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Digital Erasmus – a pan-European approach to teaching building performance and resilient design

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Abstract. The global COVID-19 pandemic in 2020 has forced universities to completely re-think their teaching concepts to provide safe, remote teaching of students off-campus. One of the challenges of this rapid transition is ensuring that the quality of the learning experience remains high and that students are able to engage and thrive in this new and predominantly digital environment. This project, entitled 'Digital Erasmus - a roadmap to using building performance simulation to achieve resilient design', responds to this context by seeking to transform the learning experience of students in built environment disciplines using a continuous digital learning cycle. This paper outlines the concept of the program and the learning objectives that it responds to, as well as some initial results highlighting the programs opportunity for students to work collaboratively and transnationally. The program is still in its infancy but it is hoped that it can serve as a template for similar future online courses that will promote safe, interdisciplinary and engaging collaboration amongst students from different universities.

Keywords. Erasmus, digital learning & education, energy, building simulation, thermal comfort.
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1. Introduction

Our pan-European approach to teaching building performance and resilient design is proposed in the context of the general restrictions on travel imposed by the COVID-19 pandemic. The restrictions that the entire Global population is facing considerably impact traditional mobility programmes offered to Higher Education students in Europe and hinder the acquisition of important interpersonal and research skills that these programmes usually promote.

At the same time, this situation has sparked a reflection about segments of the population that have often been excluded from participating in exchange and mobility activities, due to socio-economical, cultural or physical disadvantages. Moreover, the architecture, engineering and construction (AEC) sector is known for its widespread discrimination against atypical professional figures, e.g. women, minority groups and people with a wide range of disabilities [1]. We aim to tackle these issues (reduced international mobility and barriers to access in AEC professions) by taking advantage of the current re-thinking of how university lectures are structured and delivered, with a particular focus on the field of Building Performance Simulation (BPS) and resilient design.

Our objective is to develop a dynamic, experiential (see Figure 1, i.e. using both experience and observation) methodology to maximize student engagement and learning opportunities in a digital and transnational environment. With this we want to create an environment that encourages cooperation, diversity and equality. To achieve this, we started to create a safe yet challenging learning environment that exposes students to new ways of thinking and working, one which provides a framework for likeminded people to get to know each other, to collaborate and to learn with and from each other, independently of their geographical location. Building performance and the future resilience of the built environment are the core themes of this program, which responds to the rapid and well documented transitions occurring in the Earth's climatic, environmental and social conditions. Measurement, modelling and simulation are tools that can be used to futureproof our response to these challenges in the built environment. We aim to develop these skills by creating virtual test beds (linked to data from real buildings) so that students can explore existing designs and evaluate the impact of their design decisions in relation to key performance indicators including: health and wellbeing (TU Delft), energy and indoor air quality (TU Graz), and moisture and future resilience (University of Strathclyde). This paper outlines the concept of the program and its learning objectives that it is responding to, as well as some information on the different modules (in particular the workshops).

2. Context

Building simulation is traditionally taught in a classroom setting with access to computer labs, where students learn how to use the software in direct contact with staff [2,3]. In times of COVID-19 this is no longer possible. We are therefore targeting students who are enrolled in MSc programmes that include courses on building performance and resilience, but who are no longer able to participate in live classrooms activities. By doing so, we are taking into account both the current circumstances and the personal obstacles that students with disabilities might face in normal classroom settings as well as the barriers faced by those who cannot attend conventional classes (for a variety of other reasons).

In this context we propose a new pedagogical methodology that addresses the challenges of digital teaching but at the same time provides a platform for students to acquire the skills needed for a successful career. (see Figure 1)

There are a number of reasons why we have chosen to focus on innovative practices in a digital era. Building Performance Simulation (BPS) and its application in enhancing the resilience of the built Environment is by nature a digital activity. Paradoxically however, it is commonly taught in a traditional didactic manner, with students receiving direct instruction and experiencing little peer-to-peer interaction. Unsurprisingly pedagogic theory, including specific studies focused on the teaching of BPS in higher education have highlighted how such approaches have delivered exceptionally poor learning outcomes [2; 3]. This means that there is an urgent need to evolve new and innovative teaching practices, that better engage students whilst yielding more robust learning outcomes [4]. In the midst of a global pandemic, with greater than ever demand for online learning, there has never been a more appropriate moment to make this change. What we are proposing is rooted in the constructivists theory that learning occurs most profoundly when learners are actively involved in a process of meaning and knowledge construction.

