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CURRICULA DEVELOPMENT IN THE FIELD OF CLIMATE SERVICE

Version 4.0

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Work Package 01 – Work Package 03

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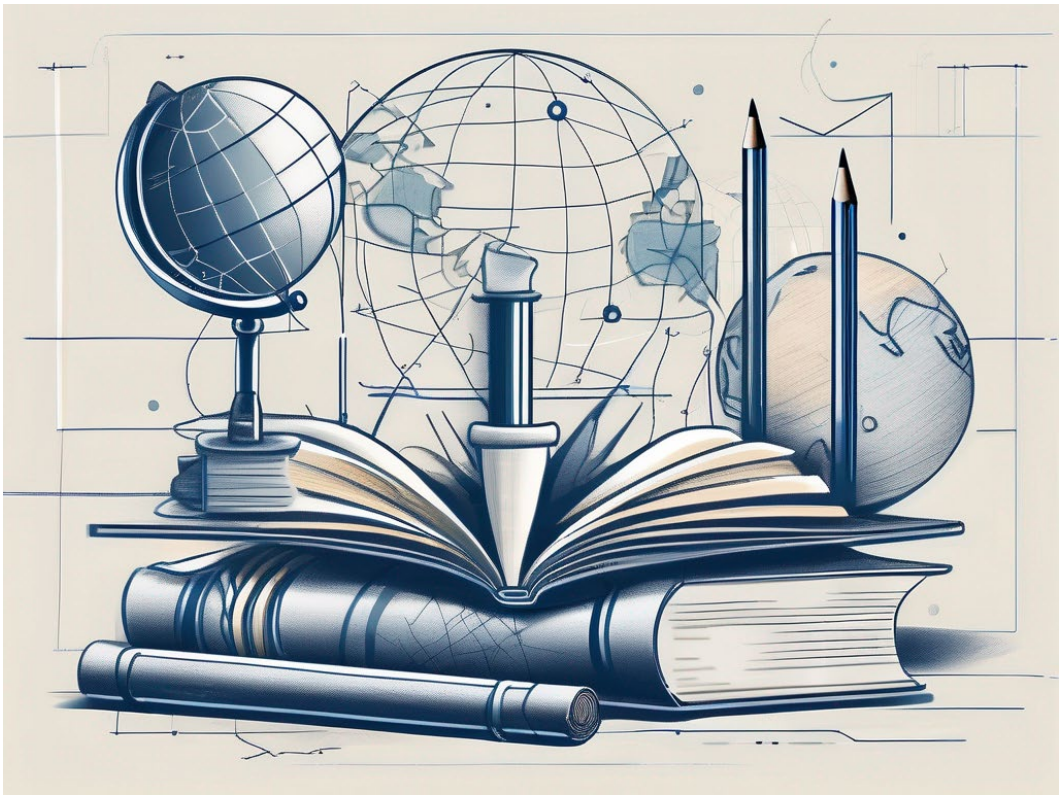
This document is the 2nd version (27th October 2024) of the “CURRICULA DEVELOPMENT IN THE FIELD OF CLIMATE SERVICE”. The document has been written by the CLimEd teams of University of Helsinki, Finland, Universitat Rovira i Virgili, Tarragona, Spain, Estonian Life Science University, Estonia, Odesa Mechnikov National University, Ukraine, Bila Tserkva National Agrarian University, Ukraine, Odessa National Medical University, Ukraine, Lviv Polytechnic National University,Ukraine, Kyiv National University of Construction and Architecture, Ukraine, O.M. Beketov National University of Urban Economy in Kharkiv, Ukraine



This document is the 4th version of a living document / interactive document, which will be expanded in a cumulatively manner by the ClimEd teams.

Contents

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INTRODUCTION

The guidelines for curriculum development are crucial for the project "Multilevel System of Education in Climate Services, Climate Change Adaptation and Mitigation for Public Bodies, Sectoral Entities, and Municipal Organizations in Ukraine" for several reasons. They ensure uniformity and consistency across various training modules, providing a standardized structure and quality of content. This standardization is vital for maintaining a uniform approach to delivering climate education across different levels and sectors.

Additionally, the guidelines help align the content with the latest scientific knowledge and practical applications, ensuring the information is accurate, relevant, and tailored to Ukraine's specific climate challenges and policies. By addressing the diverse needs of different public bodies, sectoral entities, and municipal organizations, the guidelines ensure that training materials are customized for varying levels of expertise and responsibility, making them more practical and accessible.

Moreover, these guidelines play a critical role in building the capacity of stakeholders, empowering public officials and sectoral leaders to implement effective climate strategies and facilitating the integration of climate considerations into public planning and decision-making. They also establish criteria for assessing and continuously improving training materials, incorporating feedback mechanisms to refine and adapt the content, thus maintaining high standards in training delivery.

Furthermore, the guidelines support Ukraine in meeting its international climate commitments and implementing national climate policies by aligning the training content with these obligations. They also promote interagency and intersectoral coordination by fostering a unified approach to climate adaptation and mitigation and enhancing communication and cooperation among various entities.

Finally, the guidelines provide tools and methodologies for monitoring and reporting the progress of training programs, ensuring accurate documentation of outcomes and supporting the continuous improvement of training materials based on evaluation results. This comprehensive approach ensures that the training materials are effective, relevant, and adaptable, significantly contributing to the success of the multilevel education system in climate services, adaptation, and mitigation in Ukraine.

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1. MATERIAL CREATION

As the Global and the European experience gained in the creation and application of e-courses demonstrates, the most appropriate and effective form to learn and consolidate the knowledge and the skills acquired, is the one that includes, apart from standard structural elements (lecture notes, presentations, practical work, literature), such additional elements as video lectures, self-assessment tests and final control tests, and glossary.

1.1 Formats and Media

Course Description. This training development plan (syllabus) provides a comprehensive overview of the course, detailing the target audience, defined competencies, learning outcomes, and performance criteria. The plan includes content scope, learning solutions, delivery modes, strategies, and activities, along with assessment methods. It outlines a training storyboard and lists the required learning resources and tools. A more detailed description of the plan can be found in Chapter 4.

Each credit comprises 30 academic hours, divided into classroom work and independent student work. Classroom work is allocated 12 academic hours, while independent student work is allocated 16 hours. The classroom work includes 1 to 3 lectures, with the remaining time dedicated to practical assignments. Each lecture is supported by a video lasting approximately 15–20 minutes. A flipped classroom strategy is strongly recommended for lesson delivery. This strategy is described in the paragraph 3.6.

Glossary. Include a glossary of key terms and definitions to clarify terminology used throughout the training materials. This ensures comprehension and consistency in understanding key concepts. The glossary should feature terms that are both relevant and essential for understanding the course content.

For a standard lecture, a glossary might include 10–20 key terms to ensure the most essential concepts are covered without overwhelming the learners. However, if the topic is more technical or detailed, you might include up to 30–40 terms to provide comprehensive support. The goal is to focus on terms that are vital for understanding the material, keeping explanations clear and concise.
Format: .html

Lecture Slides. Use slides to present key information, visuals, and structured content in a concise, visually engaging format. Slides are effective for explaining theoretical concepts and frameworks.
Format: .pptx and .pdf (searchable, downloadable)

Lecture Text. Each lecture should include text enriched with graphs, tables, and illustrations for clarity and engagement. Character Count: 6,000–8,000 characters (around 1,000–1,300 words).
Format: .html and .pdf (searchable, downloadable)

Video Lectures. Create 15–20 minute video lectures that present the core concepts of each lecture unit. The videos should be paired with slides and clear, concise captions.
Captions: A full-text version of captions should be provided to ensure clarity, accuracy, and synchronization with the video content.

Learning Activities. Incorporate a variety of interactive learning activities such as workshops, discussions, project-based learning, and case-based learning to engage learners actively. Workshops promote hands-on learning, while discussions encourage critical thinking and peer exchange.

Practical Tasks. Each practical task should have a comprehensive description, including detailed instructions, data sources, and any additional requirements.
Format: .html

The **structural elements of a practical task** are:

- a brief and clear description of the work task with a minimum of necessary background information;
- additional information that the student must be able to obtain, if available;
- a list of brief questions (multiple mini practice questions), contributing to the accumulation of information necessary for further analysis (if necessary);
- a worksheet (if necessary);
- answers (if applicable).

Answer Formats:

- Text: .html or .xls/.xlsx (uploadable)
- Calculations or answers: .xls/.xlsx (uploadable)

Recommended Literature. Provide a curated list of recommended readings, articles, and books to supplement the course content. These materials help learners deepen their understanding and explore topics in greater depth. All recommended literature should be easily accessible and available for download.

Self-Assessment Quizzes. Offer self-assessment quizzes proportionate to the number of lecture units, with 10 questions per set. Each question should include answer options and short comments for feedback.
Format: .html

Final Control Tests. Each study module should include a final control test with 20–60 questions, depending on the number of lecture units.
Format: .html

Web Conferencing: to be used as a complex of a technology and a toolkit for organizing online meetings and real-time collaboration over the Internet. In this case it is envisaged to conduct online presentations, collaborate on documents and applications, synchronously view websites, video files and images.

A Webinar: a type of web conference, conducting online meetings or presentations over the Internet in real time, which implies 'one-way' speaker broadcasting and minimal feedback from the audience. During the webinar the connection between the participants is maintained via the Internet through a downloadable application installed on each participant's computer or via a web application.

1.2 Quality Standards

Clarity: Ensure materials are clear, logically structured, and easy to follow. Use straightforward language and avoid unnecessary complexity to aid comprehension.

Accuracy: Verify the accuracy of information presented, citing credible sources and ensuring content reflects current knowledge and practices in the field.

Consistency: Maintain consistency in terminology, formatting, and instructional style across all materials. Consistency enhances readability and coherence, supporting effective learning.

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1.3 Accessibility

Universal Design Principles: Apply universal design principles to ensure materials are accessible to all learners, including those with disabilities:

- Use readable fonts, adequate font sizes, and high contrast for text readability.
- Provide alternative text descriptions for images and graphics to assist visually impaired learners.
- Include captions or transcripts for videos to accommodate hearing-impaired learners.
- Ensure documents are accessible formats (e.g., PDFs with text) and compatible with screen readers.

Navigation and Structure: Organize materials in a logical and intuitive manner to facilitate navigation. Use headings, subheadings, and clear navigation tools (e.g., table of contents, hyperlinks) for easy access to different sections.

Interactive Features: Design interactive features (e.g., clickable links, buttons) that are accessible via keyboard navigation. Ensure interactive elements comply with accessibility standards to accommodate diverse learner needs.

Feedback and Support: Provide mechanisms for learners to request accommodations or support as needed. Respond promptly to accessibility inquiries and feedback to enhance the learning experience for all participants.

By integrating these considerations into the creation of training materials, instructors and course designers can foster an inclusive and effective learning environment where all learners can access, engage with, and benefit from the course content.

2. UNDERSTANDING LEARNING SOLUTIONS AND DELIVERY MODES

2.1 What do we mean by Learning Solutions?

Professionals acquire skills through various avenues, including:

- Taking courses in classrooms and online
- Accessing information independently
- Collaborating with experienced colleagues
- Receiving guidance from coaches or mentors
- Engaging in work processes to innovate
- Enhancing job outcomes through practice

These diverse methods collectively define "Learning Solutions," encompassing formal, semi-formal, and informal approaches. "Delivery Modes" describe the logistical settings and environments where learning occurs, such as online platforms, classrooms, or on-the-job mentoring.

Formal learning
- Courses, teachers, assessment

Semi-formal
- Coaching and mentoring

Informal learning
- Learner-directed, communities of practice

Face-to-face
- Classrooms, labs, field trips

Online
- Many web-based options

On-location
- On-the-job, in-the-field

2.2 Formal, Semi-Formal, and Informal Learning Solutions

The categorization into formal, semi-formal, and informal learning solutions helps trainers tailor approaches to meet diverse learning needs. Formal learning involves structured programs with defined outcomes and assessments, whether in classrooms, online, or through well-designed on-the-job training. Semi-formal learning offers more individualized paths, focusing on practical skill improvement under guidance, often through coaching or mentoring. Informal learning encompasses self-directed study, peer learning, and experiential learning in unstructured settings, which are crucial for ongoing professional development.

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2.3 Choosing the Right Approach

Selecting the appropriate learning solution hinges on several factors:

1. **Skill Complexity**: The level of skill mastery required.
2. **Assessment Needs**: Whether formal certification is necessary.
3. **Learning Pace**: How quickly skills must be acquired.
4. **Pedagogical Preferences**: Preferences for collaborative versus independent learning, and experiential versus direct instruction.

2.4 Logistical Considerations: Practical constraints such as budget and resource availability.

1. *Delivery Modes: Creating the Learning Environment*

The choice of delivery mode—whether classroom-based, online, or a blend of both—shapes the learning experience. Classroom settings foster interactive discussions, practical exercises, and face-to-face learning interactions. Online platforms provide flexibility in scheduling and accessibility to diverse learning resources, including live sessions, multimedia materials, and collaborative tools. Informal settings, such as on-the-job mentoring or self-directed learning, complement formal training by offering practical application and peer collaboration.

2.5 Blended Learning: Optimizing Effectiveness

Blending different learning solutions and delivery modes often maximizes learning outcomes. This hybrid approach integrates the strengths of formal instruction with the flexibility and accessibility of informal learning opportunities. By combining structured curriculum with real-world application, trainers can create comprehensive training programs that cater to varying learning styles and professional needs.

2.6 Resources for Reading:

Determine a learning solution

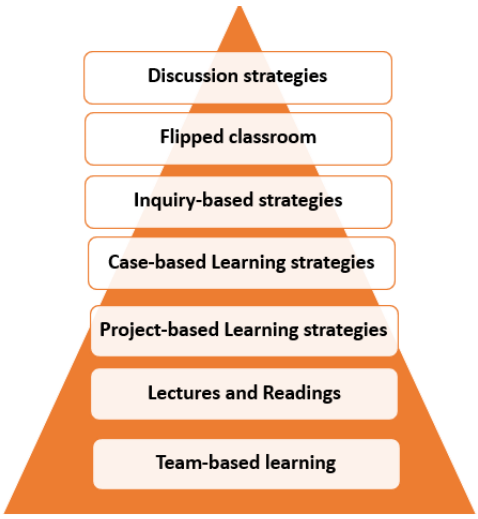
Chapter 5: Learning Solutions

3. LEARNING STRATEGIES

Educators and trainers have a plethora of options at their disposal to facilitate effective learning. Traditional methods such as lecturing and assigned readings remain foundational. Additionally, teachers engage learners through questioning to foster reflection and discussion, and assign tasks that encourage skill development. Mastery of these methods equips educators to create diverse learning pathways.

Strategies are systematic approaches to achieving educational goals. They are grounded in theory, research, and practical application, aimed at enabling students to succeed as learners. Effective learning encompasses more than acquiring information; it demands active engagement, akin to professional practice. Educators must challenge learners to deeply comprehend and apply knowledge, essential for future application. Mastery of complex cognitive skills like critical thinking, problem-solving, and analytical reasoning requires continual practice during the learning process.

Key strategies include Discussion, Inquiry, Experiential Learning, Case-based Learning, Project-based Learning, Guided Practice and Feedback, and Lectures and Readings. Each strategy serves a unique purpose, encouraging educators to reflect on their effectiveness in various contexts. By integrating these strategies thoughtfully, educators can optimize learning experiences and promote deeper engagement among students.



3.1 DISCUSSION STRATEGIES

Discussion Strategies are pivotal in promoting active learning. They involve structuring learning around questions or issues, encouraging students to engage deeply through dialogue. Discussions can be teacher-centered, where instructors guide the conversation towards specific learning goals, or learner-centered, allowing students to lead based on their interests. This approach fosters critical thinking and problem-solving skills, essential for mastering disciplinary knowledge.

In discussions, there are three key categories of strategies that can be employed depending on the time, resources, and level of engagement required: **higher-prep strategies, low-prep strategies, and ongoing strategies**.

3.1.1 Higher-Prep Strategies

These strategies require more preparation and planning before the discussion takes place. They are ideal for complex topics or when you want to ensure a deep, meaningful conversation. Higher-prep strategies often include:

3.1.1.1 Gallery Walk

In a Gallery Walk, participants move around the room to engage with various pieces of information or prompts displayed on charts or posters, typically around different stations.

- **Preparation**: Facilitators need to prepare questions, scenarios, or images related to the topic and post them at different stations.
- **How it works**: Participants walk around the room, individually or in small groups, visiting each station and reflecting on the prompts. They often write down their thoughts or respond to questions on sticky notes, making the process interactive.
- **Goal**: This method encourages active participation and reflection. It allows participants to engage with multiple perspectives and think critically about different aspects of the topic before coming together for a larger discussion.

3.1.1.2 Philosophical Chairs

Philosophical Chairs is a debate-style strategy that encourages participants to take a position on an issue and defend it, but they can change sides as the discussion evolves.

- **Preparation**: The facilitator needs to select a thought-provoking, debatable topic or statement and clearly define opposing viewpoints. The room is set up with two areas where participants can sit based on their stance: one side for those who agree, another for those who disagree. A neutral zone can also be included.
- **How it works**: Participants choose a side and explain their reasoning. The discussion flows back and forth, with participants either defending their position or moving to the opposite side if they are persuaded by others' arguments.
- **Goal**: The focus is on developing critical thinking and the ability to articulate and defend a position, as well as openness to changing one's view when presented with convincing evidence.

3.1.1.3 Pinwheel Discussion

The Pinwheel Discussion involves multiple groups of participants, each representing a different perspective or stakeholder in a discussion, creating a structured, rotating dialogue.

- **Preparation**: The facilitator assigns participants to different groups, each representing a distinct point of view on a given topic. One chair is placed in the center of the room, with groups sitting in a circle around it. Each group prepares their arguments or responses in advance.

- **How it works**: Representatives from each group take turns sitting in the "pinwheel" chair in the center to engage in the discussion. After speaking, they rotate out, and a new representative takes their place. The discussion continues, with each group having opportunities to speak.
- **Goal**: This strategy helps participants explore a topic from multiple perspectives, fostering a deeper understanding of complex issues and collaborative thinking.

3.1.1.4 Socratic Seminar

A Socratic Seminar is a formal discussion based on open-ended questions and deep inquiry, where participants explore ideas and concepts through dialogue rather than debate.

- **Preparation**: The facilitator provides participants with a text, question, or issue to analyze before the seminar. Participants are expected to read and reflect on the material, preparing thoughts, questions, and responses.
- **How it works**: During the seminar, participants engage in a discussion led by their own questions and thoughts. The facilitator acts as a guide, prompting further inquiry but not leading the discussion. Participants are encouraged to listen closely, ask thoughtful questions, and respond with reasoned arguments.
- **Goal**: The Socratic Seminar promotes critical thinking, reflective dialogue, and the ability to engage in deep analysis. It encourages participants to consider ideas from various angles and articulate their understanding.

Each of these higher-prep strategies fosters a collaborative, thoughtful learning environment, helping participants engage deeply with material and each other.

These methods are particularly useful when the goal is to develop critical analysis, reflection, and well-rounded perspectives on complex issues.

3.1.2 Low-Prep Strategies

Low-prep strategies are simpler and can be used when time is limited or when the goal is to prompt spontaneous discussion. These methods are typically less formal and encourage immediate participation. Some examples include:

3.1.2.1 Affinity Mapping

Affinity Mapping is a collaborative method where participants organize ideas, thoughts, or responses into groups based on similarities.

- **Preparation**: The facilitator presents a prompt or question related to the discussion topic. Participants jot down their responses on sticky notes, one idea per note.
- **How it works**: After writing their thoughts, participants place the sticky notes on a board or wall and begin grouping similar ideas together. The facilitator or group then discusses the clusters of ideas, identifying common themes and patterns.
- **Goal**: This strategy encourages quick brainstorming, collaboration, and organization of ideas, allowing participants to visually see connections and build a deeper understanding of the topic.

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3.1.2.2 Concentric Circles

Concentric Circles is a simple and quick discussion strategy where participants engage in one-on-one discussions, rotating to new partners in a structured way.

- **Preparation**: The facilitator develops a set of questions or prompts related to the topic. The room is set up so that participants stand or sit in two circles: an inner circle and an outer circle, with the inner circle facing outward.
- **How it works**: Participants in the inner circle discuss the prompt with the person directly facing them in the outer circle. After a set amount of time, the outer circle rotates, and participants engage in a new discussion with a different partner.
- **Goal**: This strategy promotes fast-paced, interactive discussion, allowing participants to hear a variety of perspectives in a short time and practice articulating their thoughts on the topic.

3.1.2.3 Conver-Stations

Conver-Stations involves small-group discussions that rotate, with each group building on the ideas shared by the previous group.

- **Preparation**: The facilitator prepares multiple discussion stations around the room, each with a different prompt or aspect of the main topic.
- **How it works**: Participants are divided into small groups and assigned to one station to discuss the topic. After a set time, groups rotate to the next station, where they build on the previous group's conversation by adding their thoughts or expanding on existing ideas. The process repeats until all groups have visited each station.
- **Goal**: This method fosters collaboration and idea-sharing across different groups, helping participants think critically about the evolving discussion and contribute to a collective understanding.

3.1.2.4 Fishbowl

The Fishbowl discussion is a format where a small group discusses a topic while the rest of the participants observe, creating an inner and outer circle.

- **Preparation**: The facilitator prepares a discussion topic or set of questions. Chairs are arranged in an inner circle (the "fishbowl") for the speakers, with the rest of the participants seated around them.
- **How it works**: A small group of participants in the inner circle begins discussing the topic, while those in the outer circle listen silently. After some time, people from the outer circle may join the discussion by rotating into the fishbowl.
- **Goal**: Fishbowl discussions encourage active listening, reflection, and structured participation. Observers gain insights from the focused discussion, while participants in the inner circle engage in deeper dialogue.

3.1.2.5 Hot Seat

In the Hot Seat discussion strategy, one participant is placed in the center of the group and answers questions or responds to challenges from the other participants.

- **Preparation**: The facilitator needs to decide on a topic or issue for discussion. One chair (the "hot seat") is placed at the front or center of the room.
- **How it works**: One participant volunteers (or is selected) to sit in the hot seat. The rest of the group asks questions or presents arguments, and the person in the hot seat responds, sharing their thoughts, opinions, or solutions. After a set time, another participant takes the hot seat.
- **Goal**: This strategy develops critical thinking and verbal skills, as participants must defend or explain their positions while responding to challenges from the group.

3.1.2.6 Snowball Discussion

In a Snowball Discussion, participants start in pairs or small groups, then gradually merge into larger groups to share and refine ideas.

