May 30-31
2022

Porto, Portugal

Book of Abstracts

BBC'22

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Instituto Superior de Engenharia do Porto

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Building Bridges in STEAM Education in the 21st Century

First International Conference

Porto Accounting and Business School
Porto School of Engineering
Polytechnic of Porto

May 30-31, 2022

PORTO – PORTUGAL

Event
BBC' 22 International Conference

Title
Book of Abstracts of the First International Conference Building Bridges in STEAM Education in the 21st Century

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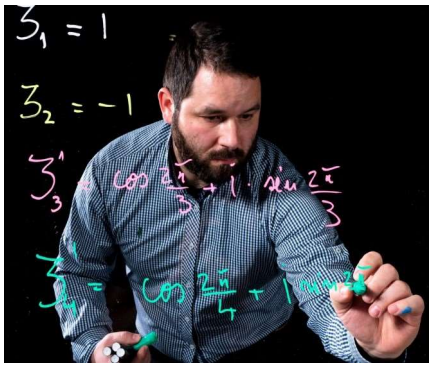
  - **Zsolt Lavicza** - Johannes Kepler University's Linz School of Education, AU

Invited Speakers

- **Dr. Ovidiu Bagdasar**

  BSc, MSc (Mathematics), PhD (Applied Mathematics), PhD (Pure Mathematics)



Dr. Bagdasar is Associate Professor at the University of Derby in the United Kingdom. He is the Program Leader for the MSc Big Data Analytics, Erasmus+ Departmental Coordinator, and an active member of the Research Centre in Data Science.

He is a Fellow of the Institute of Mathematics and its Applications (FIMA), the Higher Education Academy (FHEA), and holds membership of the International Society for Difference Equations (ISDE), American (AMM), European (EMS) and Romanian Mathematical Societies (SSMR), as well as of the Marie Curie Alumni Network.

His research is at the boundary between Mathematics, Computing and Education, including areas like number theory, optimization, computational, discrete and applied mathematics, or mathematical education, with a focus on maths anxiety. Ovidiu's publications featured in top academic journals, as Optimization, Neural Networks, Journal of Global Optimization, Applied Mathematics and Computation, Carpathian Journal of Mathematics, Mathematics and Computers in Simulation, or Education Research International. He has more collaborators in the UK, India, Romania, Thailand, Spain, China, Italy or Kuwait.

Over the past 20 years, Dr. Bagdasar has worked together with academics, teachers, students, and companies to improve standards in math education. He travels extensively and shares best practices in mathematics education through speaking engagements at conferences, seminars and academic institutions in the UK, Thailand, Romania, Moldova, India, China and South Korea. The focus of his presentations are on current issues in mathematical education, mathematics anxiety, and mathematics applied to industry.

You can learn more about Dr. Bagdasar here:

https://www.derby.ac.uk/staff/ovidiu-bagdasar/
https://www.researchgate.net/profile/Ovidiu-Bagdasar

- **Professor Pamela Burnard**

Pamela Burnard is Professor of Arts, Creativities and Educations at the Faculty of Education, University of Cambridge (www.educ.cam.ac.uk/people/staff/Burnard/).

She has published widely with 20 books and over 100 articles which advance the theory of multiple creativities across education sectors including early years, primary, secondary, further and higher education, through to creative and cultural industries and transdisciplinary (STEAM) practices.

She is co-editor of the journal Thinking Skills and Creativity.

Some of her recent publications include 'Why Science and Arts Creativities Matter: (Re-)Configuring STEAM for Future-making Education (co-edited with Laura Colucci-Gray in 2020, Brill-i-Sense); Sculpting New Creativities in Primary Education (2021, Routledge) and 'Doing Rebellious Research in and beyond the Academy (2022, Brill-i-Sense).

She is a Fellow of the Royal Society of Arts (RSA) and Fellow of the Chartered College of Teaching, UK.

- **Dr. Péter Galambos**

Dr. Péter Galambos, has a solid academic background in Informatics and Robotics. Dr. Peter Galambos (co-founder of MaxWhere) is the director of the Antal Bejczy Center for Intelligent Robotics at Óbuda University, where he built decent expertise in educational robotics and multiple other aspects of robot technology and prototype creation. MISTEMS Ltd. is a tech startup (micro-size enterprise) that develops and maintains the MaxWhere 3D (VR) software framework (https://www.maxwhere.com) with vital education technology relations. MaxWhere is a 3D virtual environment that combines conventional 2D modalities with interactive 3D worlds, leading to a provenly effective learning environment. In the composition of learning materials, especially in technical subjects, the text, graphics, and video contents can be organized in a spatial (3D) context, including interactive simulations. These characteristics make MaxWhere helpful and effective in teaching students. The software

has been developing since 2016, and for today, it has reached a decent level of maturity. The MaxWhere client can be downloaded for Windows and Mac computers. The ecosystem provides a Cloud-based content Store which makes the content distribution flawless all over the Globe. We build and sustain close cooperation with universities to involve more and more learning content into the ecosystem and foster software developers' education capable of developing MaxWhere plugins and interactive content.

- **Professor Zsolt Lavicza**

(BA, BA, MS, MA, MPhil, PhD)

After receiving his degrees in mathematics and physics in Hungary, Zsolt began his postgraduate studies in Applied Mathematics at the University of Cincinnati.

While teaching mathematics in Cincinnati he became interested in researching issues in the teaching and learning mathematics. In particular, he focused on investigating issues in relation to the use of technology in undergraduate mathematics education. Afterwards, both at the Universities of Michigan and Cambridge, he has worked on several research projects examining technology and mathematics teaching in a variety of classroom environments. In addition, Zsolt has greatly contributed to the development of the GeoGebra community and participated in developing research projects on GeoGebra and related technologies worldwide.

Currently, Zsolt is a Professor in STEM Education Research Methods at Johannes Kepler University's Linz School of Education. From JKU he is working on numerous research projects worldwide related to technology integration into schools; leading the doctoral programme in STEM Education at JKU; teaching educational research methods worldwide; and coordinates research projects within the International GeoGebra Institute.

Oral Presentations

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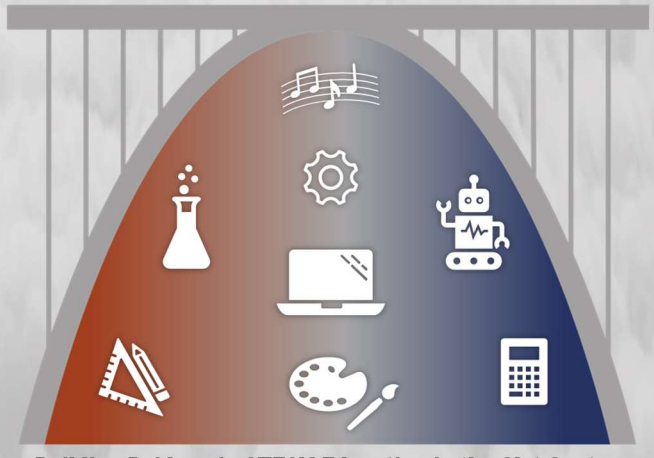
Abstracts

BBC'22



Building Bridges in STEAM Education in the 21st Century

INTERNATIONAL CONFERENCE

A game-based learning experience in math, art and science

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Abstract - **Didactic games, if properly integrated with more traditional teaching methods, have many advantages: they motivate students, facilitate the learning process and provide an informal situation, creating favorable conditions for focusing on concepts, asking questions and consolidating skills [1].**
During our experience as math teachers, we have had the opportunity to check the effectiveness of using didactic games to help students overcome their fear of math [2].
With the goal of sharing our teaching experience not only with math colleagues but also with teachers of different subjects, we present some game-based activities suitable for math, art, and science that participants will experience live during the workshop.
Since we only use everyday materials and/or commonly used software such as those available in the Google Workspace, teachers can easily replicate the activities in their own classes.
Although the proposed games are focused on students 10-15 years old, they can be adapted to different topics and levels.

Keywords - game-based learning, mathematics education, STEAM

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Accelerate the digital readiness of Polytechnic higher education institutions: the ACADIGIA project

BBC'22 - International Conference

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Abstract - **For decades, specialists in distance learning have been warning of the need to invest more in this type of teaching and learning. Resistance to this teaching modality has always been strong on the part of academic (leaders, teachers, and students), and with rare and honorable exceptions, adherence to e-learning or even b-learning has remained residual. With the pandemic caused by COVID19, it became evident that resistance to the adoption of distance learning systems could no longer be postponed. The ACADIGIA Project appears in the context of the post-covid19 pandemic intervention, with the aim of accelerating online and hybrid teaching in academia, especially in polytechnic education. The objective of this communication is to present the ACADIGIA project, as well as its model of accelerating this transformation process in academia. The project seeks to map what worked best in the academy's response to the pandemic situation, as well as offering a proposal for training mentors, who will then go "viral" when they enter the polytechnic education system, to scale the adoption of this methodology by the school community.**

Keywords – ACADIGIA Project, B-learning, Polytechnic Education, Mentors training, Digital Literacy.

ACKNOWLEDGMENT

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[2] Author's Last name, First initial, Middle initial, "Title," *Journal or book (italics),* Vol, No #., date, pp.

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Âmago Project: Intergenerational interactions using Biodesign approach for health innovation and education

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Abstract **- Health literacy among Portuguese seniors is low [1], impacting on individual decisions related to health [2]. Low health literacy should be tackled upstream, among young people. Although medical communication is currently already focusing on patient's needs [3], there is still a lot to be done to identify patients' needs in interpreting and using medical information for self- management of health conditions. Co-creation strategies can be used to address the problem. Previous works indicate that intergenerational education has multiple benefits for all the participants and for the community [4]. In this context, Âmago Project intends to create conditions for the establishment of intergenerational collaboration to develop and disseminate innovative responses in heath. The project promotes partnerships between schools and senior organizations, for the establishment of collaborative laboratories that can allow the discussion of existing problems in Communication in Health. Using the Biodesign methodology[6], young people and seniors are invited to detect needs, analyze them, deconstruct them and propose solutions to increase the population's knowledge about health, especially in challenging and transversal themes.**

Keywords - Biodesign, Intergenerational, Health co-production.

