



## A2.2, O2: Research Based Micro-modules



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## Abstract

The challenge-based approach, the core element of the ECIU University, requires Alliance Members to bring together different practices in innovative training and research, in order to provide researchers with competencies in transferring results of challenge-based research to teaching activities. This document's aim is to present an analyse of the micro-modules offered by the alliance members, in order to identify the nexus between SDG 11 research results and teaching activities.

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## Symbols, abbreviations and acronyms

AAU	Aalborg University, Denmark
DCU	Dublin City University, Ireland
EC	European Commission
ECIU	European Consortium of Innovative Universities
INSA	Institut National des Sciences Appliquées, France
KTU	Kaunas University of Technology, Lithuania
LiU	Linköping University, Sweden
TAU	Tampere University, Finland
TUHH	Hamburg University of Technology, Germany
UA	Universidade de Aveiro, Portugal
UAB	Universitat Autònoma de Barcelona, Spain
UiS	University of Stavanger, Norway
UNITN	Università degli Studi di Trento, Italy
UT	University of Twente, Netherlands

## 1 Introduction

The challenge-based approach to both education and research, which is a core element of the ECIU University, allows Alliance Members to bring together different competencies in innovative training and research, and to scale it up to a European level for the benefit of learners and stakeholders from diverse backgrounds<sup>1</sup>. The Alliance Members have been selected because they are research intensive universities, with collective emphasis on innovation, creativity and societal impact. The Challenge-based learning approach, core element of the ECIU Project, will foster transversal competencies because it “creates a playground for solving multi-disciplinary challenges in entrepreneurial, innovative ways and provides personalised learning and career opportunities for life at the European level, enabled by a novel university model based upon co-creation”.

Engaging with wider society as stakeholders in curricula redesign and developing challenge-based learning, whilst ensuring the excellence of the educational offering requires members to share practices and learning from each other with the ultimate goal being the development of novel educational programmes and curricula, based on micro-credentials, relevant to address important skill gaps and wider societal challenges. Micro-credentials can be used to certify diverse learning outcomes, including formal, informal and non-formal learning, in addition to the development of specific competencies.

In 2020 and 2021, the ECIU University identified, developed and promoted a suite of micro-modules across partner universities that meet common requirements and share a commitment to addressing UN Sustainable Development Goal SDG11: Sustainable Cities and Communities. They also, provide opportunities to learn other languages and develop important transversal skills and competencies such as problem-solving and team-work skills.

Currently, over 70 micro-modules support a diverse range of SDG11 related challenges which have been developed by the stakeholders of ECIU partner universities. These micro-modules form the basis of work currently underway to clearly define and develop related micro-credentials which recognize learning against transparent standards.

WP2 is instrumental in further integrating university research outputs and education and in providing a model to develop a joint institutional strategy to accommodate **Challenge-Based Research** initiatives with a focus on the following three main areas as applied to SDG 11:

1. Develop incentives and support schemes for researchers to engage in challenge-based research ensuring that results are fed back into educational provision.
2. Develop supporting measures to engage researchers with citizen science and derive maximum benefit from this involvement.
3. Pursue joint research objectives for the benefit of all members.

Activity 2.2 focuses on the first main area by developing specific training programmes on education-research links related to SDG 11 for Early-Career Stage Researchers (ESRs), with the aim of improving the feedback loop between research and education reinforcing the process of transferring of SDG11 research results in micro-modules content.

Following an initial mapping of all existing micro-modules already offered by the EICU University related to SDG 11, the document will analyse the process of transferring research results into training activities by means of two case studies. The analysis of the teachers' scientific profile and the content of the micro-module can bring evidence of the fact that, because the content of the teaching activities is related to the research interests of the teacher, this nexus allows the teacher to implement an

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<sup>1</sup> As explained in “ECIU University 2030” <https://www.eciu.org/news/eciu-university-2030-connects-u-for-life>

information transmission process based on a research-oriented and research-based approach, with the active involvement of the students.

Furthermore, the document will present the structure of training activities to prepare PhD students, post-docs, and assistant professors to translate the results of their research activities into micro-modules.

## **2 Mapping of the micro-modules offer**

ECIU University started offering the first challenges in 2020 along with modules/courses following the scaffolding circle implemented by WP 4. In the guidelines developed by Activity 4.1.<sup>2</sup> we find that the purpose of “*ECIU University’s micro-modules is to provide learners the basic knowledge of SDG11-related themes that are in the core of the challenges listed by ECIU University*”.

Where “A micro-module is a short learning experience that is formally assessed and supports learners to fill their knowledge gaps and boost their capabilities in order to successfully engage in ECIU University challenge-based activities” and “the ECIU University challenges are extracurricular learning offerings that are organized by the ECIU University members and currently open to the students of ECIU member universities.”