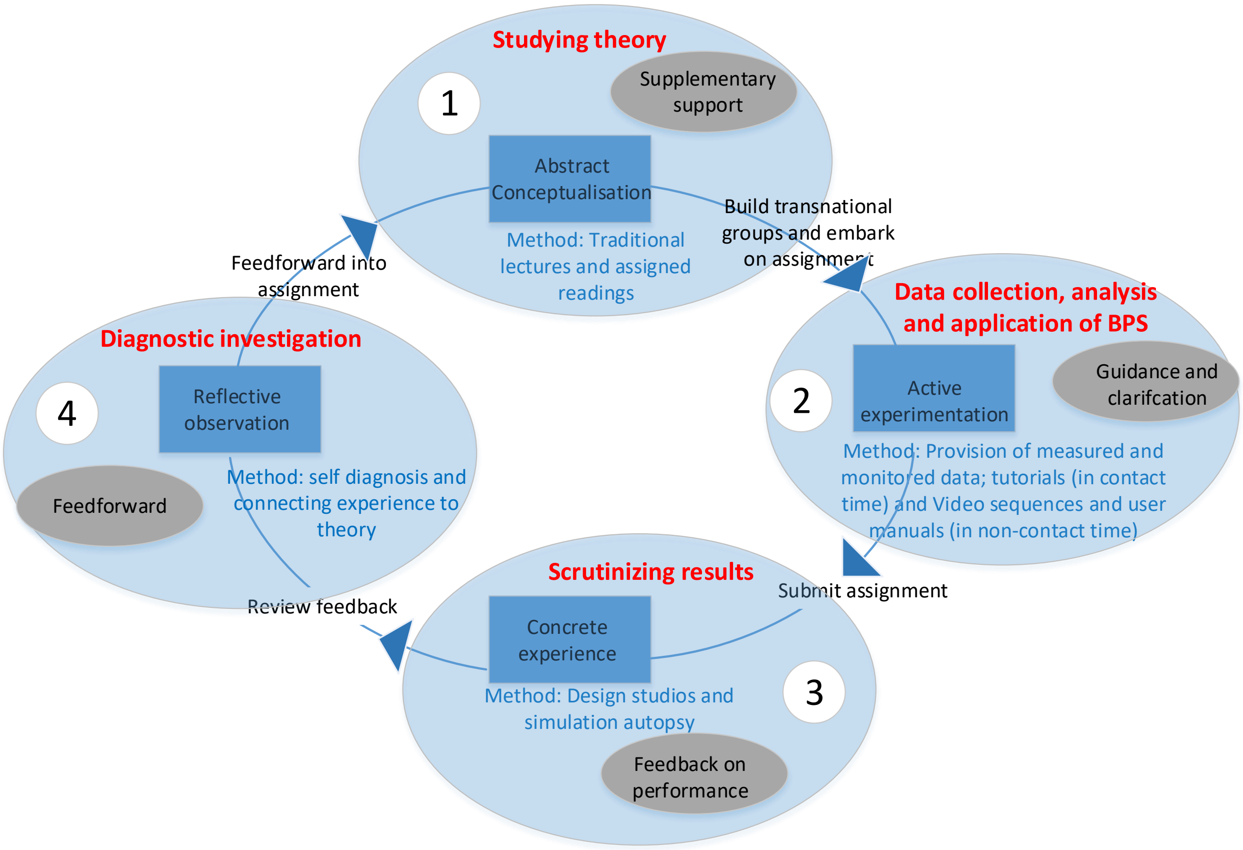

Fig. 1 – Framework continuous learning cycle. Adapted after Kolb

We believe that digital learning can be enhanced by incorporating experiential learning methods where learning is an iterative process which takes place through reflection on doing [5;6; 7]. Thus, we have designed an innovative learning cycle (see Fig 1- learning cycle) using digital practices to teach BPS in an experiential and reflective manner.