Acknowledgment

We thank all the team members of Bright Digital for their commitment and hard work developing the Âmago project, the IPDJ support for its implementation, namely to Vítor Dias, all the partner institutions that agreed to take part on the project and the participants.

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An experience of synchronously writing online

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Abstract - ***When it comes to teach online many solutions exist to prepare materials. But when we are teaching synchronously the range of options decreases dramatically. Fortunately, technology is developing very fast and it is possible to use either computers or tablets with touch screens, where with the help of a special pen we can write very easily. There are also digitalising tables which are very helpful whenever we need to draw or work with graphical contents. With them classes can be as dynamic as they are in a face-to-face environment. The teacher is free to write over the majority of the type of files he is using and can always make use of Microsoft Whiteboard. This tool is interactive and when accessed synchronously, can promote classroom engagement. According to Watts, students feel more connected to their peers through synchronous sessions. The aim of this presentation is to share an experience that took place in a Maths course.***

Keywords – Maths, Online teaching, Synchronously writing, Whiteboard.

ACKNOWLEDGMENT

(Not applicable)

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Automatic Exercise Generation for Exploring Connections Between Mathematics and Music

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***Abstract* - Mathematics and Music are closely connected and their multifaceted relationship has been explored since ancient times. Pythagoras was one of the first who discovered and formalized one of those connections by studying the arithmetic of musical intervals, expressing them by numerical ratios and relating ratios to consonance/dissonance notions, being the Pythagorean tuning and scale based on arithmetic principles. Another interesting link between Mathematics and Music is the geometric approach to musical composition. Geometric patterns are present in different musical style compositions and some composing techniques, such as the twelve-tone technique, use geometric transformations, involving also applications of modular arithmetic and set theory to Music.**

The aim of this work is to present existing relations between Mathematics and Music and to propose automatic exercise generation for exploring and studying those relations. The exercises are generated using the system Mvgen and the LaTeX package MusiXTeX. The generation process and the automatically generated exercises can be used for creating learning and assessment materials for education in Mathematics and Music, linking Science and Art.

Keywords – Automatic exercise generation, Mathematics, Music, STEAM education

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Bring mathematics and statistics closer to students of economics through Excel

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Abstract - **The outbreak of the COVID-19 pandemic has significantly affected all areas of people's lives and work, including education. Most schools and faculties were forced to organize distance learning at one time. For theoretical subjects this was much easier compared to subjects, which require solving practical tasks on the board. We believe that the biggest problems at the Faculty of Economics occur during online classes in Mathematics and Statistics. Through this paper we want to show how MC Excel can be used for online practical classes in Mathematics and Statistics. We will start by writing basic mathematical expressions and the option that all formulas can be easily seen by students. Then we want to describe an example of solving a system of multiple equations with multiple unknowns, which students can later use to solve practical problems. We also want to describe the use of various statistical functions on the example of data on human mobility during the pandemic, published by Google for 135 countries worldwide.**

Keywords - Economy, Excel, Mathematics, Statistics.

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Collaborative Online International Learning Between University and Primary School Students: Creativity in Disguise in Engineering

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Abstract **– A Collaborative Online International Learning (COIL) activity was conducted between two different primary schools in Scotland and India. The activity was supported by mechanical engineering undergraduate students from Glasgow Caledonian University, Scotland (host institution). The aim of the project is to provide students from university and primary schools (9-11 years old) the opportunity to develop themselves as global citizens [1], to develop their understanding and knowledge in engineering and to develop their meta-skills given the value of these attributes in navigating an ever evolving environment and society [2]. The undergraduate project 'Design and Manufacturing of 3D printed high heel shoes: moving from STEM to STEAM' was selected to showcase the creativity in disguise in engineering, where different webinars in the area of design, additive manufacturing and materials properties were distributed and delivered by primary schools and undergraduate students. Even at primary school level, the students were able to demonstrate their creativity and 3D print a pencil box. The Padlet digital tool was used to promote students' engagement by exchanging knowledge and intercultural understanding [3].**

Keywords – Collaborative, Engineering, International, Learning, Online, Primary Schools, University Students.

ACKNOWLEDGMENT

We would like to acknowledge university students Melissa Hodge and Jordan Doyle, Mrs Gayathri (Principal, PSGCS) Mr.Henry (Todholm PS) and their team of teachers for their support in the delivery of the workshops and for preparing the children to deliver the tasks.

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Design & Computation - A new inter-university, interdisciplinary, research-based Master's program

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www.design-computation.berlin

Abstract **- Against the backdrop of the current rapid technological and social changes as well as an increasingly dynamic academic landscape, the new Master's program "Design & Computation", which was established in a cooperation of the Berlin University of the Arts and the Technical University Berlin, offers its students the opportunity to contribute to pressing questions concerning the digitization of our societies. As the first of its kind in the German-speaking countries it is aimed at Bachelor graduates from various fields, spanning from design, art, engineering, natural sciences, humanities and social sciences. Through this inter- and transdisciplinary learning environment technological challenges are collaboratively met with both artistic, creative, and critical thinking as well as profound technical understanding. The following paper further introduces the program and demonstrates its research-based, transdisciplinary approach by also presenting an excerpt of already carried out student works and current research projects.**

Keywords - Design, Digitization, Education, STEAM, Transdisciplinarity

ACKNOWLEDGMENT

No sponsors.

REFERENCES

www.design-computation.berlin

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Albert Lang, Professor for Technological Systems in Design Director inter-university, interdisciplinary, research-based Master's program Design & Computation between University of the Arts Berlin and Technical University Berlin.

Design of teaching materials for the dissemination of Women's contribution to economic analysis: innovation, equality and new competencies

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Abstract **- It is broadly recognized that the university environment constitutes a strategic tool for the promotion of a more equitable and just society. Therefore, it is necessary to create methodological proposals in which the gender issue is transmitted to the students, as well as to train them curricularly to generate critical treatments of the social scenario in which they interact. However, in university teaching, except in a few cases where there is a specific subject, there is a lack of important advances of women scientists in their curricular agenda. Therefore, within the Galician university system, a teaching resource has been created to disseminate the work of the most important women economists, which is composed of 172 bibliographic cards and 23 readings from different periods and economic currents. The aim of this work is to describe the reasons for this innovative resource and, moreover, how it has materialized. Therefore, the methodological and formal requirements for the elaboration of the resource will be analyzed.**

Keywords - didactic resources, educational innovation, economy, gender equality.

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Effective Strategies and Digital Technologies for Improving Mathematics Classroom Experience

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***Abstract* – For many (if not most) students studying computer science, the mathematics class can be one of the most daunting experiences. However, there are effective strategies to engage students in their learning, and digital technologies which can support their studies. In this presentation we will discuss approaches used at the University of Derby, which include interactive note taking with OneNote, lecture recordings, live polls, numeracy training courses embedded with the module, as well the involvement of subject mentors. These contribute to excellent student engagement, attainment, as well as to pass rates and good grades well above the average. Students also manage to reduce their maths anxiety and to improve performance and employability. Finally, we will showcase the impact of targeted maths interventions for the students at Derby in the areas of Computational Mathematics and Biosciences, looking at module key performance indicators like pass rates, good grades, and overall engagement and satisfaction.**

Keywords – digital technology, interactive teaching, student attainment, maths anxiety, employability, maths support.

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Escape Rooms for Secondary Mathematics Education: Design and Experiments

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***Abstract* – Escape rooms are an increasingly popular form of live-action entertainment in which teams of players need to solve puzzles to escape or reach a narrative goal within a specified time limit. Current research suggests that this style of activity promotes the effective use of team skills in the classroom, which are desirable in the workplace, and also that students are more engaged in the hands-on learning environment. During this study we have created a game designed to teach mathematical concepts related to finding missing side lengths in a right-angled triangle using trigonometry to secondary school students who have not yet had a formal lesson in this specific subject. Our experiment tests the success of our escape room's teaching capabilities through comparing student performance on a test completed immediately after finishing the game. We also evaluate whether students' perception of and familiarity with mathematics generally and trigonometry improves from playing. Finally, we intend to confirm the findings of other researchers into engagement; extend that on the effective use of team skills through examining if there is a relationship between completion time and the observed behaviours within each team.**

Keywords – Escape room, teaching, trigonometry, problem solving

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This research has been sponsored by the University Of Derby. Thank you to the educational escape room professionals (Mark Hammons at BreakoutEdu, Louie Montoya at Stanford University, Sundip at Wiseminds Escape Rooms and Steven Clontz of various Mathematical Puzzle Programs) for discussing the state of the educational escape room industry and the possible directions of this project with us. Additional thanks to Richard Hale School for allowing us to test our game on their students.

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Future preschool and primary teachers ability to design lessons based on a STREAM integrated approach

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***"Abstract"* - STEM education tends to expand into education systems around the world. Its development involves the integration of STEM fields (not just a multidisciplinary approach) and the inclusion in the STEM model of Reading and the Arts so that we can finally talk about STREAM. Romanian curricular policy affirms the necessity of integrated approaches. The research included 185 future teachers for primary and pre-school education who were asked to design teaching activities based on integrated STREAM approaches. The projects were analyzed based on an evaluation grid developed by the researchers that includes 15 criteria. These criteria investigate the treatment of a topic at a monodisciplinary and integrated level. The results show the teachers' tendencies to achieve multidisciplinary approaches. At the monodisciplinary level, the main difficulties teachers face regard the treatment of topics from the perspective of technology. As a result, we consider it necessary to continuously train teachers to achieve integrated approaches.**

Keywords: future teachers, lessons, perspective, STEAM integrated approach.

