

EDU LEARN²²

14TH INTERNATIONAL CONFERENCE
ON EDUCATION AND NEW LEARNING
TECHNOLOGIES

PALMA (SPAIN)
4TH-6TH OF JULY, 2022



CONFERENCE PROCEEDINGS



EDULEARN₂₂

**CONFERENCE
PROCEEDINGS**

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Preface

EDULEARN22 Conference Proceedings contain selected and revised papers from the 14th annual International Conference on Education and New Learning Technologies.

EDULEARN22 was held in Palma (Spain) last 4-6 July 2022. Every year, EDULEARN brings together lecturers and researchers from universities and educational institutions from all over the world. This edition welcomed participants from 79 different countries, ensuring a geographic diversity and a multicultural environment.

The main objective of EDULEARN22 was to offer a meeting point for educational experts to share and discuss their experiences and projects on education, pedagogical technologies, and educational innovations. The conference program offered different keynote speeches, plenary sessions, parallel thematic sessions and workshops delivered by education experts. The keynote speeches are available at IATED Talks (iated.org/talks/)

In addition to the Technical Program, different networking activities and events were scheduled where participants could interact with other delegates and shared their perspectives on education.

The scope of EDULEARN22 included the following topics: Digital Tools In Education, Digital literacy, Open Educational Resources, Virtual and Augmented Reality, Flipped learning, e-learning experiences, Blended and Hybrid learning, m-learning, digital transformation in education, Game-based learning, MOOCs, Coding and Computational Thinking, Digital Technologies for learning under lockdown, Personalized and Adaptive learning, Peer and Team-based learning, Student Engagement, University-Industry cooperation, International Projects, Exchange and Mobility Programs, Entrepreneurship Education, Student support and Wellbeing, STEM education, Diversity and Equity in education, Special and Inclusive experiences, Tutoring and Mentoring, Curriculum design, Quality assurance, Active and Experiential learning, Professional Development of Teachers, Pre-Service Teacher experiences, Vocational Education, Digital Competence of Teachers.

The EDULEARN22 Proceedings include the accepted contributions presented at EDULEARN22 Conference. The EDULEARN22 International Program Committee is composed of lecturers and researchers from all over the world. A meticulous job in selecting papers for publication was conducted. We wish to thank the program committee members who conducted a blind peer review process to guarantee the quality of the contributions and presentations. The following points were evaluated: information content, relevance to the field, general structure, clarity of contents, originality, relation to the conference topics and disciplines. The language of the publication was exclusively English.

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Finally, we wish to extend our most sincere thanks to all members and delegates who have contributed to EDULEARN22 Proceedings. We also wish to express our gratitude to all participants and attendees for their engagement, motivation and passion for education.

Luis Gómez Chova
Agustín López Martínez
Joanna Lees

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Wayne Holmes – *University College London, United Kingdom*



Wayne Holmes, University College London (United Kingdom)

Workshop: The right type of AI in Education

Current AI in education approaches tend to be solutions- rather than problems-oriented. In this workshop, we're going to take steps to address this, focusing on identifying genuine education problems that the application of AI might help address. Throughout, we will take a critical and human rights perspective, and will ensure a voice for all.



Michelle R. Weise, National University System (United States)

Workshop: Jumping to your next S-curve

In this futures-oriented workshop, Dr. Michelle R. Weise will facilitate small group breakout sessions in which you will each have an opportunity to think through your current business or organizational model as well as your value proposition for the working learners of today and tomorrow.



Stephen Heppell, Universidad Camilo Jose Cela (Spain)

Workshop: The aggregation of marginal learning gains: making your learning space so very much better

The workshop explores the many environmental details covered in Stephen's keynote and seeks simple, cost effective, proven, try-today, solutions to optimising your learning space. If we want to be our best learning selves, then how might we start today?



Desiree Cranfield, Swansea University (United Kingdom)

Workshop: Knowledge Sharing café – teaching innovation before, during and after Covid-19

The aim of this session is to provide an opportunity for attendees, academics, to come together, in an informal setting to informally share teaching experiences, both good and bad, with the aim to inform practice.

The impact of this session can be the building of networks, the immediate sharing of teaching best practice of a time before, during, and after the pandemic, improving the knowledge around teaching practice during this difficult period.



Julie Smith, Webster University in St Louis, Missouri (United States)

Workshop: Media Literacies: The 21st Century Survival Skills that can Change the World

People around the world are spending – on average – eight hours a day with electronic mass media. Yet even in 2022, we are still not talking enough about how this affects people personally, politically, physically, emotionally and educationally. Using theoretical frameworks to provide context as well as classroom experiences to provide relevance, Smith will explain the importance of media literacy skills, how to teach them and the difference they can make in the lives of citizens and students.



Reed Stevens, Northwestern University (United States)

Workshop: FUSE Studios: A Choice and Interest Centered Learning Environment

In this one-hour session, the FUSE team, led by creator Reed Stevens, will seek to bring the audience inside the FUSE experience in two ways over the first 25 minutes: (1) We will provide a tour of the design principles and core activities of a FUSE Studio. (2) We will share vivid representations of youth and teacher-facilitator experiences in FUSE, drawn from a half decade of video-based ethnographic fieldwork and extended interviews with students. In the second 25 minutes, we will seek to bring the audience further inside the FUSE experience via trying one or more FUSE challenges.