- **Preparation**: The facilitator prepares a prompt or question related to the topic. Participants are initially paired up for a brief discussion.
- **How it works**: Pairs discuss the prompt, and then after a few minutes, two pairs combine to form a small group. This process repeats until all participants are part of one large group. At each stage, participants share the ideas discussed in their smaller groups, refining and expanding on them as they go.
- **Goal**: This strategy allows for incremental sharing and collaboration, encouraging participants to refine their thoughts through multiple conversations. By the end, the group develops a collective understanding of the topic.

Low-prep strategies are effective for creating quick engagement and encouraging participation, even with minimal resources or planning.

Each of these low-prep strategies offers an efficient way to engage participants in meaningful discussions with minimal preparation, allowing for spontaneous and interactive learning experiences.

3.1.3 Ongoing Strategies

Ongoing strategies are designed to maintain continuous engagement and reflection beyond a single discussion session. These strategies help to deepen understanding and keep the conversation relevant over time. Some examples include:

3.1.3.1 Asynchronous Voice

Asynchronous Voice discussions allow participants to contribute to a conversation using recorded voice messages over time, rather than in real-time.

- **How it works**: Participants use voice-recording tools (e.g., apps or platforms) to respond to discussion prompts, share ideas, or give feedback. Unlike live discussions, these conversations unfold over days or weeks, giving everyone time to reflect and respond at their own pace.
- **Goal**: This strategy encourages reflective thinking and allows participants to engage deeply with the material. It also supports participants in different time zones or with varying schedules.
- **Benefits**: Asynchronous voice discussions can feel more personal than text-based interactions, allowing tone and emotion to come through, fostering a stronger sense of connection in remote or online learning environments.

3.1.3.2 Backchannel Discussions

Backchannel discussions are parallel conversations that take place alongside a primary discussion, lecture, or event, typically in real-time, using digital platforms like chat or messaging tools.

- **How it works**: Participants use a shared digital space (e.g., chat rooms, Twitter, Slack) to ask questions, share comments, or discuss related ideas while a presentation or main conversation is happening. The backchannel serves as an ongoing dialogue that can continue even after the primary event.
- **Goal**: This strategy allows participants to engage in side discussions without disrupting the flow of the main event. It also gives quieter or less confident participants a space to express their thoughts, enhancing overall engagement.
- **Benefits**: It promotes continuous learning and allows participants to process information collectively in real time, encouraging collaboration and quick feedback.

3.1.3.3 Talk Moves

Talk Moves are a set of conversational strategies designed to encourage deeper thinking and promote richer discussions in the classroom or group settings.

- **How it works**: The facilitator introduces specific prompts or moves to structure the discussion. Common talk moves include:
    - **Revoicing**: "So you're saying…?" This encourages clarification and deeper understanding.
    - **Restating**: Asking one participant to restate what another has said, reinforcing listening and comprehension.
    - **Adding on**: Inviting participants to build on someone else's point.
    - **Wait time**: Giving more time for participants to reflect before answering.
- **Goal**: These moves promote active listening, encourage participants to build on each other's ideas, and ensure everyone's voice is heard in the conversation.
- **Benefits**: Talk Moves help create an inclusive environment for discussion, fostering critical thinking and making discussions more interactive and engaging.

3.1.3.4 Teach-OK

Jigsaw Discussion is a cooperative learning strategy where participants become "experts" on a segment of a topic and then share their expertise with peers to create a complete understanding of the subject. A jigsaw helps students become experts on a particular topic and share their knowledge with fellow students.

- **How it works**: Students are first divided into small groups. Each group discusses and learns more on a particular topic. These students are then re-shuffled to create new groups with representatives from each previous group. In these new groups, each student is responsible for sharing key aspects of their original discussion. The second group must synthesize and use all of the ideas in order to complete a new or more advanced task.

- **Goal**: The primary goal of Jigsaw Discussion is to promote collaboration, accountability, and active learning. Each participant is responsible for their own learning and for teaching their peers, ensuring a deeper understanding of the subject.
- **Benefits**: Jigsaw Discussion fosters teamwork, enhances communication skills, and builds a sense of responsibility, as each participant plays a critical role in the group's overall success. By teaching their peers, participants reinforce their understanding of the material and create a more inclusive learning environment where everyone contributes.

3.1.3.5 Think-Pair-Share

Think-Pair-Share is a simple, collaborative strategy that encourages individual thinking followed by paired discussions and group sharing.

- **How it works**: The facilitator presents a prompt or question. First, participants are given time to **think** about their response individually. Next, they **pair** up with a partner to discuss their thoughts. Finally, pairs **share** their ideas with the larger group.
- **Goal**: This strategy allows participants to organize their thoughts individually before engaging in discussion with others, which reduces pressure and improves participation in group discussions.
- **Benefits**: Think-Pair-Share is inclusive and can be used to get everyone involved, even those who may feel shy or hesitant to speak in front of the whole group. It encourages thoughtful discussion and helps participants refine their ideas through collaboration.

Each of these ongoing discussion strategies promotes continuous engagement and deepens participants' understanding over time, whether in face-to-face or online settings.

By combining these strategies, discussions can be dynamic and adaptive to different learning contexts and goals, ensuring meaningful participation and ongoing engagement.

3.1.4 Resources for Designing Inquiry-Based Courses:

5 Discussion Strategies to Deepen Student Engagement

My 5 Favorite Class Discussion Strategies

Structured Discussions

Higher-Prep Discussion Strategies	Low-Prep Discussion Strategies	Ongoing Discussion Strategies
Gallery Walk	Affinity Mapping	Asynchronous Voice
Philosophical Chairs	Concentric Circles	Backchannel Discussions
Pinwheel Discussion	Conver-Stations	Talk Moves
Socratic Seminar	Fishbowl	Jigsaw Discussion
	Hot Seat	Think-Pair-Share
	Snowball Discussion	

3.2 Project-based learning

Project-based learning (PBL) is a dynamic teaching approach where students actively explore real-world problems and challenges through in-depth projects over an extended period of time. Unlike traditional learning, which often relies on memorization or lecture-based instruction, PBL emphasizes hands-on, student-driven inquiry and collaboration, allowing learners to engage in meaningful tasks that relate to their personal interests or future careers. This active learning approach encourages creativity, critical thinking, and communication skills. By tackling real-world challenges, students develop practical expertise and prepare for professional roles.

3.2.1 Key Characteristics of Project-Based Learning:

- **Focus on a Driving Question or Problem**: PBL is centered around a complex question, problem, or challenge that students must address. This driving question provides purpose and direction for the project and connects learning to real-world issues.
- **Inquiry-Based**: Students engage in sustained inquiry as they explore the driving question, gather information, and develop solutions. They formulate questions, conduct research, experiment, and evaluate their findings in the process of solving the problem.
- **Student-Centered**: PBL places students at the center of the learning process. They take ownership of their learning by planning, designing, and implementing projects. The teacher acts as a facilitator or guide, providing support as needed.
- **Collaborative Learning**: Students often work in teams, allowing them to share ideas, debate perspectives, and collaborate on project outcomes. This mirrors real-world workplace environments where teamwork is essential.
- **Authentic and Real-World Application**: Projects in PBL are typically connected to real-world contexts or problems. The tasks and solutions developed by students have relevance beyond the classroom, making the learning experience more engaging and meaningful.
- **Interdisciplinary Approach**: PBL encourages the integration of knowledge and skills from various subjects. A single project might involve science, math, language arts, and social studies, promoting a holistic understanding of the topic.
- **Creation of a Product or Solution**: PBL culminates in the creation of a tangible product, presentation, or solution to the problem. This could be a report, presentation, physical model, or digital product that demonstrates students' learning and achievements.
- **Reflection and Revision**: Reflection is an essential part of PBL. Students assess their progress, reflect on their learning, and revise their projects based on feedback and new insights. This ongoing process helps them develop a deeper understanding of the subject matter.
- **Public Presentation**: Students often present their final products or solutions to an audience, such as classmates, teachers, or community members. This public presentation adds accountability and encourages students to produce high-quality work.

3.2.3 The Project-Based Learning Process:

- **Introduction of the Driving Question**: The teacher introduces a meaningful and challenging question or problem that serves as the focus of the project. This question should spark curiosity and require sustained inquiry to answer.
- **Planning and Research**: Students brainstorm potential approaches, plan their investigation, and gather resources. They might conduct research, interview experts, or perform experiments to deepen their understanding of the problem.
- **Development of the Project**: Students work individually or in teams to design solutions or create products that address the driving question. This phase involves collaboration, creativity, problem-solving, and critical thinking.
- **Feedback and Revision**: Students share their work with peers and teachers to receive feedback. They revise their projects based on this input, refining their ideas and improving the quality of their solutions.
- **Final Product and Presentation**: The project culminates in the completion of a final product or solution, which students present to an audience. This could be a class presentation, community event, or digital showcase.
- **Reflection**: After completing the project, students reflect on what they have learned, the challenges they faced, and the skills they developed. Teachers also assess students' learning and provide feedback on both the process and the final outcome.

3.2.3 Example of Project-Based Learning:

In a **science class**, students might tackle the driving question: "How can we reduce plastic waste in our community?" Over the course of the project, they conduct research on the environmental impact of plastic, interview local waste management experts, and explore potential alternatives to plastic use. They then collaborate to design an awareness campaign or develop prototypes of eco-friendly packaging solutions, which they present to local community leaders or environmental organizations.

In a **history class**, students might investigate the question: "How can we create a museum exhibit that tells the story of a significant event in our town's history?" Students would conduct research on the event, collect historical artifacts or stories, design the exhibit layout, and present their final product to the public or a local historical society.

3.2.4 Benefits of Project-Based Learning:

- **Deep Understanding**: PBL fosters a deeper understanding of subject matter because students apply what they learn to real-world problems. They move beyond memorizing facts to developing critical thinking and problem-solving skills.
- **Engagement and Motivation**: Because students are working on projects that have relevance to their interests and lives, PBL often increases motivation and engagement. They are more likely to take ownership of their learning and invest effort in their work.

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- **Development of Key Skills**: PBL helps students develop a range of skills that are essential for future success, including collaboration, communication, time management, research, critical thinking, and creativity.
- **Interdisciplinary Learning**: By integrating different subjects, PBL encourages students to see connections between disciplines and apply knowledge from multiple areas to solve problems.
- **Real-World Preparation**: PBL prepares students for real-world challenges by giving them opportunities to work on meaningful projects, collaborate with peers, and present their ideas to an audience, much like they would in a professional setting.
- **Ownership and Independence**: Since students take the lead in directing their learning, they develop independence, self-regulation, and a sense of responsibility for their educational outcomes.

3.2.5 Challenges of Project-Based Learning:

- **Time-Intensive**: PBL requires significant planning and time, both for teachers to design projects and for students to complete them. Managing time effectively is crucial to ensuring that projects are meaningful and successful.
- **Assessment Difficulties**: It can be challenging to assess PBL since the process is as important as the final product. Teachers must assess both student learning throughout the project and the quality of the final outcome.
- **Resource Demands**: Depending on the nature of the project, PBL may require additional resources, such as materials, technology, or access to external experts, which may not always be readily available.
- **Balancing Group Dynamics**: Collaboration is a key element of PBL, but it can sometimes be challenging to manage group dynamics and ensure that all students contribute equally to the project.

Project-based learning is an effective approach to education that emphasizes active engagement, collaboration, and real-world problem-solving. By working on meaningful, authentic projects, students develop deep subject matter knowledge, critical thinking skills, and key competencies that prepare them for success in school, careers, and life. While it requires careful planning and facilitation, PBL offers a highly engaging and enriching learning experience for students of all ages.

3.2.6 Resources for Designing Project-Based Courses:

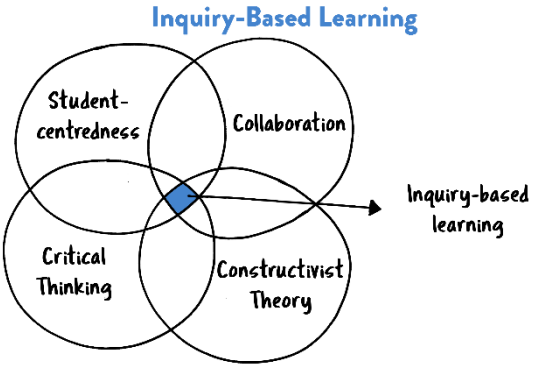
Designing an Effective PBL Curriculum: A Step-by-Step Guide for Teachers

Projects for Learning

PBL Design Tools & Resources

Tools for Project-Based Learning

3.3 Inquiry-based learning strategies



Inquiry-based learning strategies focus on posing questions or hypotheses that provoke curiosity and encourage students to explore topics independently. This learner-centered approach emphasizes critical thinking and problem-solving skills, preparing students for real-world challenges. Whether through structured research or informal investigation, inquiry-based learning empowers students to construct their understanding actively.

3.3.1 Key Characteristics of Inquiry-Based Learning:

- **Learner-Driven Questions**: Inquiry begins with questions posed by the learners, either individually or as a group. These questions often stem from curiosity or a challenge presented by the facilitator, encouraging students to pursue answers through exploration.
- **Active Investigation**: Students take an active role in the learning process by conducting research, gathering data, experimenting, or exploring sources to find answers to their questions. This hands-on approach promotes deeper engagement and understanding.
- **Critical Thinking and Problem-Solving**: Through inquiry, students are encouraged to analyze information, identify patterns, and draw conclusions. This process requires them to critically assess their findings and think logically about the evidence they collect.
- **Collaboration**: Often, inquiry-based learning involves collaboration, with students working in groups to share ideas, discuss perspectives, and build collective knowledge. This social learning aspect enhances communication and teamwork skills.
- **Facilitator as Guide**: In inquiry-based learning, the teacher or facilitator acts as a guide or coach, helping students navigate the learning process by providing resources, asking guiding questions, and encouraging deeper investigation. They are not the primary source of knowledge but rather support students in their journey to find answers.
- **Reflection and Synthesis**: Students are encouraged to reflect on their learning process, evaluate their conclusions, and synthesize new information. Reflection helps learners understand not only what they learned, but how they learned it, fostering metacognitive skills.

3.3.2 Types of Inquiry-Based Learning:

Structured Inquiry: The teacher provides a question and necessary resources, and students follow a guided investigation. It's a step-by-step process, ideal for introducing inquiry-based learning.

Guided Inquiry: The teacher provides the question, but students decide on the methods and approach for answering it. This level gives more autonomy while still offering some structure.

Open Inquiry: Students formulate their own questions and decide on the methods of investigation with minimal guidance from the teacher. Open inquiry fosters a high level of independence and creativity.

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Problem-Based Inquiry: Students are presented with a real-world problem and must research and develop solutions. This form of inquiry connects learning to practical applications.

3.3.2.1 Structured Inquiry

Structured Inquiry is the most teacher-directed form of inquiry-based learning, where the teacher provides a clear, step-by-step process for the investigation.

- **How it works**: The teacher presents a specific question or problem and provides detailed instructions or resources to guide the investigation. Students follow the prescribed process to gather information, conduct experiments, or analyze data.
- **Teacher's role**: The teacher controls the inquiry framework by determining the question, providing materials, and outlining the steps students must take. The teacher may also specify how students should analyze and present their findings.
- **Student's role**: Students actively investigate, but they do so within a predefined structure. Their task is to discover the answers or findings by following the provided methodology.
- **Best for**: Introducing students to inquiry-based learning, especially when they are unfamiliar with open-ended investigations. It's also useful when a specific learning outcome is required, such as understanding a particular scientific principle or concept.
- **Example**: In a chemistry class, the teacher might ask, "What happens when you mix baking soda and vinegar?" The teacher provides all necessary materials and procedures, and the students conduct the experiment step by step, observing the results and writing a report.

3.3.2.2 Guided Inquiry

Guided Inquiry offers more freedom to students compared to Structured Inquiry, but the teacher still provides a central question or problem to explore.

- **How it works**: The teacher poses a question or problem but allows students to determine how they will investigate and solve it. The teacher may provide a framework or resources, but the approach to answering the question is left to the students.
- **Teacher's role**: The teacher sets the stage by framing the central question or problem. They offer guidance when needed but encourage students to design their own methods of investigation. The teacher may suggest tools, resources, or strategies, but the path to the solution is flexible.
- **Student's role**: Students take responsibility for planning their investigation. They must determine how to collect data, what tools to use, and how to analyze the information. This approach requires students to engage in more critical thinking and decision-making.
- **Best for**: Students who have some experience with inquiry-based learning and are ready for more autonomy in their learning process. It fosters skills in problem-solving, independence, and creativity.
- **Example**: In a history class, the teacher might ask, "What were the main causes of the French Revolution?" Students are allowed to choose which sources to use, what research methods to follow, and how to present their findings, whether through essays, presentations, or creative projects.

3.3.2.3 Open Inquiry

Open Inquiry is the most student-centered form of inquiry-based learning, where students have full control over the learning process.

- **How it works**: Students formulate their own questions or problems and determine how to investigate and solve them. The teacher acts as a facilitator but does not prescribe any specific approach or outcome. Students conduct their research, experiments, or analyses independently.
- **Teacher's role**: The teacher provides minimal direct instruction but acts as a guide and resource when needed. They encourage students to be self-directed and independent while offering support if students encounter challenges.
- **Student's role**: Students have full ownership of the inquiry process. They decide on the research question, design their investigation, gather and analyze data, and present their conclusions. This approach requires high levels of independence, critical thinking, and self-motivation.
- **Best for**: Advanced students who are familiar with the inquiry process and are capable of managing their own learning. It's ideal for capstone projects or real-world problem-solving scenarios where creativity and independence are key.
- **Example**: In an environmental science class, students might choose their own inquiry topic, such as "How can we reduce plastic waste in our community?" They would then research the issue, design experiments or surveys, and propose solutions, without direct guidance from the teacher.

3.3.2.4 Problem-Based Inquiry

Problem-Based Inquiry focuses on real-world problems that require investigation and problem-solving, often combining inquiry-based learning with project-based learning.

- **How it works**: The inquiry starts with a real-world problem, and students work in teams to explore possible solutions. The problem is often complex and interdisciplinary, requiring students to draw from multiple areas of knowledge. While students investigate, they are expected to propose and test solutions, not just answer theoretical questions.
- **Teacher's role**: The teacher acts as a facilitator and provides a framework for the inquiry by introducing a relevant, often complex problem. They provide guidance but leave it up to the students to determine how to solve the problem. Teachers may offer feedback on solutions but encourage independent thinking.
- **Student's role**: Students work collaboratively to research the problem, test hypotheses, and propose solutions. They must engage in critical thinking, research, experimentation, and collaboration. They may also reflect on and refine their proposed solutions based on feedback or further research.
- **Best for**: Students who benefit from hands-on, practical learning and who need to develop real-world problem-solving skills. It works well for interdisciplinary projects that mirror the complexity of real-world issues.
- **Example**: In an engineering class, students might be asked to solve the problem: "How can we design a sustainable water filtration system for rural communities?" Students would research water filtration methods, develop a prototype, test their design, and evaluate its effectiveness.

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In defining the territory of enquiry-based learning, there is evident overlap with **Problem-Based Learning (PBL)**, in which the handling of a problem defines and drives the whole learning experience of the students.

Students are then challenged, within the context of a small group, to define for themselves the issues emerging from the problem, to decide for themselves what further knowledge they require in order to address these issues, to undertake the research they have identified as requisite and to apply that research towards the presentation of outcomes. The curriculum is thus structured by a series of problems, rather than, say, by a systematic presentation of subject content. But EBL, while incorporating elements of PBL, also covers a broader spectrum of approaches, including small-scale investigations and project work. Figure 3.1 illustrates this spectrum.

Small-scale investigations allow particular scope for adaptation to disciplinary contexts, and can be employed on a scale ranging from individual modules to entire programmes. The use of such investigations was an approach highlighted on the programme of staff development that underpins this guide.

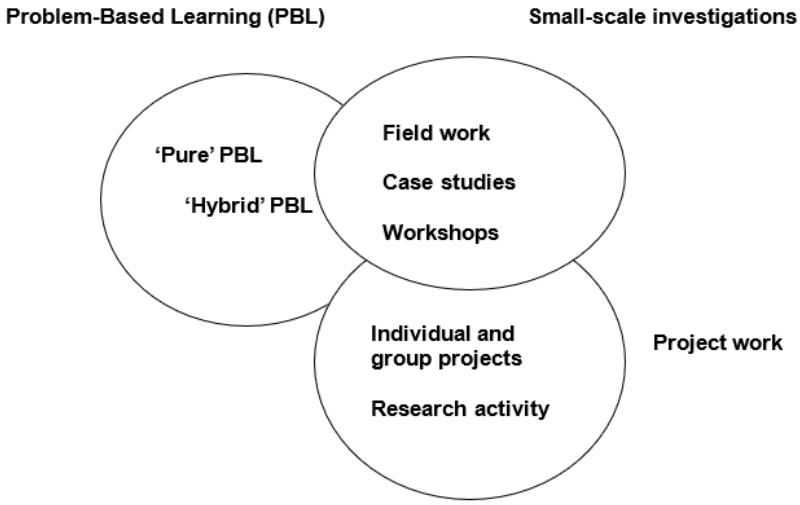

Figure 3.1 Approaches to learning covered by the term Enquiry-Based Learning (EBL)

Field work, for instance within Geology or Geography, provides evident scope for a series of small-scale investigations, conducted within a limited period of time. Case studies also provide scope for open-ended enquiry, as occurs in Business Studies with scenarios drawn from real life, and with students taking on the role of consultants. These are well-established uses of small-scale investigations that are closely tailored to the nature of the discipline.

3.3.3 Resources for Designing Inquiry-Based Courses:

Instructional Design Models and Theories: Inquiry-based Learning Model

Explanation of 5 steps, principles of, and 4 types of inquiry-based learning.

Institute for Inquiry

Created in response to widespread interest in inquiry-based science instruction, the Exploratorium Institute for Inquiry provides workshops, programs, on-line support, and an intellectual community of

practice which affords science reform educators a deep and rich experience of how inquiry learning looks and feels.

Guide to Curriculum Design: Enquiry-Based Learning

Guide produced by the Imaginative Curriculum Network (University of Manchester) to stimulate thinking and promote good practice in curriculum design.

A Questioning Toolkit

Different types of questioning tools for students of all ages.

Inquiry and Guided Practice strategies

3.4 Experiential learning

Experiential learning immerses students in real-world activities that require them to apply knowledge and skills in practical contexts. This approach fosters deeper learning by engaging students emotionally and socially, mirroring professional environments. Through authentic experiences, students develop competence and confidence, essential for their future careers.

