATION AND TRENCHING FOR YOU A TRAINING AND DECISION-MAKING TOOL FOR WORKER SAFETY IN EXCAVATION AND TRENCHING OPERATIONS IN CONSTRUCTION</b><br><i>S. Priyadarshini, E. Cochran Hameen, Z. Shi</i>  | 5071 |
| <b>THE INTERNATIONAL ATTRACTIVENESS OF THE EU HIGHER EDUCATION SYSTEM</b><br><i>P. Sospiro, M. Giurato, J. Pange</i>  | 5080 |
| <b>PERCEPTION AND PREFERENCES OF LANGUAGE LEARNERS: EDUCATIONAL EXPERIENCE IN VIRTUAL AND DISTANCE LEARNING MODALITIES</b><br><i>V. Canese, J. Mereles</i>  | 5085 |
| <b>MATHEMATICS FOR A SUSTAINABLE FUTURE: UNPACKING HIGH SCHOOL TEACHERS' EXPERIENCES WITH BIG DATA IN PEDAGOGICAL PRACTICES</b><br><i>K. Yaro, N. Louis, V. Freiman, J. Kamba, A. Erazo</i>   | 5095 |
| <b>ENHANCING CYBERSECURITY EDUCATION IN SECONDARY SCHOOLS: A CYBOK-BASED ANALYSIS AND STRATEGIC APPROACH</b><br><i>M. Alotaibi, Y. Cherdantseva, O. Rana, C. Teehan</i>   | 5096 |
| <b>TECHNOLOGIES FOR SITUATIONAL AWARENESS IN AUTONOMOUS SHIPPING AND THEIR IMPACT ON MARITIME TRAINING AND EDUCATION</b><br><i>D. Rostek, M. Baldauf</i>  | 5105 |
| <b>RE-EXAMINING THE REQUIREMENTS FOR A VLE (VIRTUAL LEARNING ENVIRONMENT) FOR A POST-COVID AND POST-AI AGE</b><br><i>D. Pike, F. Islam</i>  | 5115 |
| <b>AN INVESTIGATION INTO THE EDUCATIONAL POSSIBILITIES OF METAVERSE IN THE CONTEXT OF EDUCATIONAL GAMING: A REVIEW</b><br><i>D. Ramezani, G. Jaferian, M. Wagner</i>  | 5120 |
| <b>SOCIAL ENTREPRENEURSHIP AND COMPLEX THINKING: AN EXPLORATORY STUDY WITH A GENDER PERSPECTIVE OF STUDENTS AT A MEXICAN UNIVERSITY</b><br><i>P.E. Alonso-Galicia, J.C. Vázquez-Parra, M.S. Ramírez Montoya, J. Rehak</i>   | 5130 |
| <b>ADDRESSING THE FEAR OF PROSPECTIVE INTERNATIONAL MEDICAL GRADUATES JOINING THE NHS</b><br><i>N.T. San, K.R. Rahman, A. Mahmood, K. Brahmhatt, E. Kavanagh, J. Hodson, J.R. Wongsikhee, C. Grantham, D. Fidoe, D.J. Bowrey</i>  | 5138 |



|   |      |
|---|------|
| <b>A PROGRAMME-BASED APPROACH TO BUILDING AUTHENTICITY INTO ASSESSMENT AND FEEDBACK PROCESSES THROUGH CONSULTATION WITH PROFESSIONAL, STATUTORY AND REGULATORY BODIES</b><br><i>R. Harding, D. Dodd, N. O'Neill, J. Harvey</i>  | 5139 |
| <b>IMPROVING EXPECTATIONS OF STUDENTS WITH DISABILITIES IN SCIENCE DEGREES</b><br><i>E. Johannes</i>  | 5146 |
| <b>THE "X" FACTOR IN THE RELATIONS OF SOCIO-ECONOMIC STATUS AND "NATIONAL" IDENTITY OF BULGARIANS FROM MOLDOVA, UKRAINE AND SERBIA</b><br><i>Z. Dimova</i>  | 5147 |
| <b>ARTIFICIAL INTELLIGENCE (AI) SKILLS SETS FOR TODAY'S HUMAN RESOURCE MANAGEMENT PROFESSIONALS: RECOGNIZING THE NEED FOR ADDITIONAL TECHNOLOGY TRAINING AND DEVELOPMENT</b><br><i>B. Barrett</i>   | 5148 |
| <b>CLOSING THE WORKFORCE SKILLS GAP</b><br><i>M. Hernandez, W. Thompson, B. Zoghi</i>   | 5153 |
| <b>TRENDING OF VIRTUAL EDUCATIONAL AND BUSINESS CONFERENCES: THE SUSTAINABILITY OF NEW PRESENTATION FORMATS AND THEIR ATTRACTION</b><br><i>B. Barrett</i>   | 5162 |
| <b>THE VERTICAL PROGRAM: ENHANCING DIVERSITY IN STEM LEADERSHIP THROUGH WORKPLACE LEARNING</b><br><i>T. James, B. Zoghi</i>   | 5167 |
| <b>ENHANCING EDUCATION THROUGH MICROSOFT 365: A CASE STUDY AT TEXAS A&amp;M UNIVERSITY</b><br><i>G. Jones, S. Thompson, B. Zoghi, W. Lu</i>   | 5174 |
| <b>THE USE OF COMICS AS AN ACCEPTABLE VISUAL FORM TO COMMUNICATE ACADEMIC CONTENT</b><br><i>K. Salvador-Cisneros, W. Wonsang</i>  | 5181 |
| <b>THE IMPACT OF INTERACTIVE ONLINE FORMATIVE QUIZZES ON ACADEMIC PERFORMANCE IN ONLINE VERSUS IN-PERSON MARKETING COURSES</b><br><i>N. Saqib</i>   | 5192 |
| <b>GROWING THE GARDEN OF TEACHING &amp; LEARNING IN HEALTH EDUCATION</b><br><i>M. Brown</i>   | 5196 |
| <b>ARE HIGHER EDUCATION INSTITUTIONS PREPARED FOR ARTIFICIAL INTELLIGENCE?</b><br><i>M.J. Araiza-Vazquez, M.E. Brosig Rodriguez, F.G. Figueroa Garza</i>  | 5197 |
| <b>THE ETHICAL REPERCUSSIONS OF CHATTING WITH CHATGPT: MULTIPLE LANGUAGE LEARNERS ON AN ENGLISH-BASED HIGHER EDUCATION PLAYING FIELD</b><br><i>C. Beaton, T. Parvathappa</i>  | 5205 |
| <b>THE FLIPPED CLASSROOM BENEFITS AND CHALLENGES: PERSPECTIVES OF PRE-SERVICE AND IN-SERVICE TEACHERS IN A POST-GRADUATE PROGRAM IN THE UAE</b><br><i>M. El Samaty</i>  | 5211 |
| <b>UNROOTING BELIEFS ABOUT SECOND LANGUAGE LEARNING ANXIETY BY FOSTERING GROWTH MINDSETS IN PRE-SERVICE ELT TEACHERS</b><br><i>J. Fonseca Chacana</i>   | 5212 |
| <b>MULTIMEDIA APPLICATIONS IN EDUCATION</b><br><i>V. Stoffova, V. Gabal'ová, S. Hájníková, M. Šuplatová</i>   | 5219 |
| <b>THE READINESS OF TEACHERS TO TEACH INFORMATICS IN ELEMENTARY SCHOOLS</b><br><i>V. Stoffova, H. Hyksová, S. Hájníková</i>   | 5227 |
| <b>ENHANCING CRITICAL THINKING THROUGH SELF-ASSESSMENT AND PEER REVIEW IN GENETIC ENGINEERING AND SYSTEMS BIOLOGY SUBJECTS</b><br><i>A. Sánchez Torralba, C. Blázquez Ortiz, G. Guevara Acosta, M.T. López Conejo, M. Lorente Pérez, J.M. Mateo Mendoza, G. Piedrafita, R. Ranz Valdecasa, S. Rayego Mateos, T. Sánchez Velasco, J.M. Navarro Llorens</i> | 5238 |
| <b>TECHNOLOGY'S IMPACT ON STUDENTS' INTELLECTUAL HAPPINESS, COGNITION, AND OVERALL WELL-BEING</b><br><i>A. Pearce</i>   | 5246 |

|   |      |
|---|------|
| <b>EVALUATION OF THE TEACHING-LEARNING PROCESS WHEN USING LANGUAGE MODELS OF ARTIFICIAL INTELLIGENCE SUCH AS CHATGPT</b><br><i>R. Rangel-Corona, J.L. Mora-Guevara, B. Weiss-Steider</i>  | 5257 |
| <b>THE USE OF GAME PLAY IN A COMPARISON OF HUMAN ROBOT INTERACTIONS AND THE ADOPTION OF LEARNING STRATEGIES</b><br><i>H. Gerardo, A. Eguchi, R. Twomey</i>  | 5262 |
| <b>PROMOTING HEALTH HUMANITY: INTRODUCING AN ONLINE HEALTH HUMANITIES COURSE AS PART OF A TRANSNATIONAL MEDICAL EDUCATION PROGRAM</b><br><i>P. Brett-MacLean</i>  | 5269 |
| <b>USING PEER REVIEW TO CREATE COMMUNICATION SITUATIONS IN TEACHING WRITING</b><br><i>K. Käpp, E. Miilman</i>   | 5279 |
| <b>A STEM WORKSHOP FOR KIDS IN EARLY ELEMENTARY SCHOOL GRADES ABOUT SAMPLING THEOREM OF INFORMATION THEORY</b><br><i>D. Ikeda</i>   | 5284 |
| <b>APPROACHING TO THE IMPACT OF SCIENCE DIVULGATION EVENTS: A SURVEY ON THE SOCIAL PERSPECTIVE OF SCIENCE</b><br><i>E.J. Delgado-Pujol, G. Martínez Muñoz, M. Merinero, D. Casado, G. Raposo-Hernández, J. Vázquez Cabello, B. Begines, A. Alcudia</i>                                    | 5289 |
| <b>APPROACHING TO THE DIFFICULTIES OF SCIENCE DIVULGATION EVENTS: A SURVEY ON THE RESEARCHER PERSPECTIVE</b><br><i>G. Martínez Muñoz, E.J. Delgado-Pujol, M. Merinero, D. Casado, G. Raposo-Hernández, J. Vázquez Cabello, B. Begines, A. Alcudia</i>                                     | 5297 |
| <b>ADVANCING APPLIED TECHNOLOGY EDUCATION IN BIOMEDICINE THROUGH UNDERGRADUATE-LED COHORT-BASED TRAINING PROGRAMS</b><br><i>A. Iyer, A. Kumar, J. Rosen, D. Kumar, A. Shah</i>  | 5306 |
| <b>AN INVESTIGATION OF PARENTS' AND TEACHERS' PERCEPTIONS OF HOW THE COVID-19 PANDEMIC AFFECTS THE EDUCATION AND MENTAL HEALTH OF PRIMARY AND SECONDARY SCHOOLS' STUDENTS IN ANTIGUA AND BARBUDA</b><br><i>M. Joseph, A. Joseph</i>   | 5317 |
| <b>RE-IMAGINING SUSTAINABLE AND EQUITABLE PROFESSIONAL DEVELOPMENT FOR A NEW DIGITAL ERA: ONLINE COLLABORATIVE ACTION RESEARCH (OCAR) AS TEACHER PROFESSIONAL DEVELOPMENT MODEL</b><br><i>M. Pellerin</i>   | 5327 |
| <b>EMPOWERING SUSTAINABLE TOURISM: THE CRUCIAL ROLE OF EDUCATION AND CONTINUOUS LEARNING</b><br><i>M. Ferreira Dias, M. Amorim, M. Macedo, F. Brandão, R. Madureira</i>   | 5328 |
| <b>REALIZATION OF AN XAPI DATA TRACKING COMPONENT FOR A SIMULATION IN A PSYCHOLOGY STUDY COURSE AT A GERMAN UNIVERSITY</b><br><i>R. Srbecky, O. Eckstein, P. Sudkamp, S.A. Wetzel, W. Fraas, M. Winterhagen, J. Dettmers, M. Hemmje</i>   | 5336 |
| <b>APPLICATION OF NEW TECHNOLOGIES IN ASTRONOMICAL NAVIGATION ON TRAINING FOR DECK CADETS OF THE MERCHANT NAVY</b><br><i>B. Jigena Antelo, J.J. Muñoz Pérez, P. Lopez García, F. Contreras de Villar, A. Contreras de Villar, J. Ayuso Vilacides, P. Diaz-Carrasco, O. Castillo Lopez</i> | 5344 |
| <b>SOLUTION FOR THE TEACHING PROBLEM OF THE LABORATORY PRACTICES OF A HYDRAULICS COURSE</b><br><i>O. Castillo Lopez, F. Contreras de Villar, A. Contreras de Villar, P. Díaz-Carrasco, P. Lopez Garcia, J. Ayuso Vilacides, J.J. Muñoz Perez, B. Jigena Antelo</i>                        | 5354 |
| <b>ENHANCING DATABASE PROFICIENCY THROUGH PROJECT-BASED LEARNING IN ONLINE MASTER'S PROGRAMS</b><br><i>L. Rajabion, R. Khatami</i>  | 5362 |
| <b>A COLLABORATIVE STUDY EVALUATING THE PEDAGOGICAL VARIATION MODEL BY MASTERS COURSE STUDENTS AT FEDERAL INSTITUTE (IFRS) BRAZIL</b><br><i>M.S. Rogers, A. Grunewald Nichele</i>   | 5368 |
| <b>"GOOD CYBERCONNECTIONS": EXPLORING ALTERNATIVES TO ASYNCHRONOUS DISCUSSION FORUMS FOR ENCOURAGING MAXIMUM ONLINE STUDENT COMMUNITY</b><br><i>M. Dereshiowsky, J. Domingo, S. Carnz</i>   | 5377 |
| <b>BRIDGING THE GAP: INNOVATIVE ENTREPRENEURIAL SKILL DEVELOPMENT IN HIGHER EDUCATION</b><br><i>P. Rantanen, O. Bogdanova</i>   | 5378 |

|  |      |
|--|------|
| <b>UNDERSTANDING SALARY INEQUALITY AT THE MEXICAN UAM AND ITS RAMIFICATIONS FOR ACADEMIC PROSPECTS</b><br><i>N. Dominguez-Vergara, M.A. Abreu-Hernandez</i>  | 5384 |
| <b>UNVEILING ASPIRATIONS: EXPLORING THE MOTIVATION TO LEAD BEHIND TRANSITION TO SCHOOL PRINCIPALSHIP</b><br><i>G. Arastaman</i>  | 5394 |
| <b>EXPLORING THE IMPACT OF BLOCKCHAIN IN EDUCATIONAL SETTINGS: A COMPREHENSIVE ANALYSIS</b><br><i>A.V. Vevera, U.E. Botezatu</i>   | 5403 |
| <b>GEOSPATIAL SYNERGIES IN EDUCATION: CULTIVATING SUSTAINABLE FUTURES THROUGH GLOBAL LEARNING NETWORKS</b><br><i>U.E. Botezatu, A.V. Vevera</i>  | 5409 |
| <b>REASONING AS AN OBJECT OF MATHEMATICAL GIFTEDNESS AND CREATIVITY?</b><br><i>S. Jablonski</i>  | 5414 |
| <b>GREEN SKILLS IN AUDIOVISUAL ADVERTISING PRODUCTION STUDENTS: A CURRICULAR PROPOSAL TO PROMOTE THE 2030 AGENDA</b><br><i>V. Roger-Monzó</i>  | 5419 |
| <b>ADDRESSING CYBERSECURITY CHALLENGES IN SLOVAKIA FROM THE EDUCATION PERSPECTIVE</b><br><i>K. Kampoová, M. Madleňák, I. Dolnák</i>  | 5423 |
| <b>(WHAT IF) ARTIFICIAL INTELLIGENCE RUNS THE CLASS? OPEN QUESTIONS ON TEACHING COMMUNICATION DESIGN IN THE AGE OF GENERATIVE ALGORITHMS</b><br><i>L. Bollini</i>  | 5427 |
| <b>THE IMPACT OF COLLEGE STUDENTS' SERVICE LEARNING ON THEIR COMMUNICATION, LEADERSHIP AND MENTORSHIP SKILLS</b><br><i>G. Ragusa</i>   | 5428 |
| <b>THE SUCCESS STORY OF INNOVATIVE INTERVENTIONS TO IMPROVE STUDENT ENGAGEMENT &amp; EXPERIENCE AT ANGLIA RUSKIN UNIVERSITY BY BEING PROACTIVE IN ACADEMIC &amp; PASTORAL CARE AS WELL AS EARLY INTERVENTION TO REDUCE COMPLICATION FOR STUDENTS</b><br><i>S. Hassani, A. Mevoli</i> | 5433 |
| <b>MATCHING NATIONAL STRATEGY TO LOCAL CAPABILITY: THE DESIGN OF A NOVEL CYBER RESILIENCE MSC</b><br><i>A. Peck, P. Norris, T. Watson, I. Phillips</i>   | 5435 |
| <b>SABBATICAL FOR CONSOLIDATION OF PROJECTS TO ENHANCE TECHNOLOGICAL INNOVATION WITHIN THE TEACHING AND LEARNING DIVISION AT A UNIVERSITY OF TECHNOLOGY IN SOUTH AFRICA</b><br><i>D. Ngidi</i>   | 5442 |
| <b>USING GENERATIVE AI AND GPT CHATBOTS TO IMPROVE INSTRUCTION</b><br><i>R. Davies, M. Murff</i>   | 5451 |
| <b>AN ANALYSIS OF THE DIFFERENCES BETWEEN FACE-TO-FACE AND DISTANCE LEARNING AND THE EFFECTIVENESS OF MOCK TESTS IN MATHEMATICS EDUCATION TARGETING SOCIAL SCIENCE STUDENTS</b><br><i>Y. Miyamoto</i>  | 5460 |
| <b>ENHANCING DIGITAL CAPACITY IN EDUCATIONAL INSTITUTIONS</b><br><i>C. Caneva</i>  | 5469 |
| <b>EXAMINING THE IMPACT OF DISTANCE LEARNING ON COGNITIVE AND EMOTIONAL LEARNING RATES IN EARLY PRIMARY EDUCATION</b><br><i>M. Sadoughi</i>  | 5470 |
| <b>THE IMPACT OF ARTIFICIAL INTELLIGENCE ON THE SCHOOL MANAGEMENT: A STUDY OF OPPORTUNITIES AND CHALLENGES IN JORDAN</b><br><i>A. Al-Omari</i>   | 5478 |
| <b>TRAIN-THE-TRAINER CONCEPTS IN ACADEMIC CONTINUING EDUCATION</b><br><i>U. Georgy</i>   | 5487 |
| <b>THE INNOVATIVE TRAINING OF DIGITAL COMPETENCES FOR SENIOR PEOPLE WITH BLENDED GAME-BASED ASSESSMENT – THE CASE OF “INFINITY” GAME</b><br><i>A. Jerman Blažič</i>  | 5495 |
| <b>FROM PLAGIARISM TO HONESTY IN SCIENTIFIC PUBLICATIONS</b><br><i>F. Arteaga, A. Peirats</i>  | 5503 |