Maria Luisa Spreafico, Politecnico di Torino (Italy)

Paola Morando, Università degli studi di Milano (Italy)

Workshop: Not only math: a game-based learning experience for a new teaching approach

In this workshop we present three didactic games in two versions each: math and art, math and science and math and English. Participants will experience the activities live during the workshop. Since we only use everyday materials, like paper and recycled items, teachers can easily replicate the games in their own classes.



Hesham Elmarsafawy, Gulf University (Bahrain)

Workshop: Science Fiction Drama for Continuous Development in Higher Education

The Workshop aims to introduce innovative pedagogy and outline the mechanism of utilizing science fiction drama in the educational processes as alternative tool for Brain warm-up, support the understanding of science matters, forming futuristic view, foster creativity and enhance students' learning abilities and engagement.

EDULERN22 Keynote Speakers

Keynote Speakers

Michelle R. Weise – National University System, United States

Stephen Heppell – Universidad Camilo Jose Cela, Spain

Wayne Holmes – University College London, United Kingdom

Michelle R. Weise – National University System (United States)



Keynote speech: Long Life Learning: Preparing for Jobs that Don't Even Exist Yet

Tech is advancing; jobs are morphing, and job tenure is shorter; retirement is delayed or gone entirely; and education has to be continuous. Education and workforce strategist Dr. Michelle R. Weise talks about the infrastructure we need to build for a future filled with 20, 30, or more job changes. From wraparound supports for workers to targeted education, integrated earning and learning, and transparent and fairer hiring, Dr. Weise will discuss the research from her latest book and how we prepare talent for jobs that don't even exist yet.

Biography: Dr. Michelle R. Weise (pronounced W-ice) is the Vice Chancellor of Strategy and Innovation at National University System. She is also the author of *Long-Life Learning: Preparing for Jobs that Don't Even Exist Yet* (Wiley, 2021). Her book was awarded the 2021 Phillip E. Frandson Award for Literature by UPCEA (University Professional and Continuing Education Association), recognizing the author and publisher of an outstanding work of continuing higher education literature. Thinkers50 named her one of 30 management and leadership thinkers in the world to watch in 2021. Dr. Weise's work over the last decade has concentrated on preparing working-age adults for the jobs of today and tomorrow. She has served as a senior advisor at Imaginable Futures, a venture of The Omidyar Group. She was also the chief innovation officer of Strada Education Network as well as of Southern New Hampshire University. With Clayton Christensen, she coauthored *Hire Education: Mastery, Modularization, and the Workforce Revolution* (2014) while leading the higher education practice at Christensen's Institute for Disruptive Innovation. Dr. Weise also advises BrightHive, a data collaboration platform, the Virginia Economic Development Partnership, the Institute for Higher Education Policy (IHEP), the SkillUp Coalition, Basta, Hitch, Bayes Impact, Clayton Christensen Institute Social Capital R&D Project, and World Education's Personal and Workplace Success Skills Library. She has also served as a commissioner for Massachusetts Governor Baker's Commission on Digital Innovation and Lifelong Learning, Harvard University's Task Force on Skills and Employability, and the American Academy of Arts and Sciences' Commission on the Future of Undergraduate Education. Her commentaries on redesigning higher education and developing more innovative workforce and talent pipeline strategies have been featured in *The Economist*, *The Wall Street Journal*, *The New York Times*, *Harvard Business Review* and on *PBSNewshour*. Michelle is a former Fulbright Scholar and graduate of Harvard and Stanford.

Stephen Heppell – Universidad Camilo Jose Cela (Spain)



Keynote speech: The aggregation of marginal learning gains: why they matter so much for the future of Learning

Learners are facing unprecedented choices - not only of nomadic campuses, hybrid systems and remarkable new technologies, but also of the many details, from light brightness to levels of volatile organic compounds in their learning places, and even diet. These combine to have a substantial impact on our learning, but if we neglect them, then today's learners will seek better places for their learning, elsewhere. This keynote also explores where those better places might be.

Biography: Professor Stephen Heppell has been a professor since the 1980s, he has an unrivalled track record of success and a string of huge projects in both Learning and Technology. He is credited with being the person who put the C into ICT. His support for better Learning is sought by everyone from governments and major corporations, through schools and universities, to elite sports – lately England Rugby, and Team GB’s elite Olympic coaches. Everyone needs better learning. He currently holds the Felipe Segovia Chair of Learning Innovation at Universidad Camilo Jose Cela in Madrid. Additionally, he is Emeritus Professor and Chair of New Learning Environments at Anglia Ruskin University. A pioneer of multimedia and CD-ROM before the Internet, post-internet Professor Heppell created and led what was the Guinness Book of Record’s largest internet learning project, years before Google, Facebook et al. He has been, and continues to be, at the heart of many world leading projects since. Professor Heppell’s learning space design work extends beyond the digital and virtual. Pioneering learning space designs include the UK “Classrooms of Tomorrow” project, much work in the UK Building Schools for the Future initiative, and today school and university building projects ranging from Peru to Spain, from Australia to SE Asia, from Syrian refugees to some of the wealthiest learning institutions in the world. Pivotal research including the learnometer project analysing the light, temperatures, CO2 and more that contribute to better learning and working spaces, have led to Stephen being in considerable demand to transform physical learning spaces in education, but also everywhere from new media to the Australian mining industries.