The four modes are briefly described as follows:

- **Concrete experience (CE)** involves learning how to scrutinize results and diagnose issues with measurements, monitoring and modelling of buildings. This can happen through direct feedback and through the examination and autopsy of simulation results in a group setting. The objective is to impact a certain degree of scepticism in data and tools and to encourage greater scrutiny of simulation predictions.

- **Reflective observation (RO)** involves self-diagnosis and reviewing and connecting experience to theory. Through these activities students strengthen their understanding of building physics, models and simulation methods.
- **Abstract conceptualization (AC)** involves the study of data handling/ management, models and simulation methods through lectures, assigned readings, and group discussions. The objective is for the students to understand the theoretical implications of their choices of tools or alternate modelling methods, and to appreciate the uncertainties associated with analyses so that they can contextualize their findings.
- **Active experimentation (AE)** involves the application of methods and tools in workshops. This allows students to explore tools and alternate modelling methods to reinforce the theoretical studies.

To achieve our aim of the digital learning cycle, we have bridged the gap between BPS models (which act as a 'digital twin') and the real building by creating an interactive learning platform where students can access monitored data streamed live from the case-study buildings. This innovative shared learning platform helps to bring the three taught modules to life by allowing the students to better visualize real-world building performance data and then use this data to create accurate calibrated BPS models (which can then be compared to the real buildings). As such this process brings the digital realm closer to the reality which it seeks to model. This is an essential requisite in closing the 'performance gap' between BPS model predictions and real buildings [8]. In uniting these concepts (i.e. real-world building data with digital models) and placing them at the centre of our teaching approach we are facilitating a dialogue which seeks to embed state-of-the-art BPS practice with critical and testable thinking. This allows the students to learn experientially by developing virtual design experiments (using validated BPS models) to evaluate and inform complex design problems. Thus, we are able to use the same digital platform (and methodology) with buildings of different typologies, located in different geographic and climatic zones to focus our teaching on specific aspects of resilience (i.e. overheating, indoor air quality, daylight design, moisture control) (Fig 2-4 building case studies). Kolb's original learning cycle is therefore not only adapted to the context of teaching resilience and building performance simulation. It is also translated into a digital pan European teaching context, an approach that has not previously been investigated to the authors knowledge. The innovation here lies with the application of this method to diverse groups of students that are physically located in different universities and that are encouraged to follow this cycle together, remotely, whilst being solely reliant upon digital learning and communication tools.

2.1 Objectives

An understanding of the theory of thermodynamics underpins the application of simulation, and while it is possible through experiential learning to gain a deeper understanding of the subject, it is challenging (even for experienced users) to produce results that are transferable to the built environment. In fact, the user often becomes the greatest source of uncertainty in this process [9; 10]. To make the connection between simulation and reality clearer to students, one of the strategies adopted of late in building simulation teaching activities has been to couple simulation and on-site measurement assignments [11]. This approach has been beneficial in helping students to become familiar with uncertainty and risk in decision-making when building models and with the practicalities of the construction sector. However, as a result of COVID-19 restrictions, such measurement activities and field study work has now had to come to a halt, effectively breaking the learning cycle that had been built into building simulation teaching methods.

The objectives of our approach are as follows:

- to develop a digital Erasmus Programme to (i) address the continuing COVID-19 restrictions and limitations and (ii) to include those currently excluded and discouraged from participation in built environment disciplines for a variety of reasons;
- to provide a learning platform for Master students to complete a digital learning cycle in building performance and resilience;
- to offer a working environment in which students from multi-cultural and under-represented backgrounds can thrive, and one which enhances diversity, equality and inclusion opportunities;
- to challenge students to work in interdisciplinary and transnational teams to improve their social, communication and interpersonal skills;
- to learn from each other (through peer-to-peer and scaffolded learning) by being part of the assessment process and learning to constructively critique their peers' work.