Generating Engineer's Lifelong Skills Through Practical Cases in STEAM Education

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***Abstract* - STEAM education applied to engineering degrees has been proved to be an essential and significant model in the 21st century to pass on lifelong skills to students for the pursuit of their professional career. Engineers are a highly qualified profile in the labor market and are valued for many skills. Among others, on the one hand, for their ability to learn and, on the other hand, for their leadership and partnership in multidisciplinary work teams, both with high hardworking capacity. Within this framework, universities with a STEAM profile must enhance these future professional competencies by applying methodologies that allow to successfully achieve this challenge. This research reviews the core skills of the STEAM Thinking and, based on a real engineering project, identifies and illustrates the existing strong association among these skills and professional ones required by the Society. Connections will be introduced and discussed. In summary, this work states and emphasizes the importance of this holistic approach in teaching in engineering schools, by connecting targeted lifelong skills with successful development of the engineer's professional career.**

Keywords – Engineering projects, lifelong skills, professional skills, STEAM Thinking.

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Innovative strategies in education: service-learning

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Abstract **-** The EHEA has transformed the university methodology, changing the role assumed by the institution itself in society. It is no longer conceived as a passive actor, as a simple transmitter of knowledge. It is now presumed that it must exert the necessary impulse to collaborate in social progress. One of the most innovative and propitious tools for this purpose is Service-Learning (SL). The purpose of this paper is to present the innovative aspect of SL, a comprehensive system that promotes critical citizenship while fostering emotional and social competencies. In order to analyze the role of ApS in higher education, the factors that show ApS as a multidisciplinary approach conducive to positively impact both the active participants of the experience (teachers and students) and the passive ones will be examined. Subsequently, the suitability of the method in the university framework for the promotion of academic knowledge will be discussed, as well as the different phases necessary to successfully develop an ApS experience in the educational environment.

Keywords – educational innovation, professional skills, service-learning, university education
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Learning and teaching STEM with a water infiltration model

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Abstract - **The right to water is fundamental for life, there is no life without water. However, despite the vast amount of water on our planet, water fit-for-use is scarce and is becoming increasingly important.**

Education for water conservation and management is a fundamental tool to raise awareness and empower young people to work for better water management. Students need to be able to develop the knowledge, skills and attitudes to live more sustainably, change patterns of consumption and to contribute to a greener future. Sustainable water consumption implies voluntary changes of attitude that aim at conserving our planet and minimize the impact of water consumption. This "Green Education" will help to raise awareness to this issue.

In this work, we present an activity that intends to sensitize students to the relevance of efficient water use and to the importance of mathematical modeling. Students compare a mathematical model (Horton's equation) that models soil infiltration behavior based in the collected data. This is a good approach to show students how mathematics is useful and applies to real-life problems.

Keywords – Applied Mathematics, Experimental learning, Mathematical Models, Water Scarcity.

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Manipulative activities as a bridge for STEAM Education

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Abstract - **Nowadays, the mobility of teachers is important to consolidate the methodologies used and to better understand the curricula in other countries. A teaching strategy, in another country, is to use manipulative materials. The manipulative material allows to develop the construction of concepts, creativity and solve problems in mathematics.**
This paper is an account of the experience in Higher Education with pre-service and prospective students. The sessions, in the various classes, focused on geometry using the manipulative material, Poly-Universe from the project Poly-Universe in Teacher Training Education (PUNTE).
Using this material is an innovative methodology in mathematics and inspires creativity beyond visual learning.
The prospective and pre-service students showed curiosity and creativity in working with this material. In the end, the symmetry concepts were consolidated with this new methodological approach. The manipulative materials help in the understanding of some selected notions of mathematics and art.
It will be presented selected concept, the symmetries, with the help of the manipulative material Poly-Universe from the project PUNTE, can serve as a bridge between mathematics and art (STEAM).

Keywords – Curriculum, Geometry, Manipulative Materials, Poly-Universe

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MATH-DIGGER – A PLATFORM TO ESCAPE MATH PROBLEMS

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Abstract **– The MATHematics Digital Escape Rooms - MATH-DIGGER platform is designed to empower students in their learning process. MATH-DIGGER aims to provide a stimulating innovative learning and teaching practice, using escape rooms. Students solve several challenges (puzzles, quizzes, etc) in a limited amount of time, to escape a virtual room. MATH-DIGGER seeks to support students' digital capabilities, and other essential skills, including entrepreneurship, communication, teamwork, negotiation and persuasion, problem solving, leadership, organization, perseverance and motivation, ability to work under pressure, and confidence, which are core skills for their future professional success [1]. There will be an emphasis on females' active participation in STEM and STEAM areas. Considerations are made to Math curricula development, including these educational games, and new assessment tools.**
MATH-DIGGER is meant to set a benchmark for the development and implementation of escape rooms in mathematics subjects, in HEIs.

Keywords - MATH-DIGGER, Digital Escape Rooms, STEM, STEAM.

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Mathematics as the keystone of STEAM education

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***Abstract* – Mathematics is the language to formalize ideas and to model practical examples. It provides the frame to connect the various components of STEAM. We show examples of activities, which have been proposed to both in-service and pre-service teachers. These activities yielded explorations of various mathematical topics such as plane transformations or parametric curves, in a technology-rich environment. They helped to develop understanding of the connections of the M in STEAM with the other components. Work and analysis with students is performed in the frame of the 4 C's of 21st Century Education.**

Keywords – Animations, Computer Algebra System, Cultural background, Dynamic Geometry, Ethnomathematics, STEAM Education

D'Ambrosio [8] developed Ethnomathematics, i.e. the study of cultural influences on mathematics education, focusing on the social context of students, involving their language, behavioral norms, and cultural background. Every population has its own cultural characteristics. This appeared even more during the Covid-19 crisis, as different countries reacted in different ways, adopting different policies [5].

Ethnomathematics studies the ways of learning and teaching mathematics and conveying mathematics knowledge and skills among different populations, with regard to their respective cultural background.

We will illustrate with four examples the strong connection between Mathematics and other domains. This approach can enhance students' motivation and deepen their math understanding:

1. For students with a strong trend for sea activities (surfing et al.), the shape of the sea waves is an interesting trigger to study trigonometric functions. By that way, the structure of the waves, their periodicity and the fact that every seventh wave is bigger, can be explained [2].
2. In various countries, monuments are used as the basis of study of geometry and measurements; mathematical activities around a Hungarian synagogue of the 19th century are described in [4]. For this, we could use ancient documents, but also recent measurements provided by the architect in charge of the refurbishing of the monument. With another group of pre-service mathematics teachers, we explored a German synagogue of the same period; in this case, only ancient documents had to be used. Figure 1 shows model of the rosette in the main façade of the synagogue in Baltimore (USA), prepared with GeoGebra by a student, using plane geometry and plane transformations. On the left, the photo which has been provided to the students.

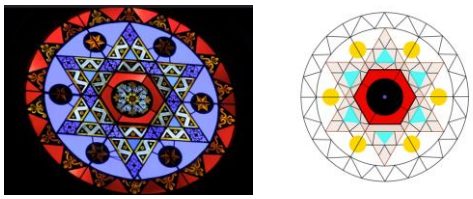

Figure 1: a model of a rosette

With this activity, students explored connections between mathematics and visual arts, mixing mathematics, general culture and arts, and developing new technological skills.

In [9], ancient Egyptian and Korean monuments, using ancient documents and 3D modelization and 3D printing.

Following the work described in [4] and [6], we could develop activities to attract the so-called Jewish Orthodox population to learn mathematics. A joint implementation of Ethnomathematics with STEAM.

3. Space exploration is ubiquitous in the newspapers: Lunar and Martian orbiters, Martian rovers. A famous example is the triple launch towards Mars by the USA, China and the UAE, attracted a huge interest in the general population. Their successful insertion into Martian orbits and the successful direct landing of the Perseverance rover, accompanied by photos, videos, and recently sound recording, reinforced the public interest. Using this background, animations and simple models of trajectories in space are constructed; Virtual constructions yielded nice virtual "space mandalas" (see [3] and Figure 2). For these studies, we used a simple model of circular planetary orbits, which yielded trigonometric parametrizations.

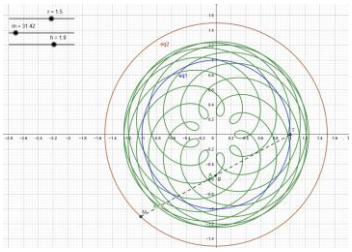

Figure 2: a virtual space mandala

As a side effect, we were able to describe a unifying frame for families of curves, which were traditionally described as disjoint examples, such as epitrochoids and epicycloids. Using different levels of approximations for the orbital data provided an opportunity to explore with students the huge influence of small changes on the final output.

4. The new James-Webb space telescope is now taking its place, not only 1.5 million kilometers from Earth at a Lagrange point, but also in the news. Among other topics, it gives an opportunity to develop animations explaining what are the Lagrange points of the system Sun-Earth. This is illustrated in Figure 3.