Wayne Holmes – University College London (United Kingdom)



Keynote speech: Artificial Intelligence and Education. A Critical Studies Perspective

Artificial Intelligence (AI) is frequently hailed as a ‘solution’ to many of education’s core problems (e.g., OECD, 2021) – problems such as the lack of qualified teachers, student underachievement, and better preparing learners for workplaces and career paths that may be very different from current paradigms. However, such claims tend to be aspirational rather than evidence-based (Miao & Holmes, 2021), and overly-simplistic, forgetting issues such as agency, pedagogy, surveillance, efficacy, and ethics (Holmes et al., 2021; Holmes et al., in press; Holmes & Porayska-Pomsta, in press; Porayska-Pomsta, Holmes and Nemorin, in press). Current approaches tend to be solutions- rather than problems-oriented, and all too often replace teacher functions rather than empower teachers, while the teaching of AI almost always focuses on the technological dimension of AI to the exclusion of the human dimension. Accordingly, this presentation will explore teaching with and about AI, from a critical studies and human rights perspective. It will identify and address many of the key myths, and will pose more questions about AI and the futures of learning than it answers.

Biography: Wayne Holmes (PhD, University of Oxford) is a learning sciences and innovation researcher who teaches at University College London and is a researcher on Artificial Intelligence (AI) and education for UNESCO, IRCAI (the International Research Centre for Artificial Intelligence under the auspices of UNESCO), and the Council of Europe. Having been involved in education throughout his life, Wayne brings a critical studies perspective to the connections between AI and education, and their ethical and social implications. His recent publications include “The Ethics of AI in Education: Practices, Challenges and Debates” (in press), “Artificial Intelligence and Education, through the Lens of Human Rights, Democracy and the Rule of Law” (in press), “Artificial Intelligence in Education. Promise and Implications for Teaching and Learning.” (2019), “Ethics of AI in Education: Towards a Community-Wide Framework.” (2021), and, for UNESCO, “AI and Education: Guidance for Policy-makers.” (2021). Wayne also co-authored the EU’s DigComp 2.2 Annex “Citizens Interacting with AI Systems” (2022), and has given invited talks on AI and education in Brazil, China, Croatia, Denmark, Germany, Greece, India, Japan, Oman, Slovenia, Spain, and the US (and online to audiences in many other countries around the world).

Conference Tracks & Sessions

The EDULEARN22 conference program is available online at <https://iated.org/edulearn22>

ORAL SESSIONS MONDAY

Digital Literacy
Next Generation Classroom
Student Engagement
University-Industry Collaboration
International Cooperation
Language Learning and Teaching
STEM Education during COVID-19
Media Literacy, Cybersecurity and Data Privacy
Flipped Learning
Peer and Team-Based Learning
Entrepreneurship Education
Exchange and Mobility Programmes
Language Learning Technologies
Architecture & Civil Engineering Education
Metaverse and Virtual Reality Environments
MOOCs & Open Educational Resources
Personalized and Adaptive Learning
Life-long & Workplace Learning
Educational Management
Pedagogical Innovations in Engineering Education
Digital Tools in Maths Education
Virtual & Augmented Reality
Blended & Hybrid Learning
Tutoring and Mentoring
Education for Sustainability
Student Support and Wellbeing
Experiences in Engineering Education
Maths in Higher Education

POSTER SESSIONS MONDAY

Emerging Technologies in Education
New Experiences in Education

ORAL SESSIONS TUESDAY

Digital Transformation of Education
Data Science & AI in Education
Student Support during COVID-19
From Face-to-Face to Remote Learning (1)
Diversity and Equity in Education
Health Literacy and Patient Education
Mathematics in Primary & Secondary Education
e-Learning Experiences
Work-based Learning
Assessment of Student Learning (1)
Early and Primary Education
Social Inclusion and Academic Success of Chinese Students in EU Higher Education
Experiences in Health Sciences Education
STEM Education Experiences

m-Learning
Active & Experiential Learning
Assessment of Student Learning (2)
From Face-to-Face to Remote Learning (2)
Digital Divide and Educational Inequalities
Special and Inclusive Education
Curriculum Design & Quality Assurance
Digital Technologies for Learning under Lockdown
Game-based Learning
Computer Science and Programming in Higher Education
From Face-to-Face to Remote Learning (3)
Teaching Experiences and Support during COVID-19
Business Education Experiences
Professional Development of Teachers
21st Century Skills
Digital Competences of Teachers
Coding & Computational Thinking
Emergency Remote Teaching during COVID-19
Student Wellbeing in Social Media and Online Learning
Vocational Education
Pre-service Teacher Experiences