2.2 Studio teaching

To challenge students to work in interdisciplinary and transnational teams to improve their social, communication and interpersonal skills we adopt the concept of studio teaching. Integrating the concepts of low carbon buildings, health and well-being and resilience, as well as the use of building performance simulation within the context of digital studio teaching allows a greater focus on project based work (compared with didactic lecturing). Experiential learning via project based work enhances the opportunity for communication between diverse groups of team members and with those outside one's own team. This concept is further strengthened by the use of interim team presentations (on work in progress) as well as via peer-to-peer-critiquing of student work. In the past years, all these activities have been de-facto moved online, removing geographical constraints. The emphasis has shifted to the need to keep students actively engaged with their courses and with their peers. The use of whole building simulation in the context of an integrated design project demands input from interdisciplinary teams comprising diverse skillsets and perspectives. Thus, the design of the learning tasks and the way in which they are structured promotes both interdisciplinary and transnational participation with a significant emphasis on peer to peer learning.

3. The Learning Cycle

In the context of the digital Erasmus scheme, five different learning phases are incorporated in our pedagogical methodology following the four modes of learning (CE, RO, AC, AE) to accomplish the objectives (see Fig 1):

1. Study of theoretical underpinning concepts (AC).
2. Collection of data and creation of validated building performance models (AE).
3. Design of experimental studies to assess specific building performance problems (CE).
4. Analysis and interpretation of simulation predictions, including their scrutiny and verification (CE).
5. Interpretation and acting upon the information that has been generated through the previous phases of the process. Here students will be expected to consider both the building specific implications as well as the wider (policy and praxis) implications of their findings (RO).

For 1, we use modern flipped learning techniques using pre-recorded lectures and guiding students through assigned readings from the literature. These are supported by live tutorial sessions and study groups. Self-learning is supported through the reading of user manuals and the examination of exemplars, as well as video sequences illustrating certain aspects of measuring and monitoring data, as well as BPS tool operation.

For 2, the student teams collect key data that describe a case-study buildings performance including, measurement and monitoring data, occupant behaviour, and operational characteristics and learn to making decisions about which inputs should be provided to their models and which program defaults can be accepted.

For 3, the students need to assess different experimental methods which could be used to test their research hypothesis, such as the use of parametric studies to test and evaluate different design interventions. They also choose and apply specific tools relevant to their chosen investigation and will make choices between alternative modelling methods (e.g. methods to predict air infiltration or convective heat transfer coefficients) and simulation options (e.g. choice of time-step or methods for coupling calculation domains) to gain an awareness of model simplifications and the impacts of uncertainty.

For 4, student teams have to present their results in a (virtual) studio-based environment and demonstrate how they have made critical decisions and interpreted their results and relate this back to their understanding of the theory learned during the theoretical part.

For 5, we encourage the students to individually reflect on what they have learnt and then to share their experiences with the other students. This is an important step in the learning process and involves reflection upon what has been learnt. Here the students place their findings in a wider context (through considering a range of international contexts presented by other participants) and explore the wider implications of their findings in relation to national and international policy and praxis. Feedback is a critical input to support this experiential learning cycle. This is provided throughout the program via peer-to-peer interaction and also with the instructor or teacher. To this end, feedback (also known as formative assessment) is provided during each learning phase and at each iteration of the learning-cycle, as this provides the students with the opportunity to identify how they are progressing and where they may need to focus their attention in order to improve. Through this approach the students gain valuable additional experience in interdisciplinary team working and critical thinking, which are requisite skills for employment and further study in this field.

4. Different modules

Following the context of the project and its objectives and in line with the teaching framework, three new modules (each taught by one of the partnering universities) are proposed to challenge students to work in interdisciplinary transnational teams, in a digital manner, across borders thereby offering some of the benefits of the classical Erasmus 'year abroad' experience. This approach is designed to facilitate experiential and peer-to-peer learning by promoting collaboration and cooperation on live projects beyond conventional barriers. The learning format combines live data-streams from real buildings, with the use of validated simulation models of the same buildings in order to create a highly realistic and interactive learning environment. This concept helps to overcome the barriers imposed by the absence of site-visits and studio tutorials, which have been a common feature of experiential learning in the built environment. This learning format is designed to immerse the students in real-world problem solving and experimentation, commensurate with the attainment outcomes of master's level programs.

Through our Digital Erasmus approach, the students gain valuable additional experience in interdisciplinary working and critical thinking.

The three MSc level modules that were developed by the three institutions target their specific areas of expertise, focusing on the importance of the indoor environment, energy monitoring, and building simulation. This set of modules is considered crucial to the delivery of this integrated course. The modules are targeted at master students in Architecture, Civil and Mechanical Engineering.