Experiential learning is a dynamic, hands-on approach to education where learners gain knowledge, skills, and understanding through direct experience. Instead of passively receiving information, students actively engage in real-world tasks and reflect on their experiences, making learning more meaningful and applicable to real-life situations. This approach is rooted in the idea that learning is a continuous process shaped by personal experiences, and it emphasizes reflection, experimentation, and application.

3.4.1 Key Characteristics of Experiential Learning:

1. **Learning by Doing**: At its core, experiential learning involves active participation. Learners engage in activities, projects, or experiences that require them to apply concepts, solve problems, or perform tasks related to their subject matter.
2. **Reflection**: Reflection is a crucial component of experiential learning. After participating in an experience, learners reflect on what they did, how they did it, and what they learned. This reflection helps them analyze their experiences and identify what worked, what didn't, and how they can improve.
3. **Application of Knowledge**: Experiential learning emphasizes applying theoretical knowledge to practical, real-world situations. Learners are encouraged to use what they've learned in the classroom in contexts that resemble real-life challenges.
4. **Iterative Process**: Experiential learning is often a cyclical process that includes trying, reflecting, learning from mistakes, and trying again. This iterative cycle enhances understanding and helps learners refine their skills and strategies through continuous improvement.

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5. **Collaborative Learning**: Experiential learning often involves collaboration, whether through group projects, peer feedback, or team-based activities. Learners benefit from different perspectives, enhancing their ability to work in diverse teams and solve complex problems.
6. **Personalization and Relevance**: Experiential learning is personalized because learners engage with tasks that have immediate relevance to their interests or goals. This makes the learning process more engaging and meaningful, increasing motivation.

3.4.2 The Experiential Learning Cycle (Kolb's Model):

David Kolb, a key figure in experiential learning theory, proposed a four-stage learning cycle that represents how knowledge is gained through experience:

1. **Concrete Experience**: The learner actively participates in an experience or task. This could be a hands-on activity, project, fieldwork, simulation, or any other practical experience.
2. **Reflective Observation**: After the experience, the learner reflects on what happened. They consider what they learned, how they felt, what they observed, and how the experience unfolded.
3. **Abstract Conceptualization**: In this stage, the learner begins to draw conclusions from the experience. They might link the experience to broader theories, concepts, or frameworks they've learned in the classroom or during their reflection.
4. **Active Experimentation**: The learner applies the new knowledge gained from the experience and reflection to future tasks or experiences. They test out new strategies, make changes to their approach, and continue learning through further experiences.

3.4.3 Types of Experiential Learning:

1. **Fieldwork and Internships**: Students gain firsthand experience in real-world work environments. Internships, fieldwork, and co-op programs allow learners to apply classroom knowledge in professional settings, gaining practical experience and career skills.
2. **Simulations and Role-Playing**: Simulations provide a controlled environment where learners can practice skills or apply concepts. For example, medical students might engage in patient care simulations, or business students might run a mock company.
3. **Service Learning**: Service learning integrates community service with academic learning. Students participate in meaningful community projects while reflecting on how their work impacts both their learning and the community.
4. **Study Abroad and Cultural Immersion**: Experiential learning in different cultural contexts helps students gain new perspectives, understand global issues, and experience personal growth by immersing themselves in a new environment.
5. **Laboratory Work**: In science education, lab work is a form of experiential learning where students perform experiments, collect data, and analyze results. This hands-on approach helps them understand scientific principles in a concrete way.

3.4.4 Benefits of Experiential Learning:

- **Deeper Understanding**: By applying concepts in real-world scenarios, learners develop a more profound and lasting understanding of the material.
- **Skill Development**: Experiential learning builds practical, transferable skills such as problem-solving, critical thinking, communication, collaboration, and leadership.

- **Higher Engagement and Motivation**: Because learners are actively involved in their learning process and can see the relevance of what they are doing, they are often more motivated and engaged.
- **Improved Retention**: When students learn through experience, they are more likely to retain and apply the knowledge over time, as they are connecting theory to practice.
- **Increased Adaptability**: Experiential learning encourages learners to experiment, adapt, and think on their feet, making them more flexible and adaptable in complex situations.

3.4.5 Example of Experiential Learning in Practice:

In a **business course**, students might be asked to create a startup company. They would conduct market research, develop a business plan, manage finances, and pitch their idea to potential investors (role-played by instructors or real professionals). Throughout the project, students would reflect on their decisions, receive feedback, and adjust their strategy, all while applying classroom knowledge to a real-world challenge.

Experiential learning is an effective approach that emphasizes active participation, reflection, and the application of knowledge in real-world contexts. It helps learners develop not only content knowledge but also critical life skills, making them better equipped for future challenges and professional roles.

3.4.6 Resources for Designing Inquiry-Based Courses:

Resources and Downloads to Facilitate Inquiry-Based Learning

Inquiry Unit Design

Unlocking Inquiry-Based Learning: A Comprehensive Guide for Teachers

Designing for Inquiry-Based Learning In Undergraduate Science And Engineering Lab Courses

3.5 Case-based learning

Case-based learning involves analyzing real-world scenarios to develop problem-solving skills and decision-making abilities. By exploring complex situations, students learn to apply theoretical knowledge to practical contexts. This method encourages reflection and discussion, facilitating deeper understanding and skill development.

Case-based learning (CBL) is an established approach used across disciplines where students apply their knowledge to real-world scenarios, promoting higher levels of cognition (see **Bloom's Taxonomy**). In CBL classrooms, students typically work in groups on case studies, stories involving one or more characters and/or scenarios. The cases present a disciplinary problem or problems for which students devise solutions under the guidance of the instructor. CBL has a strong history of successful implementation in medical, law, and business schools, and is increasingly used within undergraduate education, particularly within pre-professional majors and the sciences. This method involves guided inquiry and is grounded in constructivism whereby students form new meanings by interacting with their knowledge and the environment.

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3.5.1 The key characteristics of Case-Based Learning

- **Real-World Scenarios**: CBL uses authentic or realistic cases that reflect actual challenges or dilemmas relevant to the subject being studied. These cases allow students to apply their knowledge to situations they might encounter in their careers or daily lives.
- **Active Learning**: Students are engaged in active problem-solving and decision-making. Instead of passively receiving information, they analyze the case, discuss alternatives, and propose solutions based on their understanding of the material.
- **Collaborative Learning**: CBL often involves group work, encouraging students to collaborate with peers. This teamwork mimics real-world professional environments, where multiple perspectives and cooperation are necessary to solve complex problems.
- **Decision-Making Focus**: Cases often present open-ended problems that require students to make decisions. Students must assess the situation, consider various options, and justify their decisions based on evidence and critical thinking.
- **Application of Theory to Practice**: CBL allows students to bridge the gap between theoretical knowledge and practical application. They take the concepts learned in lectures or readings and apply them directly to the case, helping to solidify their understanding.
- **Multiple Solutions**: Most cases do not have a single correct answer, encouraging students to think critically and creatively. They must consider multiple solutions, evaluate their feasibility, and justify their choices with solid reasoning.
- **Instructor as Facilitator**: The instructor's role in CBL is to guide and facilitate discussions rather than provide direct answers. This encourages students to take responsibility for their learning and think independently.
- **Reflection and Feedback**: Students are encouraged to reflect on their decisions and receive feedback from both peers and instructors. This process helps them learn from their mistakes and understand the broader implications of their choices.
- **Interdisciplinary Approach**: CBL can incorporate knowledge from various fields or subjects. For example, a business case may involve economics, ethics, management, and marketing, requiring students to synthesize information from multiple disciplines.

3.5.2 Benefits to using Case-Study Learning

There are a number of benefits to using CBL in the classroom:

- **Utilizes Collaborative Learning:** Encourages teamwork and communication, allowing students to share diverse perspectives and collectively solve real-world problems;
- **Facilitates the Integration of Learning:** Connects theoretical concepts with practical applications, enhancing the relevance and retention of the material while promoting interdisciplinary thinking;
- **Develops Students' Intrinsic and Extrinsic Motivation to Learn:** Engaging scenarios ignite intrinsic interest, while peer recognition provides extrinsic motivation, leading to increased engagement and persistence;

- **Encourages Learner Self-Reflection and Critical Reflection:** Promotes metacognitive skills by having students assess their thought processes and decisions, fostering personal growth and deeper insights;
- **Allows for Scientific Inquiry and Integrates Knowledge and Practice:** Engages students in investigating complex problems, applying theoretical frameworks to real-world situations, and enhancing problem-solving abilities;
- **Supports the Development of a Variety of Learning Skills:** Cultivates critical thinking, communication, and research skills, equipping students with a comprehensive skill set applicable in various contexts.

3.5.3 Main types of cases and the learning they promote

Case-based learning enhances engagement, critical thinking, and problem-solving skills while promoting collaboration and reflection. Within this method, various types of cases can be utilized, each designed to foster unique learning outcomes. By exploring different case types educators can create a rich learning environment that encourages students to think critically and develop a comprehensive understanding of complex concepts. In the following sections, we will delve into each type of case and the specific skills and insights they promote in learners.

Table 3.1 Differences among various learning strategies

Case Type	Description	Skills Developed
Directed Case	A scenario is presented, followed by a discussion using a set of "directed"/closed questions that can be answered from the course material.	Understanding of fundamental principles, concepts, facts
Dilemma or Decision Case	A person, institution, or community is presented facing a problem that needs to be solved. Students may be given factual historical outcomes after working through the case.	Skills in solving practical problems and decision-making
Interrupted Case	A problem is presented that students must solve in a progressive disclosure format. Students are given the case in parts, working on them and making decisions before moving on to the next part.	Skills in solving practical problems, critical thinking
Analysis or issue case	Focused on answering questions and analyzing the presented situation. This may include "retrospective" cases that tell a story and its outcomes, with students analyzing what happened and why alternative decisions were not made.	Analytical skills

3.5.4 How to write a case study: steps and format

Now that we're clear on what a marketing case study is (and isn't), as well as why you should be producing them, let's talk about how to actually write a case study worth reading. The elements of a case study include:

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- **Clear headline:** Like a newspaper headline, it should give the most important information. A subtitle with supporting details or a customer quote is optional.
- **Snapshot:** Provide the TLDR prominently at the top, including the client's name/industry, the product/service used, and quick result stats.

- **Client introduction:** One or two sentences describing the customer and a highlight about them.
- **Problem:** State the problem/goal, consequences, and any hesitations the customer had. Include quotes.
- **Solution:** Share how they found you, why they chose you, what solution they chose, and how it was implemented. Include quotes.
- **Results:** Describe the results and the benefits, as well as any bonus benefits that came of it. Include quotes.
- **Conclusion:** Share additional praise from the customer and words of advice they have for other people/businesses like them.

Figure 3.3 Case study format

3.5.5 Creating an Effective Case Study: 12 Important Tips to Remember

Creating an effective case study requires careful planning and consideration to ensure that it serves its educational purpose. Here are 12 important tips to remember when developing a case study:

1. **Define the Learning Objectives:** Clearly outline what you want students to learn from the case study. Specific objectives will guide the case's design and ensure it aligns with curriculum goals. Consider the knowledge, skills, and attitudes you aim to develop in your students.
2. **Choose a Relevant Topic:** Select a topic that is both engaging and pertinent to the students' field of study. The case should reflect real-world challenges and scenarios that students may encounter in their future careers, making the learning experience more meaningful.
3. **Gather Comprehensive Data:** Conduct thorough research to gather relevant information and data about the case topic. Use a variety of sources, including academic literature, industry reports, and interviews with practitioners. This will provide a solid foundation for the case study and ensure accuracy.
4. **Create a Compelling Narrative:** Structure the case study as a story that engages the reader. Introduce characters (individuals or organizations) and present a conflict or challenge that they face. A well-crafted narrative helps students connect emotionally with the case and enhances their interest in the learning process.
5. **Include Context and Background Information:** Provide necessary context and background information to help students understand the case's significance. This may include historical data, industry trends, or relevant theories. Contextualizing the case helps students analyze the situation more effectively.
6. **Present Clear Challenges or Questions:** Clearly define the challenges or questions that students need to address. These should be thought-provoking and require critical thinking and problem-solving skills. Avoid overly simplistic questions; instead, encourage deeper analysis and exploration.

7. **Encourage Diverse Perspectives:** Design the case study to allow for multiple viewpoints and interpretations. This can be achieved by presenting conflicting interests or varying stakeholder perspectives. Encouraging students to consider different angles fosters critical thinking and promotes discussion.
8. **Include Realistic Data and Evidence:** Provide realistic data and evidence that students can analyze. This could include financial figures, survey results, or other quantitative and qualitative data. Realistic data enhances the authenticity of the case study and prepares students for real-world decision-making.
9. **Facilitate Discussion and Reflection:** Incorporate prompts or questions that encourage discussion and reflection among students. These can be used during class or as part of assignments. Facilitating dialogue allows students to articulate their thoughts, challenge each other's viewpoints, and deepen their understanding of the case.
10. **Consider Assessment Criteria:** Determine how students will be assessed based on their engagement with the case study. Create clear rubrics that outline expectations for participation, analysis, and presentation of findings. Assessment criteria should align with the learning objectives defined earlier.
11. **Iterate and Revise the Case:** After piloting the case study in a classroom setting, gather feedback from students and colleagues. Use this feedback to make revisions and improvements. Iteration is key to refining the case study and enhancing its effectiveness as a teaching tool.
12. **Provide Support Resources:** Offer students additional resources to aid their understanding of the case. This may include readings, videos, or access to experts. Providing support helps students navigate complex issues and enhances their learning experience.

CBL is often described in conjunction or in comparison with problem-based learning. While the lines are often confusingly blurred within the literature, in the most conservative of definitions, the features distinguishing the two approaches include that PBL involves open rather than guided inquiry, is less structured, and the instructor plays a more passive role. In PBL multiple solutions to the problem may exit, but the problem is often initially not well-defined. PBL also has a stronger emphasis on developing self-directed learning. The choice between implementing CBL versus PBL is highly dependent on the goals and context of the instruction. For example, in a comparison of PBL and CBL approaches during a curricular shift at two medical schools, students and faculty preferred CBL to PBL. Students perceived CBL to be a more efficient process and more clinically applicable. However, in another context, PBL might be the favored approach.

3.5.6 Resources for Finding and Writing Cases:

Consider utilizing or adapting open access cases – The availability of open resources and databases containing cases that instructors can download makes this approach even more accessible in the classroom.

The examples of open databases are

Case Center on Public Leadership

Harvard Kennedy School (HKS) Case Program, which focus on government, leadership and public policy case studies

Open case study library. The NCCSTS Case Collection, created and curated by the National Center for Case Study Teaching in Science, on behalf of the University at Buffalo, contains over a thousand peer-reviewed case studies on a variety of topics in all areas of science.

Case center. The Case Centre offers training in writing case studies and shares current case studies..

Case-based strategies.

3.6 Flipped Classroom

For some the flipped classroom has become synonymous with active learning. There are many ways to incorporate active learning into your courses, and the flipped classroom is but one of those methods. A flipped classroom is structured around the idea that lecture or direct instruction is not the best use of class time. Instead students encounter information before class, freeing class time for activities that involve higher order thinking.

In a flipped classroom, material typically explored in lecture is delivered outside of class through video lectures, lecture slides, digital modules, and/or other online media. In place of traditional lecture, class time focuses on the development of knowledge through active learning strategies like discussion, problem sets, case studies, group activities, or experiential learning. Research into the effectiveness of flipping a classroom continues to develop, with mixed results as to their greater effectiveness over traditional structures. A few studies suggest that flipping the classroom can improve students' conceptual grasp of content beyond memorization and basic knowledge. In their variable nature, flipped classrooms can also provide students with a greater mixture of activities, media, and opportunities to participate, thus serving more diverse populations and assuring more inclusive opportunities.

Flipping also does not ease instructor preparation time; in many cases, instructors have more to prepare, between developing quality lecture videos or out-of-class content, while designing active in-class practices with efficient assessments to measure impact. Instructors can consider a variety of examples and strategies to evaluate the best modes of flipping in order to meet their desired learning outcomes.

3.6.1 Key Features of the Flipped Classroom:

1. **Pre-Class Learning**: Students are assigned pre-class materials, which may include instructional videos, readings, or online modules. This content is designed to introduce new concepts and prepare students for more in-depth exploration during class.
2. **In-Class Engagement**: Classroom time is used for active learning activities, such as discussions, problem-solving, group work, or hands-on projects. This shift allows for more personalized instruction, as teachers can focus on facilitating and supporting students in their understanding.
3. **Student-Centered Learning**: The flipped classroom promotes student ownership of learning. Students can learn at their own pace, pausing and reviewing videos or materials as needed. This flexibility caters to different learning styles and allows students to take charge of their education.
4. **Increased Interaction**: With the focus on active learning during class time, students have more opportunities to collaborate with peers and engage with the instructor. This interaction fosters a deeper understanding of the material and builds critical thinking and communication skills.
5. **Assessment and Feedback**: Teachers can use in-class time to assess student understanding through formative assessments, such as quizzes, discussions, or interactive activities. This real-time feedback helps instructors identify areas where students may need additional support.

3.6.2 Benefits of the Flipped Classroom:

There are a number of reported benefits to implementing flipped classrooms, including:

- More individualized help during class time, as an instructor can be "guide on the side", rather than "sage on the stage."
- More opportunities for deliberate practice and increased support for students as they grapple with higher order disciplinary concepts and problems.

- More opportunities for students to interact with their instructor as well as peers.
- Student control over the pace of lectures: if providing video lectures, students can watch, rewind, and fast-forward as needed.
- Resiliency: since the lecture-style material is pre-recorded, in-classroom activities are flexible, and classes are less likely to fall behind if technology or life circumstances interfere with a synchronous course session. Depending on the content, out-of-class materials can also be used in future semesters.

3.6.3 Implementation of the Flipped Classroom:

- **Preparation of Materials**: Instructors create or curate instructional videos, articles, or other resources that students will review before class. These materials should clearly explain the key concepts and prepare students for class activities.
- **Assignment of Pre-Class Work**: Teachers assign specific materials for students to engage with before the class session. This can include watching videos, completing readings, or participating in online discussions.
- **Designing In-Class Activities**: Teachers plan engaging, interactive activities for class time that allow students to apply what they've learned. These activities can include group discussions, collaborative problem-solving, hands-on experiments, or case studies.
- **Monitoring and Assessing Learning**: Instructors assess students' understanding during class through various methods, such as quizzes, peer assessments, or informal check-ins. Feedback is provided to guide students in their learning journey.
- **Reflection and Adjustment**: Teachers reflect on the effectiveness of the flipped classroom approach and make adjustments as needed based on student feedback and learning outcomes.

3.6.4 Models of Flipped Classrooms and Recommendations

The flipped model argues that this early exposure builds in time for students to consider and familiarize themselves with content before engaging with it more actively in class.

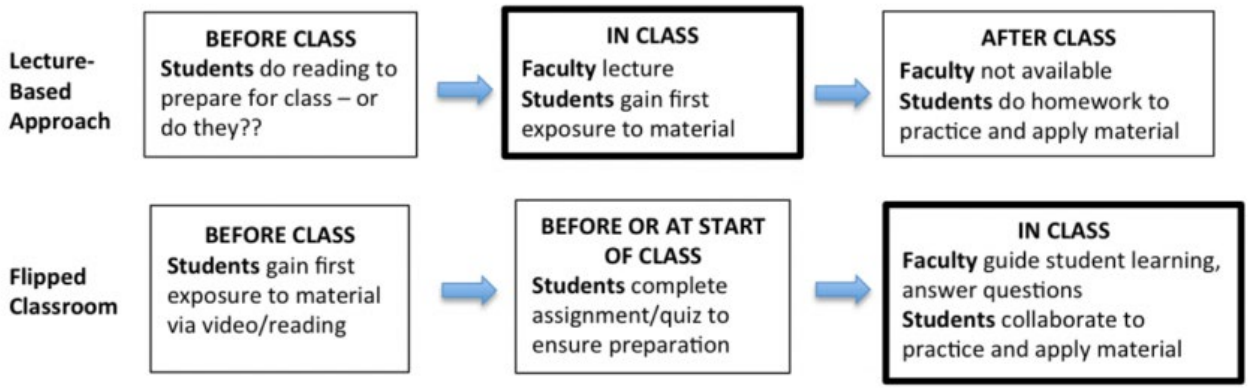

Figure 3.2 Flipped Classroom Philosophy

3.6.4.1 Models of Flipped Classrooms

Standard flipping

Lectures are recorded (either as video or as narrated screencasts). Students are required to watch these lectures as homework and then spend class time doing problem-solving or other highly interactive, structured activities, usually in groups and with guidance from instructors and GSIs.

In-class activities could include in-class discussion, problem-solving, or group work exercises. They could also be technology-enhanced activities, such as:

- Use polling to gauge student understanding of course topics and leverage poll results to spur discussion and/or individual and/or group problem-solving
    - Example polling tools are PollEverywhere, Top Hat, and Google Forms.
- Offer class time for students to work collaboratively using shared documents, including bDrive (Google Drive) Docs, Sheets, Slides, Forms and Miroboard.
    - Groups can be formed using bCourses Groups and Collaborations.

One-day-a-week flipping

If a standard flip seems overwhelming, or not appropriate for your class, try flipping one lecture a week. UCB Chemistry instructor, Michelle Douskey, has done "Flipped Fridays", where she recorded a short lecture video, which students watch to prepare for class. During class students worked in groups to complete tasks where they were solving real analytical problems. Answers were presented in class and students were asked to correct their own work and reflect on their understanding.

Selected-content flipping

Lecturing does not have to be completely eliminated from your class time. Instead, be selective and strategic about what you record for students to watch in advance. You might record only a subset of lecture materials, and reserve some of your class time for lecturing on advanced topics. Are there particular topics or concepts on which students routinely get stuck? Try designing in-class activities around these ideas or concepts. Or, consider recording lectures that cover content that's likely to be reusable in future semesters, and plan on some in-class microlectures covering "hot-off-the-presses" topics, leaving plenty of time for active learning.

Flipping without recording video lectures

It's a common misconception that instructors can only flip if they pre-record their lectures, which admittedly can be a time-consuming process. Instructors can, instead, find other ways for students to get content that might typically be delivered in a lecture: readings can be used, as well as other content such as powerpoint presentations, podcasts, or videos or animations that others have recorded.

Full hybrid flipping

Eliminate some in-class lectures completely and replace those in-class hours with time students are expected to complete online activities, typically watching the lecture. (Note: switching an existing class to a full hybrid flipped course requires approval from Committee on Courses of Instruction, COCI; see https://academic-senate.berkeley.edu/coci-handbook(link is external) for more information.)