POSTER SESSIONS TUESDAY

From face-to-face to Remote Learning
New Trends in Education and Research

VIRTUAL SESSIONS

DIGITAL TRANSFORMATION OF EDUCATION

Data Science & AI in Education
Learning Analytics & Educational Data Mining
Digital Transformation
Digital Technologies and Resources for Learning under Lockdown
21st Century Skills
Educational Programming & Robotics

DIGITAL & DISTANCE LEARNING

Distance Education in COVID-19 Times
Challenges and Practices during the Pandemic and Beyond
Blended & Mobile Learning
MOOCs & Open Educational Resources
Learning Management Systems & Virtual Learning Environments

INNOVATIVE EDUCATIONAL TECHNOLOGIES

AI, Chatbots & Robots
Virtual & Augmented Reality
Social Media in Education
Technology Enhanced Learning

TEACHER TRAINING & ED. MANAGEMENT

ICT & Digital Skills
Professional Development of Teachers
Educational Management

ACTIVE & STUDENT-CENTERED LEARNING

Gamification & Game-based Learning
Experiential Learning
Problem & Project-Based Learning
Soft Skills Development
Pedagogical Innovations

ASSESSMENT, MENTORING & STUDENT SUPPORT

Assessment & Evaluation
Rethinking Assessment in COVID-19 Times
Feedback for Learning
Tutoring & Coaching
Student Support & Motivation

EDUCATIONAL STAGES & LIFE-LONG LEARNING

From Pre-school to Secondary Education
Non-Formal and Informal Learning
Transition to the Job Market
Developing Entrepreneurship in Education
Life-Long & Workplace Learning

QUALITY & IMPACT OF EDUCATION

Quality in Education
Experiences and Challenges in Curriculum Design
Sustainability & Social Impact of Education
Links between Education and Research
University-Industry Collaboration
Mobility & International Projects

MULTICULTURALITY & INCLUSION

Multicultural Education
Diversity Issues
Special Educational Needs
Inclusive Education

STEM EDUCATION

Mathematics & Statistics
Engineering Education
STEM Experiences

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DISCIPLINE-ORIENTED SESSIONS

Architecture & Interior Design Education
Health Sciences Education
Computer Science Education
Business & Tourism Education

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VIRTUAL INTERNSHIPS IN TECH CENTERS

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Abstract

In this communication we present the contents, objectives, and methodology of the “DIGITAL COURSE: ELEARNING SIMULATION ENVIROMENT IN TECH CENTERS”, developed within the framework of the Erasmus Plus Program Project “VIRTUAL INTERNSHIPS IN TECH CENTERS: TRAINING VET STUDENTS WITH OBSTACLES INTO INNOVATIVE DIGITAL METHODS OF REMOTE WORKING AND ELEARNING CREATED FROM COVID-19”. This is a digital course, addressed to vocational education, VET, students, especially those with obstacles. The objective of the course is to train the students in the knowledge and skills required for successful and effective teleworking in technological companies. The participation in virtual internships in the companies involved in the project will complement this initial training course. We expect helping VET students to obtain a competitive curriculum that facilitates their access to the labour market and their social inclusion. All this in order to respond to the terrible situation derived from the COVID19 pandemic, which has shown the importance of teleworking and digital training.

The course is based on THE SIMULATION OF WORK LEARNING methodology, a practical work training methodology that has attracted great attention in recent years. To implement it, we present the course in a LEARNING BY DOING application. We place the student in a private e-learning environment that will simulate the scenario of a specific job with specific characteristics, structure, equipment, and available software. In this environment the student must carry out different activities related to the functions that they will have in future virtual internships in the technology company. In this way, when virtual mobility begins, they will already have met the clue points that will facilitate them to take advantage of the internship and be effective for the company.

This methodology, based on immersive computer technologies, conceives students as active agents in the development of their knowledge, skills, and professional attitudes through experience. VET students with obstacles will improve their ability to obtain and analyse information, to make decisions, and to work within a team, as well as improving their communication skills and use of technology.

Keywords: VET, virtual internships, technology companies.

1 INTRODUCTION

The effects of the COVID-19 pandemic have shown the need to carry out changes in the educational field that adapt education to a new post-covid reality. Many of these changes have begun to be urgently carried out directly by teachers and schools themselves to face the closure of schools during the first half of 2020 across Europe. It is thanks to their effort and dedication that progress has been made in the modernization and digitization of education, adapting it to the reality caused by the coronavirus and alleviating in some way the learning delays that students could suffer.

However, there has been an educational loss in a large part of the student body. In the case of VET education, the employability situation has worsened with the pandemic and many vocational training students have not been able to carry out internships in companies, having to replace them on many occasions with theoretical studies, thus losing the opportunity to have a first work experience. Likewise, COVID-19 has increased the probability that throughout their professional career they will have to face virtual jobs, in which they rarely attend the company in person.