|   |      |
|---|------|
| <b>ACADEMIC WRITING AND INNOVATION: FOR AN EFFECTIVE MANAGEMENT IN THE DIRECTION OF ACADEMIC PAPERS</b><br><i>F. Arteaga, A. Peirats</i>  | 5509 |
| <b>UNVEILING CONNECTIONS INTEGRATING CLIMATE STUDIES AND CYBERSECURITY EDUCATION</b><br><i>M. Tedeschi</i>  | 5518 |
| <b>IMPACT OF PROFESSIONAL DEVELOPMENT ON TEACHER UNDERSTANDING OF QUANTUM INFORMATION SCIENCE</b><br><i>R. Lopez, K.J. Matsler</i>  | 5523 |
| <b>EXPLORING THE SERVICE EXPERIENCE OF MUSEUM VISITORS: A REVIEW OF LITERATURE BASED ON VOSVIEWER</b><br><i>F. Saghezchi, M. Amorim, M.J. Rosa</i>  | 5530 |
| <b>THE ROLE OF AUTONOMOUS SCHOOLS AND INTERACTIVE LEADERSHIP STYLE IN THE USE OF INNOVATIVE TEACHING METHODS BY TEACHERS</b><br><i>M. Sadoughi</i>  | 5539 |
| <b>DIGITAL EDUCATION READINESS AND COLLABORATIVE VIRTUAL ENVIRONMENT FOR MATH, INFORMATICS AND PHYSICS EDUCATION</b><br><i>Z. Palkova, M. Harničárová, J. Valíček, M. Palko, Š. Srnka, H. Srnková</i>   | 5547 |
| <b>DIDACTICAL DESIGN PATTERNS - CASE STUDY DESIGN FOR VIRTUAL COLLABORATIVE LEARNING TO FOSTER THE ACQUISITION OF DIGITAL COMPETENCES</b><br><i>A. Jantos</i>   | 5553 |
| <b>THE SUPERVISING OF DOCTORAL THESES: A COMPREHENSIVE GUIDE OF GOOD PRACTICES INCLUDING PSYCHOSOCIAL ASPECTS</b><br><i>F. Arteaga, A. Peirats</i>  | 5563 |
| <b>GOOD EDITORIAL PRACTICES IN SCIENTIFIC JOURNALS: A PROPOSAL TO IMPROVE THE QUALITY IN THE DIFFUSION OF KNOWLEDGE</b><br><i>A. Peirats, F. Arteaga</i>  | 5572 |
| <b>ASSESSING THE IMPLEMENTATION OF DEANS' COUNCIL MEMBERS' ROLES IN PURSUING GOALS WITHIN JORDANIAN PRIVATE UNIVERSITY SETTINGS</b><br><i>H. Bany Issa</i>  | 5581 |
| <b>THE USE OF SOCIAL MEDIA IN THE TEACHING-LEARNING PROCESS IN HIGHER EDUCATION: A STUDY</b><br><i>A.P. Lopes, F. Soares, M. Muñoz</i>  | 5588 |
| <b>ASSESSMENT OF STUDENTS' SATISFACTION AND EXPECTATIONS WITH AN ONLINE MATHEMATICS PROJECT</b><br><i>A.P. Lopes, F. Soares</i>   | 5589 |
| <b>HOW WILL A STUDY ABROAD PROGRAM TO CHINA PROMOTE AMERICAN TEACHER EDUCATION STUDENTS' EXPERIENTIAL LEARNING, TEACHER IDENTITY, AND PROFESSIONALISM?</b><br><i>Y. Liu</i>   | 5599 |
| <b>SYNERGY BETWEEN PROBLEM-BASED LEARNING, LABORATORY PRACTICES AND THEORY IN THE SUBJECT OF STRENGTH OF MATERIALS IN THE MECHANICAL ENGINEERING DEGREE</b><br><i>J. Ferreiro-Cabello, E. Fraile-Garcia, J. Los Santos-Ortega, F. Somovilla Gomez</i>   | 5600 |
| <b>TECHNOLOGY AS A LEARNING TOOL IN THE SUBJECT OF LANGUAGE PROCESSORS</b><br><i>T. Alsinet</i>   | 5605 |
| <b>E-LEARNING COURSE ON MOBILE WEB APPLICATIONS: COMPARISON OF LEARNING</b><br><i>A. Schukin, V. Pak, E. Rezedinova</i>   | 5609 |
| <b>FEEDBACK IN E-LEARNING: COMPARATIVE STUDY</b><br><i>V. Pak, N. Scerbakov, E. Rezedinova</i>  | 5615 |
| <b>ANALYZING, GATHERING, ASSESSING, DEVELOPING AND SHARING MATH OER – IDEAS BEHIND AN ERASMUS+ PROJECT</b><br><i>F. Soares, A.P. Lopes, A. Uukkivi, V. Bocanet, J. Kurvits, C. Serrat, S. Softic, Y. Andriichenko, M.M. Bruguera, M.R. Estela, J. Guàrdia, H. Kiis, O. Labanova, X. Marcote, E. Safiulina, E. Schirgi, A. Šeletski, F. Serdean, T. Tamberg, I. Turcin</i> | 5620 |
| <b>PROJECT TEACHING AS A PLATFORM FOR ACQUIRING MUSICAL KNOWLEDGE: EXAMPLES OF THE ACADEMY OF MUSIC IN PULA</b><br><i>L. Duraković, S. Vidulin</i>  | 5621 |

|   |      |
|---|------|
| <b>BIBLIOMETRIC ANALYSIS OF RESEARCH ON COMPETENCES IN HIGHER EDUCATION IN THE FIELD OF DESIGN ENGINEERING</b><br><i>B. Pacheco-Blanco, M. Arroyo-Vázquez, V. Pérez-Belis, J. Mira-Alfaro</i>                     | 5622 |
| <b>EXPLORING THE BELIEFS OF PRE-SERVICE ENGLISH TEACHERS</b><br><i>L. Astruc, M.P. Marin Garcia</i>   | 5629 |
| <b>LEARNING SITUATIONS THAT COMBINE SUSTAINABLE DEVELOPMENT GOALS AND UNIVERSAL DESIGN IN MATHEMATICS TEACHING</b><br><i>X. Gual-Arnau, L. Gual-Vayà</i>  | 5630 |
| <b>IMPACT OF RESPONSIBLE CONSUMPTION AND PRODUCTION RESEARCH THROUGH A BIBLIOMETRIC PERSPECTIVE</b><br><i>B. Pacheco-Blanco, V. Pérez-Belis, M. Arroyo-Vázquez, E. Hontoria-Hernández</i>                         | 5636 |
| <b>COLLAGE MAKING AS A TEACHING TOOL FOR ESL STUDENTS</b><br><i>M. Vėžienė</i>  | 5637 |
| <b>PROJECT- BASED LEARNING AND EMERGING TECHNOLOGIES. A STRATEGY TO IMPROVE ACADEMIC PERFORMANCE IN THE TRAINING OF PROJECT MANAGERS</b><br><i>S. Zabala-Vargas, M. Jaimes-Quintanilla, D. Ramírez-Martínez</i>   | 5642 |
| <b>TEACHING SCHOLARS PROGRAM-ALBERTA INSTITUTE WENZHOU MEDICAL UNIVERSITY (TSP-AIWMU): FACULTY DEVELOPMENT IN SUPPORT OF AN INTERNATIONAL PARTNERSHIP IN MEDICAL EDUCATION</b><br><i>C. Hodgson</i>               | 5647 |
| <b>DIDACTIC STRATEGIES FOR TEACHING HOUSING DESIGN: THE EXPERIENCE OF THE ARCHITECTURE AND URBANISM COURSE AT UNILESTE/MG, BRASIL</b><br><i>C. Carvalho</i>   | 5652 |
| <b>VIRTUALISATION OF CAREER GUIDANCE PROCESSES USING THE CPC MODEL</b><br><i>M. Suárez-Ortega, M.F. Sánchez-García, A. Fernández-García, M.I. García-Ripa, C. Romero-García</i>                                   | 5662 |
| <b>EXPLORING THE EFFECT OF METADISOURSE MARKERS ON THE COMPOSING COMPETENCE OF POSTGRADUATE STUDENTS AT ALFASHIR UNIVERSITY IN 2022</b><br><i>M. Arga</i>   | 5668 |
| <b>LOVE AND CARE FOR NATURE – VALIDATION OF THE SCALE AND ATTITUDES OF STUDENTS AND KINDERGARTEN TEACHERS IN CROATIA</b><br><i>D. Anđić, E. Maurović</i>  | 5677 |
| <b>IMPLEMENTATION OF EXTRACURRICULAR OUTDOOR ACTIVITIES IN CROATIAN SCHOOLS</b><br><i>P. Pejić Papak, D. Anđić, L. Bobanović</i>  | 5686 |
| <b>EDUCATION AND CONCEPTS OF ETHICAL STANDARDS FOR MEMBERS OF THE FIRE AND RESCUE SERVICE OF THE CZECH REPUBLIC</b><br><i>S. Kavan, Z. Freitinger-Skalicka</i>  | 5692 |
| <b>EXAMINING THE STUDENTS' STATISTICAL LITERACY: THE CASE OF DAILY DIET</b><br><i>S.E. Elma, M. Işıksal-Bostan</i>  | 5698 |
| <b>IS THERE A NEED FOR MORE MODERN AND UPDATED PROFESSIONAL DEVELOPMENT PROGRAMS ON TECHNOLOGY-ENHANCED LEARNING FOR TEACHING STAFF?</b><br><i>M. Albahiri</i>  | 5705 |
| <b>UNDERSTANDING THE LINK BETWEEN FINANCIAL LITERACY AND ENTREPRENEURIAL INTENTIONS IN A UNIVERSITY EDUCATIONAL SETTING</b><br><i>A. Molina-García, R. Martínez-Alonso, M.J. Martínez-Romero, J. Diéguez-Soto</i> | 5706 |
| <b>PRIMARY ENGLISH PRACTICE PROGRAMME FOR AGES 6/7: THE NEED FOR A TRANSFORMATIVE AND SUSTAINABLE PRIMARY ENGLISH TEACHING AND LEARNING PROCESSES</b><br><i>M. Cruz, D. Mascarenhas, P. Medeiros, A. Pinheiro</i> | 5707 |
| <b>EXPLORING THE INTEGRATION OF ARTIFICIAL INTELLIGENCE GENERATIVE TOOLS IN TEACHING HISPANO-AMERICAN LITERATURE: A STUDENT-CENTRIC APPROACH</b><br><i>M. Cruz</i>  | 5717 |
| <b>BLENDED LEARNING AND TEACHING IN THE INVERTED (FLIPPED) CLASSROOM, EXEMPLIFIED BY DOIT (DERMATOLOGY ONLINE WITH INTERACTIVE TECHNOLOGY)</b><br><i>G. Burg, H. Gollnick, M. Bagot</i>                           | 5728 |
| <b>EMPIRICAL OBSERVATIONS STUDY OF TEACHING TEXTILES DESIGN (LU XUN ACADEMY OF FINE ARTS): VIRTUAL REALITY (VR) COLLABORATION MODELS IN PRACTICE PAINTING PROCESS</b><br><i>X. Wang, P. Henry</i>                 | 5729 |

|   |      |
|---|------|
| <b>CHALLENGES AND SOLUTIONS FOR THE REALIZATION OF AN XAPI-BASED LEARNING ANALYTICS INFRASTRUCTURE USING THE H5P MOODLE COMPONENT FOR USER EXPERIENCE QUESTIONNAIRES AND EXAM QUIZZES IN HIGHER EDUCATION</b> | 5737 |
| <i>R. Srbecky, P. Thiele, V. Cassau, U. Köferl, N. Schönberger, R. Schulte-Holthausen, M. Yevdokymova, S.A. Wetzel, M. Winterhagen, W. Fraas, J. Dettmers, M. Hemmje</i>                                      |      |
| <b>THE TRIALOGICAL LEARNING &amp; ASSESSMENT APPROACH: ASSESSMENT FOR LEARNING APPLIED TO TEACHERS' TRAINING</b>  | 5743 |
| <i>N. Sansone</i>   |      |
| <b>EVALUATION OF THE EDUCATION SYSTEM FOR MEMBERS AND EMPLOYEES OF THE FIRE RESCUE SERVICE OF THE CZECH REPUBLIC</b>  | 5744 |
| <i>S. Kavan</i>   |      |
| <b>IMPLEMENTATION OF CODES OF ETHICS IN HIGHER EDUCATION INSTITUTIONS IN THE UNITED ARAB EMIRATES: CASE OF THE MINISTRY OF HEALTH AND PREVENTION</b>  | 5751 |
| <i>A. Alwali</i>  |      |
| <b>IT PRACTICUM – A MORE ACCESSIBLE AND SCALABLE INTERNSHIP MODEL</b>   | 5760 |
| <i>M. Beheshti</i>  |      |
| <b>EFFECTS OF A SCHOOL-BASED MULTIDISCIPLINARY HPV PREVENTION PROGRAMME FOR ADOLESCENT GIRLS AND PARENTS</b>  | 5765 |
| <i>S.H.S. Lo, J.P.C. Chau, K.C. Choi, V.W.Y. Lee, A.Y.L. Lau, G.C.Y. Lui, K.M. Chan</i>   |      |
| <b>PROMOTING DISABILITY AWARENESS AMONG SECONDARY SCHOOL AND UNDERGRADUATE STUDENTS: MUTUAL EFFECTS OF A DISABILITY SIMULATION INTERVENTION</b>   | 5766 |
| <i>S.H.S. Lo, J.P.C. Chau, A.W.K. Chan, S.K.Y. Lam, S.Y. Chair, V.W.Y. Lee</i>  |      |
| <b>PROMOTING LOGICAL THINKING THROUGH CHALLENGES IN HIGHER EDUCATION - A DIDACTIC STRATEGY</b>  | 5767 |
| <i>F. Soares, A.P. Lopes, M.P. Nunes</i>  |      |
| <b>EXAMINING DIGITAL SKILLS AMONG EDUCATIONAL SUPERVISORS IN OMAN FOR EFFECTIVE EDUCATIONAL PRACTICES</b>   | 5776 |
| <i>N. Salah El-Din, L. Al Qurainiyah</i>  |      |
| <b>THE ROLE OF MENTORSHIP ON FIRST-YEAR STUDENTS AT HISTORICALLY DISADVANTAGED INSTITUTION IN SOUTH AFRICA</b>  | 5782 |
| <i>H. Schoeman, Y. Nkomo</i>  |      |
| <b>AGGRESSIVE BEHAVIOUR OF PUPILS AND ITS IMPACT ON SOCIAL DYNAMICS: PREVENTION AND TOOLS TO ELIMINATE DEVALUING COMMUNICATION</b>  | 5790 |
| <i>J. Dzuríaková, E. Diechová</i>   |      |
| <b>DEMO OF THE E-LEARNING PLATFORM "DERMATOLOGY ONLINE WITH INTERACTIVE TEACHING"</b>   | 5795 |
| <i>G. Burg, H. Gollnick, M. Bagot</i>   |      |
| <b>ORIENTATING YOUNG NON-DESIGN STUDENTS IN THE DESIGN DISCIPLINE</b>   | 5796 |
| <i>A.G. Manciaracina, G. Gerosa, F. Guarnieri</i>   |      |
| <b>ONLINE INDUCTION FOR NON-CONSULTANT HOSPITAL DOCTORS IN PSYCHIATRY: DOES IT HELP?</b>  | 5806 |
| <i>B. Oruairc, M. Gallagher, G. Crudden, A. Doherty, A. Guerandel</i>   |      |
| <b>DEMONSTRATION OF INTERDISCIPLINARITY IN STEM EDUCATION THROUGH THE EXAMPLE OF POLLUTION SPREAD MODELING</b>  | 5807 |
| <i>N. Črnjarić, M. Štefan Trubić</i>  |      |
| <b>DEVELOPING LANGUAGE SKILLS OF REFUGEE WOMEN THROUGH XR TOOLS: IDENTIFYING THE NEEDS AND CHALLENGES</b>   | 5815 |
| <i>P. Kosmas, E. Xerou, C. Vrasidas</i>   |      |
| <b>ENTREPRENEURSHIP EDUCATION AS A LONG-LIFE LEARNING STRATEGY: THE CASE OF A PROFESSIONAL MASTER'S IN PORTUGAL</b>   | 5821 |
| <i>I. Saur-Amaral</i>   |      |
| <b>DELIVERING WEB-BASED WORKFORCE TRAINING INTERVENTIONS: KEY CONSIDERATIONS FOR HEALTH RESEARCH</b>  | 5831 |
| <i>H. Blake, W.J. Chaplin, J. Hassard, L. Thomson</i>   |      |
| <b>GROUP CONCEPT MAPPING TO FACILITATE PARTICIPATORY DESIGN OF THE WEB-BASED PAIN-AT-WORK TOOLKIT</b>   | 5839 |
| <i>H. Blake, S. Greaves, V. Abbott-Fleming, S. Somerset</i>   |      |

|  |      |
|--|------|
| <b>A COMPARISON OF AUTHORITARIAN AND ADVERSARIAL LEADERSHIP IN MICRO-POLITICS—TAKE BALL (1987) AND BLASÉ &amp; ANDERSON (1995) AS EXAMPLES</b><br><i>R.F. Luo</i>  | 5844 |
| <b>STUDENTS' PERCEPTIONS ABOUT REASONS FOR DROPPING OUT OF SCHOOL: A MULTINATIONAL STUDY</b><br><i>P. Paulino, S. Correia, P. Gamito</i>   | 5853 |
| <b>EXPERIENCES FROM A VIRTUAL INTERNATIONAL MULTICULTURAL PROJECT BEFORE AND AFTER COVID-19</b><br><i>R. Gafni, C. Marsal</i>  | 5863 |
| <b>NEW DIRECTIONS IN DISCIPLINARY LITERACY</b><br><i>T.D. Wolsey</i>   | 5870 |
| <b>NEW CHALLENGES IN EDUCATIONAL INNOVATION</b><br><i>L. Cuenca, A. Boza, M. Fernández-Diego, L. Ruiz</i>  | 5876 |
| <b>HOW TO ENSURE INCLUSIVE SCHOOLS? STEPS AND CONTRIBUTIONS OF AN INTEGRATIVE LITERATURE REVIEW</b><br><i>G. Castanheira, M. Alves, R. Fidalgo, A. Reboredo, C. Costa-Lobo</i>   | 5880 |
| <b>LOW STAKES, HIGH REWARD: DEVELOPMENT AND EVALUATION OF AN ONLINE COMPARATIVE JUDGEMENT MARKING SYSTEM</b><br><i>T. Gleave, S. Goodman, S. Canning, D. Prescott</i>  | 5888 |
| <b>THE HISTORY OF CHINESE TEACHER PROFESSIONAL DEVELOPMENT MODEL</b><br><i>V. Pisarenko, Y. Hongyang</i>   | 5893 |
| <b>MODELLING IN EDUCATION SCIENCE</b><br><i>V. Pisarenko</i>   | 5897 |
| <b>USING SERVICE LEARNING PROJECTS TO INTRODUCE SOCIAL MEDIA MARKETING TO SMALL RURAL ORGANIZATIONS</b><br><i>S. Weith-Harms</i>   | 5907 |
| <b>STUDENT RETENTION: SEASONAL DEPRESSION AND STUDENT MOTIVATION</b><br><i>A. Khalil, A. Saleh</i>   | 5914 |
| <b>AI AND CHATBOTS IN FOOD ENGINEERING EDUCATION: SHIFTING FROM TASK AUTOMATION TO REFLECTIVE LEARNING</b><br><i>B.I. Maldonado-Guevara, J.J. Carracedo-Navarro</i>  | 5919 |
| <b>A COLLABORATIVE APPROACH TO LAUNCHING A CAMPUS MEDIA OUTLET IN CENTRAL PENNSYLVANIA: A CASE STUDY OF HAWKEYE MEDIA</b><br><i>C. Terracina-Hartman</i>   | 5924 |
| <b>EDUCATIONAL COOPERATION BETWEEN ELEMENTARY SCHOOL AND PUBLIC LIBRARIES - A CASE STUDY ON THE HURDLES OF RESEARCH AND COLLABORATION</b><br><i>G. Marci-Boehncke, K. Küçük, M. Gaede</i>  | 5934 |
| <b>DEVELOPMENT OF PROJECT-BASED LEARNING IN CIVIL ENGINEERING</b><br><i>Y. Kim, L.L.H. Idris, S. Das, P.C. Yau</i>   | 5942 |
| <b>VIRTUAL REALITY AS AN INNOVATIVE TOOL FOR UNIVERSITY STUDENTS TO COMPREHEND THE GLOBAL CHALLENGE OF ANTIBIOTIC RESISTANCE</b><br><i>M.A. Ruiz-Fresneda, A.M. Newman-Portela, M. Morales-Hidalgo, M.L. Merroun</i>   | 5949 |
| <b>EDUCATIONAL INNOVATION: EXPLORING FLIPPED CLASSROOM IN THE CONTEXT OF EXPERIMENTAL PRACTICES</b><br><i>D. Muñoz-Rodríguez, M. Castillo-Rodríguez, P. Aparicio-Martínez, P. Martínez-Jiménez, A.J. Perea-Moreno</i>  | 5955 |
| <b>PLAYING OUTSIDE: REFLECTION ON THE PERCEPTIONS OF FAMILIES IN A DAYCARE CENTRE</b><br><i>T. Silva, A. Pinheiro</i>  | 5962 |
| <b>COMPARISON OF DIFFICULTY OF TASKS IN SCRATCH AND PYTHON</b><br><i>M. Tomcsányiová</i>   | 5967 |
| <b>UNLOCKING SUCCESS: THE IMPACT OF TEACHER TRAITS AND PRINCIPAL LEADERSHIP ON SCHOOL OUTCOMES</b><br><i>F. Nasser-Abu Alhija, A. Badarneh</i>   | 5976 |
| <b>ADVANCING SUSTAINABLE EDUCATION: DESIGN A NOVEL STEAMS MODEL INTEGRATING TECHNICAL AND PSYCHOLOGICAL FACTORS</b><br><i>J.A. Navarro-Espinosa, D. Muñoz-Rodríguez, M. Castillo-Rodríguez, A.J. Perea-Moreno, P. Martínez-Jiménez, P. Aparicio-Martínez</i> | 5977 |