There are the four core actions that instructors can use to flip a classroom. Below are some examples of each principle. An instructor can provide:

	Principles			
	Textbook readings	An incentive for students to prepare for class	A mechanism to assess student understanding	In-class activities that focus on higher level cognitive activities
Examples	Videos from **YouTube**, the **Khan Academy**, **MIT's OpenCourseWare**, or **Coursera**	Small group discussions	Low-stakes formative assessment activities	Conceptual questions
	Professionally recorded lectures	In-class practice problem sets	Peer-evaluation of writing or problem sets	Real-world application
	PDFs with a walk-through of how to solve a problem	Group debates	Self-evaluation assignments	Data analysis and synthesis
	Detailed Power Point slides	Group projects	Pre-class worksheets	
	Video recorded from a computer or smartphone, walking through how to solve a problem		Pre-class online quizzes	

3.6.6 Resources for Designing Flipped Classroom:

DeLozier, S., and Rhodes, M. (2017). Flipped Classrooms: a Review of Key Ideas and Recommendations for Practice. Educational Psychology Review 29: 141-151.

Andrew J. Charlton-Perez, Dept. of Meteorology, Univ. of Reading, Reading, Berks, Nina Brooke, Centre for Quality Support and Development, Univ. of Reading, Reading, Berks and Elizabeth McCrum, Vice-Chancellors office, Univ. of Reading, Reading, Berks. (2020) A flipped learning approach to teaching in Meteorology.

Flipping the Classroom, University of Washington Center for Teaching and Learning

Flipping the Classroom, Vanderbilt Center for Teaching
Yale professor Kyle Jensen **flips his economics class** to enable more class discussion.

Harvard professor Peter Galison **flips his course** on the Einsteinian revolution by creating online lessons with interactive components.

3.7 Lectures and readings

Lectures and readings provide essential content and background information necessary for understanding complex concepts. These teacher-centered methods deliver information effectively, offering opportunities for reflection and discussion. Integrating lectures and readings with interactive activities enhances learning outcomes, ensuring comprehension and application of key concepts.

Lectures and readings are traditional, yet foundational, instructional strategies in learning environments. These approaches involve the direct transmission of knowledge through spoken instruction (lectures) and assigned texts (readings), serving as the basis for building understanding in various subjects. Together, they play an important role in conveying theoretical concepts, factual information, and core content to learners.

3.7.1 Key Characteristics of Lectures:

- **Direct Instruction:** Lectures are typically instructor-led and involve the teacher delivering content to students in a structured format. The instructor presents key concepts, ideas, theories, or facts, often with the aid of visual aids like slides, videos, or diagrams.
- **Efficient Knowledge Delivery:** Lectures allow teachers to cover large amounts of material in a relatively short period. They are particularly useful for introducing new topics, summarizing complex ideas, or providing overviews of key themes.
- **Expert-Led Content:** In lectures, the instructor is often considered an expert or authority in the subject. Their role is to guide students through complex material and ensure that the information presented is accurate, relevant, and up-to-date.
- **Passive Learning:** Lectures are generally more passive for students, as the teacher does most of the talking while students listen and take notes. While they provide a broad overview of topics, they may limit student interaction or engagement during the session.
- **Supporting Tools:** Modern lectures often integrate multimedia tools such as PowerPoint slides, video clips, or interactive polling to help clarify points and keep students engaged. These tools can enhance the effectiveness of lectures by making abstract concepts more concrete.
- **Opportunity for Clarification:** While lectures are typically more instructor-focused, they can include opportunities for students to ask questions or seek clarification on specific points. This interaction can occur during or after the lecture, depending on the format.

3.7.2 Key Characteristics of Readings:

- **Assigned Texts:** Readings typically involve the assignment of textbooks, academic articles, or other relevant literature. These texts provide detailed explanations of the concepts discussed in lectures and serve as supplementary material.
- **Self-Paced Learning:** Unlike lectures, readings allow students to engage with content at their own pace. They can read, pause, reflect, and review sections as needed to ensure they understand the material.
- **Deeper Exploration:** Readings often dive deeper into topics than lectures can. While a lecture may provide an overview, readings offer more comprehensive analysis, case studies, research findings, and supporting evidence that expands on lecture content.
- **Improved Comprehension and Retention:** Reading requires active engagement and critical thinking, which can improve understanding and retention of information. Highlighting key points, taking notes, and summarizing sections are common strategies to enhance comprehension.
- **Preparation for Class:** Readings are often assigned before or after lectures to help students prepare for discussions, assessments, or more interactive activities. Pre-reading helps students familiarize themselves with key ideas, making it easier to follow lectures or participate in discussions.
- **Varied Sources:** Depending on the course or subject, assigned readings may come from textbooks, peer-reviewed journal articles, book chapters, or even online content. This variety provides different perspectives and types of knowledge, enriching the learning experience.

3.7.3 Benefits of Lectures and Readings:

- **Comprehensive Knowledge Delivery:** Lectures provide a structured way to deliver foundational knowledge, while readings give students the chance to explore topics more deeply, both contributing to a well-rounded understanding of the subject.

- **Flexible Learning Approaches:** Lectures accommodate auditory learners, while readings cater to those who prefer to engage with written material. Combining both strategies allows for flexibility in how students learn and process information.
- **Foundation for Further Learning:** Lectures and readings often serve as a springboard for more interactive or applied learning methods, such as discussions, case studies, or projects. They help students build the foundational knowledge needed for deeper inquiry or practical application.
- **Time-Efficient:** Lectures are a quick way to disseminate information to a large audience, making them ideal for large classes. Readings, on the other hand, allow students to manage their own time and learn at their own pace.
- **Encourages Independent Learning:** Readings foster self-directed learning, requiring students to take responsibility for engaging with the material outside of class. This helps develop independent study skills, which are essential in higher education and professional environments.

3.7.4 Challenges of Lectures and Readings:

- **Limited Student Engagement:** Lectures, especially in large or long sessions, can become monotonous and lead to disengagement. Passive learning during lectures can hinder deep understanding if not complemented by more interactive methods.
- **Varied Learning Styles:** Some students may struggle with lecture-heavy courses if they do not learn well through listening alone. Similarly, lengthy or dense readings may be difficult for students who are not proficient readers or those who prefer visual or kinesthetic learning styles.
- **Overload of Information:** Lectures and readings can sometimes overwhelm students with large amounts of information in a short time. Without active learning techniques, it can be challenging for students to retain and process all the material.
- **Difficulty in Application:** While lectures and readings are effective for conveying information, they may not always translate directly into applied skills or critical thinking. Students may need additional opportunities to practice what they have learned in real-world contexts.
- **Requires Self-Discipline:** Readings require students to have good time management and self-discipline to complete assigned texts, especially when the material is complex or lengthy. Without adequate motivation, students may fall behind in their readings.

3.7.5 Recommendations

When planning a lecture:

- **Define Learning Outcomes** - What should students know or be able to do at the end of the lecture? Instructors can use the Storyboard (presented in the paragraph 4.13) process to develop learning outcomes for each lecture. Presenting these learning objectives at the beginning can invite students to understand the flow of a lecture and participate more fully in its success. Instructors can review outcomes at the conclusion, ask students to assess their efforts towards the outcomes, and share points that are still muddy or confusing.

- **Assess Prior Knowledge** – What is the ability and background of the audience (graduate/undergraduate)? Research **shows** that students learn most effectively when actively building on their prior knowledge frameworks. When planning and beginning a lecture, instructors can ascertain prior knowledge through questions or surveys, and ensure their lecture responds to specific student needs. They can also assess student prior knowledge through clicker

questions and other **formative assessments**, and use this information to modify their lecture as needed.

- **Consider the Room** – If seats are not fixed to the floor, instructors can consider a variety of **seating arrangements** that naturally improve quantity and quality of interactions among students and instructor.
- **Watch the Time** – How much information can be included within the time allotment? Presenting too much information can be detrimental to student learning, and instructors should design lectures that incorporate questions and discussions into a reasonable spread of material and activities.

When delivering a lecture:

- **Provide a Roadmap** – As with learning outcomes, students appreciate knowing a lecture's proposed direction. By sharing an outline, either within the lecture or written out, instructors can make their presentation structure more transparent. This type of scaffolding supports student learning by helping them conceptualize the connections and causal reasons behind lecture content.
- **Use Active Learning Breaks** – Through one-minute papers, think-pair-share, concept maps, jigsaw discussions, 3D-printed models, and other active learning practices, instructors can break up monologue with moments of digestion and inquiry for students.
- **Make Transitions Obvious** –Instructors can indicate obvious transitions between topics, concepts, or points. Students, being novice learners, may be unaware of when the instructor has shifted to a new topic or point. Instructors can clearly signal these transitionary moments during their lecture by writing an outline on the board and tapping new topics, using obvious transition words, and drawing a developing concept map on the board that visually connects new topics.
- **Use Repetition** – Without becoming rote, repeating phrases or major points can emphasize salient points of a lecture. Long lectures can exceed the attention capacity of most individuals, and repetition of salient points can help students capture important information. Additionally, instructors can consider rephrasing explanations and providing multiple media forms (oral, written, video, closed captioning, aural) to make their lecture more accessible and **universally designed** for all students.
- **Make Handouts Relevant** – Instructors should ensure that any handouts or slides appropriately correspond to the lecture, and that they refer to handouts or slides during the lecture. Lack of alignment between course materials and the lecture can impede student learning.
- **Break Down Concepts** – Difficult concepts may need to be broken down into several slides, activities, or illustrations in lecture. Students digest new knowledge through "chunking" and interconnecting points, rather than straight memory or total conceptualization, and breaking concepts down can helps students build connections and examples into fuller concepts. Instructors can utilize Miroboard, polling tools, self- or peer- observation, and formative assessments to ensure information is presented at the right speed.
- **Encourage Longhand** – Instructors can encourage students to take notes by hand during lecture. Research suggests that the process of handwriting supports student learning of material.

- **Accessibility Awareness** – Instructors delivering lectures should be aware of student accessibility concerns, and provide dynamic approaches to support students who are auditory-, visual-, or writing- disabled.

3.7.6 Resources for Designing More Engaging Lectures:

Lecturing from the Center for Teaching Excellence at the University of Illinois at Urbana-Champaign

Lecturing from Vanderbilt University's Center for Teaching

Twenty Ways to Make Lectures More Participatory from Harvard University's Derek Bok Center for Teaching and Learning

Interactive Presentations: Avoiding the Audience 'Dead Zone' from *Psychology Today*

The lectures and readings strategy remains a foundational part of education, offering a comprehensive, flexible, and efficient means of delivering knowledge. Lectures provide structured, expert-led instruction, while readings allow students to engage more deeply with the material at their own pace. However, both methods are most effective when complemented by active learning strategies that engage students in applying, analyzing, and discussing the content.

3.8 AI guidance for teachers

AI guidance for teachers refers to the use of artificial intelligence (AI) tools and technologies to support educators in improving teaching practices, enhancing student learning, and streamlining administrative tasks. AI can assist teachers in various areas, from personalizing learning experiences to providing insights into student performance and simplifying classroom management.

3.8.1 Key Areas Where AI Provides Guidance for Teachers:

- **Personalized Learning**: AI-powered systems can analyze student data (such as learning styles, performance, and behavior) to offer personalized recommendations for lesson plans, activities, and assessments. This helps teachers tailor their instruction to meet individual student needs, ensuring more effective learning outcomes.
- **Automated Grading and Feedback**: AI can assist teachers in grading assignments, quizzes, and even essays. It can also provide instant feedback to students, allowing for more timely corrections and understanding of concepts. This automation saves time and ensures consistent evaluation.
- **Adaptive Learning Platforms**: AI-driven platforms adapt to each student's learning pace and provide tailored content and resources. These platforms guide teachers in identifying areas where students need additional support or challenges, allowing for more targeted interventions.
- **Lesson Planning Support**: AI tools can suggest lesson plans, instructional materials, and resources based on the curriculum, standards, and learning goals. Some systems can even generate customized learning activities aligned with students' levels and interests, helping teachers save time on preparation.

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- **Classroom Management**: AI can help manage classroom tasks such as attendance tracking, assignment scheduling, and managing student behavior through predictive analytics. This helps teachers maintain an organized classroom environment while reducing administrative burdens.
- **Predictive Analytics for Student Performance**: AI can analyze patterns in student performance and predict future learning outcomes. This allows teachers to identify students at risk of falling behind early and take proactive steps to provide additional support or intervention.
- **Tutoring and Learning Assistance**: AI-powered tutoring systems can provide students with additional learning support outside of class. These systems can assist with subjects like math, science, or language learning, providing extra guidance when teachers are not available.
- **Virtual Teaching Assistants**: AI-driven virtual assistants can answer routine student questions, provide reminders about deadlines, and offer basic academic help. This reduces the teacher's workload, allowing them to focus on more complex teaching tasks.
- **Assessment of Learning Gaps**: AI can help teachers identify gaps in students' knowledge or skills through diagnostic assessments. Based on this data, AI tools can suggest targeted interventions and resources to address specific weaknesses in student learning.
- **Professional Development**: AI can assist teachers in identifying areas for their own growth and development. By analyzing classroom performance and feedback from students, AI tools can recommend relevant training programs, resources, or instructional strategies for teachers to improve their teaching practices.

3.8.2 Benefits of AI Guidance for Teachers:

- **Efficiency**: AI reduces time spent on routine tasks such as grading, attendance, and scheduling, allowing teachers to focus more on teaching and student engagement.
- **Personalization**: AI helps tailor learning experiences to individual students' needs, enhancing their engagement and improving learning outcomes.
- **Data-Driven Insights**: AI provides teachers with valuable insights into student performance and learning patterns, allowing for more informed decision-making and timely interventions.
- **Scalability**: AI-powered tutoring and learning systems allow teachers to offer additional support to students without being overwhelmed by the demands of individual attention.
- **Ongoing Feedback**: Teachers can receive continuous feedback on their students' progress, as well as their own teaching practices, allowing for continuous improvement and adaptation.

3.8.3 Challenges of AI Guidance for Teachers:

- **Data Privacy and Security**: Using AI in education involves handling sensitive student data, raising concerns about privacy and security. Schools and educators need to ensure that student data is protected and used responsibly.
- **Teacher Training**: Effective use of AI requires that teachers understand how to use AI tools properly and interpret the data they provide. Professional development and training on AI integration are essential.

- **Equity and Access**: Not all students or schools may have access to the necessary technology for AI-driven learning. This could exacerbate existing inequalities in education.
- **Dependence on AI**: Over-reliance on AI could lead to less human interaction in the learning process. It's important for teachers to balance AI guidance with personal engagement to maintain the human element in education.
- **Ethical Considerations**: AI-driven decisions, such as those based on predictive analytics, need to be handled carefully to avoid bias or unfair outcomes in student assessments or interventions.

AI is a powerful tool that can enhance teaching efficiency, personalize student learning experiences, and provide data-driven insights to improve educational outcomes. By automating administrative tasks and offering tailored instructional support, AI allows teachers to focus more on fostering student engagement and creativity. However, successful implementation requires proper training, ethical considerations, and equitable access to technology to ensure that AI is used effectively and responsibly in the classroom.

3.8.4 Resources for Generating Materials with AI:

Get the Best From ChatGPT With These Golden Prompts

A guide to prompting AI (for what it is worth)

ChatGPT ChatGPT is an artificial intelligence (AI) chatbot that uses natural language processing to create humanlike conversational dialogue.

Perplexity Perplexity is a free AI search engine designed to revolutionize the way you discover information. Ask any question, and it searches the internet to give you an accessible, conversational, and verifiable answer.

Microsoft 365 Copilot Microsoft 365 Copilot provides real-time intelligent assistance, enabling users to enhance their creativity, productivity, and skills. It can create a picture.

2024's Comprehensive Comparison of ChatGPT, Bing Copilot, and Perplexity for Longform Writing

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Table 3.2 Differences among various learning strategies

Aspect/Learning strategy	Case Study	Problem-Based Learning (PBL)	Inquiry-Based Learning (IBL)	Discussion Strategies	Experiential Learning	Guided Practice
Problem Definition	Pre-defined, real-world scenario provided by the instructor.	Open-ended, learners define the scope of the problem.	Open-ended, learners generate questions to explore and investigate.	May or may not be tied to a specific problem; focused on exploring ideas collectively.	Concrete experiences based on real-world activities or simulations.	Structured tasks where learners apply skills with instructor guidance.
Structure	More structured, with clear data and context provided.	Less structured, learners gather information and identify key questions.	Less structured, learners ask questions and seek out answers.	Moderately structured; instructor facilitates dialogue, often with a guiding question.	Structured but flexible; involves direct experience followed by reflection.	Highly structured, step-by-step with instructor feedback.
Focus	Analyzing and applying theoretical knowledge to specific situations.	Solving a complex, real-world problem through independent inquiry.	Investigation and discovery through questioning and research.	Collaborative exploration of ideas, perspectives, and knowledge.	Learning through doing, with reflection and application of experience.	Practice of specific skills under instructor supervision.
Learner Autonomy	Moderate: Learners analyze data but within pre-defined case.	High: Learners take ownership of the problem-solving process.	High: Learners drive the inquiry and exploration process.	Moderate to high: Learners contribute ideas but often with instructor facilitation.	Moderate to high: Learners are active participants, but within a structured experience.	Low to moderate: Learners perform tasks with direct guidance.
Instructor Role	Provides the case, facilitates analysis, and guides discussion.	Facilitator, helping learners guide their own inquiry and research.	Facilitator, supporting inquiry and helping learners navigate questions.	Facilitator or moderator, steering discussions and ensuring constructive dialogue.	Facilitator, offering real-world experiences and guiding reflection.	Instructor leads, offering feedback and adjustments as learners practice.
Learning Objective	Critical thinking and application of theoretical concepts to real-life scenarios.	Development of self-directed learning, critical thinking, and problem-solving skills.	Encouraging curiosity, research, and independent learning.	Deepening understanding of content, sharing perspectives, and developing argumentation skills.	Gaining skills and knowledge through hands-on experience and reflection.	Mastery of specific skills or concepts through repeated practice.

Continuation of the table 3.2

Aspect/Learning strategy	Case Study	Problem-Based Learning (PBL)	Inquiry-Based Learning (IBL)	Discussion Strategies	Experiential Learning	Guided Practice
Process	Analyze facts, identify key issues, apply knowledge, propose solutions.	Identify problem, gather information, analyze, and develop solutions.	Generate questions, investigate, analyze findings, draw conclusions.	Engage in a guided discussion, share insights, and reflect on different viewpoints.	Engage in an activity or experience, reflect on it, and apply learned concepts.	Perform a task or skill repeatedly under instructor supervision.
Typical Application	Business, law, medicine, environmental studies, etc.	Medicine, engineering, social sciences, education, etc.	Science education, project-based learning, research-heavy fields.	Humanities, social sciences, debate, seminars, and peer learning.	Vocational training, internships, fieldwork, lab-based courses.	Skill-based training, vocational learning, technical skills development.
Key Skills Developed	Analytical thinking, decision-making, applying theory to practice.	Self-directed learning, research skills, collaboration, critical thinking.	Research skills, inquiry, problem-solving, curiosity, and discovery.	Critical thinking, argumentation, communication, and collaboration.	Practical problem-solving, reflection, adaptability, and critical thinking.	Skill mastery, repetition, and ability to follow specific procedures.