In this context, the Erasmus Plus Project “VIRTUAL INTERNSHIPS IN TECH CENTERS: TRAINING VET STUDENTS WITH OBSTACLES INTO INNOVATIVE DIGITAL METHODS OF REMOTE WORKING AND ELEARNING CREATED FROM COVID-19” arises. The project aims at promoting the inclusion and employability of VET students with obstacles, through the creation of materials and tools that allow them to carry out virtual work practices in high-tech centers and develop critical and scientific thinking [1,2]. Specifically, two intellectual results are being developed: 1) A METHODOLOGICAL GUIDE, aimed at teachers and company tutors, which offers all the information, protocols, guidelines and tools that VET centers and technology companies need to carry out innovative and effective virtual practices, 2) "DIGITAL COURSE: ELEARNING SIMULATION ENVIROMENT IN TECH CENTERS", on which we will focus in this communication.

ELEARNING SIMULATION ENVIROMENT IN TECH CENTERS is a 120-hour digital course, aiming at training VET students with all the knowledge and skills necessary to successfully carry out virtual internships. The course is addressed to those students who participate in virtual mobilities of the network, as well as to all those who want to develop necessary job skills in the technology sector and prepare to work in technology companies.

This course follows a methodology LEARNING BY DOING [3-5] by placing the student in a private e-learning environment that simulates the scenario of a specific job with the characteristics, structure, equipment and software that the student needs to carry out activities according to the functions that they will have in future internships in the technology company.

2 METHODOLOGY

ELEARNING SIMULATION ENVIROMENT IN TECH CENTER is based on a practical work training methodology that has emerged as a very relevant educational tool in recent years: SIMULATION OF WORKPLACE LEARNING.

This is an effective method based on immersive computer technologies. It conceives students as active agents in the development, through experience, of their knowledge, skills and professional attitudes. The objective is that with this methodology students improve their ability to process and analyze information and acquire skills for teamwork, innovation and creativity. They should develop the initiative to make decisions and influence those of the work team, as well as their communication skills and use of technology.

Simulation of workplace is an excellent methodology for students to adapt to virtual work environments. It can be implemented as a collaborative environment in which a group of students make decisions, evaluate results, solve problems, evaluate risks. Each student receives feedback on their actions, since the methodology provides a high level of interaction. On the other hand, simulation of real work allows the student to train the necessary skills to carry out the tasks assigned to them in the virtual innovative projects, in addition to acquire knowledge useful for employability in technology companies. Thus, throughout the simulation they will be able to acquire mechanisms to improve their social and labor inclusion.

The course includes a learning simulator for five jobs, related to those that the technology companies which are partners of the project offer to the students as virtual internships: design of electronic circuits, design and rendering of 3D models, construction of 3D machinery, laboratory technician and programmer of digital environments. Each simulation will consist of three activities, in which students must test their knowledge and face situations like the ones they will have in a virtual practice.

The course will begin with an initial questionnaire that will define the previous knowledge and the job position that the student will develop in the future virtual mobility. Once this step has been carried out, they will access the theoretical part of the course, in which they will train the necessary skills for the development of work in a virtual environment (AREA 1: WORK IN A VIRTUAL ENVIRONMENT). A section follows with the work methods used throughout all phases of the process (AREA 2: WORK METHODS), suggestions for the use of work tools (AREA 3: WORK TOOLS) and supporting materials for each virtual environment (AREA 4: SUPPORT MATERIALS FOR SIMULATION). The theoretical part of the course will last 32 hours, in which the student will acquire basic knowledge and skills required to follow the practical work proposed.

After this step, they will access a simulated digital environment, like that of the job, where they will meet tasks and situations that prepare them to start working in a virtual environment. When accessing this environment, the students must present themselves to an avatar that represents their tutor in the company, which will explain the operation of the simulator and will take them to a gymkhana of activities

that will lead them to develop the tasks of the workstation. For instance, in the case of the position "Design and rendering of 3D models", these are activities such as the design of specific parts of a device by 3D computer assisted design software, generation of the GCODE files for printing, use of the laboratory notebook ...

3 RESULTS

In this section we include two examples of the activities that students must carry out in the simulator. They correspond to the Laboratory Technician and Programming of virtual environment jobs. We aim at clarifying the methodology that we propose, but also the skills and knowledge that students will have opportunity to acquire. The activities of the simulators start from the level of VET plan of studies, but we propose tasks that involve concepts and techniques that the student probably does not master and that make them to search for new information and learn autonomously new concepts, in addition to make use of what they learn in their studies. This is expected to prepare them for the work to be done during a virtual internship.

3.1 Activity for the Laboratory Technician simulator. Calculations to prepare a solution

✦ Objective of the activity:

In this exercise, we are going to prepare a spreadsheet that allows us to calculate the amounts of solute and solvent that we have to mix to prepare a given amount of a solution with the desired concentration.

✦ Some definitions and concepts:

Actually, there are a number of variants in this simple calculation depending on which is the solute, and which is the solvent. Depending on the substances that are at play and the application to which the solution is going to be addressed the most convenient units of measure can be mass, volume or number of moles. Thus, it will be more practical to measure the quantities of solute by weight, on a precision balance, if it is a solid. Nevertheless, when it comes to liquids it can be more practical to measure its volume with a micropipette. On the other hand, the solution may be intended to carry out a chemical reaction and we are interested in accurately dosing a previously determined number of moles of solute.