4.1 TU Delft (TUD)

The TUD "Technoledge Climate" module focuses on indoor comfort and associated physiological concepts. An important part of the teaching activities is traditionally dedicated to building surveys, where the students can collect spot measurements of comfort indicators, such as temperature, relative humidity, and illuminance. Due to the COVID-19 related restriction, the module was largely re-designed, and new innovative approaches were implemented so that students were able to engage with the experience of environmental surveys in existing buildings. Furthermore, existing content dedicated to daylight measurements and modelling required a substantial update which were implemented by staff participating in the project. Teaching concepts for visual comfort and advanced daylight modelling are essential for students to understand the importance of well-designed windows and shading systems. As complex technology advances in this field, students need to learn how to master the appropriate design tools to assess existing spaces accurately, using cutting-edge simulation methods delivered through appropriately scaffolded strategies.

Fig. 2 – Co-Creation Center Building, located in the TUD Green Village, The Netherlands

Tab. 1– Workshop and learning objectives (LO) for the Active Experimentation (AE) mode of learning at TUD

Workshop Topics Nr and title	Measurement rel. LO	IEQ rel. LO	BPS rel. LO
1.Indoor environmental quality survey	a,b,c	a,b,d	b
2.Design improvements and assessment	g	e	f,g

a, Refine how the indoor environment is experienced, looking at the existing building technology solutions with a critical mindset and identifying their shortcomings;
b. Relate changes in outdoor weather conditions to changes in the indoor environment and understand how this relationship is influenced by the building fabric and building systems;
c, Appreciate the differences in accuracy, precision and sensitivity between measuring instruments and sensors used for research/commercial purposes, and for spot-measures/continuous monitoring;
d, Appreciate the uncertainty in subjective evaluations of IEQ due to personal, seasonal, and daily variations;
e, Interpret IEQ questionnaire answers and extrapolate meaningful and representative results;
f, Recognise assumptions and model limitations that are embedded in BPS software and how they affect the virtual representation of the real building;
g, Propose improvements and/or alternative solutions to existing ones and assess their effectiveness using BPS

The two workshops organised within the module are an integral part of the module's structure and content. The students' progress is guided by expert tutors, and it is presented and shared with the class at multiple stages. During the module, the focus gradually shifts from the analysis of the case study building to the critical proposal of new design solutions. In this continuous framework, the two workshops act as catalysts for these two key learning phases. Most of the European building stock has already been built. Circular and sustainable building paradigms call for a well-planned re-use and refurbishment of existing buildings. In such a context, it is essential that students learn to critically assess building indoor performance and to think of creative and effective solutions that can reduce energy consumption while maintaining optimal indoor comfort conditions.

4.2 TU Graz (TUG*)*

TUG offers a module on Energy Monitoring and the Effects of Indoor Climate. In this module, students complement their existing knowledge in the field of energy-efficient construction with respect to the topics of energy monitoring and the impacts of indoor climate. Students get to know metrological concepts, to record the important thermal, hygric and energetic properties of the building envelope. They learn about the effect of the building's services and envelope on the indoor environmental performance and its interaction with user behaviour. This understanding of interconnected design factors allows them to better evaluate and interpret data that is captured as part of this module and accessible to students via the platform. The theoretical teaching uses the monitored operational data from the building to show the high potential for optimization of the built infrastructure. Students also learn how the indoor climate in buildings can be assessed in connection with building and ventilation systems using methods of comfort assessment. Measurement methods are introduced, to demonstrate how the room climate in real-buildings can be determined and evaluated experimentally, which can in turn be used to validate simulation models.

Researchers in academia are dealing with increasingly larger amounts of data. For this reason, students must learn to use the most appropriate tools and understand various statistical and visualisation methods that allow them to examine and exploit large data sets to support their research projects and findings (Tab. 2).