Table 3.3 Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in PhD courses[1]

Learning Outcomes/ Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
Competency 1									
LO1 (DM)	+	+			+	+	+	+	*Simulation*
LO2 (DM)	+		+		+	+	+		
LO3 (DM)		+		+		+	+	+	*Hands-on Practice*
LO4 (DM)		+		+				+	*Collaborative Work*
LO5 (DM)		+		+				+	*Data Analysis Tasks*
LO6 (DCP)	+	+		+		+	+	+	
LO7 (DCP)		+		+			+	+	*Statistical Analysis*
LO8 (DCP)		+		+			+	+	
LO9 (DCP)	+		+		+	+		+	*Report Writing*
LO10 (FM)		+		+		+	+	+	*Forecast Modelling*
LO11 (FM)	+		+		+	+	+		*Model Verification*
LO12 (FM)	+	+				+	+	+	*Climate Scenarios*
Competency 2									
LO1 (UN SDG)	+		+			+	+	+	
LO2 (UN SDG)	+		+			+	+		
LO3 (UN SDG)	+		+			+	+		
LO4 (UN SDG)	+			+		+	+		
LO5 (UN SDG)	+			+		+	+	+	
LO6 (CPU)	+		+			+	+		
LO7 (CPU)	+	+				+	+		*Economic Analysis*
LO8 (MCSU)	+			+		+	+	+	*Stakeholder Analysis*
LO9 (MCSU)	+		+			+	+	+	*Survey Design*
LO10 (BCSCS)	+					+	+		*Media Management*
LO11 (BCSCS)	+					+	+	+	*Communication Skills*
LO12 (UN SDG)	+			+		+	+	+	*Strategy Development*

[1] List of competencies and learning outcomes can been found in the Annex

Table 3.4 Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in Master 1 courses[2]

Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
Competency 1									
LO1 (GCDM)	+		+		+	+	+	+	*Simulation, Visualization Tools*
LO2 (GCDM)	+		+			+	+		*Feedback Loop Modelling*
LO3 (GCDM)	+		+			+	+		*Regional Climate Analysis*
LO4 (GCDM)	+		+			+	+	+	*Climate Modelling Tools*
LO5 (GCDM)	+		+	+		+	+		*Feedback Mechanism Simulations*
Competency 2									
LO1 (DICS)	+	+		+		+	+		*Data Collection Campaign*
LO2 (DICS)	+		+			+	+		*SWOT Analysis of Observational Networks*
LO3 (DICS)	+	+		+				+	*Statistical Evaluation, Homogenization*
LO4 (DICS)		+		+				+	*Database Design, Data Integration*
LO5 (DICS)		+		+				+	*Data Documentation and Reporting*
Competency 3									
LO1 (CP)	+					+	+		*End-User Communication*
LO2 (CP)		+		+		+	+	+	*Data Derivation Exercises*
LO3 (CP)	+		+			+	+		*Sectorial Climate Impact Analysis*
LO4 (CP)		+		+			+	+	*Climate Modelling and Forecasting*
Competency 4									
LO1 (CRA)	+		+			+	+		*Risk and Vulnerability Assessment*
LO2 (CRA)	+		+	+		+	+		*Community-based Vulnerability Mapping*
LO3 (CRA)	+	+		+				+	*Analytical Tools Practice*
LO4 (CRA)	+	+		+			+		*Prioritization Framework Exercises*
LO5 (CRA)	+		+			+	+		*Socio-Economic Impact Modelling*
LO6 (CRA)	+		+	+			+	+	*Economic Modelling*

[2] List of competencies and learning outcomes can been found in the Annex

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Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
Competency 5									
LO1 (SCSC)	+		+			+	+		*Climate Product Evaluation*
LO2 (CSCS)	+		+			+	+	+	*Data Visualization Tools*
LO3 (GVPG)	+		+			+	+		*Gender Vulnerability Analysis*
LO4 (CP)		+		+			+	+	*Report Writing, Graphical Design*
Competency 6									
LO1 (BCP)	+		+			+	+		*Climate Policy Review*
LO2 (BCP)	+		+			+	+		*Case Study Synthesis*
LO3 (MAS)	+	+		+		+	+	+	*Adaptation Strategy Design*
LO4 (GVPG)	+	+	+				+		*Gender-Specific Strategy Development*
LO5 (MAS)	+	+		+			+	+	*Low-Emission Strategy Design*
LO6 (MAS)	+		+			+	+		*Climate Justice Case Study Review*

Table 3.5 Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in Master 2 courses[3]

Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
Competency 1									
LO1 (ICS)	+		+		+	+	+	+	*Climate System Modelling, Visualization*
LO2 (ICS)	+		+			+	+		*Feedback Mechanism Simulations*
LO3 (BCCS)	+		+	+		+	+		*Global Climate Variability Scenarios*
LO4 (BCCS)	+		+			+	+		*Impact Modelling (Food, Water, Energy)*
Competency 2									
LO1 (ECC)	+		+			+	+		*Economic Case Study Review*
LO2 (ECC)	+		+			+	+		*Policy Evaluation Simulations*
LO3 (ECC)	+		+			+	+		*Financial Policy Analysis*
LO4 (ECC)		+		+			+		*Integrated Assessment Models*
LO5 (ECC)	+		+			+	+		*Cost-Benefit Case Studies*
LO6 (ECC)	+		+			+	+		*Policy Formulation Exercises*
Competency 3									
LO1 (ICS)	+	+				+	+	+	*Data Visualization Tools*
LO2 (CCP&S)	+		+			+	+		*Scenario Analysis (SSP-RCP)*
LO3 (CCP&S)	+		+			+	+	+	*Regional Climate Modelling*
Competency 4									
LO1 (CCC&PE)	+		+			+	+		*Communication Strategy Development*
LO2 (CCC&PE)	+	+				+	+		*Community Engagement Projects*
LO3 (CCC&PE)		+					+		*Collaboration Strategy Projects*
LO4 (CCL&IA)	+		+			+	+		*Legal Framework Case Studies*
LO5 (CCL&IA)	+		+			+	+		*International Agreement Review*

[3] List of competencies and learning outcomes can been found in the Annex

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Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
Competency 5									
LO1 (CCM&A)	+		+			+	+		*Sectoral Mitigation Strategies*
LO2 (CCM&A)	+	+		+		+	+		*Community Adaptation Planning*
LO3 (CCM&A)	+		+			+	+		*Co-Benefit Analysis Exercises*
LO4 (CCM&A)		+		+			+		*Integrated Climate Solutions Design*
LO5 (CCM&A)	+		+			+	+		*Case Study Analysis*
LO6 (CCM&A)		+		+			+		*Climate Action Plan Creation*
Competency 6									
LO1 (CRIVA)	+		+			+	+		*Risk and Vulnerability Assessments*
LO2 (CRIVA)	+	+				+	+		*Hazard Mapping Exercises*
LO3 (CRIVA)	+		+			+	+		*Impact Prioritization Frameworks*
LO4 (CRIVA)	+	+		+		+	+	+	*Vulnerability Modelling*
LO5 (CRIVA)	+		+			+	+		*Key Risk Analysis Exercises*
LO6 (CRIVA)	+		+			+	+		*Adaptive Capacity Assessment*

Table 3.6 Learning Strategies Matrix. Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in professional development courses in Climate Services

Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
LO1. Design and operate a climate database of climate data and metadata using a climate data management system, including raw, quality-controlled and homogenised records to organize, control, analyze and visualize climate data effectively.		+		+		+	+	+	*Hands-on Practice, Data Management Simulation*
LO2. Characterise the climate of the area of study and describe its variability and recent changes.	+	+	+	+		+	+	+	*Data Analysis Tasks, Visualization Tools*
LO3. Prepare socio-economic, sectorial and climate datasets for own usage, considering the necessary spatial and temporal coverage.		+		+			+	+	*Data Integration Workshop, Coding Exercises*
LO4. Utilise the combined socio-economic, sectorial and climate datasets to extract climate-influenced socio-economic indicators.	+	+	+	+			+	+	*Indicator Development, Statistical Modelling*
LO5. Develop and implement climate communication plans and campaigns, tailored to the cultural and educational characteristics of users, using effective materials to support adaptation and mitigation strategies.	+	+	+	+	+	+	+	+	*Media Design, Stakeholder Engagement Simulation*
LO6. Apply program evaluation approaches to assess the effectiveness of climate service delivery, taking into account unique climate challenges the country faces.	+	+	+	+		+	+	+	*Evaluation Frameworks, Case Reflection Workshops*

Notes

- **AI-Based Learning**: includes automated data processing, visualization (e.g., AI-driven dashboards), and text generation for climate communication.
- **Flipped Classroom**: recommended for LO5 to allow pre-class study of communication theories and in-class practical development of outreach materials.
- **Other Strategies**: emphasize practical digital work — data cleaning, visualization, integration with GIS, and stakeholder simulations.

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Table 3.7 Learning Strategies Matrix. Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in professional development courses in Climate Change

Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
LO1. Understand how changes in one climate system component can lead to cascading effects and feedback loops, appreciating the complexity of Earth's climate dynamics.	+		+	+	+	+	+	+	*Climate System Simulation, Concept Mapping*
LO2. Recognise and explain the dynamic interplay between the atmosphere and the sea, including the role of ocean currents, heat transfer mechanisms, and the influence of sea surface temperature on atmospheric circulation patterns.	+		+	+		+	+	+	*Data Visualization, Ocean-Atmosphere Modelling*
LO3. Understand the principles of adaptation and its role in reducing vulnerability.	+		+		+	+	+		*Expert Talks, Reflective Exercises*
LO4. Apply various adaptation strategies, including technological, policy-based, and community-driven approaches.	+	+	+	+			+	+	*Scenario-Based Planning, Stakeholder Analysis*
LO5. Evaluate the costs and benefits of various mitigation options.	+	+	+	+			+	+	*Economic Modelling, Decision-Matrix Exercises*
LO6. Evaluate the costs and benefits of various mitigation options.	+	+	+	+			+	+	*Multi-Criteria Assessment, Comparative Analysis*

Notes

- **AI-Based Learning: Use AI tools for modeling climate feedbacks, cost–benefit estimations, or automated climate data interpretation.**
- **Other Strategies: Include simulation games, role-playing (e.g., policy negotiation scenarios), and systems-thinking workshops to visualize interconnections within the climate system.**
- **Flipped Classroom: Works well for LO1–LO3, where learners review foundational materials (videos, readings) before in-class synthesis and discussion.**

Table 3.8 Learning Strategies Matrix. Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in professional development courses in climate-smart economic sectors[4]

Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
LO1. Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the causes of variability and change relevant to the specific sector.	+				+	+	+	+	*Concept Mapping, Multimedia Visualization*
LO2. Interpret temperature, precipitation, and other climate indicators in historical data and explain their connections to sectoral impacts.	+		+			+	+	+	*Data Visualization Exercises*
LO3. Assess climate risks and vulnerabilities by identifying hazards and analyzing socio-economic, environmental, and non-climatic factors.		+		+		+	+	+	*Hands-on Practice, Risk Mapping*
LO4. Evaluate adaptive capacity and determine key risks to develop adaptation or mitigation strategies.		+		+			+		*Collaborative Work, Scenario Analysis*
LO5. Apply climate service products to identify and analyze climate-related risks and opportunities.		+		+			+	+	*Data Analysis Tasks, Simulation Exercises*
LO6. Develop synthesis reports—including textual, graphical, and cartographic information – to communicate climate impacts and inform decisions.	+	+		+		+	+	+	*Report Writing, Presentation Practice*

Notes

- + Recommended strategy for this learning outcome.
- **AI-Based Learning** may include: automated feedback tools, predictive analytics exercises, climate data AI dashboards, or AI-supported writing assistants (for reports).
- **Other Strategies** are tailored sector-specific or integrative learning methods (e.g., simulation, mapping, collaborative group projects).

[4] This list of learning outcomes is general. Detailed learning outcomes for each sector can be found in the Annexes.

Table 3.9 Learning Strategies Matrix. Learning strategies matrix. Suggested learning strategies for achieving the given learning outcomes in programme "Climate-Oriented Policy and Natural Resources Management" [5]

Learning Outcomes / Strategies	Discussion	Project-Based	Case-Based	Inquiry-Based	Flipped Classroom	Lectures	Reading	AI-Based Learning	Other Strategies
LO1 Analyse the nature of contemporary climate change and its environmental, social, and economic impacts across key development sectors, including energy, agriculture, urban systems, and water resources.	+		+	+	+	+	+		*Concept Mapping, Multimedia Visualization*
LO2 Interpret international and national climate policy instruments, energy transition mechanisms, and the "green" transformation in order to assess their role in achieving climate goals and sustainable development in Ukraine.	+		+	+	+	+	+	+	*Data Visualization Exercises*
LO3 Explain the principles, institutional mechanisms, and legal foundations of Ukraine's state water policy, taking into account European directives and climate-related challenges.	+		+			+	+		*Hands-on Practice, Risk Mapping*
LO4 Assess the status of surface and groundwater resources, water balances, and water-related risks (floods, droughts, water scarcity) based on monitoring data, hydrological calculations, and climate information.	+	+	+	+			+	+	*Collaborative Work, Scenario Analysis*
LO5 Apply engineering–hydrological, spatial, and digital tools (models, GIS, remote sensing) to forecast water regimes and support managerial decision-making.		+	+	+			+	+	*Data Analysis Tasks, Simulation Exercises*
LO6 Substantiate measures for the rational use, restoration, and protection of water resources, including nature-based solutions, to enhance water security and the resilience of aquatic ecosystems under climate change.	+	+	+	+			+	+	*Report Writing, Presentation Practice*

Notes

- + Recommended strategy for this learning outcome.
- **AI-Based Learning** may include: automated feedback tools, predictive analytics exercises, climate data AI dashboards, or AI-supported writing assistants (for reports).
- **Other Strategies** are tailored sector-specific or integrative learning methods (e.g., simulation, mapping, collaborative group projects).

[5] This list of learning outcomes is general. Detailed learning outcomes for each sector can be found in the Annexes.

4. SYLLABUS DEVELOPMENT

4.1 Overview

Overview includes a general description of the training required that summarizes the key goals and states why the training is important to accomplish for an organization or region.

4.2 Audience Description

Primary audience for the training, and any secondary audiences, if they will impact any of your decisions. The assumed current knowledge and skills, or prerequisite knowledge and skills, of the primary audience, and any other characteristics that will guide your decisions.

When describing the audience for training courses, instructors and course designers should aim to provide a comprehensive yet concise overview that includes the following elements:

1. **Identify the Audience**: Clearly define who the primary audience is, such as public officials, sectoral leaders, or municipal representatives. Secondary audiences, like educators or community leaders, can also be mentioned if relevant.
2. **Professional Background**: Describe the typical professional background of the audience. This includes their roles, responsibilities, and any relevant experience in the field related to the training topic.
3. **Educational Requirements**: Specify any prerequisites or educational qualifications needed to participate effectively in the course. This could include knowledge of specific concepts, skills, or prior training.
4. **Learning Objectives**: Clearly state what the audience is expected to achieve or learn from the training. This should cover both knowledge-based objectives (understanding key concepts) and skills-based objectives (applying techniques or methodologies).
5. **Audience Needs and Goals**: Explain why the audience is interested in attending the course. What are their main motivations and professional goals that the training aims to fulfill?
6. **Contextual Factors**: Consider any unique demographic, cultural, or regional factors that may influence the audience's learning needs or preferences. This ensures that the training is relevant and engaging for all participants.
7. **Practical Applications**: Provide examples of how the training content will be applied in the participants' professional roles. This helps demonstrate the practical relevance and utility of the training.

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8. **Grouping and Customization**: Offer insights into how participants may be grouped based on their roles, expertise levels, or specific learning objectives. This facilitates tailored learning experiences within the training program.

Example Template for Describing the Audience

Primary Audience Description:

- **Target Group**: [Describe the main target group, e.g., public officials, sectoral leaders, municipal representatives]
- **Professional Background**: [Detail typical job roles, relevant experience, educational background]
- **Educational Requirements**: [Specify prior knowledge, skills, and qualifications needed]
- **Learning Objectives**: [Outline key knowledge and skills participants will gain]
- **Audience Needs and Goals**: [Explain the main motivations for attending the course]

Secondary Audience Description (if applicable):

- **Target Group**: [Describe any supplementary groups, e.g., educators, researchers, community leaders]
- **Professional Background**: [Detail relevant experience and roles]
- **Educational Requirements**: [Specify prior knowledge or skills needed]
- **Learning Objectives**: [Outline what secondary audience members will learn]
- **Audience Needs and Goals**: [Explain the motivations for secondary audience participation]

4.3 Competencies Defined[6]

In this section of the syllabus, the job competencies to be addressed through the training and learning are outlined. It also provides an overview of the learning needs at the individual, organizational, country, and regional levels. Additionally, a description of how these needs were identified and validated should be included.

Why Competencies?

Competency frameworks are being developed in many professions and industries, including those related to meteorology, hydrology and climatology. Several benefits can come about from their introduction into training practices in national and international contexts. These benefits are why WMO Congress-16 recommended that all technical commissions make definition of competency standards in their areas of service a high priority.

***Global standards*:** When competencies are adopted as standard practices, they can promote consistency of service across organizations. One of WMO's missions is to introduce standards of service, and competency frameworks are a key way to do this. They enhance trust and stimulate collaboration. Globalization means that personnel should be expected to perform at similar levels and have similar

[6] For each course proposed within the project 'Multilevel Local, National, and Regional Education and Training in Climate Services, Climate Change Adaptation, and Mitigation – ClimEd,' the competencies, learning outcomes, and performance criteria were defined. You can find them in the guidelines "Selection of Course Topics in the Field of Climate Services and Defining Curricular Solutions" and in the annex to these guidelines.

skills no matter their country of service. In fact, each NMHS serves a global market, not just a national one. Global standards allow for training to be obtained from a variety of institutions, as long as those providers design courses that are driven by the competency standards.

***Guidance for resource allocation*:** Competencies help organizations identify the most critical learning needs, but since competencies describe service responsibilities, they also may help to identify technical infrastructure needs. If projects and training events are clearly tied to competency frameworks, they will be more highly regarded.

***Clarifying training needs*:** Finally, by using a competency framework to drive choices, training events will more likely address true job needs. If competencies have been used to help define the curriculum and learning outcomes, and to help determine the learning activities to achieve the outcomes, the training will be addressing true job needs, and not merely potential needs or nice-to-know information.

Training opportunities are precious. Considering the high cost of travel and facilities for face-to-face events, and the high cost of preparation and delivery of distance learning events, as well as the cost of lost opportunity to work when personnel attend training, the return on investment should also be high. Competency frameworks help to ensure this.

Principles of competencies

Competencies have several characteristics. These can help us know when we are defining proper competencies that will stand the tests of time and, when defining them for international contexts, variations across organizations and regions.

1. Because they describe job tasks and responsibilities, there are no *basic* and no *advanced* competencies, only those appropriate for different job functions. People can be novice or expert and possess the same competencies. They just apply them with varying degrees of skill. Competencies define what must be done, not the level of skill expected.
2. Having a qualification, such as a university degree or certification, prepares a person to enter a profession, but it doesn't mean that person is competent to perform the job assigned.
3. Within different organizations, competencies may be carried out using different processes and procedures appropriate to the organization.
4. Because they are written a high level and are fundamental to meeting job responsibilities, competencies should not require significant changes over time. The introduction of new tools or data does not change the responsibility or need to perform the tasks, even if they will be accomplished in a different way.

4.4 Learning Outcomes and Performance Criteria Defined[7]

In this section of the syllabus desired learning outcomes and performance criteria of the planned event, written in terms of skills that can be assessed. You may want to begin with the statement: "After completing the training, participants will be able to…" Also include specific actions, tools or objects worked with, and the context of application, if possible. Be as specific as you can be.

[7] For each course proposed within the project 'Multilevel Local, National, and Regional Education and Training in Climate Services, Climate Change Adaptation, and Mitigation – ClimEd,' the competencies, learning outcomes, and performance criteria were defined. You can find them in the guidelines "Selection of Course Topics in the Field of Climate Services and Defining Curricular Solutions" and in the annex to these guidelines.

Learning outcomes are just what the term states—the outcomes of a learning experience. More specifically, however, the term is used to describe what teachers and trainers intend each learner to achieve during any particular education or training event, such as a class, course, or programme of study. The actual learning outcomes for each learner can include intended, peripheral (secondary), and unintended outcomes, but here we focus on those intended and documented by the trainers when planning their training.

Examples of learning outcomes:

- Apply a systems approach to analyze the context of learning and the training development process.
- Evaluate and use NWP products in the forecast process.
- Use remote sensing products for agricultural applications.
- Identify and retrieve adequate climate data from different sources to generate climate products
- Create discovery metadata records describing products and services

Why document them? Documenting the intended learning outcomes guides your training development, helping you decide what content is required (or not required) and what activities and practice opportunities will help learners achieve benefits from training. Even more directly, learning outcomes tell you how you should assess learners. Finally, learning outcomes communicate to learners what they can expect to gain from a training event or resource, and also what they will be expected to demonstrate during assessment.

Competencies should be written at a high level, describing general job tasks or responsibilities, but learning outcomes should be written more specifically at the level of training assessment.

They will appear more like the performance criteria or performance components within a competency framework than the high level competency. More specifically, they should represent those tasks you will directly assess to determine when training has achieved its goals. If your training is competency-based, then the learning outcomes should not be difficult to identify. For example, a competency may be written as

> *"Forecast marine weather phenomena, variables and parameters,"*

and **the performance criteria for this competency** may include the following:

> *"Prepare forecasts and warnings for the following weather phenomena and parameters and variables, including spatial extent, onset/cessation, duration, intensity and temporal variations:*
>
> - *wind, including directional variability, speed and wind gusts*
> - *sea state (total wave height, wind wave height, swell height, swell direction and swell period, significant wave height)*
> - *damaging or large waves*
> - *etc., etc."*

In this case you might have **a learning outcome for your training session** such as,

> *"Forecast the onset and cessation of large coastal waves using remote sensing and NWP data."*

It is likely that learning outcomes will be written at this more specific level because this provides nearly all the information you need to make an assessment of learning, including any specific information to help developing the assessment and evaluating success.

Well-written learning outcomes describe learning in terms of what a learner should be able to do following the learning experience, not just what they should know or understand. This helps to ensure a direct connection to required job competencies and job tasks, which provides the justification for the effort of training. All the examples provided in this resource so far describe tasks learners will be expected to do after their training.

However, knowing and understanding are important co-requisites to the ability to perform a task, so these "enabling" outcomes may also be important enough to document. "Knowing" and "understanding" outcomes also help prepare learners for performing tasks in a variety of contexts. For this reason, they are more common, and more justified, in educational contexts than professional ones.

However, enabling outcomes are better represented by higher-level, task-oriented outcomes that can be assessed to demonstrate knowing or understanding. Rather than simply writing "Understand the Norwegian cyclone conceptual model", which does not suggest a method of assessment of understanding, the outcome might be written as "Draw the five stages of the Norwegian cyclone model," and that should also be how the learner will be assessed (by how well they describe or draw the model). Better yet, assessment of this outcome can be embedded in a practical task, such as an exercise that asks: "Considering the Norwegian cyclone model, predict the probable next stages of evolution of the system visible in this satellite IR image."

The term "learning outcome" is sometimes used interchangeably with "learning objective" or "performance objective." Desired learning outcomes and performance criteria of the planned event, written in terms of skills that can be assessed. You may want to begin with the statement: "After completing the training, participants will be able to…" Also include specific actions, tools or objects worked with, and the context of application, if possible. Be as specific as you can be.

4.5 Content Scope

Provide a content outline consistent with learning objectives or outcomes. This could be the course outline as it would be presented to students, but not necessarily a complete syllabus. Include a high-level list of all topics you feel are necessary to cover and/or the skills that must be developed. If you think it will help clarification, state what will NOT be covered.

4.6 Learning Solutions and Delivery Modes

List the learning solutions (modes of training) used and why you have chosen them. For example: classroom training, online learning, blended learning, on-the-job training, online resources for self-directed learning, coaching or mentoring, etc.). More detailed information on this topic is provided in Chapter 2 of these guidelines.

4.7 Learning Strategies

Consider which learning strategies you will use. Provide justification for why you want to use them, including why they will help learners achieve your intended learning outcomes. Consider an appropriate

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blend of strategies that complement one another. You do not need to describe the actual activities in any detail in this section. More detailed information on this topic is provided in Chapter 3 of these guidelines.

4.8 Learning Activities

Describe the major learning activities that will be included, including lectures, readings, cases, discussions, exercises, assignments, simulations, role-play, etc. Describe the roles of trainers and learners during the activities)

The number of possible learning activities could be nearly endless, depending out how specific the activities are classified. In this resource, we take a middle-ground and list only 15 common learning activities that can also have many variations. You may think of many others we missed, but this resource should bring to mind the many options you have for creating an engaging learning experience.

They are divided into two main types, Active Learning Approaches and Information Transfer, and the Active Learning Approaches are addressed in more detail. This does not mean that there are not many, many forms of Information Transfer available to use (see the Lectures and Readings section of the Learning Strategies resource). We are stressing active approaches because traditionally these are underutilized, and yet these are the activities most necessary to achieve higher-level learning outcomes. Using Bloom's Taxonomy, Information Transfer might be adequate to achieve outcomes related to Remembering and Understanding, but those outcomes related to Application, Analysis, Synthesis and Evaluation require active practice in addition to information.

Active learning approaches are those that ask learners to engage in complex cognitive tasks like analytical thinking, decision-making, creative thinking, problem solving, or evaluation, or to complete practical tasks that require some combination of these. In the end, this is the learning that we want most learners to achieve. So, one very good way of blending learning is to ensure you use many active learning approaches, or even use them exclusively. The information required can be learned in the process of the engaging in the activities.