Based on the above, there are several ways to characterize the concentration of a solution. We put here the most frequent:

- Weight concentration (w): mass of solute divided by the total mass of the solution.
- Weight percentage (% w/w): mass of solute in grams per hundred grams of solution.
- Concentration weight/volume (w/v): mass of solute (in grams) divided by total volume of the solution (in cubic centimeters).
- Weight/volume percentage (% w/v): mass of solute (in grams) per 100 cm³ of solution.
- Molarity (M): number of moles of solute per liter of solution.
- Molality (m): number of moles of solute per kilogram of solvent.
- Weight/weight percentage: mass of solute in grams per 100 g of solvent
- Mole fraction (x): number of moles of solute divided by number of moles of solution (moles of solute plus moles of solvent)
- Parts per million, ppm: micrograms of solute per gram of solution

We can pose a problem like this: given some amounts of solute and solution, calculate the concentration expressed in the different ways listed above. This calculation will not be easy to solve depending on what units we have the data in. For example, if we dissolve 0.1 g of sodium chloride (ClNa, common salt) in water until the total volume of the solution is 200 cm³, $V_D=200$ cm³, it will be immediate to calculate the concentration weight/volume 0.0005 g/cm³ or the weight/volume percentage 0.05 %w/v. As we also know the molecular weight of ClNa, $M_w=58.44$ g/mol, we can easily calculate the Molarity, it is a 0.00856 M solution. However, to calculate the other ways of expressing the concentration would require data that are not normally known, for example the density of solute and solution, measured at the temperature at which the solution is made. Some intuitive rules that you might come up with are not

correct, for example, although the total mass of the solution is the sum of the masses of the solute and the mass of the solvent, the volume that the solution occupies is not in general the sum of the volumes of solute and solvent that we add. For instance, if we mix 1 liter of pure ethanol with 1 liter of pure water, the result is somewhat less than 2 liters of solution because the distances between one molecule of ethanol and one of water in the mixture is less than which would be an average of the ethanol-ethanol or water-water distances.

However, usually the problem that will arise will be the reverse. We would say, for example, how many grams of salt we have to add to distilled water to obtain 400 cm³ of 0.1 M solution. It is also easy to solve using the Molarity expression:

$$M = \frac{\text{number of mol of solute}}{\text{volume of the dissolution in liters}} = \frac{n_{\text{solute}}}{V_{\text{dissolution}}} = \frac{m_{\text{solute}} / M_{\text{w}_{\text{solute}}}}{V_{\text{dissolution}}} = 0.1$$

$$m_{\text{solute}} = M \cdot M_{\text{w}_{\text{solute}}} \cdot V_{\text{dissolution}} = 2.338\text{g}$$

where $M_{\text{w}_{\text{solute}}}$ is the molecular weight of the solute.

We are going to organize an Excel sheet that allows us to automatically perform these calculations. First this simple example, in which we show you some suggestions on how to organize the spreadsheet to make it easier for anyone to use it. This means, in such a way that the calculations that the computer does can be understood on the sheet itself without additional instructions. Building these types of tools can save a lot of time at work since these calculations could be repeated frequently.

★ Demo 1.- Excel Sheet that calculates concentrations from the mass of the solute and the volume of the solution, in addition to the molecular weight of the solute.

Build on your computer this simple spreadsheet that solves the first problem we have raised. Look at Figure 1. We have separated three orange framed boxes. The one above is to enter the data of the problem, the intermediate one contains the data of the substances that we may need in the calculations: molecular masses, densities... The results will appear in the box below.

	A	B	C	D	E	F
4	Preparing a dissolution					
5						
6	Mass of solute		0,1 gramos	Data of dissolution		
7	Volume of dissolution		200 cm ³			
8						
9	Molecular weight of solute		58,44 g/mol	Data of the components		
10						
11						
12	weight/volume concentration			0,0005 g/cm ³	Results	
13	weight/volume percentage			0,05 %m/v		
14						
15	Molarity			0,00855578 M		
16						
17						
18						
19	$M = \frac{\text{number of mol of solute}}{\text{volume of the dissolution in liters}} = \frac{n_{\text{solute}}}{V_{\text{dissolution}}} = \frac{m_{\text{solute}} / M_{\text{w}_{\text{solute}}}}{V_{\text{dissolution}}} = 0.1$					
20						
21						

Figure 1. Excel sheet detail for Demo 1

We point out some important details

- 1 The cells of the spreadsheet can contain a number, a text or a formula and it is important that they are not mixed. To set the mass of solute to be 0.1 grams we use cells A6 (text), C6 (number) and D6 (again text). The spreadsheet will be able to operate with the number 0.1 in cell C6. If we had put "0.1 grams" in that cell C6, the spreadsheet would no longer be able to do anything with that data, it would not be able to interpret it.
- 2 To edit a formula, for example, in cell D12 we are going to calculate the mass/volume concentration, we will edit the equation "=C6/C7" that divides the mass that is in cell D6 by the volume of solution that is in cell C7.