|   |      |
|---|------|
| <b>QUALITATIVE RESEARCH OF STUDENT VIEWS ON THE IMPACT OF AI IN HIGHER EDUCATION</b>  | 5983 |
| <i>A. Tierney, P. Peasey</i>  |      |
| <b>BRIDGING THEORY AND PRACTICE: REVOLUTIONIZING STEM EDUCATION WITH JUPYTER</b>  | 5984 |
| <i>E. Khatib</i>  |      |
| <b>LESSONS LEARNED FROM CONDUCTING PROJECT-BASED LEARNING DEBRIEFING SESSIONS IN THE METAVERSE</b>  | 5995 |
| <i>A. Takashima, A. Takagi, T. Utsumi</i>   |      |
| <b>FROM PRESERVICE TEACHER PREPARATION TO INSERVICE TEACHER DEVELOPMENT: TEACHER LEARNING IN CONTEXT</b>  | 5999 |
| <i>K. Sato</i>  |      |
| <b>PROGRESS TOWARDS THE MENTORING PROGRAMME THROUGH FEEDBACK SURVEYS AT THE SCHOOL OF ENGINEERING OF JAÉN</b>   | 6000 |
| <i>J.M. Serrano, J.J. Aguilera, D. Eliche-Quesada, E. Estévez, F.J. Gallego, C. Gutiérrez-Montes, C. Rus-Casas</i>  |      |
| <b>INTRODUCTION OF AN ELECTRONIC MODULE "ROBOTS, VIRTUAL REALITY AND NEUROROBOTICS IN REHABILITATION CLINICAL PRACTICE"</b>   | 6007 |
| <i>R. Yoshinov, B. Yoshinov, I. Koleva</i>  |      |
| <b>CRAFT BREWING AS AN INNOVATIVE LEARNING ACTIVITY FOR CHEMICAL ENGINEERING STUDENTS IN UNIVERSIDAD DE LA LAGUNA</b>   | 6016 |
| <i>J.J. Macías, J. Rodríguez-Sevilla, L.A. González-Mendoza, L. Vera, L. Rodríguez-Gómez, K. Rodríguez-Espinoza</i>   |      |
| <b>ASSESSMENT OF THE NECESSITY OF AN ELECTRONIC MODULE "PHYSICAL PREVENTION, PHYSICAL THERAPY AND REHABILITATION IN THE FIELD OF OBSTETRICS AND GYNAECOLOGY"</b>        | 6022 |
| <i>I. Koleva, B. Yoshinov, R. Yoshinov</i>  |      |
| <b>ASSESSING THE ACQUISITION OF L3 NORWEGIAN RETROFLEXES BY MEANS OF A DISCRIMINATION TASK</b>  | 6031 |
| <i>K. Hwaszcz, A. Balas, M. Wrembel, K. Kaźmierski</i>  |      |
| <b>THE IMPACT OF REMOVING SEPTEMBER EXAMS ON PEVAU LOMCE</b>  | 6037 |
| <i>A.J. Zapata-Sierra, E. Salmerón-Manzano, F. Martínez-Gil, B. Nievas-Soriano, M. Gámez-Cámara, A. Alcayde-García, F. Manzano-Agugliaro</i>                            |      |
| <b>UNIVERSITY STUDENTS' PERCEPTION OF AI USE</b>  | 6044 |
| <i>B.A. Naranjo Sánchez, F. Potes Duque</i>   |      |
| <b>GENERIC SKILLS ASSESSMENT IN THE PHYSIOTHERAPY DEGREE AT UNIVERSITY OF ALMERIA</b>   | 6052 |
| <i>B. Nievas-Soriano, F. Manzano-Agugliaro, E. Salmerón-Manzano, A. Alcayde-García, F. Martínez-Gil, A.J. Zapata-Sierra</i>   |      |
| <b>IMMERSIVE LABWORK TEACHING USING AN AUGMENTED REALITY APP</b>  | 6060 |
| <i>T. Kaiser, F.W. Lukas, J. Kretzschmar, C. Helgert, T. Pertsch, A. Tünnermann</i>   |      |
| <b>AIM: ARTIFICIAL INTELLIGENCE FOR MULTIMEDIA GENERATION</b>   | 6061 |
| <i>P. Christ, T. Munkelt</i>  |      |
| <b>EVALUATION OF FACTORS AND CAUSES OF UNIVERSITY DROPOUT</b>   | 6069 |
| <i>J.C. Aguado Franco, C. Simón de Blas, M.E. Castellanos Nueda, A.E. García Sipols, J. Cano Cancela, G. Jerez López, M.D. Pelu, G. Martínez Moreno, S.I. Elidrissi</i> |      |
| <b>USING NONLINEAR LEARNING PATHS IN SELF-DETERMINED LEARNING</b>   | 6074 |
| <i>J.C. Aguado Franco, C. Simón de Blas</i>   |      |
| <b>OPTO-LINE: AUTONOMOUS LEARNING IN OPTICS AND OPTOMETRY</b>   | 6080 |
| <i>D. de Fez, M.T. Caballero, P. Coloma, C. García, J.J. Miret</i>  |      |
| <b>LEAGUE - SUPPORTING PREVENTION AND REPORTING OF ONLINE CHILD SEXUAL ABUSE OF UNDERAGED BOYS FOCUSING ON AWARENESS-RAISING AND EDUCATION ACTIVITIES</b>               | 6084 |
| <i>N. Bessa Vilela, D. Kozhuharova, Z.J. Oplotnik</i>   |      |
| <b>LEAN MANUFACTURING: THE CASE OF LATIN AMERICAN COUNTRIES</b>   | 6085 |
| <i>E. Calvo, M. Ferrer Vasquez, R. Santa</i>  |      |
| <b>THE EDUCATIONAL PRACTICE OF HAPPINESS CURRICULUM TAKES THE SEVENTH GRADE STUDENTS OF A SCHOOL AS AN EXAMPLE</b>  | 6091 |
| <i>X. Chen</i>  |      |



|  |      |
|--|------|
| <b>PROFESSIONAL DEVELOPMENT OF MATHEMATICS TEACHERS: A CASE ANALYSIS BASED ON THE TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) MODEL</b><br><i>E. Santana Lisboa, G. Medeiros Zulato, V. Rosa</i>                                   | 6098 |
| <b>HARMONIZING TECHNOLOGY IN SUPPORT OF A TRANSNATIONAL, ONLINE MEDICAL EDUCATION PROGRAM</b><br><i>H. Lai, T. Hillier</i>   | 6104 |
| <b>BANNED, RESTRICTED, OR APPROVED: AN EXAMINATION OF THE NATION'S 20TH LARGEST SCHOOL DISTRICT'S REVIEW OF INSTRUCTIONAL MATERIALS AS A RESULT OF HB1467, FLORIDA'S CURRICULUM TRANSPARENCY LAW.</b><br><i>R. Chant, B. Zoellner</i>      | 6110 |
| <b>STUDENTS' PERSPECTIVES IN OPTIMISING QUALITY IN AN OPEN-DISTANCE UNIVERSITY</b><br><i>R. Tsephe, L.L. Lalendle</i>  | 6111 |
| <b>TEACHING STRATEGIES FOR MANAGEMENT OF INTERNATIONAL MULTIDISCIPLINARY TEAMS FOR THE DESIGN OF INDUSTRIAL PRODUCTS</b><br><i>A. Navarro-Arcas, J. Llorca-Schenk, C. Jara, I. Sentana-Gadea</i>   | 6120 |
| <b>EQUITY: RESTORING ACHIEVEMENT IN MATHEMATICS</b><br><i>R. de Andrade</i>  | 6128 |
| <b>ANALYSIS OF STUDENT PERCEPTION IN MECHANICAL ENGINEERING REGARDING THE USE OF ARTIFICIAL INTELLIGENCE TO APPROACH CASES IN MANUFACTURING TECHNOLOGY</b><br><i>D. Abellán, A. Navarro-Arcas, M. Fabra-Rodriguez, H. Campello-Vicente</i> | 6138 |
| <b>COMPARING FACE-TO-FACE AND DISTANCE LEARNING TEACHING: CASE STUDY ON AN IT APPLIED IN SOCIAL SCIENCES COURSE</b><br><i>A.B. Andreica</i>  | 6145 |
| <b>INCREASING STUDENT CAPACITY THROUGH INCREMENTALLY COMPLEX PRACTICE USING GENERATIVE AI</b><br><i>K.J. Plummer, L. Fischer</i>   | 6156 |
| <b>ENHANCING STUDENTS' FOREIGN LANGUAGE SKILLS WITH NEUROLINGUISTIC APPROACH</b><br><i>A. Raskauskiene</i>   | 6165 |
| <b>DEVELOPING EVIDENCE-BASED RESEARCH FOR SOCIAL PRESCRIBING IN WALES: CREATIVITY AT THE HEART OF COMMUNITY WELL-BEING</b><br><i>M.S. Rogers</i>   | 6173 |
| <b>MASSIVE OPEN ONLINE COURSES (MOOCS) IN HIGHER EDUCATION: ADVANTAGES, CHALLENGES, AND THE FUTURE OF ONLINE LEARNING</b><br><i>L. Kelli da Silva, E. Santana Lisboa</i>   | 6182 |
| <b>COMBINATION OF ACTIVE LEARNING METHODOLOGIES: A CUSTOM COCKTAIL</b><br><i>F. Sempere-Ripoll, B. Andrés, A. Mengual-Recuerda, R. de la Torre</i>   | 6187 |
| <b>THE PEDAGOGICAL CHALLENGES OF DIGITALISATION</b><br><i>L. Connah</i>  | 6192 |
| <b>ENHANCING STUDENT ENGAGEMENT AND UNDERSTANDING IN COMPLEX SCIENCE CLASSROOMS THROUGH STORYTELLING</b><br><i>K. Kiselyov, C. Schunn</i>  | 6193 |
| <b>CHATBOTS FOR CAREER GUIDANCE: THE CASE OF CAREPROFSYS CONVERSATIONAL AGENT</b><br><i>M.I. Dascalu, V.A. Brîndușescu, I.C. Stanica, B.I. Uta, I.A. Bratosin, D.A. Mitrea, R.E. Brezoaie</i>  | 6194 |
| <b>READINESS OF FUTURE TEACHERS TO IMPLEMENT INCLUSIVE EDUCATION</b><br><i>A. Umirbekova, L. Butabayeva, L. Shalabayeva</i>  | 6205 |
| <b>OPTIMIZING LEARNING SUPPORT SYSTEMS BASED ON THE MULTI-DIMENSIONAL STUDENT LEARNING STYLE MODEL</b><br><i>T. Akakura</i>  | 6210 |
| <b>DIGITAL AND PEDAGOGICAL INNOVATION FOR THE INSTRUMENTAL MUSIC CLASSROOM. A REVIEW OF THE LITERATURE</b><br><i>A. Triantafyllaki</i>   | 6220 |
| <b>DOING DIFFERENT THINGS LOOKING FOR DIFFERENT RESULTS: A PROJECT-BASED EXPERIENCE IN HIGHER EDUCATION CONTEXT</b><br><i>A. Santos Rodrigues, S. Pereira Lopes</i>  | 6225 |
| <b>COMPETENCIES DEVELOPMENT FOR INTERNATIONAL VIRTUAL PROJECT TEAM EFFICIENCY</b><br><i>A. Valickas</i>  | 6229 |

|   |      |
|---|------|
| <b>PROPOSAL OF A METHODOLOGY FOR THE DEVELOPMENT OF FINAL DEGREE PROJECTS: A PRACTICAL AND SYSTEMATIC APPROACH</b><br><i>R. Sanchis, R. de la Torre, B. Andrés, G. Calleja</i>  | 6234 |
| <b>EDUTAINMENT AND BUSINESS SIMULATIONS: PEDAGOGICAL INNOVATIONS IN INTERNATIONAL ENTREPRENEURSHIP EDUCATION</b><br><i>M. Pietrzykowski</i>   | 6244 |
| <b>LEADERSHIP WITH INSIGHT: INDIVIDUALISM AND COLLECTIVISM IN NORDIC AND FENNO-UGRIC ORGANIZATION CULTURES</b><br><i>K. Mullamaa</i>  | 6245 |
| <b>INNOVATION, CREATIVITY AND ENTREPRENEURSHIP: EDUCATIONAL IMPROVEMENT PLAN FOR DEVELOPING NEW LEARNING ACTIVITIES AT UPV, STUDENT PRE-ASSESSMENT</b><br><i>G. Rius-Sorolla, A. Llorca-Ponce, E. Navarro-Astor</i>                                   | 6246 |
| <b>E-TUTORING IN THE POST-COVID ERA</b><br><i>R. Sanchis, G. Calleja, A. Mengual-Recuerda, B. Andrés</i>  | 6251 |
| <b>PREPARING STUDENTS TO WORK WITH ARTIFICIAL INTELLIGENCE IN EXPERT PROFESSIONAL ACTIVITIES IN THE FIELD OF ECONOMICS AND PUBLIC ADMINISTRATION</b><br><i>E. Zarova</i>  | 6259 |
| <b>ON THE DEVELOPMENT OF MACHINE TRANSLATION POSTEDITING COMPETENCE IN TRANSLATOR TRAINING</b><br><i>S. Vasiliauskienė, D. Lisaitė, R. Kasperė</i>  | 6265 |
| <b>ETHICAL FRONTIERS IN AI-DRIVEN STUDENT DEVELOPMENT: NAVIGATING NEW REALMS OF ENGAGEMENT AND SUPPORT</b><br><i>H. Mason</i>   | 6272 |
| <b>APPLICATION OF IMMERSIVE TOOLS WITH A STEAM APPROACH IN TEACHER TRAINING IN HIGHER EDUCATION</b><br><i>J. Matias, S. Cruz, O. Riofrio, Y. Pinto</i>  | 6273 |
| <b>ANALYSIS OF KEY VARIABLES IN ACTIVE LEARNING USING GAMIFICATION: A NEUROTECHNOLOGICAL STUDY</b><br><i>D. Juárez-Varón, A. Mengual-Recuerda, F. Sempere-Ripoll, M.A. Peydró-Rasero</i>  | 6284 |
| <b>THRIVING IN ACADEMIA: LEVERAGING POSITIVE PSYCHOLOGY FOR ENHANCED STUDENT SUCCESS IN SOUTH AFRICAN HIGHER EDUCATION</b><br><i>H. Mason</i>   | 6292 |
| <b>NEUROTECHNOLOGICAL STUDY OF THE APPLICATION OF THE ACTIVE LEARNING METHODOLOGY OF ROLE-PLAYING</b><br><i>D. Juárez-Varón, A. Mengual-Recuerda, R. Sanchis, M.A. Peydró-Rasero</i>  | 6293 |
| <b>ACTIVE LEARNING INNOVATIONS IN THE CONTEXT OF BUSINESS ORGANISATION</b><br><i>A. Mengual-Recuerda, D. Juárez-Varón, B. Andrés, R. de la Torre</i>  | 6302 |
| <b>ANALYSIS OF THE COMBINED APPLICATION OF GROUP DYNAMICS IN THE CLASSROOM FOR UNIVERSITY STUDENTS</b><br><i>A. Mengual-Recuerda, B. Andrés, R. de la Torre, D. Juárez-Varón</i>  | 6307 |
| <b>PHYSICAL SELF-EFFICACY AND SELF-PERCEPTION: THE BODY AS A PEDAGOGICAL DEVICE FOR CHANGE THROUGH THE CHOREUTIC WORKSHOP</b><br><i>M.V. Marchesano, L. Pallonetto, C. Palumbo</i>  | 6314 |
| <b>BEHIND DIGITAL EDUCATIONAL POVERTY: THIRD LEVEL OF THE DIGITAL DIVIDE AS A CULTURAL DIVIDE BETWEEN STUDENTS AND TEACHERS – THEORETICAL REFLECTIONS AND EMPIRICAL EVIDENCES FROM AN ITALIAN CASE STUDY</b><br><i>S. Patera, S. Murri, D. Scotta</i> | 6322 |
| <b>PRACTICAL CLASSES IN AUTOMOTIVE ENGINEERING: AN EVALUATION OF SCENARIO-BASED LEARNING REAL-WORLD APPLICATION</b><br><i>L. Serrano, C. Ferreira</i>   | 6329 |
| <b>NAVIGATING THE FUTURE: EXPLORING SYNCHRONOUS HYBRID LEARNING IN HIGHER EDUCATION POST-COVID</b><br><i>V. Racheva, R. Peytcheva-Forsyth</i>   | 6335 |
| <b>IMPLEMENTATION OF NEW TEACHING STRATEGIES IN PRIMARY SCHOOL: THE PROMOTION OF MOTOR ACTIVITY THROUGH AN EXPERIMENTAL TEACHING-MOTOR PROTOCOL</b><br><i>R. Perrone, F. Vellone, C. Palumbo</i>  | 6346 |

|   |      |
|---|------|
| <b>REMOTE TRAINING METHOD TO ASSIST ROBOTIC ACTIVITY IN INDUSTRY</b>  | 6357 |
| <i>W. de Souza Picanço, G. Soprano Machado, M. Melo de Carvalho, C.S. Monteiro da Silva, R.L. Paiva de Medeiros, V. Ferreira de Lucena Jr</i>   |      |
| <b>MOTIVATION POTENTIAL OF AI-BASED LEARNING ASSISTANTS: A QUALITATIVE CASE STUDY INVESTIGATING AND FURTHER DEVELOPING THE MOTIVATIONAL POTENTIALS OF AI-BASED LEARNING ASSISTANTS IN MATHEMATICS LEARNING FOR STUDENTS USING THE ARCS-MODEL APPROACH</b> | 6365 |
| <i>M. Wertenaue, J. Gabrian, J. Seitz</i>   |      |
| <b>AN AUTOMATIC CORRECTION MECHANISM FOR PRACTICAL EXPERIMENTS BASED ON DIGITAL TWINS</b>   | 6372 |
| <i>G. Soprano Machado, T.R. Monteiro Salgado, W. de Souza Picanço, C.S. Monteiro da Silva, R.L. Paiva de Medeiros, V. Ferreira de Lucena Jr</i>   |      |
| <b>TOWARDS AN ADAPTIVE DATA-DRIVEN ARCHITECTURE TO MAKE EMIS A REALITY IN SUB-SAHARAN AFRICA</b>  | 6381 |
| <i>N.M. Ndiaye, B. Thiongane</i>  |      |
| <b>DIDACTICS AS THE FOUNDATION FOR TECHNOLOGICAL DEVELOPMENT: THE CASE OF THE VIRTUAL CHEMISTRY LABORATORY AT UNAM</b>  | 6388 |
| <i>M. Kriscautzky Laxague</i>   |      |
| <b>USE OF CHATGPT IN UNIVERSITY COMPUTER SCIENCE TEACHING: ADVANTAGES AND DISADVANTAGES</b>   | 6395 |
| <i>M. Serrano, A. Santos-Olmo, D. Garcia-Rosado, L.E. Sanchez-Crespo, C. Blanco, E. Fernandez-Medina</i>  |      |
| <b>PRACTISING FIERCELY - FULFILMENT THROUGH STANCE, STAMINA AND SUPPORTS A PROGRAMME-WIDE APPROACH TO SUPPORTING IDENTITY AND WELLBEING IN A TERTIARY TEACHING PROGRAMME</b>  | 6396 |
| <i>W. Holley-Boen</i>   |      |
| <b>INCORPORATION OF FLIPPED CLASSROOM IN TEACHING STUDENTS WITH SPECIAL EDUCATIONAL NEEDS TO ENHANCE INCLUSIVE EDUCATION IN HIGHER EDUCATION</b>  | 6397 |
| <i>B. Yovkova, R. Peytcheva-Forsyth</i>   |      |
| <b>AROMATAWAI: A CONVERSATIONAL APPROACH TO ASSESSMENT IN A PROFESSIONAL PROGRAMME</b>  | 6407 |
| <i>M. Mentis</i>  |      |
| <b>USING THE PROJECT BASED LEARNING METHODOLOGY WITH SUSTAINABILITY CRITERIA INTO A UNIVERSITY SUBJECT</b>  | 6408 |
| <i>R. Chalmeta, M. Palop Belloch, J. González Darder</i>  |      |
| <b>"I THINK THIS IS THE BEGINNING OF A BEAUTIFUL FRIENDSHIP." HOW MALAYSIAN AND AMERICAN STUDENTS MAPPED THE FILM CASABLANCA WITH CULTURE/CRITICAL TOOLS</b>  | 6413 |
| <i>K. Crowley, N.Z.N. Mokhtar</i>   |      |
| <b>THE CASE OF WEIGHTED GPA IN SPANISH UNIVERSITIES</b>   | 6414 |
| <i>Y. Durán Durán, C. Del Campo, A. Hernández, A.L. Cancer</i>  |      |
| <b>EXPERIENCES IN THE DEVELOPMENT OF A TRAINING AND CAREER GUIDANCE COURSE</b>  | 6418 |
| <i>M. Palop Belloch, R. Chalmeta, J. González Darder</i>  |      |
| <b>SUPPORT AND IMPLEMENTATION OF VOLUNTEERING IN THE ENVIRONMENT OF THE UNIVERSITY OF OSTRAVA IN THE CZECH REPUBLIC</b>   | 6424 |
| <i>P. Adamus, E. Satinská, E. Nyklová</i>   |      |
| <b>VOLUNTEERING BY STUDENTS AND EMPLOYEES OF THE UNIVERSITY OF OSTRAVA FOR PEOPLE WITH SPECIAL NEEDS IN THE CZECH REPUBLIC</b>  | 6437 |
| <i>P. Adamus, E. Satinská, E. Nyklová</i>   |      |
| <b>CHANGE AGENTS AND EDUCATIONAL STRATEGIES FACING RURAL DEPOPULATION IN SPAIN</b>  | 6446 |
| <i>I. Atance, E. Santaolalla, S. Camós</i>  |      |
| <b>AN AI EDUCATIONAL TOOL FOR DETECTING REDUNDANCY IN DISTRACTORS AND ITEMS WITHIN MULTIPLE-CHOICE TESTS</b>  | 6454 |
| <i>N. Hrich, M. Azekri, M. Khaldi</i>   |      |
| <b>HOW TO PROMOTE CRITICAL THINKING THROUGH THE FINAL DEGREE PROJECT</b>  | 6459 |
| <i>C. de Gispert Brosa, A. Díaz Álvarez</i>   |      |
| <b>ENCAPSULATING PERCEIVED INCLUSION (SDG 10: REDUCED INEQUALITIES) IN THE PROCESS OF DEVELOPING A CLASS PROJECT BY STUDENTS FROM SHENANDOAH UNIVERSITY USA AND INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA</b>   | 6465 |
| <i>N.Z.N. Mokhtar, K. Crowley</i>   |      |