4.9 Common Learning Activities

4.9.1 Active Learning Approaches

More than lecture

1. ***Problems, Questions, Cases and Issues.*** Instruction is presented around a situation, perhaps by telling a story or describing a case, rather than by providing only information. Discussion is encouraged in which students explore the situation and propose explanations or solutions, using what they've learned to support their positions, while the teacher provides information and ideas to expand and clarify. Instruction is limited to short, but critical information. A conclusion can summarize the ideas proposed, as well as make the key points that would have been made in a lecture on the same topic.
2. ***Demonstration.*** Rather than built around telling, a demonstration allows learners to see the procedures, concepts and principles in action. A demonstration can show how to use real technologies, show scientific principles through real or simulated processes, or reveal human behaviors with students or others as subjects in staged activities. When possible, demonstration

is followed by practice. Field trips are also a form of demonstration, showing sites where work is conducted.

3. ***Socratic Lesson.*** For this specialized, teacher-led activity, a series of questions guides learning within a topic, probing students' understanding and questioning assumptions, not just testing memory. (If this activity type is unfamiliar, recall films where you may have seen how teaching is done in a Law School classroom.) Questions should be designed to demonstrate critical thinking in the topic domain. Some questions can be prepared in advance, but questions should also be allowed to arise spontaneously in response to the responses. The direction of the conversation should explore increasing levels of complexity of an issue or topic or help to uncover fundamental principles and definitions. For example, instead of just describing the components of a numerical weather prediction system, allow learners to discover them by asking them questions that lead them to realize that qualitycontrolled observations, data assimilation methods, physical parameterizations, forecast models, post-processing for product generation, and verification methods are all required components. "How can we use data from so many varied sources and times of day to be compatible to define initial conditions? How would a modeler deal with the data at the edges of a limited model domain? What do you need to help a model decide if precipitation will occur? How can you keep a model from going further and further astray due to errors in previous forecasts? Etc."

4.9.2 Discussion Options

4. ***Structured discussions.*** Discussion is used to meet specific learning outcomes, based on discussion guidelines and expected outcomes. Rules might restrict the boundaries of the topic, tell when and how to make contributions to the discussion, ask students to represent sides to an argument, require responses to a set of questions, or work toward a planned conclusion. A debate is a structured discussion with a highly specified set of rules.

5. ***Open discussions.*** Students are provided a direction, but empowered to freely explore a topic together. Students are encouraged to answer each other's questions and even guide the direction of discussion. The teacher offers input only when no student can answer a question, or when it can expand or steer the discussion in a more productive direction. On the whole, when the teacher does contribute, it is more often to ask probing questions than provide information and answers.

6. ***Small group discussions.*** Students are divided into small discussion groups to encourage more individuals to contribute, bringing out a greater diversity of opinions. Small groups can discuss the same topic and then compare and discuss their outcomes, or discuss different topics and then teach what they discussed to the large group.

7. ***Collaborative Decision Making.*** Students work together in loosely structured ways to explore complex problems or issues. They collaborate in analyzing information, drawing conclusions, generating solutions and making decisions. Room is offered for creative approaches and evolving team dynamics, which also develops teamwork skills.

4.9.3 Focus on Practice

8. ***Practice exercises.*** Sets of numerous practice exercises, such as lab exercises, require the application of the procedures or cognitive skills being learned. The exercises should require

practice under varying situations or conditions, and might increase in difficulty or complexity. They can include, for laboratory exercises, math problems, and other short practice exercises with objective answers.

9. ***Tutorials.*** The teacher provides a sequence of instructions, readings or presentations with frequent, interspersed testing and opportunities to practice what is taught. Tutorials may include individual branching based on assessment, redirecting those that need reinforcement to additional lessons, and allowing those that succeed to advance more quickly. In this way, it is personalized learning.
10. ***Case studies.*** Instructional case studies require students to make decisions similar to those that would be made in real-world situations. Cases should be realistic, but might be simplified to focus on specific aspects of a case or specific learning goals. Students practice using data, interpretation, analysis, decision-making, and/or communication skills.
11. ***Simulations.*** Instructional simulations call for authentic decision-making in realistic conditions, including representative data, tools, and time limits, and in the responses learners receive in to their decisions.
12. ***Role play.*** Role-play is a form of simulation in which a group of learners improvise in a scenario, taking on the roles of people in the situation with differing needs, goals, and responsibilities in order to have first-hand experience in responding in such situations. If some students are in the role of observers, they should also be given guidelines on what to watch for. The teacher sets up the scenario, establishes the roles, and helps students to debrief and reflect on the experience.
13. ***Games.*** Instructional games use game-tactics to heighten the learning experience through time limits, competition, and engaging and creative tasks like solving puzzles. In games, students have tasks to complete, they play by rules, and they work with the limited set of resources and tools provided. These constraints make a game fun and more comfortable than everyday life—by setting a beginning and end and by providing a level of fairness and equality through chance, while also rewarding skill. In these ways, games can be like simulations, which are often called "serious games."

4.9.4 Bigger Tasks

14. ***Problem-based learning.*** Instead of merely using a problem to initiate learning, the teacher designs large-scale problems that provide the overarching context for learning. Problembased learning problems might require days or weeks of planning, researching, and developing a solution. The teacher provides resources and strategies, but let's learners create their own solutions, justify them, and reflect on the process.
15. ***Projects.*** Learners engage in realistic or real tasks and challenges. Projects might include research, report writing, data gathering, trying a new technique, developing a model or tool, or creating a local application.

4.9.5 Information Transfer

The most common learning activities are those based on the traditional assumption that learning occurs best in a process of transmitting information. Learning certainly does occur through activities such as lectures, readings, and watching or listening to digital media. How effective that learning occurs is a

matter of whether the intended learning outcomes are met. Higher-level learning outcomes that are application-oriented are rarely fully met through information transfer alone. However, information transfer plays an important role in higher-level learning outcomes if active learning approaches like those above are blended within and around them.

Even when only Remember- and Understanding-level outcomes are intended, Information transfer activities can improve learning by asking students to test their knowledge and reflect simply by including questions and stories that connect otherwise abstract concepts and principles to real situations. Information transfer interspersed with periodic discussion is one basic way to ensure learning outcomes are met.

4.11 Learning Assessment

Describe your plan for assessing learners before, during, and/or after the course, including tests, exercises, graded activities, and projects or products to be evaluated. Describe the use of self or peer assessment, if used. Show how assessment is linked to the Learning Outcomes). More detailed information on this topic is provided in Chapter 5 of these guidelines.

4.12 Learning Resources and Tools

List existing resources you will use for readings or presentations, activities, case studies, data, etc. Describe content resources you will need to search for. Describe the technologies that will be used to support training development and delivery, including instructional technologies and operational equipment.)

4.13 Training Storyboard

4.13.1 ABC curriculum design

The storyboard is made up of pre-printed cards representing the type and sequence of learning activities (both online and offline) required to meet the module or programme learning outcomes.

The ABC curriculum design method, as outlined on the websites you mentioned, emphasizes a structured approach to designing effective learning activities. Here's an overview based on the information available:

1. **Concept**: ABC stands for "Arena, Bonding, and Concept". This method is designed to facilitate the design of learning activities that are engaging, effective, and aligned with learning objectives.
2. **Arena**: This refers to the learning environment or context in which the activity will take place. It involves considering the physical or virtual space where learning will occur and how it can be utilized to enhance engagement and interaction.

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3. **Bonding**: Bonding focuses on fostering relationships among learners, between learners and educators, and within learning communities. It emphasizes the importance of creating a supportive and collaborative atmosphere that encourages participation and exchange of ideas.
4. **Concept**: The concept stage involves defining the core learning objectives and content that the activity aims to address. It includes identifying the key concepts or skills that learners should acquire through the activity.
5. **Approach**: The ABC method encourages a systematic approach to curriculum design, starting with understanding the learning environment (Arena), fostering relationships and community (Bonding), and clearly defining learning goals and content (Concept).
6. **Pedagogical Strategies**: ABC promotes the use of various pedagogical strategies and techniques to achieve effective learning outcomes. These may include active learning methods, collaborative activities, use of technology, and reflective practices.
7. **Application**: Educators and instructional designers can apply the ABC method to various educational settings, from traditional classrooms to online learning environments. It helps in structuring learning experiences that are engaging, meaningful, and conducive to learning.

The ABC method is intended to be flexible and adaptable, allowing educators to tailor their instructional approaches to meet the needs of diverse learners and contexts. It provides a framework for designing holistic learning experiences that integrate physical, social, and cognitive elements effectively.

For more detailed information and practical examples of how ABC is implemented, you can explore the resources available on the UCL blog (https://blogs.ucl.ac.uk/abc-ld) and the official ABC website (https://abc-ld.org/). These sources typically provide case studies, workshops, and additional materials to support educators in applying the ABC curriculum design method in practice.

4.13.2 Creating a Storyboard of the Training

In this final version of your Training Development Plan we are asking you to create a visual storyboard of your blended course. We hope you will find this a change of pace in that it is about visualizing what you have already decided in your plan, and not making new decisions --- unless after the visualization you decide that some changes would be useful.

Visualizing a course is a helpful step that we usually do only in the form of a daily or weekly calendar of a training event. In this case, you will be also be describing the course visually by showing for each part of the course what **Delivery Mode**, **Learning Strategy**, and **Learning Activity** you will use. You will also indicate for the Learning Activities what the student **Grouping** (or **Scope of Interaction**) will be, and whether the activity will be included as an **Assessment** or not. "Test or Quiz" as a new Learning Activity was added.

There are several ways you can create this storyboard.

- Probably the easiest method: Use the PNG images in the folder "Storyboard Cards to Print and Cut (PNG)". This file contains all the cards you need to assemble your own colorful storyboard on your table or floor. When you are done, just take a photo of the storyboard and share with us. You will be surprised how this brings a course plan to life!

Warning: When printing the cards, make sure your printer is set to print at the **Actual Size**, and not "Fit" or "Fit to Frame" or an equivalent adjustment. Printing at the wrong size will make it difficult to fit the items together.

- Look at the examples provided. The Delivery Mode and Learning Strategies cards can be used as is. For the Learning Activity cards, you will note that they have a white background. This allows you to write a bit of detail about the activity that describes it. If you have the cut-out version, you can also write on the back. On the digital version, use a text box, but if you need more space, you can number them and write more detailed details on a separate document.
- Another option is to use a different tool you are more comfortable with, such as a Mind Map software tool like iMindMap or any other. You could even lay this out in MS Word, but I don't think it would be as rewarding as building the storyboard using the PowerPoint, especially using the cut-out cards.

Figure 4.1 Example of a finished storyboard for a course with 4 phases.

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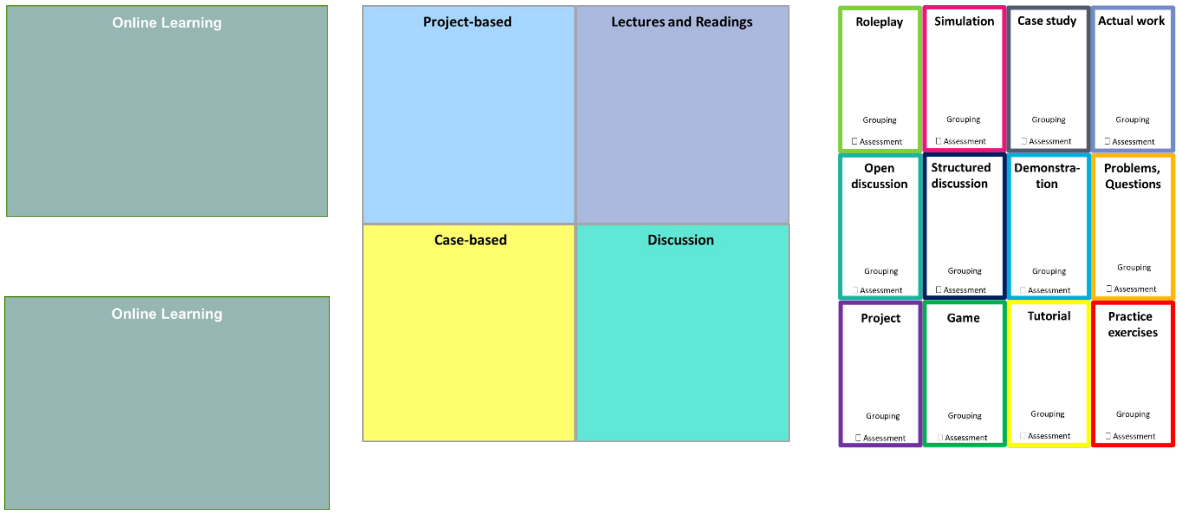

Figure 4.2 Examples of cards to cut out

Follow these steps:

1. Whatever method you use, establish a timeline that fits your training. Each row can be a week, a day, a unit of study, or a specific learning outcome, whichever works best for you. Indicate this however you wish, with another piece of paper or text box.
2. Then layer your design choices, starting with Delivery Mode on the bottom, then one or more Learning Strategies on top of that, and then one or most likely more Learning Activity types on top of the strategies.
3. Write in the short description of the Learning activity on the card, state the Grouping, and check whether or not it will be used for assessment, either formative or summative. In other words, a chance to provide individual feedback. You can provide additional details about the learning activity in your TDP as appropriate.
4. When finished, take a photo of your storyboard (or save the Powerpoint file, if you are using this method), and upload it as a second file along with your written TDP.

4.13.3 Recommendation for Further Reading:

https://blogs.ucl.ac.uk/abc-ld

https://abc-ld.org/

Digital Storyboard Example (large PNG)

Storyboard Large Digital Poster Raw Materials (Powerpoint)

Storyboard Cards to Print and Cut (PPT)

Storyboard Cards to Print and Cut (PDF)

Step-by-step Building a Blended Learning Storyboard

5. ASSESSMENT

Student assessment is arguably the cornerstone of effective teaching and learning. It plays a critical role in determining whether students are acquiring the knowledge and skills that a course is designed to impart. Without a structured way to collect and analyze evidence of student learning, educators cannot accurately gauge the impact of their teaching. In this sense, assessment acts as a magnifying glass that allows instructors to see whether their teaching strategies are effective or need adjustments.

This guide aims to provide a comprehensive overview of learning assessment by addressing the following key goals:

1. Defining what student learning assessment is and explaining why it is crucial.
2. Discussing various approaches that can help refine and guide student assessment.
3. Exploring different methods of assessment, such as tests, essays, and other formats.
4. Offering resources for further exploration, including a five-part video series on assessment from Vanderbilt's Center for Teaching.

What is Student Assessment and Why is it Important?

Student learning assessment is "the systematic collection and analysis of information to improve student learning" (Stassen et al., 2001, p. 5). It is essential for providing feedback to both students and instructors on how well students are meeting learning objectives. In their influential work, *Understanding by Design*, Grant Wiggins and Jay McTighe emphasize the importance of "Backward Design," where assessment plays a central role in determining whether students have attained course goals. By assessing learning outcomes, instructors gather the evidence they need to confirm whether meaningful learning has taken place (Wiggins & McTighe, 2005, p. 18).

Moreover, effective assessment fosters reflective teaching. Stephen Brookfield, in his book *Becoming a Critically Reflective Teacher*, stresses that critically reflecting on one's teaching practices is vital for professional growth. Reflecting on assessments and student evaluations allows educators to refine their teaching strategies and improve learning outcomes. According to Brookfield, "A critically reflective teacher is much better placed to communicate to colleagues and students (as well as to herself) the rationale behind her practice. She works from a position of informed commitment" (Brookfield, 1995, p. 17). Through this process, teachers can better understand what works in their teaching and what needs improvement.

Types and Purposes of Student Assessment

There are two primary types of assessment in education: summative and formative.

- **Summative Assessment**: This type of assessment takes place at the end of a course or instructional period, such as through final exams or major projects. It aims to evaluate overall student achievement by providing a final assessment of what students have learned. Summative assessments are typically comprehensive and focus on learning outcomes. However, they offer limited opportunities for students to reflect on their progress or for instructors to adjust their teaching before the course concludes (Maki, 2002).

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- **Formative Assessment**: In contrast, formative assessment occurs during the learning process and is designed to provide both students and instructors with feedback that supports growth and improvement. By using formative assessments—such as quizzes, peer feedback, and progress discussions—teachers can help students identify areas where they need to develop further (Maki, 2002, p. 11). As Pat Hutchings notes, formative assessment looks beyond the final outcomes to understand how learning occurs, providing insights into the processes that lead to successful learning (Hutchings, 1992, p. 6).

Importantly, assessment methods can be either formative or summative depending on how and when they are used. As Sally Brown and Peter Knight point out in *Assessing Learners in Higher Education*, the purpose of the assessment—not the method—determines its nature. Without proper feedback, even a seemingly formative assessment can become summative in function, providing little opportunity for growth (Brown & Knight, 1994, p. 17).

Assessment vs. Grading: A Key Distinction

It's essential to distinguish between assessment and grading. While grading merely involves assigning a letter or numerical score to student work, assessment links student performance to specific learning objectives, providing meaningful feedback on both learning and teaching. As Stassen et al. explain, "Grades don't tell you about student performance on individual learning goals or outcomes. They provide little information on the overall success of your course in helping students to attain specific learning objectives" (Stassen et al., 2001, p. 6).

Grades may indicate a student's academic standing, but they do not provide detailed insights into the student's mastery of course content or skills. By focusing more on the broader purpose of assessment—enhancing learning and intellectual growth—both students and instructors can shift their attention away from grades and towards meaningful educational development.

Student assessment is a powerful tool that drives both teaching effectiveness and student growth. When implemented thoughtfully, it provides crucial insights into how well students are learning, while also encouraging teachers to critically reflect on their practices. Whether through summative or formative methods, assessment allows educators to measure and improve the learning process, ultimately enhancing the educational experience for all involved.

For further exploration, consider viewing the five-part video series from the Vanderbilt Center for Teaching's Online Course Design Institute, which offers additional insights into assessment strategies.

5.1 Types of Student Assessment

5.1.1 Quizzes and Objective Tests

Description:

Quizzes are short assessments that use multiple-choice, true/false, or short-answer questions. These tests are designed to gauge a student's understanding of specific concepts and are commonly used for formative assessment.

Purpose:

The primary purpose of quizzes and objective tests is to assess knowledge and comprehension of course material, helping instructors quickly identify areas where students may need further support.

Advantages:

- **Broad Coverage**: Quizzes can assess a wide range of topics in a relatively short time, allowing for comprehensive evaluation.
- **Efficiency**: They are quick to administer and easy to grade, especially when using computer-based tools.
- **Reliability**: Objective tests provide consistent and highly reliable results, with minimal variability in scoring.
- **Automated Feedback**: Quizzes can be designed for immediate feedback, offering students a quick sense of their progress, though this feedback may be more superficial than in-depth.

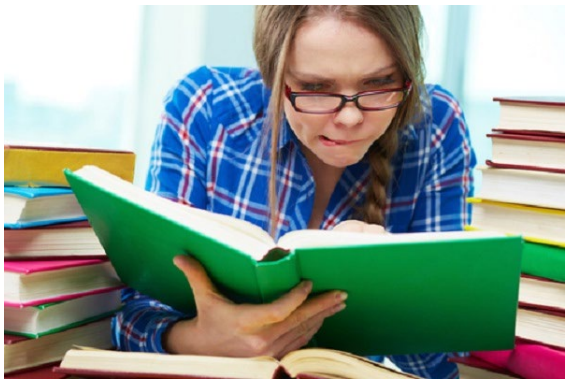
Disadvantages:

- **Limited Depth**: Quizzes and objective tests may promote rote memorization rather than encouraging deep, critical thinking or the ability to construct complex arguments.
- **Costly to Develop**: Creating effective, well-designed quizzes, particularly computer-based versions, can be time-consuming and expensive.
- **Stressful**: Time limits and the format of objective tests can be stressful for students, potentially impacting performance.
- **Lack of Creativity**: These tests do not assess original thinking or the ability to construct well-reasoned arguments.

Considerations:

- **Computer-Based Assignments**: Many quizzes are now administered online, with automated marking and feedback, which further enhances efficiency but may remove the personal touch of instructor-provided comments.

5.1.2 Oral Exams



Description:

Oral exams involve face-to-face questioning, where students verbally respond to questions posed by the instructor. These assessments test students' knowledge, understanding, and ability to articulate their thoughts clearly under direct questioning. Oral exams can range from one-on-one interviews to panel assessments.

Purpose:

The primary aim of oral exams is to evaluate a student's depth of understanding, critical thinking, and ability to communicate complex ideas effectively. They also assess how well students can respond to unexpected questions or discussions, demonstrating their reasoning and verbal skills in real time.

Advantages:

- **Immediate Feedback**: Instructors can provide instant feedback, allowing students to clarify their thoughts or elaborate on areas of weakness during the exam.

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- **Assessing Depth of Knowledge**: Oral exams allow instructors to probe deeper into a student's understanding, going beyond surface-level memorization to evaluate critical thinking, reasoning, and problem-solving abilities.
- **Communication Skills**: These exams assess not only what students know but also how effectively they can express their knowledge, which is a crucial skill in many fields.
- **Flexibility**: Instructors can adapt questions during the exam based on student responses, allowing for more personalized assessment and dynamic interaction.

Disadvantages:

- **Subjective Grading**: The evaluation of oral exams can be more subjective compared to written tests, with different instructors potentially interpreting responses differently. This can introduce variability in grading.
- **Stressful for Students**: Many students find oral exams intimidating due to the pressure of thinking and responding on the spot, which may not accurately reflect their true knowledge.
- **Time-Consuming**: Oral exams are typically more time-consuming to administer, especially for large classes, as they require individual or small-group assessments.
- **Limited Scope**: Due to time constraints, oral exams may cover a narrower range of topics than written exams, potentially missing a comprehensive evaluation of a student's overall knowledge.

Considerations:

- **Structure and Fairness**: To ensure fairness, it's important to have a clear and consistent structure for questioning and grading, possibly with standardized rubrics or guidelines.
- **Preparation**: Students should be well-prepared, not just in terms of content, but also in their ability to communicate their knowledge effectively. Offering practice sessions or mock exams can help ease anxiety and improve performance.
- **Follow-up Questions**: Oral exams allow for follow-up questions based on student responses, offering opportunities for deeper assessment but also the risk of leading students in unintended directions.

5.1.3 Traditional Written Exams

Description:

Traditional written exams are assessments in which students answer questions in a written format, typically within a set time limit. These exams can include a variety of question types, such as multiple-choice, short answer, and essay questions, and are commonly used in educational settings to evaluate student learning.

Purpose:

The primary aim of traditional written exams is to assess students' knowledge and understanding of course material, providing a standardized method for evaluating performance across large groups of students.