Micro-modules relate to one of the three thematic focus areas of ECIU: SDG11, Language skills and Transversal skills and the topics chosen for SDG11 are:

- Energy and sustainability
- Circular economy
- Transport and mobility
- Resilient communities

As presented in Table 2.1, in Autumn 2020, 34 micro-modules were listed on the ECIU Website, 23 of those related to SDG 11 topics In Spring 2021, the number of SDG 11 related micro-modules remained almost unchanged, with an increase in the total number of micro-modules offered (Table 2.2).

**Table 2.1: Micro-modules listed on ECIU Website for Autumn 2020**

Project Partner	Nr Micro-modules	SDG 11 related	SDG11 Topic	Advanced level and CBL	Advanced Level no CBL
TUH	2		Circular economy, transport and mobility	0	0
KTU	1	1	Resilient communities	0	1
TAU	3	0	0	0	0
UAB	5	3	Climate change, waste management, sustainable production	0	0
UA	13	12	Energy and sustainability; Resilient communities	4	5

<sup>2</sup> See WP 4, Guidelines for teacher offering SDG11 modules (2020 and 2021), 4.1 Scaffolding criteria and guidelines for ECIU University modules 2021-2022.

UIS	2	1	Transport and mobility, Energy and sustainability	0	0
UNITN	6	5	Resilient community, Circular economy, Energy and sustainability	1	1
INSA	2	1	Transport and Mobility	1*	0
<b>TOTAL</b>	<b>34</b>	<b>23</b>		<b>6</b>	<b>7</b>

**Tab. 2.2: Micro-modules listed on ECIU Website for Spring 2021**

Project Partner	Nr Micro-modules	SDG 11 related	SDG11 Topic	Advanced level and CBL	Advanced Level no CBL
KTU	9	7	Resilient community , Circular economy	5	0
LIU	2	0		0	0
TAU	27	2	Transport and mobility	0	0
UAB	6	2	Climate change, Resilient communities	0	0
UA	6	4	Energy and sustainability; Circular economy; Transport and mobility; Resilient communities	2	1
UIS	2	1	Energy and sustainability	0	0
UNITN	8	4	Energy and sustainability, circular economy	0	1
INSA	4	0		0	0
<b>TOTAL</b>	<b>64</b>	<b>20</b>		<b>7</b>	<b>2</b>

The micro-modules offered display differences in the level (Introduction / Basic / Advanced) and adoption of the challenge-based learning approach. The analysis will focus on the subset “SDG 11 micro-modules, advanced level) in order to describe the process of transferring SDG 11 research results in teaching activities in ECIU Universities.

### 3 Research Teaching nexus

The research teaching nexus is described in literature with a range of terms. According to Griffiths (2004) teaching may be:

**Research-led:** the curriculum is structured around subject content selected and directly based on the research interests of teaching staff; and teaching is based on a traditional 'information transmission' model;

**Research-oriented:** the curriculum places emphasis as much on understanding the processes by which knowledge is produced as on learning the codified knowledge that has been achieved;

**Research-based:** the curriculum is largely designed around inquiry-based activities, rather than on the acquisition of subject content; the experiences of staff in processes of inquiry are highly integrated into the student learning activities; the division of roles between teacher and student is minimized.

Furthermore, as pointed out by Healey (2005) different approaches to teaching are reflected in different ways of linking with research. **Teacher-focused approaches** emphasise the transmission of research knowledge to a student audience, whereas **student-focused approaches** emphasise students constructing their own knowledge through active participation in class.

In ECIU University the student-focused approach is enhanced by the challenge-based learning framework, but even in micro-modules at advanced level without the CBL approach, teaching can be research-oriented or research-based with the active involvement of students. The theoretical framework helps in analyzing the existence of the nexus between research activities and teaching, without the aim of presenting a further classification because of the mixed nature of the majority of ECIU Micro-modules (some are both research-led and research-based, some are research-led and research-oriented).

Micro-modules at the advanced level are detailed in Table 3.1 and Table 3.2. All the responsible teachers are active researchers, with expertise in the research areas related to the SDG11 topic indicated. The analysis will concentrate on three micro-modules of two project partners: University of Aveiro and University of Trento. These specific case studies had been selected on the basis of the teachers' CV (list of publications, H-index, track record), the course content, and the availability of the teachers for an interview.