|  |      |
|--|------|
| <b>STRATEGY FOR IMPROVING THE MONITORING AND MEASUREMENT OF THE TRANSIT TO HIGHER EDUCATION OF HIGH SCHOOL GRADUATES OF PUBLIC SCHOOLS IN THE CITY OF BARRANQUILLA, COLOMBIA</b><br><i>E. Calvo, M. Ferrer Vasquez, V. Garcia, M. Ojeda, R. Santa</i>                  | 6466 |
| <b>INVESTIGATING THE ROLE OF COGNITIVE FLEXIBILITY IN SHAPING TEACHER ENGAGEMENT IN A SIMULATED VIRTUAL CLASSROOM</b><br><i>Ş. Çağlar Özhan, P. Tekeli, A. Altun</i>   | 6475 |
| <b>REAL-TIME CONTINUOUS STUDENT MONITORING DURING COMPUTER-BASED PROBLEM-SOLVING ACTIVITIES</b><br><i>J. Remón, E. Romero</i>  | 6481 |
| <b>IMPROVING STUDENTS' LAB CLASS PREPARATION THROUGH VIDEO INTRODUCTORY PILLS AT HIGHER EDUCATION</b><br><i>E. Romero, J. Remón</i>  | 6487 |
| <b>HISTOLAB: EXTENDED REALITY PLATFORM FOR HISTOLOGY LEARNING</b><br><i>G. Rocha Astorga, Z. Zatarain Barron, R. Zatarain Cabada, M.L. Barrón Estrada</i>  | 6495 |
| <b>COLLABORATIVE DEVELOPMENT OF ALBERTA INSTITUTE WENZHOU MEDICAL UNIVERSITY (AIWMU), CHINA'S PIONEER COOPERATIVE MEDICAL EDUCATION INITIATIVE</b><br><i>T. Hillier, H. Chen, X. Wang, S. Phillips, J. Ruan</i>  | 6505 |
| <b>EDIT VIDEO CHALLENGE – HACKATHON AND BLENDED INTENSIVE PROGRAM</b><br><i>P. Bauer, D. Enne, J. Bauer</i>  | 6506 |
| <b>CRAFTING A COORDINATED, ADAPTIVE MEDICAL EDUCATION CURRICULUM WITHIN AN INTERNATIONAL LEARNING CONTEXT BETWEEN CANADA AND CHINA</b><br><i>T. Hillier, J. Ruan, H. Chen, P. Brett-MacLean, C. Hodgson, T. Winton, B. Chiu, X. Wang, H. Lai</i>                       | 6512 |
| <b>STRESS COPING STRATEGIES: EDUCATIONAL STYLES AND EXPERIENCE IN CLOSE RELATIONSHIPS AS PREDICTORS</b><br><i>I. Janković, M. Nikolić, J. Todorović</i>  | 6513 |
| <b>THE SURGICAL ESCAPE ROOM: AN INNOVATIVE EDUCATIONAL STRATEGY TO FACILITATE UNDERSTANDING OF OPERATION THEATRES IN A RECREATIONAL WAY</b><br><i>A. Mahmood, J. George, K.R. Rahman, J. Hodson, M. Seabrook, N.T. San, K. Brahmhbhatt, J. Wongsikhee, D.J. Bowrey</i> | 6514 |
| <b>NAVIGATE BEE-BOT THROUGH MARKED VS. UNMARKED PATH: ITS INFLUENCE ON VISUAL DISCRIMINATION AND MENTAL ROTATION ABILITIES AMONG PRESCHOOL CHILDREN WITH DEVELOPMENTAL LANGUAGE DISORDER</b><br><i>G. Dushnitzky, O. Tova, S. Zilbernel</i>                            | 6515 |
| <b>THE HIERARCHICAL NESTING EFFECT IN THE STUDY AND INTERPRETATION OF ACADEMIC PERFORMANCE IN THE SOCIAL SCIENCES: A 2-LEVEL MULTILEVEL APPLICATION</b><br><i>J.L. Peñaloza Figueroa, C.G. Vargas Pérez, J. Mello</i>  | 6520 |
| <b>THE GIFTEDNESS AS A SPECIAL EDUCATIONAL NEED: DEVELOPMENT TRAJECTORIES AND PROFESSIONAL PRACTICES IN ITALIAN SCHOOL</b><br><i>E. Treglia, A. Giuliani</i>   | 6527 |
| <b>INNOVATION IN EDUCATION, AS A CREATIVE PRODUCT</b><br><i>T. Ichim</i>   | 6537 |
| <b>LEADERSHIP PRACTICES AND MIDDLE MANAGEMENT AS RESOURCES TO QUALIFY TEACHERS' PROFESSIONAL EXPERIENCES: A CASE STUDY</b><br><i>A. Giuliani, E. Treglia</i>   | 6544 |
| <b>ENRICHING THE POST-PANDEMIC ECOLOGY OF LEARNING FOR LIFE: THE CASE OF SLOW FOOD NARRATIVE LABELS</b><br><i>M.C. Dal Pian, L.F. Dal Pian, M. Dal Pian</i>  | 6554 |
| <b>CONCEPTS OF OPEN INNOVATION IN A PROJECT-BASED LEARNING ENGINEERING COURSE: A CASE STUDY WITH ASSESSMENT OF ACTIVE LEARNING MATURITY LEVEL</b><br><i>H. Arruda, A. Passos</i>   | 6564 |
| <b>INSIGHTS FROM CO-DESIGN WITH ADOLESCENTS TO CREATE INNOVATIVE DATA COLLECTION AND ANALYTIC TOOLS</b><br><i>K. Meissel, S. Morton</i>  | 6574 |
| <b>EXPERIENCE OF TEACHING NON-COMPUTER SCIENCE MAJORS COMPUTER PROGRAMMING</b><br><i>Y. Tseng</i>  | 6575 |

|  |      |
|--|------|
| <b>CHATED: A CHATBOT LEVERAGING CHATGPT FOR AN ENHANCED LEARNING EXPERIENCE IN HIGHER EDUCATION</b><br><i>K. Wang, J. Ramos, R. Lawrence</i>   | 6580 |
| <b>EDUCATING FOR THE FUTURE OF US-CHINA RELATIONS</b><br><i>D. Kuhn, S. Xiao</i>   | 6590 |
| <b>BUILDING CRITICAL THINKERS: REDEFINING PROBLEM SOLVING IN THE AGE OF CHATBOTS</b><br><i>J.J. Carracedo-Navarro, B.I. Maldonado-Guevara</i>  | 6591 |
| <b>STRONGER TOGETHER: DESIGN AND EVALUATION OF A COOPERATIVE GAME-BASED LEARNING FOR NEWCOMER TWEENS</b><br><i>O. Bani-Taha, M. El Kouzi</i>   | 6596 |
| <b>EVALUATION OF CHANGE FOR SCIENTIFIC CONCEPTIONS OF UPPER SECONDARY SCHOOL STUDENTS REGARDING CALCITE BIREFRINGENCE: THROUGH PRACTICAL LESSONS WITH DEVELOPED TEACHING METHODS</b><br><i>M. Taga</i>   | 6605 |
| <b>A BLUEPRINT FOR A NOVEL INTERDISCIPLINARY AND INTERNATIONAL GAME-DEVELOPMENT BASED LEARNING APPROACH IN STEM EDUCATION: DESIGN, INTEGRATION, AND CHALLENGES</b><br><i>C. Sperrfechter, N. Ondrusch</i>  | 6614 |
| <b>ACADEMICS ON TIKTOK?!: AN INTEGRATED LITERATURE REVIEW</b><br><i>R. Cutri, E. Whiting</i>   | 6624 |
| <b>UNVEILING THE POTENTIAL: EMPIRICAL INSIGHTS INTO ONLINE UNDERGRADUATE RESEARCH EXPERIENCES' INFLUENCE ON SCIENTIFIC IDENTITY AND COMMUNITY BELONGING</b><br><i>A. Austin, N. Tarr, A. Hale, R. Griffin, A. Ramirez Hall, M. Simon, S. Grayson</i> | 6630 |
| <b>PRACTITIONERS VS EDUCATORS IDENTITY CONFLICT: MAPPING OBSTACLES, CHALLENGES AND STRENGTHS</b><br><i>N. Katz, O. Lahav, M. Bar Tulien</i>  | 6640 |
| <b>ONLINE VS. FACE-TO-FACE EXAMS - DETERRENCE THEORY EXPLAINING CHEATING BEHAVIOUR IN SUMMATIVE WRITTEN EXAMS</b><br><i>A. Jantos, A.B. Brendel, L. Kilz</i>   | 6641 |
| <b>NAVIGATING THE "NEW NORMAL" IN HIGHER EDUCATION: INTERPLAY BETWEEN SOCIAL DISRUPTIONS, ACADEMIC ACHIEVEMENTS, AND EMOTIONAL WELL-BEING</b><br><i>E. Pipia, L.A. Rawlins Williams</i>  | 6649 |
| <b>LEARNING DIARY: A TOOL TO CONTRIBUTE TO METACOGNITION DEVELOPMENT</b><br><i>P. López-Fresno, M. Ikonen, A. López-García, U. Mäenpää-Crujo, L. González-Díaz</i>   | 6657 |
| <b>TECHNOLOGY SUPPORT PREDICTS LEARNING OUTCOMES IN INTERPROFESSIONAL EDUCATION: THE MEDIATING EFFECT OF RELATEDNESS</b><br><i>X. Shen, J.I.W. Dizon, F.A. Ganotice, Q. He, J. Lei, G.L. Tipoe</i>   | 6658 |
| <b>TEACHING A COURSE IN ACADEMIC ETHICS AND INTEGRITY TO UNIVERSITY STUDENTS</b><br><i>I.A. Drobot</i>   | 6659 |
| <b>BODY AND LEARNING: THE EMBODIED PEDAGOGY THEORETICAL REFLECTIONS AND EMPIRICAL EVIDENCE FROM AN ITALIAN CASE STUDY</b><br><i>D. Scotta</i>  | 6669 |
| <b>EDUCATIONAL BOTS: HOW CHATBOTS AND INTELLIGENT AGENTS CAN IMPROVE STUDENT EXPERIENCE</b><br><i>P. Cheung, I. Chan, R. Guo, B.S. Woo</i>   | 6673 |
| <b>EMERGING SKILLS IN THE HUMANITIES PANORAMA FACING THE DIGITALISATION DISRUPTION: THE DIGITAL CURATOR TRAINING AND TOOL BOX</b><br><i>R. Quattrini, C. Stefanelli, A. Agapiou</i>  | 6680 |
| <b>THE BULLISH GAME: THE ROLE OF VIRTUAL CURRENCY IN INCENTIVIZING HOMEWORK ON THE SKYENG PLATFORM</b><br><i>K. Adamovich, T. Chirlina</i>   | 6690 |
| <b>INTERIOR META-DESIGN FOR INNOVATIVE REACTIVATION OF HIGH-CULTURAL PLACES</b><br><i>A. Rebaglio, L. Brenna, A. Colombo, L. Carugati, F. Mannini, B. Spada</i>  | 6691 |

|  |      |
|--|------|
| <b>GOVERNMENT CONSIDERATIONS FOR TRANSITIONING A WORKFORCE FROM A DECLINING SECTOR OF THE ECONOMY TO A GROWING HI-TECH SECTOR</b><br><i>S. Creaner, G. Creaner</i>   | 6700 |
| <b>PLAYMOBIL PRO SYSTEM TO DEAL WITH SOFT SKILLS IN INDUSTRIAL ENGINEERING</b><br><i>B. Andres, R. de la Torre, A. Mengual-Recuerda, F. Sempere-Ripoll</i>   | 6701 |
| <b>COLLECTIVE INTELLIGENCE: A NEW WAY OF E-LEARNING</b><br><i>P. Bautista, S. Valero Tapia</i>   | 6708 |
| <b>LEARNING THROUGH COLLECTIVE INTELLIGENCE</b><br><i>P. Bautista, O. Casanova</i>   | 6715 |
| <b>SIMULATION TO FACILITATE THE ACQUISITION OF KNOWLEDGE: THE CONCEPT OF PRODUCTIVITY</b><br><i>B. Andres, A. Mengual-Recuerda, R. de la Torre, R. Sanchis</i>   | 6721 |
| <b>INCLUSIVE EDUCATION. A LOOK AT THE ROLE OF INCLUSION SERVICES IN REINFORCING STUDENTS WITH LEARNING DISABILITIES</b><br><i>R. de la Torre, G. Calleja, R. Sanchis, A. Mengual-Recuerda</i>  | 6728 |
| <b>E-LEARNING: NOT ONLY GOOD REPUTATION OF EDUCATIONAL INSTITUTIONS MATTER. HOW SUPPORT PROCESSES MAY AFFECT TRUST</b><br><i>P. López-Fresno, T. Savolainen, B. Rojas, A. López-García</i>   | 6737 |
| <b>DESIGNING INCLUSIVE AND CUSTOMIZED TRAINING SOLUTIONS FOR DIVERSE LEARNER PROFILES</b><br><i>K.E. Stavroulia, K. Demetriadou, M. Emmanouil</i>  | 6738 |
| <b>ROLE-PLAYING EDUCATIONAL GAMES IN MATH LESSONS</b><br><i>Z. Václavíková</i>   | 6745 |
| <b>PROCEDURE FOR THE DESIGN AND IMPLEMENTATION OF ACTIVITIES TO WORK ON CREATIVITY, ENTREPRENEURSHIP, AND INNOVATION IN HIGHER EDUCATION</b><br><i>R. de la Torre, G. Calleja, R. Sanchis, F. Sempere-Ripoll</i>                           | 6750 |
| <b>RECONSIDERING THE ROLE OF TEACHER PROFESSIONAL LEARNING IN SHAPING THE SOCIAL AND PROFESSIONAL IDENTITY OF TEACHERS: REFLECTIONS FROM AN ONGOING STUDY IN BUILDING TEACHER AGENCY THROUGH DIGITAL TECHNOLOGIES</b><br><i>G. Zavatta</i> | 6756 |
| <b>EXCURSIONS IN SCIENCE EDUCATION. A REVIEW OF THE PEDAGOGICAL PROGRAM OF THE INSTITUCIÓN LIBRE DE ENSEÑANZA (1876-1939) BASED ON THE SUSTAINABLE DEVELOPMENT GOALS</b><br><i>M. Corell Domenech</i>                                      | 6765 |
| <b>EVALUATION OF QUR'AN MEMORIZATION TECHNIQUES AT AL-ITQAAN ACADEMY KADUNA: A COMPREHENSIVE ANALYSIS OF IMPLEMENTATION STRATEGIES</b><br><i>M.N. Muhammad, A.G. Fahm</i>  | 6769 |
| <b>THE POSTCARD PROJECT: AN INVESTIGATION INTO ENGAGEMENT AND RETENTION ON A LEVEL ONE MODULE AT THE OPEN UNIVERSITY</b><br><i>E. Huxor, T. Philcox</i>  | 6782 |
| <b>HOW QUESTION TYPE AFFECTS STUDENT PRODUCTION IN A DIGITAL COLLABORATIVE LEARNING SPACE</b><br><i>S. Orejudo, M. Denoni Bujan</i>  | 6783 |
| <b>EVOLUTION OF DIGITAL STEREOTYPES OF SECONDARY SCHOOL STUDENTS ON THE COLLECTIVE LEARNING PLATFORM</b><br><i>S. Valero Tapia, S. Orejudo</i>   | 6790 |
| <b>LEARNING ARTIFICIAL INTELLIGENCE / MACHINE LEARNING TECHNOLOGIES BASED ON AMAZON WEB SERVICES SOLUTIONS</b><br><i>A. Sierszen, D. Drabek</i>  | 6798 |
| <b>ENHANCING THE LEARNING OF METACOGNITIVE SKILLS IN HIGHER EDUCATION: EXPERIENCES AND SUGGESTIONS FOR PEDAGOGICAL CHOICES</b><br><i>M. Ikonen, P. López-Fresno, U. Mäenpää-Crujo</i>  | 6806 |
| <b>APPLYING GENERATIVE AI TO FACILITATE CLASS ORCHESTRATION WITH TECHNOLOGY: CHATGPT AND NEARPOD FOR SEMINAR ACTIVITIES</b><br><i>L. Huang, C. Holtham, M. Rich</i>  | 6807 |
| <b>INCORPORATING A EUROPEAN GLOBAL CITIZENSHIP FRAMEWORK IN ENGLISH AND COMMUNICATION-RELATED COURSES OF JAPANESE UNIVERSITIES</b><br><i>K. Matsumoto, T. Kitazawa</i>   | 6808 |