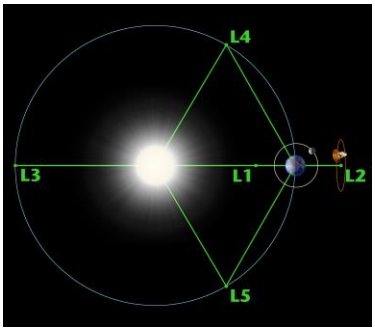

Figure 3: The Lagrange points of the system Sun-Earth (Credit: NASA/WMAP Science Team)

During the last decade, we could see important developments of mathematics education in the broader framework than the traditional one, namely the STEAM framework. Mathematics plays an important role, as it enables formalization of ideas. Its ability to express conjectures in a formal way opens ways to prove them. This role allows also the integration of Ethnomathematics into the curriculum in a way adapted to the students.

Work has been performed in a technology-rich environment (Computer Algebra Systems and Dynamic Geometry Systems), for computing, modelling, 3D printing, etc. Such activities are the core of STEAM education,

The Covid-19 crisis led to huge developments in distance learning, mixing technologies for communication between humans and between humans and machines. The need for new ways of communication between different kinds of mathematical software, at least CAS and DGS, has been analyzed in [7]. The technological skills acquired by the students are an integral part of the new knowledge. Teaching has changed; in particular, a new technological discourse has been developed, whose importance Artigue [1] emphasizes. Actually, the crisis enforced strongly the implementation of the 4 C's of 21st century education [10]: Communication,

Collaboration, Critical Thinking and Creativity. The examples presented in this talk show that confinements did not hurt collaboration, but enhanced new way to collaborate using new ways of communication by sharing discussion via technology.

Finally, we wish to mention that stills plots and animations have been developed using GeoGebra, a freely downloadable package. A Computer Algebra System (CAS), called Giac, is embedded in it. For other animations and heavier algebraic computations, we used the CAS Maple.

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Both authors contributed equally to this research. The first author has been partially supported by the CEMJ Chair at JCT.

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Mobile Math Trails: an experience in teacher training with MathCityMap

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Abstract **- Studies show that the outdoors can be a privileged context to promote positive attitudes towards mathematics [1]. In this context, math trails stand out. Recently, an app was created to articulate the dimensions of mathematics outside the classroom and technology, MathCityMap (MCM), which has proved to be useful in supporting the teaching-learning process [2]. This paper reports a study, with 48 future teachers of elementary education, that aims to understand their perceptions about the use of digital technology, namely MCM, in the learning of mathematics outside the classroom. A qualitative methodology was adopted and data were collected through participant observation, questionnaires and photos. Results show that they valued the experience, solving problems in real context, developed collaborative work and established mathematical connections. They considered the app intuitive and motivating, mentioning its contribution to user engagement through active learning, promoting autonomy and spatial orientation. They highlighted as limitations the possible lack of access to wi-fi when downloading the trail; younger students may not have smartphones; and the limitation of answer formats in task design.**

Keywords – Math Trails, Mobile Learning, Teacher Education.

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Narrative Didactics in Mathematics Education: Results from a University Geometry Course

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***Abstract* – In a Swedish second semester course on Euclidean and non-Euclidean geometry in mathematics education at Karlstad University, a bridging teaching strategy comprising elements from Mathematics, Didactics, History, Literature and Technology was applied by using the concept of Narrative Didactics and Digital Interactive Mathematical Maps. Amongst others, at the end of the course students were asked to formulate a short historical-oriented narrative motivation for a school topic of own choice with the help of information provided by the timeline of the Mathematical Map. Examples of these arts-combining products are presented and evaluated according to elements of Narrative Didactics. Results indicate a fruitful, promising and synergetic connection between different STEAM fields that can lead to a richer and more sustainable learning process in mathematics lessons both at university and school level.**

Keywords – Narrative Didactics, Geometry, Teacher Education, Mathematical Maps

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Origami meets STEAM in "A Wheatfield on a Summer's afternoon"

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***Abstract* – We present a STEAM vertical project carried out in an Italian school from kindergarten to high school [1]. For each class we covered some element of a poster of a painting of a famous artist with origami models. We used each model to propose a mathematical topic adapted to the level of the students involved. At the end of the project students organized an exhibition where they proposed to general public mathematical activities with origami.**
In this talk we will focus on the activity carried out with the group of 13 years old, who worked on the painting: "A Wheatfield on a Summer's afternoon" by M. Chagall. We give an overview of the main mathematical contents associated with this painting (tessellation and bees, octagon and circle) and we focus in particular on the lesson related to the One-cut Theorem [2] where we discussed the "strange job" of the mathematician.

Keywords - art, exhibit, mathematics, origami.

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Peculiarities of metacognition in prospective elementary teachers

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"Abstract". **Metacognition has been extensively studied over the past decade and has an important role in teaching and learning. To promote metacognition in the school context, teachers must be familiar with this concept and have both metacognitive knowledge and skills. In this context of the intense research on metacognition within the school context, this study investigates the characteristics of metacognition in prospective elementary teachers. The research uses a mixed methods design to reveal the characteristics of metacognitive knowledge and skills in prospective elementary teachers. Participants completed the Metacognitive Awareness Inventory, two open-ended questions and a vignette-type task. A study invitation has been sent to 125 students and a total of 107 students accepted the invitation (85.6% response rate). The SPSS and ATLAS.ti software have been used for quantitative respectively qualitative data analysis. Results indicate that although prospective elementary teachers believe they have quite good metacognitive knowledge and skills (above average), they encounter difficulties when asked to apply and use them in a specific educational context.**

Keywords: metacognition, mixed methods design, prospective elementary teachers, students.

Pedagogical model applying Commedia dell'Arte and art workshops in higher education design studies

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Abstract - Brenda Laurel introduces theatre as an analogy for computers and foundation for designing human-computer experience [1]. Progressive inquiry is a method to foster collaborative construction of knowledge resembling scientific communities [2][3]. Co-creation enhances engagement, collective creativity, adds value and relies on network resources whereas co-design focuses on integrating stakeholders' and designers' creativity, relies on high levels of engagement and collective dialogue in decision making [4]. All these domains represent action with multiple human and machine agents. Computer interfaces allow participation in the ongoing action of representation, sensory immersion and the tight coupling of kinesthetic input and visual response [1].

In this article we present a case study where student teams designed and developed an interactive Game Wall and a game with storyline and characters based on Commedia dell'Arte. In the game the characters use masks that turn the art form to be very body conscious [5]. The interactive Game Wall enables immersion and kinesthetic experiences for the players.

The students' teams were guided by applying process drama methods. Drama with its emphasis on action provided strong social contexts for learning and motivated students' desire to communicate [6]. Process drama ensured collaborative knowledge construction through dealing with tension, conflict, searching for solutions, planning, persuading and stepping in and out of the characters' shoes [7][8]. The method has a special feature of simultaneous observation and action, research and exploration of the fictive world to create understanding, negotiate meaning as well as experience empathy towards the fictive characters [7][9][10][11].

Participatory learning environment with process drama consisted of four elements. First, three service design workshops were conducted with pre-assignments which utilized fictive *personas* and *future headlines* as tools to produce *design drivers*. Second, four characterization workshops studied the Commedia stock characters and their motivations through process drama methods. Third, workshops investigated Commedia dell'Arte as an art form by making plaster masks, preliminary sketches for costumes and accessories. A demonstration on actors' art with a mask was given for workshop participants, who learned how to move and act with their own designer artifacts – the masks. Fourth, the results were integrated into creating characters and game design for the digital multiplayer game in a 3D space.

Qualitative data was gathered via participant observations, semi-structured interviews and expert interviews. In line with the Grounded Theory approach a pedagogical model is under construction through the iterative process of collecting qualitative data, coding, memo writing and purposeful theoretical sampling and theory building [12][13].

Our initial results suggest that the participatory learning environment promoted creativity and student-oriented practices. Commedia dell'Arte was found useful as a supportive structure for the multidisciplinary student group competency building and to fuel collective creativity. Elements of progressive inquiry [3][14][15] were present and supported the learners in a deepening iterative question-explanation process. Students practiced collective creativity as considered important in art and design education [4].

Drama pedagogical methods were usable in characterization and creating the game storyline. The link between intellectual understanding and the body, embodied learning in communicating with and through the body was crucial for the end product [16].

The participants encompassed a wide array of university of applied sciences students from programming, game design and other design programmes as well as hitech and drama students from a local comprehensive school and stakeholders

consisting of a company specializing in experience architecture, city theatre and youth work specialists.

The pedagogical model in progress is expected to provide new insight for integrating thematic art contents to multidisciplinary design processes and is applicable for design university education and STEAM-integration.

The analogy between computers and theatre in the game wall interface and game creation was usable, as both art forms orchestrate and amplify experience as well as rely on action, affordances and sensory immersion [1]. Transition from expression to experience through drama was used to evoke collective creativity in the contents creation. The study demonstrates how design processes that contain characters can benefit from drama methods.

Keywords – co-design, co-creation, collective creativity, Commedia dell'Arte, Grounded Theory, interdisciplinarity, pedagogy, progressive inquiry, STEAM

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PYTHAGORAS – Erasmus+ project for STEM education

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***Abstract* – The PYTHAGORAS project will address the role of mathematics within STEM education and examine how it might be advanced through three approaches:**
(1) Improving mathematics teaching and learning, by helping teachers and students to enhance digital skills and by linking the subject to real life problems and examples.

(2) Making mathematics teaching and learning (in face to face, online, and blended form) more interactive by using gamification.

(3) Support the fundamental knowledge with the introduction of an online and open access course in pre-Calculus available to any stakeholder;

These approaches contribute to the goal of making mathematics education compatible for blended teaching and learning (by introducing automated and frequent assessments, online games along teaching mathematics, visualizations, and micro-credentials).
At the end, project PYTHAGORAS approaches will be ready to be applied in any STEM module or degree [1].

Keywords - personalized teaching & learning approach, STEM, digital tools, hybrid teaching.