- 3 Doing it like this, if you now want to solve another case, in which the mass instead of 0.1 is 0.42, the only thing you have to modify is the number of the Cell C6. You write 0.42 and moments later you have the new value calculated in the cell D12.
- 4 So you can prepare a spreadsheet that you can apply to new problems without having to edit any equation. If in cell D12 instead of writing =C6/C7 we had put =0.1/C7, we would have to edit it again to change the starting data. In this case it is something simple, but we are going to do calculations with more complex equations.
- 5 If the spreadsheet only has the cells that calculate it, it will not be very useful either because whoever is going to use it will not understand what it is doing, what equations it uses and where to enter the data. You have to enter explanations, equations in image boxes, labels that separate the data from the results, etc. It is a matter of imagination.

We could build an Excel with several sheets, each one for one of the different ways of measuring the amount of solute and the amount of solvent or the amount of solute and the amount of solution. On each of these pages, only the concentration expressions that can be determined would be calculated. We find between four and eight variants that can be considered of interest.

★ Demo 2.- Excel Sheet that calculates the mass of solute to obtain a given volume of a solution of given molarity. The molecular mass of the solute will be given.

	A	B	C	D	E	F
4	Preparing a dissolution					
5						
6	Molarity		0,1 M		Data of dissolution	
7	Volume of dissolution de d		400 cm ³			
8						
9	Molecular weight of solute		58,44 g/mol		Data of the components	
10						
11						
12					Results	
13						
14						
15	mass of solute			2,3376 g		
16						
17						
18						
19						
20						
21						

Figure 2. Excel sheet detail for Demo 2

You don't have to start from the beginning. We add a sheet in our Excel, It will appear as Sheet2, we can give it a different name if we want. Now we point to the entire Sheet1. We copy it to the clipboard and go to Sheet2. We also mark it whole and paste it. To solve the new problem, we only have to change the data entry. In A1 we put Molarity, in C6 we put the value we want, in our example 0.1 and in D6 the units M.

From the results we will have lines 12 and 13 left over, we delete them and in line 15 we put solute mass in A15 and in D15 we edit the equation that allows us to calculate it =C6*(C7/1000)*C9. It is done. It looks like figure 2

The number of possible variants in this type of calculation is greater than in the previous one, there are many possible starting data, and you may want to calculate mass or volume of solute or solvent or solution. Many pages would have to be prepared for these calculations. But there is an Excel tool: the Solver, which will allow us to do all these calculations easily using the Demo 1 type pages, as we see in Demo 3.

★ Demo 3.- Solver tool in Excel.

Here we will explain how it is used and the large number of applications that this tool has. If we want to solve the problem of Sheet 2 in Sheet 1, what we could actually do is put the value of 400 cm³ of the volume of the solution in cell C7 and try values of the mass of solute in cell C6 until that in cell D12 the value we want for the molarity appears. Try to do it. It is a bit tedious but you will surely find the value. You don't really need to do it like that, the Solver tool does exactly that. Put any value in cell C6, it will be an initial estimate, in cell D15 you will see that it results in a different molarity than the one we want to obtain. In the Data menu you open the Solver and the window in Figure 3 appears. In the first window

it asks to “set target”, that is, in which cell is the variable that you want to have a specific value. In your case, which cell is the molarity in? We put D15. Further down it asks you if what you want is for that cell to reach a value as high as possible, as low as possible or a specific value. The latter is our case, we mark it and put the value we want 0.1 because we want a 0.1M solution. Further down, it asks you for the cell with which it can play to reach the desired value. In our case it is cell C6, where the mass of the solute is. In this simple example you do not have to do anything else, click on solve and you will see that the value of 2,338 grams immediately appears in cell C6.

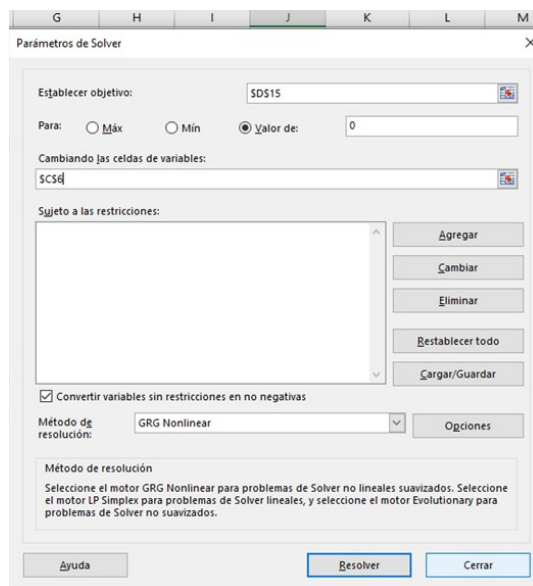


Figure 3. Solver

It's very simple, but the most important thing is that it allows us to solve other problems without editing anything new. For example, we have 100 cm³ of a 1M NaCl solution in water and we want to dilute it to make it 0.5 M, for that we add water. What final volume of solution do we have to reach? First, we determine the mass of solute that our solution contains using the Solver. The goal is for cell D15 to have a value of 1, putting a value of 100 in cell C7. We obtain the value of 5.844 g of solute That mass will not vary when the solution is diluted: we add water, but we neither add nor remove salt. We use the Solver again to now target cell D15 to have a value of 0.5 and let the value in cell C7 move. As expected, it gives us the value of 200 cm³.