|  |      |
|--|------|
| <b>CUSHA – COIL</b>  | 6813 |
| <i>A. Deschner, M. Weinmann, R. Barallon</i>   |      |
| <b>EMPOWERING XR PROFICIENCY: EXPLORING PROFESSIONAL CASE-BASED LEARNING SCENARIOS</b>   | 6821 |
| <i>A. Berglund</i>   |      |
| <b>ENVIRONMENTAL AWARENESS ON SECONDARY EDUCATION STUDENTS IN SPAIN</b>  | 6829 |
| <i>M. Vázquez Dominguez, L. Gimeno Sotelo, R. Sorí Gomez, M. Stojanovic, M.J. Valente</i>  |      |
| <b>A SYSTEMS THINKING APPROACH TO EMOTIONAL INTELLIGENCE</b>   | 6830 |
| <i>S. Armenia, A. Loporchio, T. De Angelis</i>   |      |
| <b>THE REAL GAMES: INTERMEDIA, HYBRID AND INTERACTIVE MOVEMENT-BASED PERFORMING ARTS AS AN APPROACH TO EMBODIED LEARNING</b>                                       | 6835 |
| <i>N. Cappello</i>   |      |
| <b>AN INCLUSIVE PROGRAMME TO LEVEL UP ASSESSMENT LITERACY AND TACKLE AWARDING GAPS IN BIOMEDICAL SCIENCE STUDENTS</b>  | 6836 |
| <i>K. Hargreaves, A. Hidalgo-Bastida</i>   |      |
| <b>TEACHER TRAINING IN IMPLEMENTING VIETNAM'S 2018 GENERAL EDUCATION PROGRAM: CHALLENGES FOR LOCAL UNIVERSITIES AND SOLUTIONS</b>                                  | 6837 |
| <i>T. Hoang</i>  |      |
| <b>OPTIMIZING DISTANCE LEARNING EDUCATIONAL PROGRAMS: THE RATIONALE AND METHODOLOGY OF AN INNOVATIVE AND EFFECTIVE FRAMEWORK</b>                                   | 6845 |
| <i>G. Aretoulis, S. Armenia, D. Miricescu, J. Papathanasiou, J. Stanković, G. Tsaples, E. Aretouli</i>   |      |
| <b>THE IMPACT OF ACADEMIC ENTREPRENEURSHIP ORIENTATION ON CAREER MOTIVATION</b>  | 6853 |
| <i>G. Sart</i>   |      |
| <b>THE IMPACT OF SERVICE QUALITY IN HIGHER EDUCATION ON CORPORATE IMAGE</b>  | 6854 |
| <i>G. Sart</i>   |      |
| <b>ANALYSIS OF METHODOLOGIES, ACTIVITIES AND EVALUATION FOR LEARNING CREATIVITY, INNOVATION AND ENTREPRENEURSHIP</b>   | 6855 |
| <i>A. Llorca-Ponce, G. Rius-Sorolla, E. Navarro-Astor, M. Sancho, A. Herrero-Debón, P.O. Letelier Torres, A. Sapena-Bañó, D. Furió Vita, I. Fernández-Plazaola</i> |      |
| <b>AUTONOMY AND SOCIAL RESPONSIBILITY OF A LOCAL UNIVERSITY IN VIETNAM: CURRENT SITUATION, CHALLENGES AND SOLUTIONS</b>  | 6861 |
| <i>T. Hoang</i>  |      |
| <b>AUDIOVISUAL DISTURBANCES IN ONLINE EDUCATION – AN OVERVIEW OF CURRENT RESEARCH AND A SUGGESTED FUTURE RESEARCH INITIATIVE</b>                                   | 6869 |
| <i>T. Swenberg</i>   |      |
| <b>XRTL – EXTENDED REALITY TWIN LAB FOR PRACTICAL TRAINING IN PHOTONICS HIGHER EDUCATION</b>   | 6881 |
| <i>F.W. Lukas, F. Sojka, C. Henkel, J. Domke, J. Kretzschmar, T. Kaiser</i>  |      |
| <b>ILLUMINATING AND NURTURING TEACHER KNOWLEDGE FOR IMMERSION EDUCATION: A SOCIOCULTURAL PERSPECTIVE</b>   | 6882 |
| <i>T.J. Ó Ceallaigh, G. Nig Uidhir</i>   |      |
| <b>TOWARDS A PRACTICAL COMPUTER NETWORKING PLATFORM FOR ONLINE LEARNING ABOUT NETWORKS IN SCIENCE AND TECHNOLOGY COURSES</b>                                       | 6883 |
| <i>E. Ndassimba, Y.P.K.S. Dodoagnen, N.G. Ndassimba, G. Mendy, S. Ouya</i>   |      |
| <b>A SYSTEMIC MODEL FOR EVALUATING ONLINE COURSE DESIGN: A CRITICAL REALIST APPROACH</b>   | 6892 |
| <i>P. Reddy, D. Pratt</i>  |      |
| <b>ETHICAL ISSUES ON ARTIFICIAL INTELLIGENCE AND HUMAN RELATIONSHIPS</b>   | 6902 |
| <i>R. Romano</i>   |      |
| <b>PERCEPTION AND BEHAVIOUR OF BALTIC AND FINNISH COMPANIES CONCERNING THE EMPLOYEES' TRAINING IN HIGHER EDUCATION INSTITUTIONS</b>                                | 6910 |
| <i>E. Titov, M. Kantanen, L. Pihel, A. Koelde</i>  |      |
| <b>BREAKING BARRIERS: EMPOWERING NON-STEM STUDENTS IN DATA SKILLS THROUGH INQUIRY-BASED AND COLLABORATIVE LEARNING</b>   | 6918 |
| <i>J. Andritsch, D. Sobnath, S. Ahmad</i>  |      |
| <b>TECHNOLOGY-ASSISTED SOCIAL WORK PRACTICE WITH CHILDREN AND YOUTH: DISCIPLINARY RELEVANCE FOR THE TWENTY-FIRST CENTURY</b>                                       | 6925 |
| <i>F. Ó Súilleabháin</i>   |      |

|  |      |
|--|------|
| <b>ENHANCING EDUCATION &amp; RESEARCH: 3D BONE ANATOMY OF THE WHITE-TAILED EAGLE (HALIAEETUS ALBICILLA)</b>  | 6926 |
| <i>A. Miguel-Batuecas, J.A. De Pablo-Moreno, L. Bendito-Buhles, P. Plaza, F. González, M.I. García-Real, E. Mínguez-Pereira, L. Reuelta</i>        |      |
| <b>CHARACTERISTICS OF TROLL RESPONSES CREATED BY PRIMARY SCHOOL STUDENTS ON THE COLLECTIVE LEARNING PLATFORM</b>                                   | 6928 |
| <i>M. Denoni Buján, O. Casanova</i>  |      |
| <b>THE INFLUENCE ON PRESERVICE TEACHERS AS THEY ENGAGE WITH STUDENTS WITH DISABILITIES IN SERVICE-LEARNING ENVIRONMENTS</b>                        | 6934 |
| <i>A. Hussein, J. Kelly, L. Mitchell</i>   |      |
| <b>THE INFLUENCE OF MULTITASKING ON ADHD ELEMENTS IN THE ACADEMIC DIGITAL WORLD</b>  | 6935 |
| <i>C. Chiorean, S. Malaescu</i>  |      |
| <b>DESIGNING INTERDISCIPLINARY RESEARCH IN EDUCATION</b>   | 6944 |
| <i>L. Dantas, C. Galego, J. Oliveira</i>   |      |
| <b>EXPLORING THE EDUCATIONAL POTENTIAL OF GENERATIVE AI: AN APPLICATION FOR SPELLING PRACTICE</b>  | 6945 |
| <i>B. Boras, E. Smolić, G. Gledec, T. Jaguš</i>  |      |
| <b>TEACHING AND LEARNING CRITICAL THINKING IN PORTUGUESE LANGUAGE COUNTRIES</b>  | 6953 |
| <i>L. Dantas, C. Galego, J. Oliveira, E. Santo, M.T. Costa, R. Lambo, M.J. Rios, R. Reis</i>   |      |
| <b>BUILDING A BRIDGE BETWEEN SCIENCE COMMUNICATION AND SCIENCE EDUCATION TO PROMOTE SCIENCE LITERACY</b>   | 6954 |
| <i>S. Puecher</i>  |      |
| <b>ENVIRONMENTAL EDUCATION AT SCHOOL: EXPLORING THE INTERPLAY OF ASSUMPTIONS AND OBJECTIVES IN THE EDUCATIONAL PRACTICE AT SCHOOL</b>              | 6963 |
| <i>C. Buzzacchi</i>  |      |
| <b>EDUCATION FOR CITIZENSHIP: A NARRATIVE REVIEW OF CIVIC EDUCATION PROGRAMS AND PEDAGOGICAL APPROACHES</b>  | 6964 |
| <i>C. Buzzacchi</i>  |      |
| <b>ENHANCING EVIDENCE-INFORMED PRACTICE IN YOUTH WORK: THE ACTIVE YOUTH HUB PROJECT</b>  | 6972 |
| <i>D. Vlachopoulos, C. Debu, C. Oala, O. Eleftheriou, M. Giangkempotzidou, D. Elek, D. Tsekouras</i>   |      |
| <b>A THEORETICAL FRAMEWORK FOR RESEARCH-INTEGRATED STEM LEARNING MODULES: FOSTERING COGNITIVE DEVELOPMENT AT EVERY EDUCATIONAL STAGE</b>           | 6981 |
| <i>Z. Ahmad, N. Siby, N.J. Al-Thani</i>  |      |
| <b>THE BIOT-SAVART LAW IN MODERN PHYSICS EDUCATION: UTILIZING MOBILE MAGNETOMETERS</b>   | 6982 |
| <i>C. González-Pavón, P. Arizo-García, S. Castiñeira-Ibáñez, D. Tarrazó-Serrano</i>  |      |
| <b>TEACHING FOR EQUALITY STARTS WITH TEACHER'S TRAINING: THE WOMEN LEGACY PROJECT STEAM COURSE</b>   | 6989 |
| <i>M. Delgado-Pinar, M.C. Sánchez-Monserrate, L. Vilar-Bohigues, I. Pont-Niclós, S. Castarlenas-Sobreviela, E. Delgado-Pinar, A. López-Navajas</i> |      |
| <b>DATA STORYTELLING IN EDUCATION: A SYSTEMATIC REVIEW</b>   | 6990 |
| <i>H. Ciralı Sarica, D. Yıldırım</i>   |      |
| <b>PROJECT ATHENA: A CASE STUDY ON ONLINE FASHION DESIGN COURSES</b>   | 6998 |
| <i>G. Guedes, P. Gomes</i>   |      |
| <b>STRATEGIES TO PROMOTE RELATIONSHIP BETWEEN MASTER STUDENTS AND ENTREPRENEURSHIP</b>   | 7008 |
| <i>M.D. La Rubia-García, D. Eliche-Quesada, J.D. Aguilar-Peña, C. Rus-Casas</i>  |      |
| <b>CONNECTING HIGH SCHOOL STEM CONTENT WITH FUTURE CAREER PATHWAYS</b>   | 7014 |
| <i>J. Cwikla, M. Dannreuther, D. Reider, R. Mohn</i>   |      |
| <b>ON A MISSION TO CREATE EQUITABLE AND INCLUSIVE CLASSROOMS: THE INCLUSIVE SCHOOL HUB PROJECT</b>   | 7019 |
| <i>D. Vlachopoulos, M. Christodoulidou, A. Kanellakopoulou, K. Kronenberg, E.R. Kambel</i>   |      |
| <b>BODILY IMAGINATION IN EDUCATIONAL RESEARCH: EMBODIED AND EXPERIMENTAL METHODS FROM MOVEMENT-BASED PERFORMING ARTS</b>                           | 7026 |
| <i>N. Cappello, L. Daher, D. Cañabate</i>  |      |



|  |      |
|--|------|
| <b>TRAINING PROCESSES IN TECHNOLOGICAL SKILLS RELATED TO ARTIFICIAL INTELLIGENCE, EMOTIONAL AND FINANCIAL INTELLIGENCE TO PROMOTE DIGITAL TRANSFORMATION PROCESSES AT THE UNIVERSIDAD NACIONAL DE COLOMBIA</b> | 7027 |
| <i>L. Díaz-Santamaría, N.P. Parra-Ortiz, J. Garcia, L.K. Herrera-Quintero</i>  |      |
| <b>NURTURING LANGUAGE PROFICIENCY IN SPANISH-SPEAKING CHILDREN THROUGH DIGITAL COMPETENCE</b>  | 7034 |
| <i>R. Jolley Rangel</i>  |      |
| <b>ARTIFICIAL INTELLIGENCE AS A DIDACTIC TOOL IN THE TEACHING OF INFECTIOUS DISEASES</b>   | 7042 |
| <i>A. López-Arencibia, C. Expósito-Izquierdo</i>   |      |
| <b>WOMEN'S EXPERIENCES OF A VIRTUAL AVATAR-BASED SESSION TO EXPLORE POWER AND LEADERSHIP AS PART OF A BLENDED EXECUTIVE EDUCATION DEVELOPMENT PROGRAM</b>  | 7051 |
| <i>D. Bayntun-Lees, C. Paine Schofield</i>   |      |
| <b>GAMIFICATION IN THE DEVELOPMENT OF RESEARCH PROTOCOLS: PERSPECTIVES ON UTILITY AND CHALLENGES AMONG UNDERGRADUATE STUDENTS IN ADMINISTRATION AT THE UNIVERSITY OF VERACRUZ, MEXICO</b>                      | 7061 |
| <i>L. Perea Ramírez, C.A. Torres Gastelú, C.B. González Calleros</i>   |      |
| <b>"I'M NOT GONNA LET THEM WIN" - AN ONGOING EXPLORATION OF YOUTH ENCOUNTERS WITH HATE SPEECH AND CYBERBULLYING ON SOCIAL MEDIA</b>  | 7070 |
| <i>C. Ong, S. Krongard</i>   |      |
| <b>INCORPORATING LEARNING SCIENCES' BEST PRACTICES INTO STEM COURSEWARE</b>  | 7076 |
| <i>C. Gordon, J. Snare, Y. Rajasekhar</i>  |      |
| <b>OUTREACH VIDEOS CREATED BY STUDENTS AS A MEANS OF ACQUIRING CROSS-DISCIPLINARY SKILLS IN THE FOOD SCIENCE AND TECHNOLOGY DEGREE</b>   | 7086 |
| <i>S. Morante-Zarcelero, J. Gañan, N. Casado, I. Sierra</i>  |      |
| <b>ACHIEVING EQUITY, DIVERSITY, AND INCLUSION IN ONLINE LEARNING THROUGH AN INCLUSIVE CURRICULUM COMMUNITY OF PRACTICE</b>   | 7096 |
| <i>T. George</i>   |      |
| <b>TOWARDS AN AGILE AND DATA-DRIVEN WORK PROCESS FOR SUSTAINABLE INFRASTRUCTURE DESIGN IN MUNICIPALITIES</b>   | 7097 |
| <i>A. Svensson, J. Einarsson, A. Kumar Mishra, T. Pederson</i>   |      |
| <b>A TRANSNATIONAL EUROPEAN MULTI-CASE STUDY FOR IDENTIFYING A GREEN TOURISM AGENDA</b>  | 7103 |
| <i>S. Armenia, G. Chryssikos, E. Franco</i>  |      |
| <b>ETHICAL CONSIDERATIONS IN IMPLEMENTING TELEMENTORING AND VIDEO MODELLING FOR SURGICAL EDUCATION: A CASE STUDY OF THE CLINICALMODELLING PROJECT</b>  | 7112 |
| <i>N. Gerbaudo-Gonzalez, R. Rodriguez-Gonzalez, D. Facal, M. Pazos-Couselo, D. Rey-Bretal, M. Gando-y-Crego</i>  |      |
| <b>AI4EDU: AN INNOVATIVE CONVERSATIONAL AI ASSISTANT FOR TEACHING AND LEARNING</b>   | 7119 |
| <i>A. Vacalopoulou, V. Gardelli, T. Karafyllidis, F. Liwicki, H. Mokayed, M. Papaevripidou, G. Paraskevopoulos, S. Stamouli, A. Katsamanis, V. Katsouros</i>   |      |
| <b>PROPOSAL OF ARONSON'S PUZZLE TECHNIQUE TO IMPROVE THE DESIGN, ANALYSIS, AND INTERPRETATION OF GROUP EXPERIMENTS PERFORMED BY MASTER STUDENTS IN AGRONOMY</b>  | 7128 |
| <i>P. Arizo-García, N. Pascual-Seva, C. González-Pavón, D. Tarrazó-Serrano, S. Castiñeira-Ibáñez, A. San Bautista</i>  |      |
| <b>PROJECT-BASED LEARNING IN INTRODUCTION TO ENGINEERING DESIGN COURSE</b>   | 7135 |
| <i>J. Song</i>   |      |
| <b>ORGANIZING COMMUNICATION SUPPORT FOR BUSINESS ACTIVITY: A COURSE FOR UNDERGRADUATE STUDENTS AND PROFESSIONALS</b>   | 7140 |
| <i>M. Frolova</i>  |      |
| <b>NAVIGATING THE INTEGRATION OF FORM-FOCUSED INSTRUCTION IN IMMERSION EDUCATION: UNRAVELING KNOWLEDGE DEMANDS AND PROFESSIONAL DEVELOPMENT PERSPECTIVES</b>   | 7146 |
| <i>C. Ní Mhurchú, T.J. Ó Ceallaigh, S. Ní Aogáin</i>   |      |

|   |      |
|---|------|
| <b>IMPORTANCE OF COLLABORATION BETWEEN UNIVERSITIES AND BUSINESSES FOR THE VALORIZATION OF MADE IN ITALY WITH A VIEW TO SUSTAINABILITY AND CIRCULARITY</b><br><i>B. Chiti, G. Pontillo, G. Lotti</i>  | 7147 |
| <b>STUDENTS' PERCEPTIONS OF PRESENCE AND REALITY IN VIRTUAL REALITY ENVIRONMENT</b><br><i>P. Tekeli, A. Altun</i>   | 7156 |
| <b>LEADERSHIP TRAINING MODELS FOR JUNIOR OFFICERS AND CAPTAINS IN EUROPE</b><br><i>F. Kiluange, J.C. Dias Rouco, A.P. Silva, L.G. Fragoso Baio</i>  | 7162 |
| <b>GREEK UNIVERSITY STUDENTS' PREFERRED LEARNING STYLES IN THE CONTEXT OF DISTANCE EDUCATION</b><br><i>G. Aretoulis, E. Aretouli, P. Digkoglou, D. Manou, J. Papathanasiou, G. Tsaples</i>  | 7169 |
| <b>DESIGNING A SUSTAINABLE COMMUNICATION CAMPAIGN BY IMPLEMENTING AGILE METHODOLOGIES</b><br><i>L. Andreu, E. Bigné, P. Hauptfeld, C. Pérez-Cabañero</i>  | 7177 |
| <b>IMPLEMENTATION OF QUALITY IMPROVEMENT PLANS: EFFECTIVENESS OR COMPLIANCE? A VIEW FROM THE SOUTH</b><br><i>Z. Mdledle, E. Johannes</i>  | 7186 |
| <b>A GAMIFIED COURSE FOR TEACHERS TO GAMIFY THEIR TEACHING</b><br><i>S. Arkiin Kocadere, Ş. Çağlar Özhan, J. Marti-Parreño</i>  | 7193 |
| <b>THE ROLE OF CRITICAL AND CIVIC THINKING IN CITIZENSHIP EDUCATION</b><br><i>A. Nuzzaci, F. Orecchio, R. Romano</i>  | 7198 |
| <b>RECOMMENDER SYSTEMS TO SUPPORT STUDENTS' EMPLOYABILITY: THE CASE STUDY OF CAREPROFSYS</b><br><i>R. Birzaneanu, M.I. Dascalu, I.C. Stanica, I.A. Bratosin, A. Vasilateanu, T.M. Ursachi, R.E. Brezoaie</i>  | 7208 |
| <b>ACTIVE DIGITAL LEARNING TO ENHANCE PRACTICAL SKILLS AND MOTIVATION OF STUDENTS IN A COORDINATED MANNER ACROSS SUBJECTS RELATED TO FOOD ANALYSIS</b><br><i>S. Morante-Zarcelero, N. Casado, G. Casado-Hidalgo, B. Fernández-Pintor, J. Gañan, L. González-Gómez, G. Martínez-García, I. Martínez-García, D. Pérez-Quintanilla, J. Rodríguez-Castaño, I. Sierra, F.L. Vera-Baquero</i> | 7218 |
| <b>POSSIBILITIES AND LIMITS OF USING THE GOLDEN PROFILER OF PERSONALITY (GPOP) IN THE CONTEXT OF THE DEVELOPMENT OF UNIVERSITY STUDENTS' COMPETENCIES</b><br><i>R. Pospíšil, P. Škobrtal</i>  | 7228 |
| <b>FOSTERING CREATIVITY IN ARCHITECTURAL DESIGN EDUCATION THROUGH GAME-BASED SKETCHING</b><br><i>L. Alkhodari, S. Yıldız</i>  | 7235 |
| <b>DISTANCE EDUCATION PROGRAMS AND GREEK UNIVERSITY INSTRUCTORS: DEFINING AND ASSESSING THEIR TEACHING STYLES PREFERENCES</b><br><i>G. Aretoulis, E. Aretouli, P. Digkoglou, D. Manou, J. Papathanasiou, G. Tsaples</i>   | 7243 |
| <b>LEVERAGING SOCIAL MEDIA AND NETWORKS IN LANGUAGE EDUCATION: ENHANCING MOTIVATION AND ASSESSING ACQUISITION</b><br><i>C. Pardo-Ballester</i>  | 7249 |
| <b>IMPLEMENTING CONTENT CURATION AS A STRATEGY FOR INTEGRATING THE SUSTAINABLE DEVELOPMENT GOALS (SDGS) INTO MATERIALS SCIENCE COURSES</b><br><i>M.D. La Rubia-García, C. Rus-Casas, J.D. Aguilar-Peña, D. Eliche-Quesada</i>   | 7259 |
| <b>SOCIOECONOMIC EQUITY POLICY IN THE PORTUGUESE EDUCATION SYSTEM: THE PERSPECTIVES OF POLICYMAKERS</b><br><i>C. Toledo, T. Neves, E. Enchikova, R. Trindade, G. Nata</i>   | 7265 |
| <b>IMPLEMENTATION OF ACTIVE PEDAGOGICAL PRACTICES IN TEACHING CONSTITUTIONAL LAW TOWARDS DEMOCRACY</b><br><i>D. Alves, D. Castilhos</i>   | 7266 |
| <b>EXPLORING PISA'S INFLUENCE ON SOCIOECONOMIC EQUITY IN PORTUGUESE EDUCATION</b><br><i>C. Toledo, T. Neves, E. Enchikova, R. Trindade, G. Nata</i>   | 7273 |
| <b>LECTURERS' VIEW AT UNIVERSITAT POLITÈCNICA DE VALÈNCIA (SPAIN) ABOUT TRAINING INNOVATION, CREATIVITY AND ENTREPRENEURSHIP TRANSVERSAL COMPETENCE</b><br><i>E. Navarro-Astor, A. Llorca-Ponce, G. Rius-Sorolla, M. Sancho, M.A. Baviera Puig, A. Sapena-Bañó, P.O. Letelier Torres, G. García Martínez, P. García Segovia, A. Herrero-Debón</i>                                       | 7274 |