Advantages:

- **Structured Format**: Written exams typically follow a clear and organized structure, making it easy for students to understand what is expected.
- **Extended Response Opportunities**: They provide students with ample time and space to express their knowledge and articulate their understanding in detail.
- **Assessment of Writing Skills**: These exams evaluate students' ability to communicate effectively in writing, which is an essential skill in academia and many professions.
- **Analytical Skills**: Essay-type questions can assess students' critical thinking and analytical skills, as they require the application of knowledge to construct coherent arguments.
- **Efficiency in Assessment**: Traditional written exams can effectively assess a large group of students simultaneously, making them a practical choice for instructors.
- **Quick and Easy Design**: They are often easier to create than other forms of assessment, allowing instructors to design exams that fit their curriculum with relative speed.

Disadvantages:

- **Not Suitable for All Students**: Some students may not perform well in exam settings, which can result in a misleading evaluation of their true abilities.
- **Rote Memorization**: The focus on memorization can lead to superficial learning, where students prioritize recalling facts over understanding concepts.
- **Cheating Risks**: The potential for cheating can undermine the integrity of the assessment process.
- **Limited Interaction**: In written exams, students cannot ask clarifying questions or engage in a dialogue with the examiner, potentially limiting their ability to express their knowledge fully.
- **Minimal Feedback**: Feedback on traditional written exams is often limited, providing little guidance for students to improve their understanding or performance.
- **Lack of Insight into Learning**: These exams do not effectively help learners identify what they have truly learned or where they need improvement.
- **Grading Fatigue**: Markers may rush through exams when grading, leading to potential biases and inconsistencies due to fatigue or boredom.
- **Surface Learning**: The format can encourage surface-level learning rather than deep understanding and critical thinking.
- **Disconnect from Real Life**: Traditional written exams may not reflect real-world scenarios where knowledge is applied in practical contexts.

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- **Irrelevance to Postgraduate Study**: They often do not align with the skills and competencies required for advanced study or professional work, which may emphasize collaboration, creativity, and applied knowledge.

Considerations:

- **Diverse Assessment Methods**: To counteract the limitations of traditional written exams, instructors might consider incorporating a variety of assessment methods that encourage deeper learning and better reflect students' knowledge and skills.
- **Balanced Feedback**: Providing more detailed feedback on written exams can help students identify areas for improvement and enhance their learning experience.
- **Alternative Formats**: Exploring alternative assessment formats, such as open-book exams, take-home assignments, or oral presentations, may promote a more comprehensive evaluation of student learning.

5.1.4 Useful Tips for Effective Exam Preparation

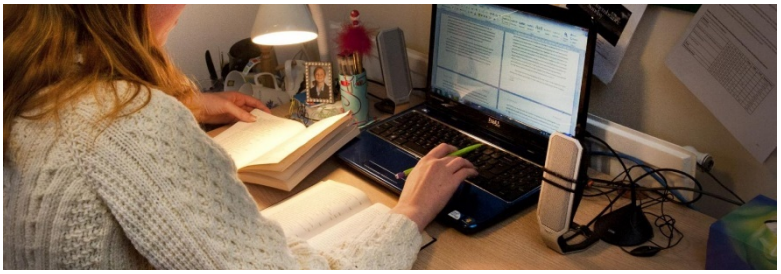
- **Focus on Learning Outcomes**: Set questions that seek to discover what students have learned rather than what has been taught.
- **Use Clear Language**: Keep the language of the questions simple and unambiguous to avoid confusion.
- **Provide a Rubric**: Distribute the grading rubric to students in class before the exam and explain it thoroughly.
- **Avoid Trick Questions**: Ensure that questions are straightforward and assess knowledge without confusing elements.
- **Consider Effective Responses**: Think about what a student would need to do to answer each question effectively.
- **Conduct a Revision Class**: Hold a revision session covering the materials that will be included in the exam.
- **Facilitate Exam Preparation**:

  Organize an exam preparation class using the following three steps:

  - Display one question and have the class brainstorm answers, then provide a model answer.
  - Present two or three old questions and have students create essay plans individually.
  - Give the class one question to attempt under exam conditions.

- **Provide Practice Questions**: Ensure that students have access to practice exam questions to try at home, covering all aspects of the course.

5.1.5 Open Book Exams



Open book exams allow students to bring their textbooks and other approved materials into the examination room. This format shifts the focus from rote memorization to the application and interpretation of knowledge.

Key Features:

- **Emphasis on Application**: The primary goal of open book exams is not to test what students can remember but rather to evaluate how effectively they can utilize the material they have studied. This approach encourages critical thinking and deeper engagement with the content.
- **Importance of Analysis**: Analysis plays a crucial role in this exam format. Students are required to demonstrate their ability to analyze information, draw connections, and apply concepts to solve problems.
- **Focus on Problem Solving**: Open book exams are designed to measure students' problem-solving abilities and their capacity to interpret and apply knowledge in practical situations. Instead of merely finding the correct answer in a textbook, students must synthesize information and articulate their reasoning.

Benefits:

- Encourages a deeper understanding of the material, as students must engage with concepts rather than memorize facts.
- Prepares students for real-world scenarios where they may need to reference resources and apply knowledge in a dynamic environment.

Considerations:

- While open book exams reduce the emphasis on memorization, they require students to be well-organized and familiar with their materials to navigate them effectively during the exam.

5.1.6 Thinking Exams

Thinking exams involve a single, large topic that all students must address, typically requiring them to write a comprehensive essay within a specified time frame, such as three hours.

Key Features:

1. **Structured Approach**: Students are encouraged to allocate their time wisely, with a suggested breakdown of one hour for brainstorming, note-taking, and structuring their essay, followed by two hours of focused writing.

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2. **Integration of Course Elements**: This exam format challenges students to synthesize various elements of the course material, demonstrating their understanding and ability to interconnect different concepts.
3. **Focus on Critical Thinking and Analysis**: Thinking exams require students to engage their analytical skills and thought processes actively. Rather than relying solely on memorization, students must think critically and creatively to develop their arguments and insights.

Benefits:

- Encourages deep engagement with the material, fostering a comprehensive understanding of the topic.
- Promotes the development of important skills such as critical thinking, organization, and effective communication.

Considerations:

- This format can be challenging for students, as it demands both high-level thinking and effective time management. Preparing adequately for this type of exam is essential to ensure success.

5.1.7 Take-Home or Seen Exams

Take-home exams, also known as seen exams, allow students to receive the exam paper in advance. Students typically have a timeframe of two days to a week to complete and submit their work, or they may review the exam paper before sitting for the exam.

Key Features:

1. **Flexible Timing**: Students are given the opportunity to manage their time effectively, allowing for deeper engagement with the material and a more thoughtful approach to their responses.
2. **Access to Resources**: This exam format encourages students to utilize a variety of resources, fostering research skills and the ability to synthesize information from different sources.

Benefits:

- **Reduced Anxiety**: The flexibility of take-home exams can lower student anxiety, leading to higher-quality work and more comprehensive responses.
- **Emphasis on Research and Application**: Students are tested on their abilities to research, use available resources, and apply their knowledge effectively, rather than simply recalling information.

Challenges:

- **Disruption to Other Courses**: The extended timeframe for completion may interfere with other courses or exams, potentially leading to scheduling conflicts.

- **Risk of Academic Dishonesty**: The likelihood of cheating and plagiarism may increase, as students have more opportunities to collaborate or access unauthorized materials.

5.1.8 Essays

Essays are a common assessment tool in academic settings that require students to engage deeply with a topic, demonstrating their understanding and analytical skills.

Benefits:

- **Development of Analytical Skills**: Essays necessitate the application of critical thinking and analytical skills, allowing students to explore complex ideas and arguments in depth.
- **Authentic Expression of Ability**: This format enables students to showcase their true capabilities, focusing on their understanding of the subject matter rather than their ability to write quickly under pressure.
- **Enhancement of Academic Writing Skills**: Through the process of writing essays, students develop essential academic writing skills, including structure, style, and proper citation practices.
- **Encouragement of Originality**: Essays provide an opportunity for students to express original ideas and perspectives, fostering creativity and independent thought.
- **Deep Understanding of the Subject**: Engaging with a topic in essay form promotes a comprehensive understanding, as students must research, analyze, and articulate their insights effectively.

Challenges:

- **Lack of Relevance to Course Content**: Essays may sometimes stray from course material, failing to connect with key concepts or readings.
- **Absence of a Clear Research Question or Thesis**: A well-defined research question or thesis is essential for guiding the essay; without it, the focus can become unfocused or vague.
- **Poor Structure and Organization**: Essays lacking logical structure can confuse readers and obscure the main argument, diminishing the overall effectiveness of the writing.
- **Insufficient Logic and Argumentation**: Essays should present coherent arguments supported by evidence; however, some may lack logical consistency, weakening their impact.
- **Overly Broad Scope**: An essay that attempts to cover too many topics may result in superficial treatment of important ideas, hindering depth of analysis.
- **Risk of Plagiarism**: The temptation to plagiarize can be significant, particularly if students do not fully understand proper citation practices or the importance of originality.
- **Use of Poor Language**: Essays may suffer from inadequate terminology, citation issues, stylistic flaws, and errors in grammar and spelling, which can detract from the overall quality of the work.

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Considerations:

- **Guidelines for Topic Selection**: Instructors should provide clear guidelines on topic selection to ensure essays remain relevant to course content and objectives.
- **Emphasis on Thesis Development**: Encouraging students to develop a strong thesis statement will help focus their arguments and provide direction throughout the essay.
- **Organizational Support**: Providing resources or workshops on essay structure can aid students in organizing their thoughts logically and coherently.
- **Encouragement of Drafting and Feedback**: Allowing for drafts and peer reviews can help students refine their arguments and improve their writing before final submission.
- **Plagiarism Awareness**: Educating students about plagiarism and the importance of originality, along with the use of plagiarism detection tools, can reduce the likelihood of academic dishonesty.
- **Focus on Language and Style**: Offering guidance on academic language and writing conventions can help students improve the quality of their essays and better convey their ideas.

Preparation for Essays

Strategies for Effective Preparation:

1. **Summaries**: Summarizing key readings helps students distill essential concepts and arguments, fostering comprehension and retention.
2. **Reflection Papers**: Writing reflection papers encourages students to think critically about their learning experiences and how course content relates to their personal and academic growth.
3. **AQCI Papers**: Utilizing the AQCI framework (Argument, Question, Connections, Implications) allows students to develop structured essays that engage with complex ideas and demonstrate analytical skills.
4. **Guided Essays**: Providing guided essay prompts or outlines can help students stay focused and organized as they develop their arguments.
5. **Essay-Type Questions**: Crafting responses to essay-type questions throughout the semester prepares students for the types of assessments they will encounter.

Further Tips for Essay Preparation

A. Break the Essay Process into Manageable Parts Throughout the Semester:

- **Proposal**: Students should submit a proposal outlining their thesis and approach to the essay, encouraging early engagement with the topic.
- **Annotated Bibliography**: Creating an annotated bibliography helps students identify and evaluate relevant sources, improving their research skills.
- **Literature Review**: Writing a literature review allows students to synthesize existing research and position their argument within the broader academic context.

- **Essay Drafts**: Submitting drafts for feedback fosters iterative improvement and helps students refine their arguments and writing style.
- **Final Essay**: The final submission should integrate feedback from earlier drafts, showcasing the student's growth and understanding of the topic.

B. Provide Access to Old Essays: Sharing examples of successful essays can serve as models for students, illustrating effective writing techniques and structure.

C. Allow for Re-Writes: Encouraging students to revise their essays based on feedback promotes deeper learning and mastery of the material.

Key Elements of a Successful Essay

1. **Clear Thesis**: Develop an effective thesis that articulates the central argument of the essay. Express it clearly and succinctly at the beginning, explore it throughout the main body, and revisit it in the conclusion.
2. **Logical Structure**: Ensure the essay is well-structured, progressing logically from one point to the next, which helps guide the reader through the argument.
3. **Understanding of Theory**: Discuss the chosen theory in a way that demonstrates a thorough understanding. A more advanced comprehension will earn additional marks, especially if critical analysis and original insights are included.
4. **Use of Course Texts**: Incorporate relevant primary and secondary texts from the Course Reader, demonstrating engagement with the material.
5. **Effective Use of Sources**: Know how to utilize sources effectively to advance your discussion, ensuring proper referencing throughout to avoid plagiarism.

5.1.9 Role Play Essays

Benefits: Role play essays can enhance the learning experience by making the task more relevant and engaging for students. They help foster personal interest and promote a more natural and fluent writing process, positively influencing students' attitudes toward writing assignments.

Examples:

1. **Letter to the Minister of Education**: Write a letter protesting the lack of schools in your county, incorporating sociological arguments and referencing evidence from government reports.
2. **Decision-Making Scenario**: Describe the factors to consider in deciding whether to sell your inherited urban estate quickly or wait for potential appreciation.

5.1.10 Student Portfolio as an Assessment Method

The concept of a **student portfolio** originates from the realms of fine art and graphic design, evolving into a robust assessment method that supports **learning-by-doing** and reflective practice. A portfolio is essentially a curated collection of materials compiled by the student, complemented by reflections that articulate the learning journey. This assessment tool can be implemented at various educational levels, including university-wide initiatives, departmental frameworks, or within individual courses.

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Components of a Portfolio

A student portfolio might include a diverse array of items such as:

- Essays
- Critiques
- Short reflections
- Fieldwork reports
- Major projects
- Theoretical pieces
- Practical pieces
- Conference papers
- Book reviews
- Annotated bibliographies
- Audio and video clips
- Reflective notes and diaries

Each entry in the portfolio is typically accompanied by a **written explanation** that highlights the importance of the work, fostering a deeper understanding of the material and the student's learning process.

Advantages of Student Portfolios

The use of student portfolios presents several benefits:

- **Evidence of Engagement**: Portfolios provide tangible evidence of what students are actively doing outside of formal course activities, demonstrating their engagement with the subject matter.
- **Encouragement of Learning**: They promote a “want to learn” mindset, inspiring students to take ownership of their education.
- **Control Over Assessment**: Portfolios give students greater control over their assessment, allowing them to select pieces that best represent their learning and growth.
- **Ongoing Monitoring**: They offer tutors an opportunity to monitor students' ongoing performance and progress, facilitating timely feedback and support.
- **Reflection and Self-Assessment**: Portfolios encourage students to engage in reflective practice and self-assessment, helping them identify strengths and areas for improvement.

Challenges of Student Portfolios

Despite their advantages, student portfolios also pose challenges:

- **Assignment Design**: Assignments must be meticulously designed to ensure they align with learning objectives and effectively assess students' capabilities.
- **Feedback Quality**: Providing constructive feedback is crucial; poor feedback can demoralize students and undermine the portfolio's purpose.

- **Risk of Non-Academic Reflection**: While reflection is vital, total freedom in portfolio content can lead to personal reflections that lack academic rigor.
- **Time-Consuming**: Compiling a portfolio can be time-intensive for students, requiring careful consideration and effort in selecting and reflecting on their work.

Examples of Portfolio Assignments

Example 1:

Students are required to submit a portfolio consisting of 4-8 pieces of coursework, totaling approximately 4,000 words. The interim due date for submitting initial work is November 1, with the final submission due by February 15. The portfolio should encompass a range of writing styles and topics covered in the module, demonstrating coherence and a comprehensive understanding of the material. Examples of coursework might include:

- An exploration of a specific idea, issue, or theory presented during the module.
- Notes reflecting on seminar discussions.
- Responses to assigned readings.
- Initiative writings based on set texts.

Example 2:

A student portfolio must include the following components:

- Two works that showcase the student's growth as a critical thinker (one from the beginning of the course and another from later in the semester).
- A work demonstrating interdisciplinary thinking.
- A piece that reflects knowledge of cross-cultural issues related to ethnic minorities or gender topics.
- A work that highlights skills in utilizing scientific research methods.

In summary, student portfolios are a valuable assessment method that fosters deep learning, reflection, and personal development, while also presenting certain challenges that educators must carefully navigate to maximize their effectiveness.

5.1.11 Group Project as an Assessment Method

Group projects are a collaborative assessment method that allows students to work together to explore and deepen their understanding of a specific topic. This approach not only promotes teamwork but also enables students to apply a wide range of skills in a real-world or simulated context.

Advantages of Group Projects

1. **Demonstration of Abilities**: Group projects provide students with the opportunity to showcase what they can do, allowing for the demonstration of a variety of skills, including practical, analytical, interpretative, and interpersonal abilities.

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2. **Collaborative Learning**: Students can reference each other's work, consult lecturers, and access various sources of information, which enhances their learning experience and fosters a supportive environment.
3. **In-Depth Exploration**: This assessment method enables students to explore a topic more deeply than they might in individual assignments, encouraging thorough investigation and critical thinking.
4. **Real-World Application**: Group projects allow students to apply their knowledge and understanding to real or simulated situations, bridging the gap between theory and practice.
5. **Skill Development**: Students develop essential skills such as management, cooperative teamwork, and leadership, which are valuable in both academic and professional settings.
6. **High Motivation**: The collaborative nature of group projects can lead to high levels of motivation among students, as they work together towards a common goal.
7. **Focus on Process and Product**: Group projects assess both the process of collaboration and the final product, providing a comprehensive evaluation of student engagement and learning outcomes.
8. **Personal Ownership**: Students take personal ownership of their learning, which can enhance their investment in the project and the learning process.
9. **Stakeholder Cooperation**: Group projects often involve collaboration with external stakeholders, providing students with a broader perspective and enhancing the relevance of their work.

Disadvantages of Group Projects

1. **Time-Consuming Design**: Designing and setting up group projects can be time-intensive for instructors, requiring careful planning and coordination.
2. **Complex Grading**: Marking group projects can be complicated and time-consuming. To alleviate this, self-assessment and peer assessment can be utilized.
3. **Monitoring and Feedback**: Providing effective monitoring and feedback throughout the project can be challenging, especially in larger groups.
4. **Plagiarism Risks**: The collaborative nature of group work can lead to potential issues with plagiarism, necessitating clear guidelines and expectations.
5. **Technical Difficulties**: Groups may face technical challenges, particularly if they are working on projects that require specific software or online collaboration tools.

Tips for Implementing Group Projects

- **Joint Topic Formulation**: Collaborate with students to formulate project topics, taking into account their interests to enhance engagement.
- **Network Formation**: Allocate time for students to form networks and build rapport within the classroom, fostering a sense of community.
- **Independent Activities**: Suggest activities that students can undertake independently, promoting initiative and self-direction.

- **Practice Group Work**: Integrate group work practice into the classroom to build students' confidence and skills in collaboration.
- **Address Questions**: Set aside time at the beginning of class to answer any questions that arise from group discussions, ensuring clarity and support.

Assessing Group Work

There are various options for assessing group work, each with its own approach to grading:

- **Option 1**: The instructor assigns one grade to the entire group based on the final product. All group members receive the same grade, regardless of individual contributions.
- **Option 2**: The instructor gives a group grade based on the final product, which serves as an average. It is then up to the group to determine individual grades, ensuring that the average aligns with the instructor's grade. For instance, if a group receives a B for their product, members might assign themselves grades that average to this overall grade.
- **Option 3**: A three-fold assessment approach is utilized, where the instructor grades the final product, group members assess each other, and each member self-assesses their contribution. The final grade for each student is then a combination of 50% instructor's grade, 30% average of peer grades, and 20% self-assigned grade, encouraging accountability and reflection.

Table 5.1 Assessing group-work (dynamics) by its members

Group number: _____

Most of our meetings were confused	1 2 3 4 5	Most of our meetings were well organized
We often got side-tracked during discussions	1 2 3 4 5	We stuck to the task most of the time
We did not listen to each other	1 2 3 4 5	We did listen to each other
Some talked to much, some did not talk enough	1 2 3 4 5	We all contributed to the discussion
We did not think through our ideas sufficiently	1 2 3 4 5	We thought through our ideas well
Some got aggressive and some got upset	1 2 3 4 5	We were able to discuss and argue without rancour
Most of us seemed to be bored by the discussion	1 2 3 4 5	Most of us seemed to enjoy the discussion
The group work did not improve our discussions skills	1 2 3 4 5	We did improve our discussions skills
Most of us did not learn much	1 2 3 4 5	Most of us did learn through our group work

In summary, group projects are a dynamic assessment method that fosters collaboration, skill development, and deep engagement with course content. While they present certain challenges, thoughtful implementation and assessment strategies can enhance their effectiveness in the educational process.

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Assessment matrix for PhD learning outcomes

Learning Outcomes/ Assessment Techniques	**Quizzes**	**Oral Exams**	**Written Exams**	**Essays**	**Projects**	**Case Studies**	**Thinking Exams**	**Take-Home Exams**	**Role-Play Essays**	**Portfolios**	**Self-Assessment**	**Presentations**
Competency 1												
LO1 (DM)	+		+		+							
LO2 (DM)	+		+			+						
LO3 (DM)			+		+							
LO4 (DM)			+	+								
LO5 (DM)				+	+							
LO6 (DCP)	+					+						
LO7 (DCP)	+					+						
LO8 (DCP)					+							
LO9 (DCP)						+						
LO10 (FM)					+							
LO11 (FM)												
LO12 (FM)				+								
Competency 2												
LO1 (UN SDG)	+						+					
LO2 (UN SDG)	+			+								
LO3 (UN SDG)						+						
LO4 (UN SDG)						+						
LO5 (UN SDG)				+								

Learning Outcomes/ Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
Competency 2 (continuation)												
LO6 (CPU)	+					+						
LO7 (CPU)					+							
LO8 (MCSU)						+						
LO9 (MCSU)						+						
LO10 (BCSCS)	+											
LO11 (BCSCS)				+								
LO12 (UN SDG)					+							

Summary of Suggested Assessments:

1. **Quizzes**: Useful for quick checks of understanding, especially in foundational knowledge areas (e.g., LO1, LO2, LO6, LO7).
2. **Oral Exams**: Useful for assessing understanding of complex concepts (e.g., LO5, LO8).
3. **Written Exams**: Effective for assessing comprehensive knowledge across learning outcomes (e.g., LO3, LO4, LO10).
4. **Essays**: Allow for in-depth exploration and critical analysis of topics (e.g., LO4, LO5, LO2, LO11).
5. **Projects**: Encourage practical application of knowledge (e.g., LO3, LO5, LO6, LO8, LO10).
6. **Case Studies**: Provide real-world context for assessing critical thinking and application of knowledge (e.g., LO2, LO6, LO8, LO9).
7. **Thinking Exams**: Encourage higher-order thinking skills and critical analysis (e.g., LO1 from UN SDG).
8. **Take-Home Exams**: Allow for extended response and deeper reflection (not explicitly assigned but can be applied as needed).
9. **Role-Play Essays**: Could be used to simulate real-world scenarios in climate policy and communication (potentially applicable to LO7 and LO12).
10. **Portfolios**: Useful for collecting various works over time, demonstrating growth and understanding (not explicitly assigned but can be applied to multiple LOs).
11. **Self-Assessment**: Encourages reflection on personal learning and understanding (potentially applicable to multiple LOs).
12. **Presentations**: Ideal for demonstrating understanding and communication skills (can be integrated with several LOs).