Fig. 3 – TUG- Institute for building physics, services and construction (outside left and inside institute right), Austria

Tab. 2 – Workshop and learning objectives (LO) for the Active Experimentation (AE) mode of learning at TUG

Workshop Topics Nr and title	Measurement rel. LO	Resilience rel. LO	BPS rel. LO
1.Thermal comfort survey (Tableau)	a,b	a,b	b
2.Working with large data sets	d	c,d	c,d
3.Statistical analyses (R) of data sets	e,f	e.f,g	f,g

a. Understand sensitivity of thermal comfort survey data with respect to individuals, countries, continents and seasons;
b, Understand the differences between operative temperature, calculate using different equations and understand uncertainty when comparing to recorded data;
c, Understand and compile different weather formats for use in BPS;
d, Appreciate complexity of large data sets and understand how to identify, handle, reshape and clean incomplete data sets;
e, Understand various statistical and visualisation methods to examine, summarise and analyse environmental, climate and energy data;
f. Understand forecasting of indoor temperatures based on gas consumption, climate and environmental variables using linear regression;
g, Understand various error metrics of forecasting accuracy and model bias and understand their impact on predicted building performance.

The workshops at TUG have the objective of providing to students an overview and introduction to some commonly used tools that are used in academia and industry to work with data, identify some common pitfalls in data analysis and outline various methods to draw some meaningful insight from data. The workshops are structured into three parts: 1. Thermal comfort survey in Tableau; 2. Working with large data sets in R; and 3. Statistical Analysis of data sets in R.

In the first workshop, the student familiarises themselves with the use of Tableau which is an analytics software that is widely used in business intelligence. Due to its user-friendly drag-and-drop functionality, Tableau can be rapidly learned by students and allows them to create quick analyses and visualisations of existing data sets. The workshop allows the students to draw on knowledge of thermal comfort concept learned in the module's lectures and investigate the available data sets of the institute as well as one of the largest publicly available data sets on the subject, i.e. the ASHRAE Global Thermal Comfort Database II [12]. The latter contains thermal comfort data of various individuals that was gathered independently in many countries and continents in different seasons and buildings. This makes it an excellent exercise to test the capabilities of the software to produce quick dynamic visualisations and maps to get insights from the data set. In addition to the thermal comfort data, the students learn various approaches to derive the operative temperature from the observed environmental data.

In the second workshop, the students get an introduction to programming in RStudio to explore and analyse a large-scale monitoring data set. Learning to work efficiently with large data sets is becoming a necessity for young researchers. Spreadsheet programs (e.g. MS Excel) may be relatively easy to use, however, they have many limitations that are quickly becoming evident as soon as one attempts to open and analyse a large data set. In the second workshop, students learn the basics of programming in R/RStudio and how to load, clean and reshape a large data set which contains climate, environmental, and energy data. The exercise allows the students to experiment and exploit the power of R in handling, cleaning and reshaping massive amounts of data, exporting the findings with ease and compiling weather files for BPS.

The third and final workshop in this module builds upon the second one. In order to make sense of the large data sets and their analyses, the use of statistics and the creation of various plots is imperative to summarise the data and get some meaningful insights from it. This workshop teaches students some basic descriptive statistics, data analysis and how to exploit various types of plots to examine the data. Creating useful plots and communicating the findings is a necessary skill for every researcher and a prerequisite for most reports and publications. The workshop introduces the students to statistical data modelling and forecasting with the use of linear regression and various error metrics to evaluate the forecasting accuracy and bias of the developed models. Ultimately, the workshop allows students to understand the impact of model bias on the predicted building performance.

4.3 University of Strathclyde (UoS)

Building on existing knowledge in relation to static energy balancing methods, students at UoS acquire the necessary knowledge to carry out dynamic building simulations and to assess uncertainties. For this purpose, students gain knowledge about what is important at key points in the design process, depending on what the user wants to know when undertaking a building simulation (environment, building, plant, user). They will learn appropriate modelling approaches for the mathematical description of the corresponding heat and mass transfer processes. This includes a deeper insight into individual simulation modules, which students develop on their own by means of didactically suitable programming tools. Students implement their theoretical knowledge by modelling and simulating a reference building and calibrating it with the monitored data set from the UoS.