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RStudio in Teaching Statistics

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***Abstract* - The use of software in the classroom plays an important role in the teaching as it allows students to increase their ability to interpret results, encourage diverse experiences and develop critical thinking (Dawson, K., Cavanaugh, C., & Ritzhaupt, A. D.).**

In recent years, the statistic discipline has benefited from a remarkable increase in available software that can be used as a support tool in classes.
There are available several statistics software packages, such as SPSS, Minitab, SAS and R or even Excel, even though it is a spreadsheet.
R (https://cran.r-project.org/) is a free software environment for statistical computing and graphics, compatible with Unix, Apple and Windows operating systems and has been regularly improved to make software intuitive and friendly for new R users.
The R/RStudio software was implemented in the Statistic course as supported software to facilitate an active approach in the learning process, avoiding the use of pocket calculator and statistical tables. The curricula of the course were developed in a way that students can concentrate on statistical principles and analysis, not spending much time and effort in learning the software.
Based on a questionnaire carried out in the first theoretical class, students should bring their own laptops to practical classes already with the support software installed in practical classes. It is intended to promote autonomous learning, based on problem solving and practical applications (Wenglinsky, H.). They must present solutions to problems, determined using RStudio and properly justified with the theoretical concepts previously learned.
Over the course, 2 practical assignments were required, done in groups. Working in groups helps students solve problems and troubleshoot faster.
The use of R software was well accepted by the students, helped in the teaching learning process. All students enrolled in the course completed the required assignments, with positive evaluations. The methodology used in the course has shown to be an enriching approach, together technology and pedagogy, turns the classroom more interactive and collaborative and promoting the active assimilation of knowledge.

Keywords – Statistics, Teaching-Learning, Educational Software, Statistical Software, R software.

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Secondary-tertiary Transition in Mathematics for Engineering Students: Results from a Study with Focus beyond the Purely Cognitive Aspects

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Abstract – **High dropout rates in the first year of undergraduate studies are an expression of the secondary-tertiary transition problem and they seem to be particularly high in those degree programs where specialized mathematics courses are taught in the first year of study. Research shows that students' difficulties during the transition period cannot be reduced to purely cognitive factors. In this paper, we address the secondary-tertiary transition problem in mathematics for engineering students. Based on a questionnaire with focus beyond the purely cognitive aspects, a comparison of the transition problem at three European mid-sized universities is carried out, in order to identify common challenges and difficulties, as well as differences. The questionnaire concentrates on the four dimensions (personal, organizational, content-related, and social) and corresponding critical requirements for a successful transition described in Trautwein and Bosse [4]. A group of 306 first-year engineering students partook in the study. In the presentation, we highlight students' perceptions regarding the transition, changes and challenges they experienced under the above-mentioned four dimensions, and discuss similarities and differences between countries.**

Keywords – Dropout rates, Engineering Education, Mathematics, Secondary-tertiary transition.

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Solving problems through Engineering Design: a pathway for a connected STEAM Education

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***Abstract* - International recommendations emphasize the importance of STEAM education in preparing students to deal with societal challenges. We may find different perspectives concerning STEAM education and the integration of its' disciplines, a possible pathway to achieve a balanced integration is through Engineering Design [1]. There are several frameworks for ED, we adapted the model of Cunningham and Hester [2]. This paper reports a study, with future teachers of elementary education (6-12 years old), which aims to analyze the learning displayed and difficulties underlying the use of ED in solving STEAM problems. The participants were 45 pre-service teachers. We adopted a qualitative methodology and data were collected through observation, documents, artefacts and photos. Preliminary results show that the participants valued the experience, solving real context problems collaboratively, mobilizing mathematical and physical sciences concepts in an integrated way. We identified active engagement, persistence and motivation in the creation of a model that fulfilled the requested conditions. Difficulties were evidenced in the identification of some concepts and the mobilization of adequate scientific language in the argumentation of decisions.**

Keywords – STEAM Education, Engineering Design, Teacher Education.

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STEAM approach in pre-service Teacher Education: a case study

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Abstract **- International research demonstrated the importance of STEAM approach in teachers training [1]. The development of critical thinking skills, creativity, innovation, problem solving, collaborative work, plus the ability to better understand the concepts involved in different areas of knowledge is appointed as a quality factor [2]. This qualitative study, developed over seven years with 161 students of 1st year students of Basic Education in the curricular unit of Oficina das Ciências, it was possible to collect data that showed advantages in the STEAM approach in overcoming the difficulties of students inherent to the construction of prototypes that involved knowledge from different areas, highlighting collaborative work, communication and problem solving proved to be fundamental for overcoming the difficulties that arose. The involvement of students in the development of activities and in the ability to argue in the face of the problems they were faced with is demarcated. Over the years the results have shown advantages in the STEAM approach in the development of different skills and in the complexity, increasingly, of the prototypes presented by the students..**

Keywords – STEAM Education, Creativity, Teacher Education.

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Teachers' digital and metacognitive competence profiles in the virtual learning environment perspectives

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***Abstract* – Nowadays educational challenges emerge from the teachers' skills regarding the didactic integration of virtual learning environments in their classroom practice. Literature reviews indicate metacognition as a central tendency in terms of learning approaches in the virtual environment. The aim of this paper is to showcase pre-service and in-service teachers' metacognitive awareness, digital competence, and their perspective on the virtual learning environment success. In a quantitative research approach, 123 Romanian teachers and prospective teachers answered an online questionnaire. The instruments used to collect the data are The Metacognitive Awareness Inventory, The European Framework for the Digital Competence of Educators, and the Virtual Learning Environment Success Scale, all having remarkable psychometric properties. The results highlight educators' competencies profile in association with their virtual learning environment usage perspectives and the implications concerning reframing classroom activities. Based on the results, in agreement with empirical evidence, an analysis draws attention to the pathways teacher education programs and policies are meant to take.**

Keywords - Digital competence, metacognition, teacher education, virtual learning environment success

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Teaching evaluation and student response rate

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***Abstract* - The purpose of this presentation is to share the author's viewpoint on how to increase student response rate in course evaluation surveys. The approach is to highlight measures which increased student response rate in online surveys of the author's teaching evaluation at The University of the West Indies, Jamaica. The findings suggest that student response rate to course evaluation can be improved by the lecturer's effective communication. This work will encourage the lecturers to initiate more student engagement to improve response rate of their teaching evaluation. Initial pilot paper to read is Ahmad (2018).**

Keywords - Course evaluation, Online survey, Paper survey, Response rate, Teaching evaluation

ACKNOWLEDGMENT

[I acknowledge the heartfelt support of Professor D. Williams in all initiatives I take. Thank you!]

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Teaching Statistical Models in a Corporate Finance Master's Degree

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***Abstract* - This work describes the experience of several years teaching statistical models in a master's degree on Corporate Finance, at Polytechnic of Porto. Corporate finance is the division of finance that deals with how corporations address funding sources, capital structuring, and investment decisions. Advanced statistical models are a key part of finding relationships between financial indicators and understanding many important features of companies, such as: their capital structure, the way they manage working capital, the way they bankrupt or how their performance is changed after they start exporting, for example. In this context, it is necessary to deal with large amounts of data, as it is common to analyze data that simultaneously cover both the temporal dimension and the individual characteristics of thousands of companies. Students enrolled in this course often come from a bachelor's degrees in management or accounting, with some basic statistical knowledge, but usually no programming skills. To implement advanced econometric models, it is necessary to either use expensive proprietary software such as SPSS, E-Views or STATA, or to use freeware programming languages such as R or Python. The teaching strategy in this course moved from the first method to the second. Its implications, some practical considerations, and an analysis of the skills acquired by students and applied in their master's thesis will be addressed in this work.**

Keywords – Corporate Finance, Master's degree, Statistical models, R programming.

ACKNOWLEDGMENT

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The impact in students of a STEAM approach in a Calculus I Extraordinary Semester

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Abstract **- The curricular unit of Calculus I - Extraordinary Semester (UCCISE) was created to explore the difficulties students encountered with and failed Calculus I (UCCI) previously. Considering students' familiarity with mathematical software, the potentials of group work to stimulate collaboration among students, and art pieces displayed throughout the University Campus, offered us opportunities to develop group-based projects of calculus to mathematically explore these art pieces. Hence, we designed the UCCISE course based on STEAM approaches connecting different subjects and the arts. Our research project on the UCCISE course aimed at understanding how the use of STEAM approaches could assist students' understanding of mathematical concepts, promote improvements in their course achievements, and contribute to lower failure rates in UCCISE. Four researchers designed a teaching experiment on the course and one teacher contributed to data collection thorough his action research study. The interpretive paradigm of analysis was used with triangulation of data. The collected data come from students' work, interviews, and from questionnaires. Results showed that the thirty-five students considered the work developed was relevant, allowing them to overcome difficulties, and should be a practice also used in UCCI. In addition, the course led to a reduction lower failure rate compared to the regular UCCI. Some of the students enrolled in the UCCISE, did not get involved in the proposed work, only taking the final exams, that is, they gave up a work that appealed to understanding and construction of knowledge. In the opinion of those involved, the STEAM approach used proved to be useful in motivating them to study and improve their results, with some of them mentioning that similar experiences should be used in the first years of their university courses. The study shows that the STEAM approach used is viable for teaching this mathematical topic, with positive effects on the development of students' learning, but the results indicate that it cannot be seen only as a remedial learning practice.**

Keywords – Calculus, Higher Education, STEAM, Teaching Experiment.