**Table. 3. 1 Selection of SDG11 micro-modules offered in Autumn 2020**

Project Partner	Module name	SDG 11 Topic	CBL	Teacher
KTU	Computational Intelligence and Decision Making	Resilient Community		Agne Paulauskaité-Taraseviciene
UA	Advanced Production Technologies	Resilient communities	X	Victor Neto
UA	Energy and Environment	Energy and sustainability;		Luís Tarelho
UA	Urban Regeneration Policies / Políticas de Reabilitação IUrbana	Energy and sustainability; Circular economy; Transport and mobility; Resilient communities		Paulo Silva
UA	Urban Public Space	Transport and mobility; Resilient communities	X	Jose Carlos Mota
UA	Industrial Ecology	Circular economy;		Manuel Arlindo Amador de Matos
UA	Hydrogeology	Energy and sustainability; Circular economy;		Eduardo Anselmo Ferreira da Silva

UA	Environmental Infrastructures-II	Energy and sustainability;		Maria Helena Gomes de Almeida Gonçalves Nadais
UA	Eco-design and Eco-efficiency	Energy and sustainability; Circular economy; Resilient communities	X	Victor Neto
UA	Energy in Buildings	Energy and sustainability; Resilient communities	X	Nelson Martins,
UNITN	The City and the Futures. Perspectives and Experiences for Resilient Communities	Resilient Community; Circular Economy	X	Sara Favargiotti; Rocco Scolozzi
UNITN	Bioenergy	Energy and sustainability, circular economy		Luca Fiori
INSA	Interdisciplinar Project in Critical Embedded Systems	Transport and mobility	X	Elodie Chanttery; Pierre-Emmanuel Hladik; Barbara Moore

**Table. 3. 2 Selection of SDG11 micro-modules offered in Spring 2021**

Project partner	Module name	SDG11 Topic	CBL	Teacher
KTU	Innovative Production Technologies	Resilient communities, circular economy	X	Antanas Čiuplys
KTU	Sustainability Management and Law	Circular economy	X	Inga Stasiulaitienė
KTU	Component Based Software System Design	Resilient communities	X	Šarūnas Packevičius
KTU	Productivity Management	Resilient communities, circular economy	X	Rasa Lalienė
KTU	Urban Sociology	Resilient communities	X	Laura Jankauskaitė-Jurevičienė
UA	Traffic and Road Safety	Transport and mobility	X	Joaquim Macedo
UA	Renewable Energy Conversion	Energy and sustainability;		Luís Tarelho; António Samagaio
UA	Urban Metabolism	Energy and sustainability; Circular economy; Transport and mobility; Resilient communities	X	Myriam Alexandra dos Santos Batalha Dias Nunes Lopes; Teresa Fidélis
UNITN	Business Strategy in the Digital Economy	Circular economy		Alberto Nucciarelli

## 4 Case Study: University of Aveiro (UA)

**Teacher:** Prof. Victor Neto is an active researcher, with expertise in the field of additive manufacturing; business models; circular economy; decision making; eco-design and eco-efficiency; industry 4.0; manufacturing processes; nanotechnology; nanotechnology usability; product development; teaching methodologies; thermoplastics injection moulding; university-business cooperation. He has published more than 60 papers in international refereed journals, and communications in more than 50 conferences. He has been involved in several research projects, on the management of scientific events; and on science dissemination activities.

**Module Name:** Eco design and Eco efficiency

**Module level:** Advanced

**Webpage:**<https://edee2021.wordpress.com/>

**Content:** Eco-design and Eco-efficiency (EDEE) course is intended to promote an entrepreneur mindset for the creation of sustainable products and processes, in scope with industrial trends of digitalization and circularity. Students are challenged to develop new products, or rethink them, to decrease the resource use intensity, giving priority to the use of renewable materials, including recyclable and/or bio-based materials, and with less hazard and risk (for humans and the environment) and reuse of materials. Eco-design and eco-efficiency concepts and tools, and their application in the different stages of engineering and product development are covered, as well as rules and regulations.

**SDG11 Topic: Energy and sustainability; Circular economy; Resilient communities**

**Teaching -research nexus:** The course starts with a critical review of scientific papers. Each student has to revise 3 papers with two different roles (evaluators and reviewers). The second assignment is related to the identification of a product and improvement/redesign it – The design of the product shall be based on scientific knowledge as well as national and international rules and regulation and standards. At the end of the course, the students will publish the product on the webpage of the course.

The content of the micro-module is structured on the research interests of the teacher, but teaching is not based on a traditional information transmission model, students experience the role of reviewers and they will be then evaluated by peers. Furthermore, the teaching is research-oriented and research-based, because students will be directly involved in the design process of new products and/or processes.