Fig. 4 – Test house, UoS; UK

Tab. 3 – Workshop and learning objectives (LO) for the Active Experimentation (AE) mode of learning at UoS

Workshop Topics Nr and title	Resilience rel. LO	BPS rel. LO
1.Building physics	f	a,b,c
2.Problem representation	d	a,b,c,e
3.Information management and analysis (R)	b,e,f	b,c,f

a, Understanding of heat and mass transfer processes occurring within energy supply and demand systems in the context of building performance modelling;
b, Understanding of simulation principles: problem representation, treatment of time and space, numerical methods, validation, use in practice;
c, Understanding of simulation practice: problem description, modelling methodology, results interpretation, case studies;
d, Understanding of built environment: energy demand, passive and active energy systems, options for intervention, performance assessment methods.; e, Understanding of renewable energy system modelling, focusing on supply-demand matching.,
f, Understanding of information systems: energy management, monitoring and targeting, classification techniques, trend analysis, smart metering and the role of these in calibrating simulation models.

5. Preliminary results

The project is at an early stage, but thus far with our pan-European approach to teaching building performance and resilient design we have produce the following results:

- an innovative knowledge exchange programme format, which will hopefully become a permanent offer of the partner universities (TUD, TUG, UoS), especially aimed at students who are not able to participate in traditional mobility programmes;
- an administrative procedure to enrol remote students from partner universities and to formally recognise their participation in courses in the form of the European Credit Transfer and Accumulation System (ECTS);
- the development of new, integrated digital procedures/ approaches and methodologies to facilitate the teaching of resilience and building simulation in the built environment;
- networking and learning about digital teaching methodologies and best-practice from colleagues in different institutions across Europe;
- construction of a shared web- and teaching platform and database with environmental data available for teaching purposes;
- building models that facilitate the analysis of outcomes on indoor environmental quality, energy, behaviour and future resilience;
- feedback from student and staff participants to further enhance existing programmes;
- action based pedagogic research leading to journal and/or conference publications, project report and brochure.

Additionally, we are actively working towards the sustainability and retention of the project's outcome for future use, so that it will be easier for institutions outside the partnership to embed the Digital Erasmus format in their permanent offer.

6. Conclusions

The presented pan-European approach to teaching building performance and resilient design creates a pedagogic framework for a digital Erasmus learning experience which can be used as a roadmap for other programmes in the STEM sector to follow.

Beyond the innovative methodological aspects of our program there are several wider reasons that this approach provides in breaking down conventional barriers to higher education in the construction and built environment sectors, which to date have been heavily male dominated disciplines.

Because of the partial anonymity and enhanced flexibility provided by digital learning we hope to break down many of the barriers which have hitherto prevented under-represented groups from engaging in higher education, particularly in this subject area.

We expect that the opportunity to undertake transnational studies using an interactive approach will appeal to those who might not have had the opportunity to consider this in the past and that the project will provide them with as close to an immersive experience as is possible in a digital realm. This new set of modules will provide opportunities to analyse buildings in a high level of detail - both theoretically, and from an end user perspective whilst focusing on three different aspects of resilient design. The project provides an opportunity for students to work collaboratively and transnationally, whilst exploring solutions in a supportive risk-free environment. This enables them to develop a deep knowledge of building performance and resilience, scaffolded by world-class facilities and expert knowledge.

7. Future work

We aim to target the following three steps in the future:

1. With the Covid pandemic hopefully coming to an end, it is apparent that in-class teaching will once again be prioritised in the future. This means that students will be back in attendance mode with the possibility to conduct measurements and make site visits in person. In order to maintain the flavour of the pan-European digital Erasmus year under these new circumstances we will look to new ways of incorporating hybrid teaching modes that will allow students to continue collaborating between the different partner countries, without losing the richness and diversity provided by the Erasmus+ experience.

2. At UoS we found out that despite the availability of some of the teaching materials to architecture students there has been a lack of uptake in comparison to students with a background in mechanical engineering. We would like to explore why that might be in the future and to broaden the appeal by linking the teaching of tools with some of the practical issues that the students might be faced within the real world. While we are hoping for uptake from existing student cohorts we also expect to see interest from qualified architects and engineers in the future.

3. In the near future, we aim to create close links to the professional body of the International Building Performance Simulation Association (IBPSA) to support the impact of this project by linking the IBPSA-academy and various other organisational activities to the work that is carried out within the student teams.

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