The relationship of reflective thinking skills with teachers' perspective of electronic portfolio

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"*Abstract*" Reflective thinking is a fundamental part of human mental processes. It involves the use of meta-cognitive and cognitive skills and is concerned with highlighting how individuals think and construct both their learning, and social experiences. One method through which reflective thinking can be developed is through the use of the electronic portfolio, which contains a collection of students' work over a period of time, highlighting their progress, difficulties, and how they have overcome them. This study examines teachers' views on the practice of reflective thinking and the use of e-portfolios in teaching. The study involved 241 participants, and it was conducted using a 60-item questionnaire that could be completed online using a Likert scale. The results of the present study center attention on the differences between the opinions of future teachers and teachers with different specializations who follow a retraining program regarding the practice of reflective thinking and electronic portfolio in teaching.

Keywords: electronic portfolio, reflective thinking skills, teachers, students.

Using Digital Tools to Improve Engagement and Motivation: The Case of Accounting Education

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Abstract

The use of digital tools to improve education effectiveness in higher education is becoming more and more usual. One of the examples of this importance is the development of the Padagogy Wheel based on stages of Bloom's Taxonomy [1] [2].
One of the most used digital tools is Kahoot, which can be used for gamification and evaluation purposes in education. The literature admits that Kahoot improves engagement and motivation among students [3].
In this paper we present the experience of using Kahoot in Management Accounting classes. Evidence was collected through a questionnaire administered to students from the graduation of accounting and administration in the Porto Accounting and Business School, Portugal. The feedback from students was aligned with the literature, namely a high level of motivation and engagement among them and a self-comprehension of what they need to focus on in their studies in order to improve their knowledge.

Keywords – Engagement, Motivation, Accounting Education; Higher Education; Digital Tools.

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Using flipped teaching to engage Higher Education students in laboratory activities

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***Abstract* - Instructional laboratories are a key element of Engineering Education. However, the massification of Higher Education is challenging, as it requires more human and material resources. On the other hand, the broad use of information and communications technology opens new possibilities. To implement laboratory practice in thermodynamics, a flipped method was used, with five optional laboratory activities (2021/2022). Students could enroll online, selecting from available schedules. They had resources on moodle to prepare in advance: interactive videos; written and video procedures; instrumentation technical data; links to additional information. They reported the experiments' results and assessed the activities in an online questionnaire. After each activity, a report made by the teacher, which summarized and commented on the results, was sent to the students and discussed online. Thirty-six students attended the activities. What students most appreciated was having the results report. They preferred the written procedure over the video and considered the documentation adequate. They believed in having learned with these activities and they would like for these to be available in other curricular units.**

Keywords – Engineering Education, Higher Education, Laboratory Practice, Flipped teaching.

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Poster Presentations

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Abstracts

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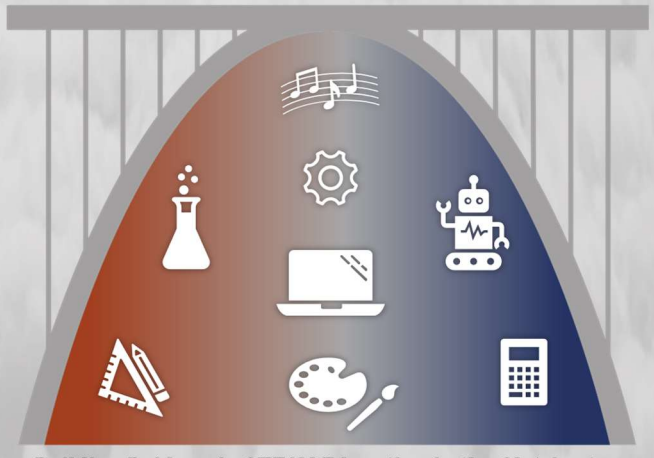

Building Bridges in STEAM Education in the 21st Century

INTERNATIONAL CONFERENCE

A pilot study on the use of Eye-tracking technology for assessing comprehension of mathematical text

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Abstract - Over the last period the results of PISA test in Romania indicate the importance of improving mathematical competencies, however in many cases the reason of this problem is the poor level of student's comprehension. To identify the difficulties in reading comprehension, there is an effective instrument used in educational researches: eye-tracking. Using this sensor technology, it is possible to know where a person is looking by detecting the presence, attention and focus, offering the opportunity to observe manifestations of internal processes. The current pilot study aims to explore the process of comprehension of mathematical text and the main differences between students with or without mathematical difficulties. Accordingly, we focused on the fixation duration, fixation counts and saccadic activity on a small sample (second-year students from the specialization of Pedagogy of Primary and Preschool Education) during problem solving. The results of present research help us to assess the feasibility of the main study with a large sample, identifying any weaknesses and work on consistent practices and familiarize with the protocol of using Eye-tracking technology.

Keywords: Eye-tracking, pilot study, problem solving, reading comprehension

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Active Learning Practices in Higher Education

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***Abstract* – Active Learning (AL) has its origins in constructivism theory where knowledge is gradually expanded through a process of reflection and active construction in the mind** [1], [2]**. AL "definition" has evolved over time in a constructive way as the subject itself** [3]–[6]**. Following this path, AL may be characterized as activities that students engage in to build comprehension, knowledge and skills. The activities setting and features may be quite distinct but these must always challenge students to use higher order thinking skills. Additionally, for a real AL, metacognition connections should be promoted in order to establish links between activity and learning, i.e., it is crucial to push students to think about their own learning outcomes.**

Therefore, "Active teaching" must reflect a way to teach that focuses on the student, engaging them in the learning process through a series of distinct tasks as writing, discussions, simulations, games, among others, instead of exclusively emphasizing the content [7]–[9]**. AL classrooms should incorporate meaningful activities that emphasize reasoning, thinking and active interaction with the subjects covered** [10]**. This is especially relevant in science, mathematics, architecture, engineering, computer programming, marketing studies, among others, where teamwork and a lifelong learning mindset are essential** [5], [11], [12]**. The main goal of all "active" approaches is to capture students' attention and improve their motivation** [13]**, since, without these, the process of reflection and knowledge construction is not conceivable.**

Different teaching and learning environments provide different options, such as synchronous or asynchronous activities, online or in person education, among others [6]**. To structure and enhance cooperative communication within the AL scope, a variety of peer activities have been, and are, being developed.**

These activities can be used whether students are learning basic science ideas or more advanced, system-level science features and may be grouped (with possible subgroups) as, for instance, Small Lectures Supplements, Activities to replace some Lecture and Other activities. Other arrangements can be done as to group activities by goals, like 'Analysis and critical thinking' or 'Synthesis and creative thinking' or 'Application and performance", etc. With these, or other possible groupings and general classifications, there is an almost endless array of activities commonly recognized as AL facilitators, as, with no particular order: Concept Maps, Flipped classroom, Think-pair-share, Peer Instruction, Jigsaw, Case Studies, Post-It Collection, Card Ranking, Dot Voting, Snowball, Memory Game, Fishbowl, Each One Teach One, Debates, Pro-Con Grids, Consider All Factors, Fist to five, One Minute Paper, Stick Debate, Mindmap, Jeopardy, Kahoot, etc.

Through the use of these kinds of AL settings, students from STEM fields may experience engaging, challenging and productive teaching/learning experiences and their access these fields can be facilitated.

Keywords - Higher Education, Active Learning, STEM Education, Teaching/ Learning Methodologies.

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Bibliometric analysis of the use of gamification as a learning technique in higher education

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Abstract **- Gamification is one of the most used techniques in recent years in the teaching-learning process. Its use in primary and secondary education is frequent and has given rise to many and very varied successful experiences, but at the higher education level it is not something that is used in a generalized way. In this work we carry out an analysis of the scientific works that address gamification as a learning technique in higher education and that have been published in the last five years. In addition to offering an overview, this review distinguishes the works dedicated to gamification based on the different areas of knowledge. The results show, on the one hand, the growing importance of this technique as a teaching methodology in higher education and, on the other hand, the existence of important differences between the works published on this subject in the different areas.**

Keywords – Gamification, higher education, bibliometric analysis, areas of knowledge

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Blockchain towards e-learning

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***Abstract* - We live in a technological era, defined by the constant adaptation to the increasing influence that the digital world has had in people and activities. This requires us all to be up-to-date on all its advances, especially when we are considering the effectiveness of digital business.**
The fact that this is a hot topic contradicts the number of studies and relations between the two subjects, which require much deeper investigation and, consequently, more articles to be published.
This article is informatively approaching one of the most influential technologies in the current digital world: Blockchain; the aim is to analyse its creation, evolution and blending characteristics regarding, not only its place and relevance in the crypto currency market, but also its relation with the whole world of digital business, namely in terms of reliability, safety, and privacy, while understanding how it relates and can be advantageous to e-learning or even in assessment activities. These benefits include tools that are being implemented and used to fulfil requirements for health records, digital identity, cloud storage, among other areas of influence.

Keywords – e-learning,,e-assessement, blockchain technology, privacy, reliability.

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Bosnia and Herzegovina must accelerate the digital transformation of public administration, economy and education

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Abstract **- Today, digital transformation affects all segments of people's lives and businesses, and it is no longer a matter of choice but of need. Research conducted shows that the level of digital transformation in Bosnia and Herzegovina is unsatisfactory. According to most indicators that assess the degree of digital transformation, Bosnia and Herzegovina is at the bottom of Europe. Due to the complexity of the political system in Bosnia and Herzegovina, we believe that governments at various levels have not defined and implemented adequate measures to achieve digital transformation of the country. As positive examples of digital transformation, however, we want to highlight changes in education and medium-sized companies. The COVID-19 pandemic has accelerated or initiated the use of information technologies in everyday life and work in Bosnia and Herzegovina, because they have enabled remote work and the use of new sales channels. In this paper, we want to point out the parameters that reflect the digital transformation in Bosnia and Herzegovina, and especially the importance of education in it.**

Keywords - Digital transformation, economy, education, public administration.