**Module Name:** Advanced Production Technologies

**Module level:** Advanced

**Webpage:** <https://apt2021.wordpress.com/>

**Content:** Advanced Production Technologies (APT) are all the innovative forms of transforming raw materials or components in new products, applying either conventional processes or making use of the most recent and cutting-edge scientific breakthroughs. In this scope, the main objective of the Advanced Production Technologies course is to promote an entrepreneur mind-set in the use of these technologies. The course placed particular focus on the advanced processing and characterization of thermoplastics, and on micro and nanofabrication processes, as well as the characterization of these materials and products. Design for X requirements, manufacturing economic costs, and environmental impacts of the different production options are stressed.

**SDG11 Topic Resilient communities**

**Teaching Research nexus:** The first assignment of the module is the analysis of the literature through scientific papers. The second assignment will focus on the challenge to develop a project to transform the Aveiro Region into a more technological, connected and intelligent territory to provide the inhabitants and tourists of this region with an increase in their quality of life and simplicity of daily tasks. At the end of the course, the students will publish the project/solution on the webpage of the course.

The content of the micro-module is structured on the research interests of the teacher, but teaching is not based on a traditional information transmission model. Teaching is research-oriented and research-based and students are directly involved in the challenge to develop projects and solution for the Aveiro Region.

## 5 Case Study: University of Trento

**Teacher:** Prof. Luca Fiori is an active researcher, with the main research focus on extraction and thermo-chemical conversion processes, in particular at high pressure for the exploitation of organic waste and biomass: waste and biomass to energy and added-value compounds and materials, author or co-author of more than 150 publications in national and international peer-reviewed journals and has been involved in national and international research projects. He ranks 1631 in the area of Energy at world level according to the World Ranking of Scientists by Stanford University 2021

**Module Name:** Bioenergy

**Module level:** Advanced

**Content:** The course focuses on Bio-Energy and in particular on the exploitation of biomass and biomass waste for energy recovery. The course encompasses thermochemical energy processes (combustion, gasification, pyrolysis, reforming, hydrothermal conversion), mechanical and chemical processes (e.g. oil extraction and trans-esterification), finally biochemical processes (fermentation and anaerobic digestion). The course provides chemical engineering tools applied to the analysis of energy conversion processes involving biomass and organic waste. Finally, the course provides the fundamentals of ASPEN PLUS® - a software package designed for process modeling and simulation that is extensively utilized in the chemical and energy industrial sectors.

**Teaching -research nexus:** During the course the lecturer will address both informative and formative topics. The informative activity will provide a comprehensive overview of the bio-energy sector (through review of scientific publications). The training activity will be divided into a discussion of the theoretical topics and the development and solution of some "practical" problems, where the theory will be applied.

The content of the micro-module is structured on the research interests of the teacher, teaching is research-oriented and research-based and students are directly involved to develop solution of some "practical" problem.

## 6 Workshop planning

After the issue of the ECIU White paper on micro-credentials in 2021, the network members started the organization of awareness workshops on micro-credentials. The first workshop on ECIU University micro-credentials was organized by the ECIU University on 28 January 2021, 100 participants attended. Awareness-building workshops on micro-credentials and CBL at partner universities followed this event. For instance, at UNITN the workshop was organized on 24 February 2021 with 78 participants. The main goal of the workshop was to explain the micro-credentials concept and make researchers aware of their importance.

As described in the ECIU University proposal, the workshop on research-based micro-modules should facilitate the process of transferring research results with the aim of having 15 new micro-credentials at the end of the pilot phase. ECIU University has already presented 13 research-based micro-modules for Autumn 2020, and 9 research-based micro-modules for Spring 2021, nevertheless the content of a future WP4 workshop could have the focus groups dedicated to the research teaching nexus in creating micro-modules.

Awareness building workshops which will be organised following instructions issued by WP4, will be the best means to reinforce the research training nexus, particularly for Early-Career Stage Researchers (ESRs). The researchers responsible for creating micro-modules shall be involved in the workshop programme to describe the process to transfer research results in teaching activities.

Mapping existing micro-modules has shown that offered list has already reached the number of 15 micro-modules with SDG11 research teaching nexus set as a deliverable at the end of the pilot phase of the ECIU University.

Guidelines and activities foreseen and developed in WP4 have been an important element in order to reach this goal. The activities of the ECIU University Research Institute for Smart European Regions (SMART-ER) through its Academy will further strengthen the link between education and research, involving researchers from all their professional stages in stimulating training, based on the challenge-based learning approach (CBL), following a long-term research strategy on smart regions to address common research challenges related to SDG 11 (Sustainable Cities and Communities) topics<sup>3</sup>.

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<sup>3</sup> See "ECIU Challenge-based research" <https://www.eciu.org/smart-er-for-researchers>