|   |      |
|---|------|
| <b>DIGITAL AGE FORESIGHT IN SERBIAN UNIVERSITY STRATEGIC PLANS IN DISRUPTIVE TIMES</b><br><i>O. Sedlak, R. Korhec, S. Stojkovic, J. Eremić Dođić</i>  | 7284 |
| <b>ENRICHING THE HIGH SCHOOL STEAM CURRICULUM USING ARDUINO: THE CASE OF AGUASCALIENTES</b><br><i>D. Cuartielles, I. Fajardo</i>  | 7291 |
| <b>FAVOURABLE LEARNING ENVIRONMENT FOR MODERN STUDENTS AND MEASURES FOR ITS IMPROVEMENT</b><br><i>R. Pocevicicene</i>   | 7298 |
| <b>PERFORMANCE ANALYSIS OF VIRTUAL ASSISTANTS - A CASE STUDY BASED ON THE CROATIAN LANGUAGE</b><br><i>M. Asenbrener Katic, E. Miletic, S. Candrlic</i>  | 7305 |
| <b>DEVELOPMENT OF MULTICULTURAL LITERACY OF NATIONAL AND INTERNATIONAL STUDENTS IN HIGHER EDUCATION</b><br><i>R. Pocevicicene</i>   | 7316 |
| <b>GENDER DIFFERENCES IN BELIEFS AND PREFERENCES ABOUT DISTANCE LEARNING AMONG EDUCATORS: EVIDENCE FROM FOUR EUROPEAN COUNTRIES</b><br><i>E. Aretouli, J. Papathanasiou, E. Konstantinopoulou, S. Armenia, D. Miricescu, J. Stanković, G. Tsaples, G. Aretoulis</i>   | 7323 |
| <b>21ST CENTURY SKILLS IN FOREIGN LANGUAGE LEARNING</b><br><i>Z. Strakova, I. Cimermanova, M. Sepešiova</i>   | 7329 |
| <b>COMPUTATIONAL THINKING AND PROBLEM SOLVING IN THE PISA ERA</b><br><i>J. Bilbao, E. Bravo, O. García, C. Rebollar, V. Dagienė, V. Masiulionytė-Dagienė, A. Jankauskienė, M.J. Laakso, H. Kaarto, D. Lehtonen, M. Parviainen, I. Givoen, Y. Gulbahar, T. Öztürk, F. Özdemir Öncül, N. Tan Yenigün, Z. Pluhár, P. Sarmasági, A. Pears</i> | 7335 |
| <b>TRANSFORMING EXECUTIVE AND PROFESSIONAL DEVELOPMENT BY HIGHER EDUCATION THROUGH GENERATIVE AI-BASED PEDAGOGY</b><br><i>C. Holtham</i>  | 7343 |
| <b>TEACHER EDUCATION AND THE CHALLENGES OF TRAINING NEW TEACHERS FOR NEW ERA</b><br><i>Z. Strakova, I. Cimermanova, M. Sepešiova</i>  | 7344 |
| <b>CHEMISTRY TEACHERS' BELIEFS ABOUT READING COMPREHENSION OF SCIENTIFIC TEXTS</b><br><i>S. Rojas, C. Flores, M.I. Rojas</i>  | 7351 |
| <b>DILABORATION - A DIGITAL LAB AGAINST DISADVANTAGED OPPORTUNITIES IN SOCIO-SPATIAL SEGREGATION IN GERMAN CITIES, ESPECIALLY FOR SOCIALLY DEPRIVED RESIDENTS OF CERTAIN NEIGHBORHOODS</b><br><i>M. Koplin</i>  | 7352 |
| <b>DATA DIVING: EXPLORING THE UTILITY OF DIGITAL TRACES FOR MEASURING SELF-REGULATED LEARNING IN BLENDED COURSES</b><br><i>A. Gorbunova, R. Sutarmina, M. Boitcov, A. Kapuza</i>  | 7359 |
| <b>THE INFLUENCE OF THE STUDENT'S GENDER IN THE EXPERIENCE OF DISTANCE EDUCATIONAL PROGRAMS: THE CASE OF GREEK STUDENTS</b><br><i>G. Aretoulis, P. Digkoglou, D. Manou, J. Papathanasiou, G. Tsaples, E. Aretouli</i>   | 7364 |
| <b>A PROPOSAL FOR THE INTEGRATION OF THE SUSTAINABLE DEVELOPMENT GOALS IN THE TEACHING OF PSYCHOLOGY OF PHYSICAL ACTIVITY AND SPORT</b><br><i>S. Agut, L. Sales</i>   | 7369 |
| <b>LEVERAGING ON AI MENTOR TO BOOST LEARNING EFFECTIVENESS AND EFFICIENCY</b><br><i>B. Bán</i>  | 7375 |
| <b>GENERATIVE ARTIFICIAL INTELLIGENCE IN HEALTH PROFESSIONS: A BIBLIOMETRIC DESCRIPTIVE ANALYSIS</b><br><i>A. Alves Lopes</i>   | 7384 |
| <b>THE IMPACT OF MULTITASKING ON THE COMPREHENSION, LOGICAL COHERENCE, AND RETENTION OF STIMULI IN POSTGRADUATE BIOMEDICAL STUDENTS</b><br><i>S. Malaescu, C. Chiorean, V. Petronikolou, A. Anagnostopoulou, D. Petsani, K. Tagaras, K. Mitsopoulos, P. Antoniou, P. Bamidis, E. Konstantinidis</i>                                       | 7390 |
| <b>TRANSFORMING SOCIAL RESONANCE - A CREATIVE PROJECT TO STRENGTHEN SOCIAL COHESION</b><br><i>M. Koplin</i>   | 7400 |

|   |      |
|---|------|
| <b>DEVELOPING A MINDSET FOR INCLUSION IN PRE-SERVICE TEACHERS' DIGITAL COMPETENCE</b><br><i>A. Luís, C. Rodrigues</i>   | 7405 |
| <b>TEACHING DICTIONARY SKILLS AT THE ACADEMIC LEVEL: AN EXAMPLE OF DICTIONARY-BASED ACTIVITIES IN A BUSINESS ENGLISH COURSE</b><br><i>I. Planinšek-Čikara, M. Linčir Lumezi</i>   | 7411 |
| <b>VALUATION AND FUNDING OF SCIENCE</b><br><i>I. Rosanda Žigo, J. Lasić Lazić, M. Milković, M. Šantalab</i>   | 7422 |
| <b>STRENGTHENING THE METHODOLOGY SKILLS OF POSGRADUATE STUDENTS: NETNOGRAPHY RESEARCH ON COUNTERING MISINFORMATION ON MASS SCHOOL SHOOTING</b><br><i>D. Mikulec, S. Stibohar, Z. Bagaric</i>  | 7430 |
| <b>NEW CHALLENGES FOR THE FIELD OF HIGHER EDUCATION</b><br><i>I. Rosanda Žigo, Z. Tomić, N. Lazić</i>   | 7437 |
| <b>MAJOR REASONS THAT ENABLE DOCTORAL STUDENTS IN EDD PROGRAMS TO COMPLETE DISSERTATIONS IN PRACTICE</b><br><i>J. McAtavey</i>  | 7443 |
| <b>DEMISTIFYING SURGICAL TRAINING: SUSTAINABLY ADDRESSING BARRIERS FOR SURGICAL CAREER ASPIRANTS IN THE UK</b><br><i>J. George, F. Morgan, R. Lefroy, S. Rajagopalan</i>  | 7447 |
| <b>REAL-WORLD TEAM PROJECTS AS PART OF THE INTRODUCTION TO SOFTWARE ENGINEERING</b><br><i>P. Petrovič</i>   | 7448 |
| <b>HOW DOES TEACHERS' SENSE OF ACADEMIC CITIZENSHIP AFFECT THEIR PERCEPTION OF TEACHING ABILITIES?</b><br><i>I.L. Söderberg, L. Snickare</i>  | 7459 |
| <b>CHANGE IN EQUALITY OF OPPORTUNITY IN EDUCATION OVER 20 YEARS OF PISA</b><br><i>E. Enchikova, G. Nata, C. Toledo, T. Neves</i>  | 7467 |
| <b>KEEPING PACE WITH EACH OTHER: EXPERIENCES OF AND EXPECTATIONS ON CHATGPT AMONG UNIVERSITY STUDENTS AND TEACHERS</b><br><i>S. Engerstam</i>   | 7468 |
| <b>ASSESSMENT AND MEASUREMENT IN HIGHER EDUCATION WITH MULTIPLE CRITERIA, SCALES, AND RATERS: A THEORETICAL APPROACH AND A PRACTICAL EXAMPLE</b><br><i>P. Vossen, S. Ajit</i>   | 7469 |
| <b>CORRELATION AMONG STUDENTS' PROFILE AND DISTANCE EDUCATIONAL PROGRAMS</b><br><i>G. Aretoulis, P. Digkoglou, D. Manou, J. Papathanasiou, G. Tsaples, E. Aretouli</i>  | 7476 |
| <b>INEQUALITY OF EDUCATIONAL OUTCOMES: A COMPARATIVE REVIEW OF NATIONAL TRENDS BASED ON THE 2000-2022 PISA</b><br><i>E. Enchikova, G. Nata, C. Toledo, T. Neves</i>   | 7483 |
| <b>LACK OF STAKEHOLDERS ENGAGEMENT DURING QUALITY ASSURANCE IN INFORMATION SYSTEMS DEVELOPMENT</b><br><i>R. O'Chiobi</i>  | 7484 |
| <b>USING INTERDISCIPLINARY UNPLUGGED CS ACTIVITIES TO SUPPORT THE DEVELOPMENT OF PRESCHOOL CHILDREN</b><br><i>F. Özdinç, N. Kandemir-Özdinç</i>   | 7492 |
| <b>EXPERIENTIAL LEARNING AS A CONSTRUCT FOR CHILD MOTIVATION</b><br><i>S. Querido, I. Freire Ribeiro, E. Mesquita</i>   | 7497 |
| <b>CITIZENSHIP EDUCATION IN INITIAL TEACHER TRAINING: PERCEPTIONS OF THOSE TRAINING TO TEACH</b><br><i>I. Freire Ribeiro, E. Mesquita, A. Pereira</i>   | 7502 |
| <b>THE ABC FOR PICS FROM BASIC TO COMPLEX PROBLEMS</b><br><i>R.J. Díaz Martínez, R. Villalpando Hernández, J.L. Ibarreche Cueto, G.A. Peña Ugalde, D.E. González Cabrero, D.E. Calderón Hurtado, L.C. López Motola, P.A. Arenas Morales, S.K. Uribe López Ávila</i> | 7507 |
| <b>SHAPING THE CULTURE OF QUALITY IN HIGHER EDUCATION IN THE ACADEMIC ENVIRONMENT - THE CASE OF 'UNIVERSITY PLATFORM FOR MUTUAL INSPIRATION'</b><br><i>E. Lakoma</i>  | 7514 |
| <b>COMPARATIVE ANALYSIS OF EXISTING FRAMEWORKS ON TRANSVERSAL COMPETENCES FOR HIGHER EDUCATION</b><br><i>E. Osipovskaya, A. Coelho</i>  | 7518 |

|  |      |
|--|------|
| <b>MONITORING EDUCATIONAL SYSTEMS EQUITY THROUGH PISA: THE POTENTIAL AND LIMITATIONS FOR A COMPREHENSIVE ASSESSMENT OF SOCIOECONOMIC EQUITY</b>  | 7525 |
| <i>G. Nata, E. Enchikova, C. Toledo, T. Neves</i>  |      |
| <b>BENEFITS, CHALLENGES AND CONTROVERSIES OF ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION: ALL IN OR ANXIETY INDUCING</b>   | 7526 |
| <i>J. DeBello</i>  |      |
| <b>ENHANCING REHABILITATION FOR SPINA BIFIDA: INNOVATIVE SOLUTIONS FROM THE FACULTY OF ENGINEERING</b>   | 7527 |
| <i>R.J. Díaz Martínez, R. Villalpando Hernández, A.J. Vallejo Guevara, D.E. González Cabrero, C.A. Cisneros Rodríguez, P.A. Arenas Morales, A.J. Franco Reyes, J. Aguilera de la Cruz, F.G. Zamudio Ortiz, G.A. Peña Ugalde, A.S. Gallegos González, R.U. Martínez Muñoz, D.A. Flores Carrillo, N.A. Luján, A.E. Cansino González, J.L. Ibarreche Cueto, M. González Muñoz, D.E. Calderón Hurtado, L.C. López Motola, E. Medina Leal, S.K. Uribe López Avila</i> |      |
| <b>ASSESSING POLICY EFFECTIVENESS THROUGH PISA: ANALYSIS ON THE RELATION BETWEEN PORTUGAL'S EQUITY CHANGE AND THE IMPLEMENTATION OF EQUITY POLICIES (2000-2022)</b>  | 7533 |
| <i>G. Nata, C. Toledo, E. Enchikova, T. Neves</i>  |      |
| <b>THE GEOLOGIC YELLOWSTONE EXPERIENCE: FROM VIRTUAL MINECRAFT LEARNING TO ACTIVE IN-PERSON EXPLORATION</b>  | 7534 |
| <i>S. Arnold</i>   |      |
| <b>SPECIAL TOPICS COURSES IN ABET ACCREDITED COMPUTER SCIENCE DEGREE CURRICULUM: BENEFITS AND CHALLENGES</b>   | 7535 |
| <i>J. DeBello, P. Ghazizadeh, F. Keshtkar</i>  |      |
| <b>TRENDS OF PRESENT DAY EDUCATION: STUDENT SUPPORT AND MOTIVATION IN INTERPRETING CLASSES</b>   | 7536 |
| <i>R. Mukhametzyanova, A. Gainutdinova, O. Akimova, I. Kurmaeva</i>  |      |
| <b>IMPROVING SPEAKING SKILLS THROUGH COMMUNICATIVE GRAMMAR</b>   | 7537 |
| <i>A. Gainutdinova, O. Akimova, R. Mukhametzyanova, I. Kurmaeva</i>  |      |
| <b>MULTIPLE USES OF A SENSORY GARDEN FOR SUSTAINABLE EDUCATION</b>   | 7541 |
| <i>I. Coutinho Marinho, A. Graziela Gomes Travassos, K. Gomes Lima, J. Ramires Rodrigues Silva, P. Gabrielly Jacyntho Freire, C. Calvi Anic Cabral, J. Mesquita Vidal Martínez de Lucena</i>   |      |
| <b>DEVELOPMENT OF A MOTIVATION IMPLEMENTATION CHECKLIST FOR COLLEGE COURSES</b>  | 7548 |
| <i>Y. Suzuki, R. Matsuba, S.I. Kubota</i>  |      |
| <b>COMIC STRIPS AND ITS POTENTIAL IN RESEARCH COMMUNICATION INNOVATIVE WAYS TO COMMUNICATE RESEARCH IN THE HUMANITIES: COMIC STRIPS</b>  | 7553 |
| <i>K. Salvador-Cisneros, W. Wonsang</i>  |      |
| <b>ADOLESCENT TECHNOLOGY USERS' ATTITUDES, PERCEPTIONS, EXPERIENCES, AND ENGAGEMENT WITH PROBLEMATIC INFORMATION AND INFORMATION-BASED COGNITIVE CYBERATTACKS</b>  | 7554 |
| <i>R. Honomichl</i>  |      |
| <b>EVALUATION OF SURGICAL SKILLS TRAINING IN FOUNDATION TRAINEES: FACTORS FOR LONG-TERM COURSE SUSTAINABILITY</b>  | 7565 |
| <i>S.W. Lwin, K.F.K. Suen, S.P. Koh</i>  |      |
| <b>A SYSTEMATIC REVIEW OF THE PERUSALL APPLICATION: EXPLORING THE BENEFITS AND CHALLENGES OF SOCIAL ANNOTATION TECHNOLOGY IN HIGHER EDUCATION</b>  | 7566 |
| <i>C. Craig, R. Kay</i>  |      |
| <b>HOW TO BUILD A SCHOOL – THE WORK OF MANUEL TAINHA, ARCHITECT</b>  | 7575 |
| <i>I. Simão, A.M.T. Martins-Nepomuceno, N. Juan-García</i>   |      |
| <b>INTEGRATION OF ARTIFICIAL INTELLIGENCE INTO THE GENERAL EDUCATION CURRICULUM: IMPORTANCE, APPROACHES, CHALLENGES, AND A CONCEPTUAL FRAMEWORK FOR LIBERAL ARTS UNIVERSITIES</b>  | 7582 |
| <i>Y. Tong</i>   |      |
| <b>OPTICAL SCIENCES EDUCATION BRIDGING THEORY TO PRACTICE THROUGH LOCAL, DOMESTIC, AND INTERNATIONAL OUTREACH INITIATIVES</b>  | 7590 |
| <i>D. Kim</i>  |      |
| <b>MEASURING UNDERGRADUATE STUDENT SATISFACTION AT THE CONCLUSION OF THEIR INTERNSHIPS USING SENTIMENT ANALYSIS WITH ARTIFICIAL INTELLIGENCE TOOLS</b>   | 7595 |
| <i>M. Chan-Pavón, V. Menéndez-Domínguez, R. Gil-Herrera, J. Escalante-Eúan</i>   |      |

|  |      |
|--|------|
| <b>BASIC DESIGN OF ENTREPRENEURSHIP EDUCATION AS A PERSONAL MATTER</b><br><i>A. Takahashi, M. Sasaki</i>   | 7601 |
| <b>VIRTUAL INTERNATIONALIZATION IN PHYSIOTHERAPY EDUCATION: A THREE-YEAR EXPERIENCE</b><br><i>A. Alves Lopes</i>   | 7606 |
| <b>USE OF DIGITAL TECHNOLOGIES IN VOCATIONAL EDUCATION AND THEIR CONNECTION WITH INDUSTRY 5.0</b><br><i>P. Marinič, P. Pecina</i>  | 7615 |
| <b>DEVELOPING FINANCIAL LITERACY BY USING DIGITAL COMPETENCES</b><br><i>P. Marinič, J. Válek</i>   | 7622 |
| <b>DECOLONISING THE HIGHER EDUCATION CURRICULUM: A NECESSITY IN THE ANGOLAN CONTEXT</b><br><i>F. Kiluange</i>  | 7632 |
| <b>THE EDUCATIONAL PROCESS AND ITS IMPACT ON THE DEVELOPMENT OF CRISIS MANAGER SKILLS</b><br><i>A. Kelíšek, J. Kubás, S. Strelcová, M. Ballay</i>  | 7633 |
| <b>THE IMPORTANCE OF THE LEVEL OF PROFESSIONAL COMPETENCE OF MEMBERS OF VOLUNTARY FIRE BRIGADES, AS A CRUCIAL FACTOR FOR INCREASING SAFETY IN MUNICIPALITIES</b><br><i>M. Ballay, J. Kubás, S. Strelcová, A. Kelíšek</i>   | 7640 |
| <b>IDENTIFY TRAINING REQUIREMENTS FOR REMOTE CONTROL OPERATORS OF MARITIME AUTONOMOUS SHIPS</b><br><i>M. Baldauf, D. Rostek</i>  | 7646 |
| <b>NAVIGATING THE ETHICAL LANDSCAPE OF AI INTEGRATION IN EDUCATIONAL SETTINGS</b><br><i>N. Nur, S.J. Goh, J. Patel, M. Mizrahi</i>   | 7654 |
| <b>NAVIGATING THE CHALLENGES: UNDERSTANDING ANXIETY AMONG INTERNATIONAL GRADUATE STUDENTS IN THE UNITED STATES</b><br><i>S. Sudhakaran, N. Nur, A. Zarraa</i>  | 7664 |
| <b>PEDAGOGICAL CONTRIBUTIONS FOR ENGLISH LANGUAGE TEACHING</b><br><i>A. Luís</i>   | 7673 |
| <b>TECHNOLOGY ACCESSIBILITY. PROMOTING INCLUSION FROM THE UNIVERSITY</b><br><i>J. Díaz, M.A. Osorio, P. Amadeo, A. Schiavoni, I. Harari</i>  | 7679 |
| <b>OPEN SOCIETY UNIVERSITY NETWORK: GLOBAL LEARNING IN A NETWORKED FORMAT</b><br><i>A. Tarnai, E. Egensteiner</i>  | 7689 |
| <b>COMMUNITY ENGAGEMENT IN THE CLASSROOM: A CASE STUDY, OPEN SOCIETY UNIVERSITY NETWORK</b><br><i>A. Tarnai, E. Egensteiner</i>  | 7690 |
| <b>DEMOCRATIZING LEARNING</b><br><i>P. Hunter</i>  | 7691 |
| <b>NAVIGATING THE EVOLUTION OF ARTIFICIAL INTELLIGENCE: TOWARDS EDUCATION-SPECIFIC RETRIEVAL AUGMENTED GENERATIVE AI (ES-RAG-AI)</b><br><i>A. Elmessiry, M. Elmessiry</i>  | 7692 |
| <b>LEARNING ABOUT THE CONSTRUCTION OF CITIZENSHIP FROM THE IMPLEMENTATION OF THE PEACE CHAIR IN CARTAGENA DE INDIAS – COLOMBIA</b><br><i>L. Garcia-Noguera, I. Silva, Ó. Otálvaro</i>                                      | 7698 |
| <b>THEMATIC ANALYSIS OF STUDENT PERCEPTIONS OF A VIRTUAL SIMULATION ENCOUNTER AND PEER-LED DEBRIEF</b><br><i>K. Langston, B. Tran, J. Roye, K. Campbell</i>  | 7702 |
| <b>A PROFILE OF THE PREFERRED INSTRUCTOR FOR DISTANCE EDUCATION AS CONSIDERED BY ITALIAN STUDENTS</b><br><i>T. De Angelis, L. Balleri, G. Aretoulis, S. Armenia, I. Messuri</i>  | 7708 |
| <b>CRITICAL THINKING EDUCATION AS A TOOL OF INCREASING MEDIA LITERACY</b><br><i>V. Soltes, V. Adamova, B. Liska</i>  | 7715 |
| <b>AMSHI: ADVANCED SOLUTIONS FOR MITIGATING THE IMPACT OF HEAT ISLANDS ON URBAN ROADS THROUGH AN INTER-ACADEMIC AND MULTIDISCIPLINARY INTERNATIONAL HONOUR PROGRAM</b><br><i>B. Di Prete, C. Mastrantoni, M. Mazzolani</i> | 7723 |