Another example would be calculating the mass of solute to have a given weight percentage.

★ Final test of the activity.

Use the spreadsheet you have prepared to calculate how many cubic centimeters of water and how many cubic centimeters of ethanol you have to mix at 25°C to get 200g of a solution that has an ethanol mol fraction of 0.2. (The densities of water and ethanol at 25°C are respectively 1 g/cm³ and 0.789 g/cm³)

3.2 Activity for Programming of virtual environment: Building a simple web page with HTML and CSS

The activity will lead the student to the creation of a simple web page, in this specific case of a coffee shop, starting from very basic elements of HTML and CSS languages.

There will be 9 lessons in total and at the end of the 9th lesson the student will have all the information required to build the web page from scratch. Each lesson is made by a folder: in this folder the student will find two basic elements:

- A read-me note with all the explanations of the activities to be carried out in order to reach the objectives of the lesson
- An empty HTML document that the student will need to fill with code as explained in the read-me note.

Going on with the different lessons the student will find extra materials such as:

- A sub-folder with images to be included in the coding
- A style.css document to be filled with coding as well as the HTML document
- Extra material useful for the optimization of the final results such as a .psd file with the graphical project of the final website and modernizr.js file.

The final results of each lesson will have a self-explaining content and the student will be immediately able to check the result opening the HTML file into the provided browser of the virtual simulated environment.

Along with the lessons there will be a folder containing the finished project as it should appear, in order for the student to compare the final result of their activity with the expected result.

Here in detail is explained the content of each lesson:

LESSON 1: concepts of attributes such as:

<title>, <header>, <paragraph> are explained, plus the usage of stiles such as bold and italics. The student is here asked to fill a simple web page (text only) with a few lines of code putting into practice the stiles and attributes learned.

LESSON 2: it is explained how to add images inside a web page, with all attributes, as in:

. The student is asked to create a web page adding the code for images and caption inside the html document. In addition, it is explained hot to make bullet lists and to indent the different paragraph of a text. At the end of the lesson the student will be able to create a mini website with all the notions learned.

LESSON 3: this lesson is dedicated to the implementation of forms, therefore the student will become familiar with the concepts of input fields and buttons, radio button, checkbox, plus the rendering of special characters. With this information the student will be asked to create a page with a sample subscription form.

LESSON 4: in this lesson the student will become familiar with concepts typically related to blog posting, such as header, footer, references, navigation menus etc. In addition they will learn the concepts of class and ID, which are the two ways of creating different styles in HTML. At the end of the lesson the student will create a final index.html document with a sample blog article containing the notions learned.

LESSON 5: in this lesson the student will start using style sheets: styles.css and master.css. The student will then learn the different ways of adding CSS to their HTML, that is:

- Inline CSS
- Internal CSS
- External CSS

LESSON 6: this lesson is dedicated to the study of selectors: class selectors, ID selectors, descendant selectors, grouping selectors. Therefore they will become familiar with the use of <div> element (the generic container for flow content) and its effect on the content or layout when styled in some way using CSS.

LESSON 7: here the student will practice with styling at different levels of content, in particular with text, borders and forms. They will also learn different ways in using background images, using different properties such as:

- background-image
- background-color
- background-repeat
- background-position

At the end of the lesson they will able to build a web page with a styled contact form and some graphical effects.

LESSON 8: this lesson focuses on the study and practice of relative and absolute positioning, learning the difference between the two. In addition they will see how to put a link into the text using the attribute link text and realizing different styling for different links.

LESSON 9: for the final lesson a series of starter files will be given to the student in order to recreate a small mini-site that summarizes and contains all the notions learned. The starter files include:

- Style sheets
- Images
- The file modernizr.js (a JavaScript library that allowsHTML5 elements to work in older browsers)

The student will be asked to arrive at the final result that is an index.html file that reproduces the conceived site. At the end of the lesson a similar folder will be provided with the web page created by the tutor, in order to verify the correspondence of the final result.

In this mini site all or most of the notions learned will be used in order to test the student's ability to collect all the bricks formed in previous lessons and put them into practice.

4 CONCLUSIONS

Through the Erasmus Plus Programme Project "VIRTUAL INTERNSHIPS IN TECH CENTERS: TRAINING VET STUDENTS WITH OBSTACLES INTO INNOVATIVE DIGITAL METHODS OF REMOTE WORKING AND ELEARNING CREATED FROM COVID-19" we are developing a methodological guide and an e-Learning course that enables VET students, teachers, and technicians to carry out virtual internships in technology companies.

In this communication, we have presented the main characteristics and methodology of this course, which includes a job simulator with which students will carry out exercises that, on a small scale, include the main ingredients of teleworking and self-training necessary to face the challenges of their professional career in the field of new technologies.

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