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Dancing with Physics

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***Abstract* - We consider dance as a more appealing means of approaching physics. What kind of examples other than a rotating door can attract the lovers of fine arts towards natural sciences? In this work, we use the aesthetics of ballet as a practical tool to engage students in the understanding of physics. The pirouette is possibly one of the most recognizable movements in ballet. We decompose this complex and elegant movement in its rotational and equilibrium forces to describe what allows the ballerina to spin repeatedly in a seemingly effortless manner. By *recognizing* and *feeling* how such forces act on her body, a dancer achieves control and understanding through an *experiential* approach of physics. When it comes to the understanding of rotational forces, equilibrium and momentum, a similar approach can be considered for students: an appealing visual depiction of the forces supplemented with a little practice to enhance the experience of learning notions of physics through dance.**

Keywords - dance, experiential, interdisciplinary, pirouette, physics

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Exploring STEAM in Teacher Education with Poly-Universe

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Abstract **- This paper presents the report of a training module integrated in a curricular unit of an initial teacher training course within the PUNTE Project (Saxon & Stettner, 2019; Poly-Universe in School Education, 2022). This project is based on materials of different geometric shapes, with different colours, which obey certain characteristics that allow various constructions. Using this material, named Poly-Universe, and the experiential learning model, and according to the principle of methodological isomorphism, we proposed activities of construction and copy of models, which involved student teachers from different areas of training of Sciences, Mathematics, Arts and Humanities, Sport, which led to an appropriation of these materials in different disciplinary fields, as well as to the identification of the skills put into play. The participants started by observing the proposed models, some of which were adapted to their subject areas, explored the materials, copied proposals and/or proposed their own ideas, observing the proposals of colleagues and interacting with them. Finally, they wrote a report about the experience. The diversity of ideas and models that emerged for each subject area highlights the potential of Poly-Universe materials in various subject areas. Considering also the dimensions of construction and transformation involved in the activities, it is discussed Poly-Universe potential for promoting STEAM education.**

Keywords - Poly-Universe; Teacher Education; experiential learning cycle; STEAM

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Guiding Play with Poly-Universe Material to promote STEAM education

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Abstract - **This paper presents the report of a set of activities carried out with a three-year-old male child in residential care, using the Poly Universe material. This material involves sets of 24 pieces of geometric shapes and basic colors (square, circle and triangle), which allow puzzle-like constructions, becoming a colorful geometric game of skill development based on symmetry of change of scale, created by the artist János Szász Saxon. The Poly-Universe material can be used in diverse contexts, allowing activities that bring together Mathematics and also other STEAM elements. In fact, Poly-universe materials can be used to construct endless figures, shapes, artwork, allowing a single task to promote STEAM. In this paper, we focus on guided play, rather than free play or an activity with rules, because in a residential foster care condition, the affective bond becomes crucial in the children's development. In cooperation with the child, the educator made the material available, introducing circles, then squares, and finally triangles, guiding the child in exploring the material. Besides leading to the construction of creative patterns and playful solutions, to which other objects were associated (e.g. the car track and the box for a garage), the child was able to playfully recognize and name geometric shapes and colors; to develop her curiosity, motivation, attention and visual perception. In this way, the child's curiosity and desire to learn gave way to intentional processes of exploring the material and understanding different mathematical and science concepts. It was possible to observe a gradual evolution in the handling of the material, showing more and more willingness to make/discover new connections. He autonomously sorted the pieces by color, created imaginary shapes or ones he could play with, put equal-sized magnitudes together and was able to create different geometric figures.**

Keywords - Poly-Universe; Development; Preschool, Guided-Play, STEAM

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Integrated Curriculum Design for a Self-Paced Online Geometry Course for Engineering Students

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***Abstract* - To improve academic performance, teachers should look for opportunities to increase students' involvement in the learning process. According to the growing number of distance learning students at TTK University of Applied Sciences, it was decided to create an online course for an elective subject in the field of geometry. This approach provides an opportunity for students to study this subject regardless of the timetable and go through it at their own pace. The article describes both the pedagogical and technical aspects of designing and developing an online course through the Moodle virtual learning environment. The authors also present the modeling, management, and organization of the self-paced learning process, supported by teachers' guidance. The results of a survey of students about the chosen approach showed the validity of the chosen teaching method.**

Keywords - Online Learning, Course Design, Mathematics Instruction, Educational Technology, Self-Paced Learning.

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Interactive Lessons in Statistics as Tools for Academic Success

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Abstract **- In the past few years, many studies have emerged on the search and development of interactive learning materials in order to improve the effectiveness of the teaching/learning process ([1], [2], [3], [4], among many others). Several of these promote the use of technology in this process, concluding that can be an asset in the development and implementation of new pedagogical features that are in line with the real expectations of today's students, challenging them in innovative and inclusive ways ([3], [4], [5], [6], [7]). Therefore, student centered activities seem to be the core for new pedagogical paths that shift the educational "focus" from the teacher to the student. This also makes the students more responsible for their academic success, since the teachers' role is transformed from being the "usual" anchor and knowledge transmitter into a sort of tutor that supports and guides students through each learning track.**

In a Statistics course at higher education level, the presence of students with different academic paths and diverse mathematical backgrounds drives the implementation of measures to establish a minimum level of statistical knowledge, essential for a coherent and continuous study of the area. This will have to be done simultaneously with normal teaching activities, allowing less knowledgeable students to fill in their gaps without greatly interfering with the educational path of other students.

Hence, interactive lessons were, and are being developed along with practical quizzes and applications. This is done by transforming animated PowerPoint presentations into "e-Lessons" with interactions, questions with step-by-step feedback, formative quizzes and alternative paths in the Lesson navigation options, without losing the presentation effects. These "e-Lessons" are SCORM packages created with iSpring Suite 9 software, an extension of PowerPoint, and iSpring Quiz Maker software was used to sequentially insert different types questions (from the 14 available types) to be answered before moving on, promoting students' interaction with the lesson contents ([8], [9], [10]). These SCORM packages are uploaded and shared through the Learning Management System (LMS) Moodle from the institutional Project MatActiva [11]. Moodle is being used as the support platform for this specific eLearning activities, since it is an open source and user-friendly system that has a large implementation in the field of Education. It permits the dissemination and usage of all kind of resources and materials, allowing to keep track of the students' engagement and progress, an important feature in this teaching/learning process.

This work shows how the use of technology and particular digital features, in the teaching/learning process, can promote students' engagement and skills in the field of Statistics. This can also be implemented in any other course and/or scientific area, giving to the theory presentation several appealing interactive features, revealing a high potential in terms of transferability. Further research might be made to investigate the level of interaction between students and "eLessons" in the form of self-assessment tasks and formative feedback.

Keywords - Higher Education, Innovation, Interactive Learning Materials, Online Learning, Technology enhanced teaching/learning.

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INVITE project: Developing Competences and Innovative Designs for International Virtual and Blended Learning Modalities

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***Abstract* – The new Erasmus+ INVITE project aims at developing teaching and learning competencies for designing and implementing new virtual and blended modalities of international collaboration in European Higher Education Institutions, an objective aligned with several ambitions of the European Commission agenda for Higher Education. More specifically INVITE project intends to i) Map the current institutional and educational approaches to the different cross-border and international collaboration in virtual and blended learning environments, ii) Develop an active-learning design framework applicable for different international virtual and blended modalities, iii) Design and implement an action-training online program targeting interdisciplinary teachers and institutional staff from HEI institutions to build capacities to design, implement and sustain innovative international virtual and blended programs/initiatives, iv) Develop an open interactive digital ecosystem that will host the action-training program and also support the organization of international competition hackathons bringing together institutions and teachers, and v) Identify Higher Education policies and strategies for innovation in teaching and learning aiming to establish and sustain crossborder virtual and blended programs.**

Keywords - Higher Education, International Collaboration, Virtual and Blended Learning.

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"MusiMath": Creativity in Music, Math and Technology

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Abstract **- Multidisciplinary education (STEAM education) enables different students to learn in a diverse way and improve their learning skills (Allina, 2013; Quigley, Herro, & Jamil, 2017). The present study examines the effectiveness of learning mathematical basics in music patterns using explicit instruction and its impact on the creative thinking of 3rd graders (N=84) in both fields (Guilford, 1973; Torrance, 1969). For the purpose of the study, an original intervention program, "Musimath", was developed with an emphasis on patterns' creative thinking. The study used a mixed method while the mathematical knowledge, the musical knowledge and components of the students' creative thinking in both disciplines were tested using writing assignments and separate computerized questionnaires. In order to collect the data, we developed software that allowed the students to perform musical and mathematical tasks which included questions with one correct answer and questions that invited original and varied answers that encouraged creative thinking. The study is being conducted these days. Detailed results comparing the mathematical and musical creative thinking and the interaction between them will be presented.**

Keywords – Creative thinking, STEAM Education, Multidisciplinary, Patterns

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Poly-Universe Resources for Solving Geometric Tasks by Portuguese Basic Education Students

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Abstract **- This poster presents the analysis and discussion of solving geometry tasks by Portuguese Basic Education students, using material from the Poly-UNiverse in Teacher Training Education (PUNTE) project. The teaching experience developed was aimed at testing and disseminating new resources, innovative and transdisciplinary methodologies in the areas of Science, Technology, Engineering, Art and Mathematics (STEAM). The adopted methodology involved two phases. The first phase was exploratory, followed by a second phase where the exploration of geometry concepts in the plane (namely, the perimeter, the similarity of triangles) was carried out using the PUNTE material. The results of the study show that the PUNTE materials constituted an important teaching resource in solving the proposed tasks. Its manipulation allowed the visualization of the situations involved in the tasks, as well as contributed to an implication in the activities developed by the students.**

Keywords – Geometry, Perimeter, PUNTE, Triangle Construction

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Remarks after Implementation of Tutoring in the AGH University of Science and Technology

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Abstract **- The top 10 skills for 2030 refer to active learning, independent research, and creative and critical thinking. This fact must also impact engineering curricula. What can contribute here is tutoring, which is gaining popularity at universities in Central and Eastern Europe countries. At the AGH University of Science and Technology in Cracow, Poland, in the academic year 2020/2021, the first edition of the "Tutoring in AGH-UST" program was conducted; it comprised developmental and scientific tutorials addressed to first-year students with the highest admission scores. Despite the generally positive opinions of tutors and tutees, two main developmental areas were identified: (1) the need for developing tutoring tools dedicated to STEAM, which will guarantee their effectiveness in engineering education, (2) constant improvement of tutor-tutee matching system to maximize both students' satisfaction and to increase tutors' self-confidence. In this paper, a case study of the implementation of tutoring in a technological university is presented along with recommendations for the tutors' academic development.**

Keywords – tutoring, technological university, STEAM, skills for the future, academic development.