|  |      |
|--|------|
| <b>BRIDGING STEAM AND INCLUSIVE EDUCATION IN THE SPICE PROJECT</b>   | 7732 |
| <i>N. Spyropoulou, G. Sakellaropoulou, A. Kameas</i>   |      |
| <b>A METHODOLOGY FOR DEVELOPING TRAINING AND MENTORING PROGRAMS: EMPOWERING INSTRUCTIONAL DESIGNERS TO CREATE COURSES ALIGNED WITH THE DIGCOMP FRAMEWORK</b>                             | 7737 |
| <i>N. Spyropoulou, A. Kameas, R. Kalantzi, G. Vonitsanos</i>   |      |
| <b>INTEGRATION OF BLENDED LEARNING IN ARCHITECTURE: FROM DIGITAL DESIGN TO PARAMETRIC FABRICATION</b>  | 7744 |
| <i>N. Araujo, J. Eiji</i>  |      |
| <b>THE CONNECTION BETWEEN EDUCATION IN THE FIELD OF CRIMINALISTICS AND STUDENT RESEARCH ACTIVITIES</b>   | 7748 |
| <i>V. Adamova, V. Soltes, M. Madlenak</i>  |      |
| <b>GOVERNANCE MODELS FOR HIGHER EDUCATION INSTITUTIONS</b>   | 7758 |
| <i>A.K. Tripathy</i>   |      |
| <b>DIVERSE HIGHER EDUCATION INSTITUTIONS AND STANDARDISED INTERNATIONAL RANKINGS</b>   | 7762 |
| <i>N.S. Bisht, A.K. Tripathy</i>   |      |
| <b>PROJECT-BASED LEARNING IN THE COMPLETION OF VOLUNTARY TASKS TOGETHER WITH THE PERFORMANCE AND SUCCESS RATES OF ENGINEERING STUDENTS</b>   | 7766 |
| <i>N. Uriarte, I. Uriarte</i>  |      |
| <b>ENHANCING STUDENT LEARNING</b>  | 7771 |
| <i>J. Elmer, A. Dingli</i>   |      |
| <b>CVRRICULUM PROGRAM: EMBEDDING VIRTUAL REALITY AS AN EXPERIENTIAL EDUCATION MEDIUM TO TEACH EMPATHY</b>  | 7780 |
| <i>E. Peisachovich, L. Appel</i>   |      |
| <b>TEACHING EMPATHY TO HEALTHCARE PROVIDERS AND CAREGIVERS OF PERSONS LIVING WITH DEMENTIA USING AUGMENTED REALITY</b>   | 7781 |
| <i>E. Peisachovich, K. Kapralos, G. Hollaender, C. Culver, A. Dubrowski</i>  |      |
| <b>AN INTERDISCIPLINARY APPROACH: EXPLORING ENVIRONMENTAL IDENTITY IN EAST TIMOR THROUGH THE GUIDANCE OF AN ACADEMIC THESIS</b>  | 7785 |
| <i>F.L. Soares Pereira, R. Florencio da Silva</i>  |      |
| <b>DEVELOPING AND IMPLEMENTING CHILD RIGHTS EDUCATION IN DIVERSE GLOBAL SETTINGS: A PARTICIPATORY ACTION RESEARCH PROJECT WITH TEACHERS AND CHILDREN IN UGANDAN AND CANADIAN SCHOOLS</b> | 7789 |
| <i>S. Jones, K. Manion</i>   |      |
| <b>AWARENESS THROUGH ENVIRONMENTAL EDUCATION ON THE POTABLE WATER SITUATION IN MOZAMBIQUE</b>  | 7790 |
| <i>R. Florencio da Silva, F.L. Soares Pereira, A.J. Mc Namara Valdes, M.N. Mabui Dimande</i>   |      |
| <b>TEACHING SKILLS IN THE USE OF ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION</b>   | 7795 |
| <i>J.L. Armijos Carrión, Y.M. Portela Leiva, S.D. Reyes Loaiza, D.G. Solano Sisalima, Y. Esquivel Rivero</i>   |      |
| <b>KNOWLEDGE DIALOGUE AS A PEDAGOGICAL STRATEGY TO REDUCE THE EDUCATION DIGITAL DIVIDE</b>   | 7800 |
| <i>Y.M. Portela Leiva, J.L. Armijos Carrión, M.E. Palomeque Solano, T.P. Vega Henríquez, Y. Esquivel Rivero, M.C. Loján Carrión</i>  |      |
| <b>TEACHING ELECTRICAL ENGINEERING STUDENTS THROUGH CREATIVE MOVEMENT ON THE TOPIC OF "GREEN TRANSITION"; VALIDATION THROUGH PSYCHOPHYSIOLOGY</b>  | 7806 |
| <i>V. Geršak, G. Gersak</i>  |      |
| <b>FLUENCY UNLOCKED: TEACHING LANGUAGE THROUGH CONTEXTUALIZED PRAGMEMES AND CULTUREMES</b>   | 7807 |
| <i>H. Al Sharoufi</i>  |      |
| <b>FIELD TRIPS AS A TOOL TO HOLISTICALLY LEARN STRUCTURAL DESIGN</b>   | 7808 |
| <i>I. Payá Zaforteza, E. García-Castillo, C. Lázaro-Fernández</i>  |      |
| <b>BRIDGE INSPECTION AND MAINTENANCE IS IMPORTANT! AN AWAKENING EXPERIENCE IN A CIVIL ENGINEERING COURSE ON PHILOSOPHY OF STRUCTURES</b>   | 7815 |
| <i>E. García-Castillo, I. Payá Zaforteza, R. Mansilla-Ruiz</i>   |      |

|  |      |
|--|------|
| <b>THE EVOLUTION OF TRAINING METHODOLOGIES IN A 16-YEAR EXPERIENCE IN THE FRAMEWORK OF THE BETTER TRAINING FOR SAFER FOOD PROGRAMME: SCALABLE AND TRANSFERABLE LESSONS LEARNED AND BEST PRACTICES</b><br><i>F. Pompei, C. Albanello, A. Falconi, O. Pediconi, M. Piersanti, B. Alessandrini, S. D'Albenzio</i> | 7823 |
| <b>UNVEILING THE NEXT WAVE OF LEARNING: NAVIGATING CHATGPT'S IMPACTFUL APPLICATION IN EDUCATION</b><br><i>S. Jancheska, M. Jancheski</i>   | 7833 |
| <b>UNLOCKING THE FUTURE OF EDUCATION: A COMPREHENSIVE ANALYSIS OF KEY DOCUMENTS SHAPING ARTIFICIAL INTELLIGENCE IN EDUCATION</b><br><i>M. Jancheski, S. Jancheska</i>  | 7834 |
| <b>DEVELOPMENT OF NUMERICAL STRATEGIES IN INTEGRATED PHYSICS AND MATHEMATICS COURSES</b><br><i>AJ. Sánchez Hernández, DD. Jiménez Suro, EM. Hernández Cooper, RD. Santiago Acosta</i>  | 7835 |
| <b>DEVELOPMENT OF SKILLS IN SOLVING PROCEDURAL AND MATHEMATICAL MODELING PROBLEMS IN HIGHER EDUCATION CALCULUS STUDENTS THROUGH A PLATFORM WITH SYMBOLIC RESPONSE</b><br><i>DD. Jiménez Suro, AJ. Sánchez Hernández, RD. Santiago Acosta, EM. Hernández Cooper</i>   | 7843 |
| <b>WHAT IS A COMMUNITY OF MEANING?</b><br><i>S. Azulay</i>   | 7847 |
| <b>ASPECTS OF FOREIGN LANGUAGE TEACHING TO MULTIETHNIC AND MULTICULTURAL STUDENT GROUPS. CASE STUDY OF INCOMING UKRAINIAN STUDENTS</b><br><i>G.A. Necula</i>   | 7848 |
| <b>ASPECTS OF GENDER EQUALITY IN SPORTS EDUCATION IN THE REPUBLIC OF MOLDOVA</b><br><i>G. Braniste</i>   | 7849 |
| <b>DISCOVERING INSECTS TO OVERCOME STEREOTYPES. A DIDACTIC RESEARCH IN BIOLOGY EDUCATION IN KINDERGARTEN</b><br><i>E. Puller, G. Veronese, S. Pacchini, E. Piva, S. Schumann, G. Vanzan, P. Irato, G. Santovito</i>  | 7850 |
| <b>EDUCATE ABOUT THE RICHNESS OF BIODIVERSITY. USING THE SQUARE TECHNIQUE TO DISCOVER THE ECOLOGICAL VALUE OF BIOLOGICAL VARIETY IN AN OUTDOOR SCHOOL</b><br><i>M. Morello, E. Piva, S. Pacchini, S. Schumann, G. Vanzan, P. Irato, G. Santovito</i>   | 7860 |
| <b>DIGITAL PLATFORMS IN HIGHER EDUCATION IN LIGHT OF INDUSTRY 4.0</b><br><i>I. Milošević, J. Ruso, A. Rakić</i>  | 7870 |
| <b>CAN ONE SIMULATE THE ENTIRE ENTREPRENEURIAL PROCESS IN A PHYSICAL CLASSROOM - LEARNINGS FROM DEPLOYMENT OF AN EDUCATIONAL BOARD GAME ESHIP: NAVIGATING UNCERTAINTY AT A MASTERS LEVEL ENTREPRENEURSHIP COURSE</b><br><i>R.V. Basaiawmoit</i>  | 7875 |
| <b>USE OF INTERNET RESOURCES IN FOREIGN LANGUAGE LEARNING</b><br><i>N. Sigacheva, G. Eremeeva, M. Sigachev</i>   | 7876 |
| <b>DEVELOPING ORAL COMMUNICATION SKILLS - ROMANIAN AS A FOREIGN LANGUAGE - LEVEL A1- A2</b><br><i>G. Ciobotaru</i>   | 7884 |
| <b>A REVIEW OF COMPETENCY BASED EDUCATION IN COLLEGE ECONOMICS COURSES</b><br><i>K. Adzima</i>   | 7889 |
| <b>STUDENT SELF-SELECTION OF THEIR FINAL EVALUATION: AN EDUCATIONAL EXPERIENCE FOR INSTRUCTORS AND STUDENTS</b><br><i>J. Richards</i>  | 7890 |
| <b>COERCIVE MEASURES WITH AN EDUCATIONAL CHARACTER</b><br><i>A. Nastas</i>   | 7891 |
| <b>GETTING TO KNOW SCIENCE FROM SCIENTISTS - ENCOURAGING SCIENTISTS TO TALK ABOUT SCIENCE</b><br><i>L. Halbrügge</i>   | 7892 |
| <b>CAPACITAR PROJECT: SKILLS FOR ACCESS TO THE WORLD OF WORK. A PARTNERSHIP BETWEEN THE COMPANY ALLOG GROUP AND INSTITUTO CRESCER IN DEVELOPING A PROFESSIONAL QUALIFICATION COURSE FOR BRAZILIAN YOUNG PEOPLE</b><br><i>J. Bondicz, M. Borges, A. Caregnato</i>   | 7893 |



|  |      |
|--|------|
| <b>CRESCER PROJECT: LEADERSHIP FOR THE 21ST CENTURY – INTERNATIONAL PARTNERSHIP BETWEEN FUNDACIÓN MAPFRE AND INSTITUTO CRESCER TO DEVELOP A PROFESSIONAL QUALIFICATION COURSE FOR BRAZILIAN YOUNG PEOPLE AND ADOLESCENTS</b> | 7894 |
| <i>J. Bondicz, M. Borges, A. Caregnato</i>   |      |
| <b>ENHANCING AWARENESS OF THE PROS AND CONS OF GROUP LEARNING: COLLABORATING WITH EDUCATORS TO NAVIGATE CHALLENGES IN DESIGNING EFFECTIVE ACTIVITIES</b>   | 7895 |
| <i>M. Milani</i>   |      |
| <b>DEVELOPING ENTREPRENEURSHIP AND MARKETING SKILLS THROUGH BUSINESS GAMES</b>   | 7900 |
| <i>C. Pérez-Cabañero, E. Bigné, E. Caplliure, A. Cuenca, C. Martínez, J.E. Selma</i>   |      |
| <b>VISUAL CODES AND MULTIMODAL LEARNING: ENHANCING ENGLISH LANGUAGE ACQUISITION IN HISPANIC CHILDREN FROM AN EARLY AGE</b>   | 7904 |
| <i>R. Jolley Rangel, P. Paredes, V. Vinuesa</i>  |      |
| <b>EVOLUTION OF TEACHING METHODS FOR ENTREPRENEURSHIP: A COMPARATIVE ANALYSIS OF IN-CLASS AND ONLINE TRAINING APPROACHES FOR ADULT LEARNERS</b>  | 7905 |
| <i>A.P. Pavel, A.R. Iordache-Munteanu</i>  |      |
| <b>ADAPTING EDUCATIONAL APPROACHES FOR SUSTAINABLE AIR TRANSPORT</b>   | 7913 |
| <i>A.P. Pavel, S.E. Zaharia, A.R. Iordache-Munteanu</i>  |      |
| <b>SYNCHRONIZED IOT BASED DIGITAL TWIN MANAGEMENT PLATFORM FOR FLEXIBLE WIND FARM OPERATION – SYNC-TWINWIND ACADEMIC PROJECT</b>   | 7921 |
| <i>S. Skok, M. Mak, A. Vaccaro, S. Djokic</i>  |      |
| <b>STUDENTS AS CO-CREATORS OF AN ENVIRONMENT-FRIENDLY CAMPUS IN TIMISOARA</b>  | 7929 |
| <i>M. Cernicova-Buca, V. Gherheș, A. Palea, G.M. Dragomir</i>  |      |
| <b>RELATIONSHIP BETWEEN STUDENTS’ ICT INTERACTIONS AND SCIENCE ACHIEVEMENT: SEM ANALYSIS</b>   | 7938 |
| <i>F. Örnek, E. Afari, S. Alaam</i>  |      |
| <b>INSTRUCTIONAL LEADERSHIP PRACTICES THAT ENHANCE SCHOOL PERFORMANCE: CASE STUDY OF SELECTED QUEENSTOWN, EASTERN CAPE SCHOOLS</b>   | 7943 |
| <i>K. Nyikanyika, M.S. Mkhomi</i>  |      |
| <b>THE DIGITAL DIVIDE: DIGITAL TRANSFORMATION, EMPLOYMENT AND INCLUSIVE GROWTH IN SOUTH AFRICA</b>   | 7954 |
| <i>N.C. Lesame</i>   |      |
| <b>APPRAISAL ON THE USE OF DIGITAL TECHNOLOGY AS A MEANS OF ACHIEVING LEAN PROJECT DELIVERY</b>  | 7963 |
| <i>A.B. Sholanke, J. Eleagu</i>  |      |
| <b>THE USE OF THE INTERNET FOR STUDENT PERFORMANCE AT SELECTED SOUTH AFRICAN UNIVERSITIES STRUGGLING WITH DIGITAL DIVIDES</b>  | 7972 |
| <i>N.C. Lesame, N.C. Baloyi</i>  |      |
| <b>HISTORY OF SCIENCE AND TECHNOLOGY IN STEAM APPROACHES: IMPACTS OF A NON-FORMAL EDUCATION PROJECT ON THE DEVELOPMENT OF PARTICIPANTS' SCIENTIFIC LITERACY</b>  | 7980 |
| <i>C. Venturine, I. Malaquias</i>  |      |
| <b>DEVELOPMENT OF A PSYCHOMETRIC INSTRUMENT TO DIFFERENTIATE STUDENTS' PERSONAL CHARACTERISTICS IN MASTER'S PROGRAMS IN THE FIELD OF EDUCATION</b>   | 7989 |
| <i>A. Terekhova, E. Sidorkina</i>  |      |
| <b>APPROACHING SOLUTIONS FOR INCLUSIVITY THROUGH THE USE OF 3D-PRINTING IN THE END-OF-DEGREE PROJECT: A SERVICE-LEARNING METHODOLOGY</b>   | 7993 |
| <i>A. Jimenez Suarez, A. Cortés, S. García-Rodríguez, A. Rodríguez Lorente</i>   |      |
| <b>NATIONAL AND INTERNATIONAL EXPERIENCES IN THE FIELD OF SOCIO-EDUCATIONAL INCLUSION OF YOUNG PEOPLE WITH DISABILITIES</b>  | 7994 |
| <i>S. Racu, N. Cebotaru</i>  |      |
| <b>DEVELOPMENT OF A CLIMATE CHANGE INTEGRATED SCIENCE EDUCATION CURRICULUM FOR PRE-SERVICE TEACHERS: A MULTIDISCIPLINARY PERSPECTIVE TO KNOWLEDGE INTEGRATION</b>  | 7999 |
| <i>K. Booï</i>   |      |

|   |      |
|---|------|
| <b>DESIGN, DEVELOPMENT, AND EVALUATION OF THE ROUNDNESS OF MACHINED PARTS IN PRACTICAL TRAINING</b>   | 8005 |
| <i>M. Ramirez-Peña, M. Batista, I. Del Sol, J. Salguero, J.M. Vazquez-Martinez</i>  |      |
| <b>IMPROVEMENT IN THE PRACTICAL TEACHING OF SAND-CASTING PROCESSES THROUGH THE USE OF ADDITIVE MANUFACTURING TECHNIQUES</b>   | 8011 |
| <i>J.M. Vazquez-Martinez, M. Batista, I. Del Sol, J. Salguero, M. Ramirez-Peña</i>  |      |
| <b>IMPROVING THE STANDARD OF TEACHING AND LEARNING OF LIFE SCIENCES AT A SOUTH AFRICAN SECONDARY SCHOOL THROUGH INTEGRATION OF ICTS</b>   | 8017 |
| <i>Z. Mkhanyiswa, K. Booii, M. Moyo</i>   |      |
| <b>GENERATIVE READER: EXPLORING THE USE OF GENERATIVE AI IN ENHANCING READING EXPERIENCES FOR CHILDREN WITH DYSLEXIA</b>  | 8023 |
| <i>N. Li</i>  |      |
| <b>ARE HISTORICALLY DISADVANTAGED RURAL SCHOOLS IN SOUTH AFRICA CAPACITATED TO ENGENDER A CULTURE OF SOCIAL JUSTICE AMONGST THEIR LEARNERS?</b>   | 8028 |
| <i>N. Gqeba, L. Gqeba</i>   |      |
| <b>SELF-EVALUATION ROLE IN TEACHING AND LEARNING</b>  | 8034 |
| <i>L.B. Peral, P. Ebrahimzadeh, M.F. Barbés, M.A. Argüelles, I.F. Pariente</i>  |      |
| <b>SIMPLE LINEAR REGRESSION OF SOCIAL MEDIA ACTIVITY AND STUDENT PERFORMANCE IN MINE SURVEYING STUDIES</b>  | 8035 |
| <i>M. Mpanza</i>  |      |
| <b>ENSURE EDUCATIONAL ENCOURAGEMENT FOR STUDENTS IN LEARNING MATHEMATICS USING THE DIGITAL PLATFORM AS A TECHNOLOGICAL APPLICATION IN THE TEACHING PRACTICE OF TEACHERS IN A SCHOOL CONTEXT</b> | 8044 |
| <i>A. Henriques</i>   |      |

# TEACHING DESIGN AND ACTIVELY APPLYING IT THROUGH PROJECT-BASED LEARNING FORMAT: A PRACTICAL CASE STUDY OF A COLLABORATION BETWEEN A UNIVERSITY COURSE AND A COMPANY

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## Abstract

Project-Based Learning (PBL) is one of the most popular strategies for facilitating experimentation and the transfer of design principles. For many years, the literature has highlighted how beneficial this approach is for helping students understand and assimilate the core ideas of a subject. In fact, it is founded on the constructivist finding that when students apply their own ideas and work practically, they comprehend subjects more quickly and easily.

This research is based on the practical example of a collaboration between a company and a university course. The company, an industry leader in smart products, decided to collaborate with the university to explore new possibilities. The course faculty and the company reference people jointly developed a brief for the students as part of a PBL project. Fifty students had the opportunity to cooperate with the company for four months. During this time, they got to know the company, analysed it and proposed new directions to support the company in engaging new customers. Thanks to the application of PBL, the students experienced the project first-hand, being able to continually confront both the lecturer and the company contact people. This enabled students' increasing and participative engagement.

The article shows and discusses the different steps applied during the PBL project, focusing both on students' perspectives and on the benefits achieved (and declared) by the company thanks to this collaboration and the adopted format. The study demonstrates how PBL is an effective and useful approach in the design world to tackle ambitious challenges and generate new ideas. It also proves how it is not only educational for students but also how the results that can be achieved are real and interesting for companies.

Keywords: Design teaching, design studio, project-based learning, experimental learning, university-industry collaboration.

## 1 INTRODUCTION

Over the past two decades, a significant body of literature has stimulated the discussion over how to transfer and teach design knowledge in the fields of innovation, management, and design. Much of his teaching is related to practical activities, following the principle of learning by doing.

In this perspective, one of the formats that lend itself particularly well to the transfer of design education through practice is Project Based Learning (PBL).

PBL has been defined in a variety of ways. However, the literature states that students can solve novel and creative challenges by experiencing them firsthand. The proactivity it requires has often been described as an enabler of meaningful experiences.

PBL has also been recognized to help develop a crucial skill needed inside the design processes: becoming a more efficient problem solver. It also reflects teamwork, which is another essential quality in the design profession. It has been noted that the classroom transforms into a community of learners due to the collaborative approach that PBL demands.

This research aims to focus on how PBL can be a valid method for teaching in the design world. To support this theory, a practical case involving a collaboration between a company and a university course is examined.

Fifty students challenged themselves to develop innovative ideas for the company. The PBL approach was mixed with Design Thinking (DT) phases.

This is because Design Thinking is emerging as a paradigmatic approach to innovation in academic research debates and classroom instruction. Studies demonstrated how Design Thinking training gives the possibility to shift away from an excessive emphasis on traditional passive teaching methods to a more active problem-based learning.

The phases taken as reference in the project development in PBL format were those conventionally coded in the Double Diamond. The process is composed by four main phases: Discover, Define, Develop and Deliver.

This choice was made to understand how PBL can actually work in the design world. Moreover, it served to highlight how the mix of PBL and DT can tackle ambitious challenges and bring innovative results that are not only didactically useful but also beneficial for real actors such as companies.

The article is articulated into four main sections. In the first part, the theoretical background presents how PBL has been theorised, its main characteristics and how it is an effective way of learning by doing. Subsequently, the same section takes up the key steps of the Design Thinking process, describing how the two methods were mixed in the present study. The methodology follows, describing how the research has been structured and the sample used inside the study. Later, results analysis shows the different activities performed in applying PBL through DT phases inside the study and the related output achieved. The last part discusses the benefits that have emerged from this study in applying PBL in the design world, highlighting both the benefits for the participants and the benefits found by the company involved in the study.

## **2 THEORETICAL BACKGROUND**

### **2.1 Project-based learning: learning fast by being engaged**

Learning is not only related to theoretical notions but can also result from what is experienced and transformed into knowledge [1]. Therefore, if we build on this view of learning, one of the most valuable processes for learning by doing is represented by the "Project Based Learning" format.

PBL has been described as a comprehensive way of teaching and learning in the classroom that is designed to get students interested in researching new and real-world problems [2][3]. The project acts as the primary teaching tool in PBL, providing students with an opportunity to engage with and acquire the discipline's core concepts [4].

The concept came from studies conducted more than a century ago by John Dewey [5], who showed that students were actively involved in their learning when they were encouraged to participate in activities that replicated what professionals did in real-world settings. The absence of opportunity for learners to construct their own knowledge of the phenomenon is linked to a greater difficulty in learning associated with strictly theoretical approaches [6]. It is rooted on the constructivist finding that when students apply their own ideas and work practically, they comprehend subjects more quickly and easily [7].

This is made achievable through PBL because it represents a student-centered instructional approach that is based on the need that students engage with others, share their knowledge and comprehension of the material, and take an active role in their education [8].

According to Blumenfeld et al. [2], the project definition for students must "be crafted to connect activities and the underlying conceptual knowledge that one might hope to foster". Meaningful experiences for learners are being made possible by the proactive nature that PBL demands [9].

According to published studies, projects should be realistic rather than academic, and they should have elements that give them a sense of authenticity. Organizing this way of learning requires the creation of a challenge able to motivate students: it is necessary to create interest and produce value for students in the assigned projects.

Typically, a "driving question" or an ill-defined problem is used for this [10]. Students do engage in a productive exploration process through projects; this is made through a process that includes inquiry, knowledge creation, and problem-solving.

Being educated in a project context entails defining objectives, choosing a plan of action, integrating complexity and ambiguity, accepting risk, and experimenting with non-school-like scenarios that can be prototyped and tested in real-world settings.

To do this, tasks must be diversified and have fresh aspects; the challenge must also be real and demanding; projects must also have a sense of completion, requiring concepts to appear in the form of tangible artefacts [11].

Over time, it has been recognized that the PBL method allows for the advancement of project management abilities as well as the improvement of people's creative attitudes and project readiness [2] [4] [10].

## 2.2 Mixing PBL and Design Thinking: a hands-on way to innovate

While the majority of PBL-related academic research dates from the 1980s and 1990s, teaching design has recently drawn the interest of academics and experts, partially integrating and strengthening PBL pedagogies [12]. In particular, Design Thinking is emerging as a paradigmatic approach to innovation in academic research debates and classroom instruction. It combines creative and intuitive thinking, strengthens user empathy, facilitates discussion and consensus through visual thinking, substitutes abduction for deduction and inductive reasoning, and makes particular use of "how might be" and "what-if" questions [13] [14] [15] [16].

Glen et al. [17] conducted a theoretical investigation on Design Thinking training, highlighting the broader trend in education to shift away from an excessive emphasis on passive teaching methods and toward more active problem-based learning. These authors reaffirm the advantages of teaching Design Thinking, highlighting how it supports the development of interpersonal skills related to teamwork, the capacity to work with multidimensional contexts and solutions associated with active engagement in real-world situations, the capacity to work through the innovation process, and the learning through the use of specific tools.

This growth of interest around design approach, methods and tools raises from the evolution of design discipline itself, which is gradually moving toward a way of working and thinking that is focused on creating solutions and intangible offers that deal with complex problems [18].

Using the Design Thinking approach to perform the project activities is particularly good for the development of the final solution. This is because it presumes that designers have empathy for all parties involved, including the end user, and can rely on their pain points to address solutions. Additionally, Design Thinking approach emphasizes both divergent and convergent phases, wherein several solutions are developed to address the initial difficulty. Ideation is considerably more than just a eureka moment since the methodology doesn't stop at the first thought; instead, it explores a wide variety of ideas by moving through several solutions.

This is necessary to prevent the development of a product or service that no one wants. Design Thinking nature can assist in creating concepts, products, and services that take real-world issues into account as a source of inspiration for innovation [19].

One of the most used representations of the Design Thinking process is the Double Diamond. It was developed by the Design Council in 2005. It is represented by a double diamond reflecting the divergent and convergent stages of the design process. This model is also known as 4 D model because of the name of each phase that starts with a "D": Discover, Define, Develop and Deliver [20].

- During the *discover* stage, insights are gathered. In order to gather pertinent data and identify patterns, we must approach the user context by entering into users' lives and observing them. This is what distinguishes the outside-in method: outside perspectives are incorporated into the organization to foster innovation.
- During the *define* stage, new frames are created by utilizing insights. The aim is to formulate novel approaches to address the issue and establish fresh avenues for innovation.
- During the *develop* stage, concepts are created. More precisely, the goal is to generate new concepts following the previously established paths. It is a diverging activity since solving the problem requires generating numerous ideas. The secret to originality and diversity is quantity.
- During the *delivery* phase, prototypes are made to test the chosen path of action. Asking users for feedback on the work that was generated during this creative process is the goal.

This process is iterative. The final ultimate solution will not always result from following the complete path once. It is necessary to use the input gathered during the *deliver* phase to guide a new round of the process starting again from the *discover* phase. The goal is to create a completed product or service that can be introduced to the market [21].

### 3 METHODOLOGY

This paper is based on a project conducted with a real company as part of a master's course in the School of Design at the Politecnico di Milano.

A company, an industry leader in smart products, requested the opportunity to collaborate with the university. This was done in order to explore new possibilities.

Fifty students had the opportunity to develop the project during one of the courses in their curriculum. The project was carried out in groups of five students, with a weekly discussion with the lecturers.

Intermediate presentations and photo and video materials were collected during the process to document what the students had done. As suggested by Frick and Reigeluth [23] and Merriam and Tisdell [23], qualitative data were collected through the methods of real-time/video observations.

The course faculty, together with the company, set up a brief. The brief was then presented to the students who had the opportunity to develop a design solution in four weeks. Both the course faculty and the company remained available to the participants and organised review meetings both separately and collectively.

The structure adopted for the project reflects the PBL approach. Furthermore, considering the nature of the course in which the project was inserted and the company's desire to develop new human-centered solutions, it was decided to mix the PBL approach adopting the Design Thinking phases covered in the relevant section of the literature review.

### 4 ACTIVITIES AND RESULTS

During the four-month process, as previously mentioned, the four classical phases of Design Thinking were followed in pursuing the project with a typical PBL approach. For this reason, the four Design Thinking phases explained on a theoretical level in the literature review are resumed below and used to present the results obtained.

For ease of understanding of the different steps performed by participants during the process, the different activities have been schematised in Figure 1. It also shows the connection of the different activities to the respective phases of the Design Thinking process.

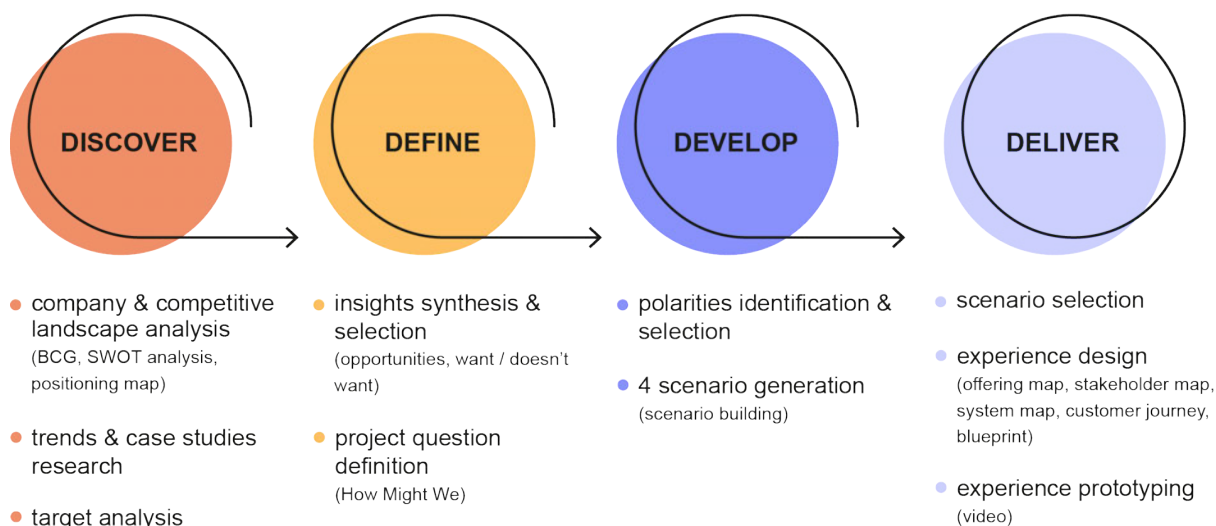


Figure 1. Project activities divided into the four phases of the design process (The authors, 2023).

#### 4.1 Discover

During the Discover phase students explored and detailly analysed both the company itself and the external environment that could influence the project activities - including final users and the company's employees – by applying strategic design tools.

Thanks to the cooperation with the company, students had the chance to collect both second-hand and first-hand data, thus replicating the research activities usually occurring in the work-world. Specifically,

company representatives held a dedicated lecture on its history, characteristics, and goals, with a specific focus on the product portfolio. Moreover, pupils integrated their comprehension of the topic through field research, by visiting the company's flagship store as well as stores located in shopping malls. In this way, they could observe how the company is promoting, displaying, and proposing its smart products as well as interview store clerks to gain their perspective. These collected data informed all students' Discover activities, that are explained hereunder.

Research activities started with the scrutiny of the company's product portfolio to identify products categories and sub-brands. In this step, students applied as a tool the BCG Matrix, a portfolio management framework that allowed them to analyse the proposed products in relation to their relative market share and growth [24]. Each team then examined the company's strengths and weaknesses as well as external opportunities and threats through the SWOT analysis. The purpose was to identify and examine the company's existing resources, both internally and externally, including the impact of current trends, in order to identify possible positive and negative implications on the business [25].

The results of these first two activities guided them in the selection of relevant aspects to look at when studying the competitive landscape. Indeed, pupils identified a series of significant players active in the same market field and evaluated them through a positioning map, based on the previously selected aspects. Students also investigated the specific target the company is currently addressing, to better define the customers' profiles they should later focus on when developing their solutions. Finally, they integrated this analysis with research on trends – both related to the world of smart products and other contexts of interest – and on case studies relevant for the brief proposed by the company with the aim to gain a deeper understanding of the overall project context.

## 4.2 Define

In the Define phase students synthesized the research insights gathered during the previous phase, to transform the received brief into a specific project question to solve. Indeed, the overall aim of the PBL activity was the same for all the involved students - proposing new directions to support the company in engaging new customers - but each team addressed it from a different perspective, based on their Discover activities and results. In this way, the class worked on multiple possible directions (one for each team), ensuring a greater level of differentiation in terms of potential outputs for the company. The faculty had a guiding role, supporting each group of students in the definition of their project question, based on the carried-out research activities.

This phase began with the selection of the most significant insights emerged in the Discover phase. These insights became the starting point to define the specific needs and problems that the identified target might have within the project context, expressed as *want* and *don't want*. *Wants and don't want* are simple ways to summarise all the key information obtained in the research phase. I.e., *I want a house that relieves me from duties and activates my physical daily life* or *I don't want to be stuck in front of technology*. This step led to the definition of the specific project question, conveyed as a *How Might We* question: the opportunity to address during the Develop phase. *How Might We* are powerful questions that enable people to creatively address issues identified during user research, transforming them into opportunity areas [26].

## 4.3 Develop

The Develop phase included generating different solutions that could address the defined project question, through the scenario building tool. Indeed, each solution corresponded to a scenario: a synthetic representation of an experience to engage customers and increase the company's brand awareness. The aim of this phase was to identify four possible experiences, so that, in the Deliver phase, the company and faculty could indicate them the most desirable and feasible one.

Specifically, students selected two sets of polarities opposites, corresponding to likewise aspects emerged as significant in the Discover phase. These polarities allowed them to create a 2x2 matrix, thus generating four diverse scenarios [27]. To better develop them and, in view of the next phase, narrate them, for each experience students created a significant and imaginative title, a visualization to convey the intended atmosphere and a series of keywords. To develop these proposals, students employed the scenario building tool.

## 4.4 Deliver

The Deliver phase began with the selection of which experience (one out of the four proposed) each team should focus on and finalize. Students presented their proposals during a plenary session to both the faculty and the company reference people. In this way, the faculty was able to evaluate the solutions from an academic perspective, focusing on how students applied the theoretical knowledge and the tools previously explained. At the same time, students also received the company's feedback, in terms of its interest for the proposed experiences, their feasibility and innovative degree, as well as the possibility to truly realize them. The experience selection was jointly carried out by the faculty and company reference people.

Successively, students detailly designed the chosen experience with the final aim of presenting it to the company for conclusive feedback. Specifically, each team designed the overall experience, applying service design tools to better structure it. Indeed, pupils identified all the significant elements and features of the experience, corresponding to its offer, and schematized them through an offering map. They also defined which stakeholders should be involved in their experience, not only in terms of selected final users, but also staff members, partner organizations, both private and public. The relationship and exchanges of these stakeholders was visually represented through a system map. To better describe final users' actions, students realized a customer journey, that depicted all the steps needed to access and live the proposed experience, as well as the related touchpoint. Considering the complexities of practically realize and manage an experience, each team also applied the blueprint map to explicitly analyse both the frontstage and backstage activities that the involved stakeholders need to perform, as well as the support processes [28]. Finally, each team realized a video to depict the designed experience. In this way, they had the chance to try and verify on a small scale the functioning and potential realization of the experience.

The faculty advised pupils along the whole path, also through a dedicated review, to guide their activities towards the final delivery by practically supporting them.

At the end of this phase, students presented their designed experiences to the faculty and company reference people. The company selected three experiences, considered the most feasible and desirable, to evaluate. Indeed, the final aim is the selection of an idea that the company can propose during the Milan Design Week and for the realization of a new concept store.

## 5 DISCUSSION AND CONCLUSIONS

This paper contributes to the understanding of the implications of applying PBL in design courses, with a specific focus on didactic design projects involving the collaboration with a company. It detailly analyses the different phases of the PBL project, based on a real brief jointly defined by the faculty and involved company reference people. The study, therefore, allows to identify and reflect on both students' perspectives and experiences during the PBL project and the benefits achieved by the company thanks to the adoption of this approach and the collaboration itself.

As mentioned before, PBL allows students to address a real design challenge, thus anticipating the experience they will have in their future workplace. This aspect is reinforced by the collaboration with a specific company, in this case the project client. Indeed, students highly benefited from the possibility to work on a concrete project, and, above all, from the constant interaction and cooperation with the company. This continuous exchange favoured the research phase, by providing students with additional knowledge sources and giving them the chance to integrate first-hand data by interviewing also store clerks and company's technicians. Moreover, the structure of the PBL project intrinsically included formal moments of discussion both with the faculty and the company reference people. These occasions required students to share their understanding of the covered topics and to be actively involved in the learning process. This approach, therefore, increased students' active participation, as well as their engagement both with the project and the course itself. Indeed, all the tools applied during the four project phases were previously explained during lectures. Students were hence able to put them in practice, by employing them during the project activities, rather than learning them only from a theoretical point of view or through general exercises.

The adopted approach for this collaboration was also beneficial for the company itself. Indeed, it had the chance to actively participate to the project activities, as in the moments of discussion mentioned above. Consequently, the company reference people could intervene and guide students, thus ensuring that the designed experiences would be both feasible and desirable from its point of view. As declared by them, some of the proposed experiences well-fit into the company future direction and could be



implemented in the following months. Another significant aspect is that the company was able to obtain a great number of initial ideas (four per group, corresponding to the initial scenarios) and finalized experiences (one per group), developed in a short timeframe.

Being a technology company, the results produced internally often look only ultimately at the user dimension and its needs. Thanks to this project, adopting the Design Thinking process, students came up with new ideas to put the user's needs first. Considering the advantages of this new perspective, many of the ideas generated during the project are currently the subject of a feasibility study by the company. The company wants to realise the obtained concepts as a new way to engage and attract customers.

This paper, therefore, highlights how the collaboration between academia and an external company through an approach of PBL could be beneficial for both of them while also increasing students' engagement. To further explore and validate the above-mentioned benefits, a series of semi-structured interviews could be organized, to investigate more in detail the students' experience. Additionally, the sample could be scaled for the very same purpose, as by applying this format to other design courses with a similar structure and aim or to the next academic year of the same course.

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