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Review of learning methodologies. Teaching experience in STEM careers

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***Abstract* – With the entry in 1999 of the European Higher Education Area, the way of conceiving university teaching has recently changed. There was a shift from lectures in some cases combined with laboratory practices (mainly in technology and science degrees) to more participatory teaching using a wide variety of teaching methodologies that were accompanied by the use of software to promote learning. This study shows the evolution of these methodologies for different subjects of different academic courses in Engineering and Architecture degrees. To see if these methodological changes are adequate, they are the same with the related academic results.**

Keywords –University, technological studies, European Higher Education Area, learning software.

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STEM studies and gender. At what point does the trend reverse?

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***Abstract* – Today's society is in need of qualified professionals in the field of STEM education due to the large increase in population and the growing use of technologies, which are a fundamental pillar in the development of society. In addition to this, in this type of degree, the female presence at the university is minimal but not in the STEM projects carried out in the high school. In this study, an analysis is made of the change in the trend of girls at the ages in which they attend high school, reaching values of 60%, compared to girls who study STEM degrees at university, reaching values of 30%, especially for degrees in the scientific field of engineering and architecture. The case shown in this research is that of the University of A Coruña (Spain), which has been offering this type of project since 2018 (267 projects offered) and where the investment in the trend of girls can be clearly seen to pursue this type of study.**

Keywords – gender, university, technological studies, STEM

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STEMbach: experiences in the Galician region

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***Abstract* – The objective of the present paper is to explain various experiences of STEMbach in different fields of science: engineering, economics, materials, etc. The STEMbach program can be developed by high school students during their two years studing for obtaining the High School Diploma (Equivalent to A-Levels). It is a**

subject of the "*Bachillerato de Excelencia*" in Science and Technology, designed for both the Humanities and Sciences modality and created alongside the Galician Strategy for digital education. It promotes the vocation of the students towards scientific and technological research and allows a connection directly with university education. All these STEM works have been carried out between the University of A Coruña and different high schools located in the region of Galicia (North-West of Spain). Results are very positive in order to promote the STEM careers in this region.

Keywords – economics, engineering, high school, STEM.

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Team development in an industrial environment: the experience of the Universities of Future project

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***Abstract* - The teaching of individual skills in higher education has always been one of the biggest focuses of the academy. The VUCA/BANI environments that accompany the Industrial Revolution 4.0, demand from academic leaders the inclusion of educational solutions that develop team skills and their improvement, to develop much higher levels of performance, as well as positivity in the team. The Universities of Future (UoF) project presents an intervention development model that incorporates this concern of not only working on personal (hard and soft) skills, but also targeting the team as a single entity, which focus on a real problem of a company. This communication aims to present the model proposed by the UoF project, as well as its main results. Some recommendations are made in terms of educational methodologies, as well as the transformation of the mindset of the more conservative academic culture.**

Keywords – Team development, I4.0, Universities of Future, Team coaching, Simulation.

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The Flipped Classroom optimized through Gamification and Team-Based Learning

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Abstract **- The increase in digital teaching and learning methodologies creates the opportunity for new educational approaches, both in terms of pedagogical practice and in the availability of new technological tools. The Flipped Classroom (FC) as an active teaching methodology is one example of b-learning, which aims to harmonize and enhance the fusion of face-to-face teaching with online teaching, allowing students to get better use of both face-to-face contact with classmates and teachers, and digital teaching resources. However, active teaching methodologies allow us to merge educational techniques from different methodological approaches, for example, Gamification and Team-Based Learning (TBL), among others. The aim of this study is to demonstrate how FC can be enhanced by Gamification and TBL, indicating possibilities and challenges to overcome, through the comparative study and research carried out with students in Higher Education.**

Keywords - b-learning, e-learning, Flipped Classroom, Gamification, Information and Communications Technology, Team-Based Learning, Virtual Learning Environment.

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The impact of some pedagogical strategies on the improvement of the individual learning process in statistics from students' point of view: A case study

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***Abstract* - Historically, a significant percentage of higher education students have many difficulties acquiring knowledge and statistics skills. These impediments stem from a lack of reflection on non-trivial concepts, difficulties in building mathematical models, and a lack of writing development in mathematics.**
In this study, from the students' perspective, we present the results of the pedagogical strategies implemented to increase the students' study performance, namely publishing detailed solved exercises with embedded explanatory comments and conducting a data analysis computational workgroup.
During the academic years 2020/21 and 2021/22, the opinions of 96 students were collected in a non-probabilistic sample carried out on moodle.
The publication of the exercises to be performed in the theoretical-practical classes enriched with explanatory comments proved to be, in the students' opinion, a successful strategy for improving the individual learning process of statistics. Results show that 91.8% of the students considered that commented resolutions contributed decisively to the improvement of their learning process and that 93,8% of the students considered that the comments guided them to a better understanding of the resolution of the exercises.
According to 76,6% of the surveyed students, a workgroup with computational implementation helps them better understand data analysis concepts, and 70,1% mentioned that they learned from exchanging and discussing ideas with their peers.

Keywords – Engineering Education, Learning process, Pedagogical Strategy, Computational Statistics, Workgroup

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The Use of Role-Playing to Motivate Accounting Students

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***Abstract* - More and more professors in higher education are requested to use innovative methodologies to motivate and engage students. The focus in education tends to be the development of new skills such as creativity and critical thinking, considered key skills for students to be able to deal with uncertain realities. This paper presents the case of public accounting course where higher education students faced new methods such as role-playing and simulation. The study aims to understand how these students "embraced" this method to enhance creativity and autonomy. The quantitative methodology was the chosen one for this study. The results allowed us to conclude that students are more engaged in their self-learning when faced with active methodologies.**

Keywords - active learning; public accounting; role playing; simulation.

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Towards gamification for online and hybrid mathematics education: The PYTHAGORAS approach

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Abstract – **Gamification can be defined as the use of game design principles and mechanics in non-game contexts in order to make those contexts more inviting, encourage users to engage in desired behaviour, and optimize the overall experience and results [1]. Gamification has become a popular tool in several applications, including learning, since it provides a natural and attractive human experience. But learning is a *complex* and *personalized* process [2]. To succeed learning personalization, gamification should follow a player/user centred design. Moreover, gamification should identify the appropriate motivators of the target audience. To this result, the Self-determination Theory (SDT) is employed. SDT is concerned with the psychological needs behind motivation and the social conditions that foster these processes [3]. SDT identifies two distinct types of motivation: *intrinsic* and *extrinsic*. Intrinsic motivators include the following: acceptance, curiosity, autonomy, competence, skill development, order, social contact. Extrinsic motivators include the following: badges, points, positive feedback, status, grades, fame. In this context, PYTHAGORAS project aims (among others) at exploring gamification impact for online and hybrid mathematics education.**

Keywords - Gamification, Mathematics Education, Online and Hybrid Learning

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Abstract - Problem-solving competency is important not only in many careers, but also in everyday life. Successful problem solvers regulate their cognitive processes and emotions. Our research aimed to study the efficacity of gamified problem sheets designed in Seppo for developing self-regulated learning skills (SRL). The intervention was carried out with second-year students from the specialization of Primary and Preschool Pedagogy. The research tool was a self-regulated problem-solving scale used as pre- and posttest. The students were divided into experimental and control groups. In the experimental group gamification for 6 weeks. The game had 3 levels and the players could choose exercises from any level they wished. Exercises from lower levels were awarded with fewer points than those on higher levels. The aim was to achieve 12 points during each seminar. The results show no significant improvement in students' self-regulation skills while solving math problems. This could be due to the short length of the intervention. Also, the development of a more sophisticated research tool for measuring SRL skills is needed.

Keywords: Seppo platform, gamification, problem-solving, self-regulated learning

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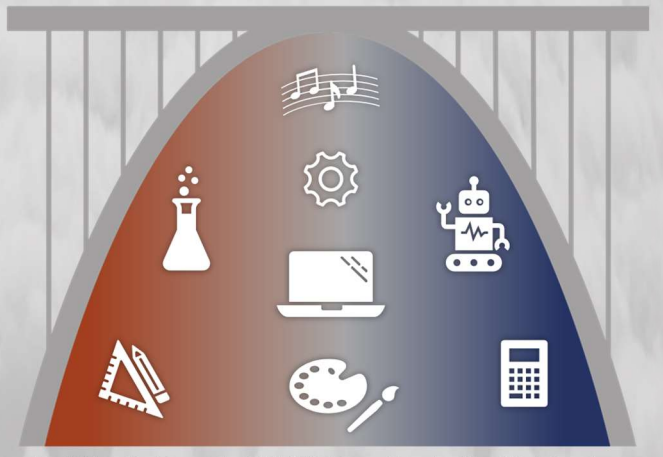

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