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Assessment matrix for Master 1 learning outcomes

Learning Outcomes / Assessment Techniques	**Quizzes**	**Oral Exams**	**Written Exams**	**Essays**	**Projects**	**Case Studies**	**Thinking Exams**	**Take-Home Exams**	**Role-Play Essays**	**Portfolios**	**Self-Assessment**	**Presentations**
Competency 1												
LO1 (GCDM)	+											
LO2 (GCDM)			+									
LO3 (GCDM)						+						
LO4 (GCDM)			+									
LO5 (GCDM)				+								
Competency 2												
LO1 (DICS)	+											
LO2 (DICS)												
LO3 (DICS)												+
LO4 (DICS)					+							
LO5 (DICS)												+
Competency 3												
LO1 (CP)	+											
LO2 (CP)												
LO3 (CP)												
LO4 (GCDM)			+									
Competency 4												
LO1 (CRA)												+
LO2 (CRA)												
LO3 (CRA)					+							
LO4 (CRA)												
LO5 (CRA)				+								
LO6 (CRA)												+
Competency 5												
LO1 (SCSC)												
LO2 (CSCS)	+											

Learning Outcomes / Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
LO3 (GVPG)				+								
LO4 (CP)						+						
Competency 6												
LO1 (BCP)												+
LO2 (BCP)				+								
LO3 (MAS)										+		
LO4 (GVPG)					+							
LO5 (MAS)					+							
LO6 (MAS)												+

Summary of Suggested Assessments:

1. **Quizzes**: Useful for quick checks of foundational knowledge (e.g., LO1 GCDM, LO1 DICS).
2. **Oral Exams**: Can be utilized for assessing understanding of climate processes and dynamics (e.g., LO2 GCDM).
3. **Written Exams**: Ideal for comprehensive evaluation of knowledge and critical thinking (e.g., LO4 GCDM, LO4 GCDM).
4. **Essays**: Encourage in-depth analysis of complex topics (e.g., LO5 GCDM, LO5 CRA).
5. **Projects**: Foster practical application and hands-on experience (e.g., LO4 DICS, LO3 CRA).
6. **Case Studies**: Allow for real-world context and critical evaluation of climate data (e.g., LO3 DICS, LO4 CP).
7. **Thinking Exams**: Promote critical thinking and application of knowledge (e.g., LO6 CRA).
8. **Take-Home Exams**: Provide opportunities for reflection and detailed exploration of topics (not explicitly assigned but can be applicable).
9. **Role-Play Essays**: Can be used for simulating real-world scenarios (applicable to LO4 CP).
10. **Portfolios**: Effective for collecting various works to demonstrate growth over time (not explicitly assigned but can be applicable).
11. **Self-Assessment**: Encourages reflection on learning and understanding (potentially applicable to multiple LOs).
12. **Presentations**: Useful for demonstrating understanding and communication of complex information (especially in engaging diverse audiences; applicable to multiple LOs).

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Assessment matrix for Master 2 learning outcomes

Learning Outcomes / Assessment Techniques	**Quizzes**	**Oral Exams**	**Written Exams**	**Essays**	**Projects**	**Case Studies**	**Thinking Exams**	**Take-Home Exams**	**Role-Play Essays**	**Portfolios**	**Self-Assessment**	**Presentations**
Competency 1												
LO1 (ICS)	+											
LO2 (ICS)			+									
LO3 (BCCS)	+											
LO4 (BCCS)			+									
Competency 2												
LO1 (ECC)				+								
LO2 (ECC)				+								
LO3 (ECC)						+						
LO4 (ECC)					+							
LO5 (ECC)												
LO6 (ECC)				+								
Competency 3												
LO1 (ICS)						+						
LO2 (CCP&S)	+											
LO3 (CCP&S)							+					
Competency 4												
LO1 (CCC&PE)												+
LO2 (CCC&PE)												+
LO3 (CCC&PE)					+							
LO4 (CCL&IA)			+									
LO5 (CCL&IA)												
Competency 5												
LO1 (CCM&A)												+
LO2 (CCM&A)	+											

Learning Outcomes / Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
LO3 (CCM&A)												
LO4 (CCM&A)				+								
LO5 (CCM&A)					+							
LO6 (CCM&A)					+							
Competency 6												
LO1 (CRIVA)	+											
LO2 (CRIVA)	+											
LO3 (CRIVA)												
LO4 (CRIVA)												
LO5 (CRIVA)						+						
LO6 (CRIVA)												

Summary of Suggested Assessments:

1. **Quizzes**: Good for quick checks of knowledge, particularly in foundational concepts (e.g., LO1, LO3, LO1 CRIVA).
2. **Oral Exams**: Useful for assessing deeper understanding of complex interactions and consequences (e.g., LO2, LO1 ECC).
3. **Written Exams**: Effective for comprehensive assessments on critical knowledge (e.g., LO4 BCCS, LO4 CCL&IA).
4. **Essays**: Ideal for in-depth analysis and understanding of complex issues (e.g., LO1 ECC, LO4 CCC&PE).
5. **Projects**: Encourage practical application and synthesis of knowledge (e.g., LO6 ECC, LO1 CCM&A).
6. **Case Studies**: Provide real-world context for critical analysis and application (e.g., LO3 ECC, LO1 ICS).
7. **Thinking Exams**: Promote higher-order thinking and critical analysis (e.g., LO3 CCP&S).
8. **Take-Home Exams**: Useful for extended reflection and in-depth exploration of topics (not explicitly assigned but can be applied).
9. **Role-Play Essays**: Can simulate real-world scenarios to assess understanding of complex communication (applicable to LO2 CCC&PE).
10. **Portfolios**: Ideal for collecting various works to demonstrate growth and understanding over time (not explicitly assigned but can be applied).
11. **Self-Assessment**: Encourages reflection on personal learning and understanding (potentially applicable to multiple LOs).
12. **Presentations**: Effective for demonstrating understanding and communication skills (especially in engaging diverse audiences; applicable to multiple LOs).

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Assessment Matrix for Learning Outcomes of the Climate Service Programme

Learning Outcomes / Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
LO1 *Design and operate climate database of climate data and metadata using a climate data management system, including raw, quality-controlled and homogenised records to organize, control, analyze and visualize climate data effectively*	+		+		+	+		+		+	+	+
LO2 *Characterise the climate of the area of study and describe its variability and recent changes*	+		+		+	+	+	+		+		+
LO3 *Prepare socio-economic, sectorial and climate datasets for own usage, considering the necessary spatial and temporal coverage*			+	+	+	+	+	+		+		+
LO4 *Utilise the combined socio-economic, sectorial and climate datasets to extract climate-influenced socio-economic indicators*			+	+	+	+	+	+		+		+
LO5 *Develop and implement climate communication plans and campaigns, tailored to the cultural and educational characteristics of users, using effective materials to support adaptation and mitigation strategies*	+	+	+	+	+	+		+	+	+	+	+
LO6 *Apply program evaluation approaches to assess the effectiveness of climate service delivery, taking into account unique climate challenges the country faces*	+	+	+	+	+	+		+	+	+	+	+

Assessment Matrix for Learning Outcomes of the Climate Change Programme

Learning Outcomes / Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
LO1 Understand how changes in one climate system component can lead to cascading effects and feedback loops, appreciating the complexity of Earth's climate dynamics.	+		+		+	+	+					+
LO2 Recognise and explain the dynamic interplay between the atmosphere and the sea, including the role of ocean currents, heat transfer mechanisms, and the influence of sea surface temperature on atmospheric circulation patterns.	+		+			+	+					+
LO3 Understand the principles of adaptation and its role in reducing vulnerability.		+	+	+		+		+			+	
LO4 Apply various adaptation strategies, including technological, policy-based, and community-driven approaches.		+		+	+	+		+	+		+	+
LO5 Evaluate the costs and benefits of various mitigation options.			+	+	+	+	+	+			+	+
LO6 Evaluate the costs and benefits of various mitigation options (extended application or comparative analysis).			+	+	+	+	+	+			+	+

Summary of Suggested Assessments:

1. **Quizzes** assess conceptual understanding of climate processes and feedbacks (LO1–LO2).
2. **Projects and case studies** test applied skills in adaptation and mitigation planning (LO4–LO6).
3. **Thinking exams (problem-solving exams)** evaluate systems thinking and causal reasoning.
4. **Portfolios** may collect progressive project work and reflective exercises.
5. **Presentations and role-play essays** develop communication and decision-making competencies.
6. **Self-assessment** supports reflection on professional growth and interdisciplinary integration.

Assessment Matrix for Learning Outcomes in Climate-Smart Economic Sector Programmes

Learning Outcomes / Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
LO1 Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the causes of variability and change relevant to the specific sector	+		+			+	+				+	+
LO2 Interpret temperature, precipitation, and other climate indicators in historical data and explain their connections to sectoral impacts			+	+	+	+	+	+		+		+
LO3 Assess climate risks and vulnerabilities by identifying hazards and analyzing socio-economic, environmental, and non-climatic factors		+	+	+	+	+	+	+		+		+
LO4 Evaluate adaptive capacity and determine key risks to develop adaptation or mitigation strategies		+	+	+	+	+	+	+		+		+
LO5 Apply climate service products to identify and analyze climate-related risks and opportunities			+	+	+	+	+	+		+		+
LO6 Develop synthesis reports—including textual, graphical, and cartographic information—to communicate climate impacts and inform decisions		+	+	+	+	+	+	+		+	+	+

Assessment Matrix for Learning Outcomes in Climate-Oriented Policy and Natural Resources Management

Learning Outcomes / Assessment Techniques	Quizzes	Oral Exams	Written Exams	Essays	Projects	Case Studies	Thinking Exams	Take-Home Exams	Role-Play Essays	Portfolios	Self-Assessment	Presentations
LO1 Analyse the nature of contemporary climate change and its environmental, social, and economic impacts across key development sectors, including energy, agriculture, urban systems, and water resources.	+		+	+		+	+				+	+
LO2 Interpret international and national climate policy instruments, energy transition mechanisms, and the "green" transformation in order to assess their role in achieving climate goals and sustainable development in Ukraine.	+	+	+	+		+	+	+	+		+	+
LO3 Explain the principles, institutional mechanisms, and legal foundations of Ukraine's state water policy, taking into account European directives and climate-related challenges.	+	+	+	+		+		+			+	+
LO4 Assess the status of surface and groundwater resources, water balances, and water-related risks (floods, droughts, water scarcity) based on monitoring data, hydrological calculations, and climate information.			+		+	+		+				+
LO5 Apply engineering–hydrological, spatial, and digital tools (models, GIS, remote sensing) to forecast water regimes and support managerial decision-making.					+	+		+		+		+
LO6 Substantiate measures for the rational use, restoration, and protection of water resources, including nature-based solutions, to enhance water security and the resilience of aquatic ecosystems under climate change.				+	+	+	+	+		+	+	+

ANNEXES

Annex 1. Syllabus

Course/Project Title

Overview

A general description of the training required that summarizes the key goals and states why the training is important to accomplish for your organisation or region.

Audience Description

Primary audience for the training, and any secondary audiences, if they will impact any of your decisions

The assumed current knowledge and skills, or prerequisite knowledge and skills, of the primary audience, and any other characteristics that will guide your decisions

Competencies

Overview of the learning needs at the level of the individual learners, organization, country, or region. Some description of how these were identified and determined as valid needs.

Job competencies to be addressed by the training

Learning Outcomes and Performance criteria

Desired learning outcomes of the planned event, written in terms of skills that can be assessed. You may want to begin with the statement: "After completing the training, participants will be able to…" Also include specific actions, tools or objects worked with, and the context of application, if possible. Be as specific as you can be.

Content Scope

Provide a content outline consistent with learning objectives or outcomes. This could be the course outline as it would be presented to students, but not necessarily a complete syllabus.

Include a high level list of all topics you feel are necessary to cover and/or the skills that must be developed. If you think it will help clarification, state what will NOT be covered.

Learning Solutions and Delivery Modes

*List the learning solutions (modes of training) used and **why** you have chosen them. For example: classroom training, online learning, blended learning, on-the-job training, online resources for self-directed learning, coaching or mentoring, etc.*

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Learning Strategies

Consider which learning strategies you will use. Provide justification for why you want to use them, including why they will help learners achieve your intended learning outcomes.

Consider an appropriate blend of strategies that complement one another.

You do not need to describe the actual activities in any detail in this section.

Learning Activities

Describe the major learning activities that will be included, including lectures, readings, cases, discussions, exercises, assignments, simulations, role-play, etc.

Describe the roles of trainers and learners during the activities

Learning Assessment

Describe your plan for assessing learners before, during, and/or after the course, including tests, exercises, graded activities, and projects or products to be evaluated. Describe the use of self or peer assessment, if used. Show how assessment is linked to the Learning Outcomes.

Training Storyboard

Use one of the recommended methods to produce a visual storyboard of your blended training event.

Learning Resources and Tools

List existing resources you will use for readings or presentations, activities, case studies, data, etc. Describe content resources you will need to search for.

Describe the technologies that will be used to support training development and delivery, including instructional technologies and operational equipment.

Examples of Syllabi

TDP Example 1: WMO/Eumetcal Online Course for Trainers of RA-VI

TDP Example 1: WMO/Eumetcal Online Course for Trainers of RA-VI

TDP Example 3: Practical Meteorological Course

TDP Example 4: Mesoscale Convective Systems in Southeastern South America

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Annex 2. A Syllabus Example

Course Title

Economics of climate change

Overview

Global climate change poses a threat to the well-being of humans through impacts on the basic elements of life for people around the world – access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms. Change is occurring at so swift a rate that a society has very little time to adopt and mitigate climate change. Climate change varies from region to region and have various effects on different sectors of economics.

Therefore, it is necessary that climatologists know basics of world and regional economics, understand how climate change impacts on the various sectors of economy, and are able to develop and apply main strategy of climate change adaptation and mitigation.

The proposed course focuses on giving master students professional competences in accordance with the WMO training and retraining programs.

The course "Economics of climate change" may include several levels of training, depending on the educational needs and level of education of the audience.

A course that combines elements of online and offline training (blended study) will be proposed to master students throughout the entire period of study. The course lasts 2 semesters.

Audience Description

The main audience is master students of universities, who receive education in the field of meteorology and climatology.

Participants must be divided into groups depending on the level of education and the goals for which they attend the course.

Master students have to acquire knowledge concerning the Earth's general circulation and climate system in terms of the physical and dynamical processes that are involved, and the mechanisms responsible for climate variability and climate change (including the influence of human activity).

Competencies

The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response. Using the results from formal economic models, the estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more.

So prompt and strong action is clearly warranted. Because climate change is a global problem, the response to it must be international. It must be based on a shared vision of long-term goals and agreement on frameworks that will accelerate action over the next decade, and it must build on mutually reinforcing approaches at national, regional and international level.

Therefore, specialists in the climatology and meteorology have to be able to obtain and analyze climate data, interpret climate prediction and climate change projection, develop climate change mitigation and adaptation strategies.

Competencies that learners have to succeed during studying course "Economics of climate changes":

Master students, specialists in meteorology and climatology have to

1. Create and/or interpret climate forecasts, climate projections and model output.
2. Communicate climatological information with users.

Learning Outcomes and Performance criteria

LEARNING OUTCOMES

After completing the training, master students will be able

- articulate key issues relating to climate change;
- create and/or analyze climate forecasts, climate projections and model output;
- detail and assess critically the relationships between climate change and economic development, in particular the major impacts of climate change on economic development and of economic development on climate change;
- assess impact of climate change on natural resource potential and the socio-economic indicators of the region;
- create value-added products and a specialized climate forecast for various economic sectors and quantify the degree of uncertainty of this forecast;
- propose own climate change mitigation and adaptation strategies or improve existent one using economic assessments;
- assess the benefits of climate change mitigation and adaptation strategies at the regional level under uncertainty.

PERFORMANCE CRITERIA

- compute Climate Indices for the monitoring of climate change, climate variability and climate extremes;
- apply statistical and geo-statistical analysis to monitor the spatial distribution and temporal evolution of climate;
- create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as health, agriculture, water, energy and disaster management;
- locate, select and retrieve climate forecasts and climate models output generated by Regional Climate Centers, Global Producing Centers and other institutions;
- create sub-seasonal, seasonal and longer scale forecast products;
- create future climate projections using climate models over selected domain for different scenarios and parametrization;
- evaluate the performance of climate models output and quantify the associated uncertainties;
- create value-added products, such as graphics, maps and reports to communicate climate forecasts and climate model information;
- assess risks of climate change and quantify economic damages from climate change;
- prioritize the communication of climatological information according to social, political and economic relevance;
- develop and implement climate change mitigation and adaptation strategies.

Content Scope

Course of "Economics of climate changes" consists of 7 modules:

1. **Description of the climate system and their components.** The atmosphere. The ocean. The cryosphere. The land surface and the terrestrial biosphere.
2. **Introduction to Climate Change.** Internal climate variability. Global warming, radiative forcing, greenhouse gases, feedbacks. The Carbon Cycle. Basic Facts on Emissions. Climate Change Observation.
3. **Climate Change Impacts.** Global social systems. Regional social systems. Biological systems. Geophysical systems. Extreme events. Vulnerability, adaptive capacity, tipping points. Planetary boundaries.
4. **Modelling the climate system.** A hierarchy of models. Components of a climate model. Numerical resolution of the equations. Testing the validity of models. Emission scenarios. Climate projections for the 21st century.
5. **Coupling the economy and the climate.** Modelling issues. Introduction to Integrated Assessment Models (IAMs). The macroeconomics of climate change. Damages from climate change. The choice of the discount rate. Uncertainty. Classification of uncertainties. Willingness to pay for a risk reduction. Uncertainty and Discounting. Regional issues and spatial climate models.
6. **Climate Policy.** Policy responses to mitigation and adaptation**.** Carbon taxes. Cap-and-Trade. The EU-ETS. Carbon Capture and Storage (CCS). Reducing emissions from deforestation and degradation (REDD). Adaptation to Climate Change. International Cooperation in Theory and Practice: International agreements. The Kyoto Protocol. COP21-The Paris Agreement. Solar Radiation Management (SRM).
7. **Mitigation and adaptation strategies in different sectors, including land and bioenergy, cities and transport, power generation and geoengineering.** Linking adaptation and mitigation within climate policy mechanisms. Policy and technology requirements. Policy options.

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Learning Solutions and Delivery Modes

For the master students, it is desirable to choose formal classroom learning for several reasons:

1) students will be trained on the basis of the Odessa State Environmental University (practical criteria);
2) they of all the audiences are the least prepared for independent learning and they may not have developed time management skills (learning needs);
3) these audiences more than other ones need the support of the teacher and closer contact with him (pedagogical values).

Sometimes it is supposed to combine classroom learning with elements of informal online one, since students will be encouraged to independently work, in addition such delivery mode greatly helps to hone obtained skills and gives constant access to educational materials.

In this case, the elements of online learning can be used to achieve the same training level by students at the beginning of the studies, since students from different universities may have different knowledge and skills and, as a result, it may obstruct to undergo the course. For example, if a preliminary assessment of the training level of students shows that they should develop some knowledge and skills before starting the course, the online training will include a set of online lessons based on the personalized learning pathways.

Elements of online learning will include tests, additional educational resources reflecting recent advances in climate and its changes, and will be used as an optional part of the course until properly adapted to the student.

Upon completion of the course, students will be awarded certificates.

Learning Strategies

During training following learning strategies will be used:

Lectures and Readings (Lectures and existing online resources will help gain required scientific knowledge in the field of climate change and its impact on the global and regional economies and they also assist to introduce students to main adaptation and mitigation strategies for climate change);

Inquiry strategies (These strategies help students get acquainted with the needs of the workplace and how production objectives may be achieved);

Case-based learning strategies (Situational analysis will require practice in issuing specialized climate forecasts through cases and simulations);

Discussion strategies (Meetings and debriefings assist students to become more critical thinker and make good decisions and better choices during developing adaptation and mitigation strategies for climate change);

Project-based Learning strategies (Developing project help access vulnerability various region to climate change and elaborate adaptation and mitigation policies for climate-sensitive sectors of the global and regional economies).

So many strategies will be used in the training because it meets two main selection criteria such as flexibility and variety. All of the strategies help provide the most opportunities to think and practice in more ways.

All of the strategies also meet practical and learning needs criteria because help develop complex skills and knowledge.

Learning Activities

Master students

Training activities for the master students will consist of lectures, which will comprise approximately 20% of the total time allotted for the course. Practical exercises will be implemented in the form of various practical tasks (20% of the time), situational analysis (30%) and case study/project (30%). The situational analysis and the project will also include discussions that will be held either upon completion of the task or during its performance. Self-assessment and final control tests will be offered for the sections of the course to test the knowledge.

Practical exercises will cover the following topics:

1. Processing of climate information and presentation of the results in the form of products with additional functionality, taking into account the needs of various sectors of the economy.
2. Interpretation of maps, graphs for analyzing the current state of the climate system. Comparison of the results with the climate inventory data.
3. Production, processing and interpretation of climate model products. Comparative analysis of the climate model products for various scenarios i.e. A1, B1, RCP 4.5, RCP8.5, etc.

In this case, the inquiry strategy will be implemented, since all of the tasks are the ones that the climatologist faces in practice. The role of the teacher in this case is great, since the choice of such a strategy should control the learning process and support students who have difficulties

Cases (situational analysis) will include a research on topics:

C1. Preparing a specialized climate forecast for a specific sector of the economy (transport, energy, construction, city management, etc.) and quantify the degree of uncertainty of this forecast.

C2. Assessment of the impact of the climate change on various sectors of the economy (transport, energy, construction, city management, etc.)

C3. Developing climate change mitigation and adaptation strategies for various economic sector (transport, energy, construction, city management, etc.) or certain city, town or village

During the entire training period, the project must be completed:

C4. Comprehensive assessment for vulnerability of a particular region to the climate change. Recommendations for development of measures to adapt the region to the climate change.

Based on the climatological information obtained for a specific region of Ukraine in 1991–2016, its socio-economic indicators and natural resource potential, assess climate changes that are already occurring in the region and the dangerous consequences they lead to. Based on data from various scenarios, e.g, A1, A2, RCP4.5, RCP8.5, etc,, make an assessment of the possible effects of the climate change that will occur in the future. Determine the degree of uncertainty for this assessment. Propose adaptation measures for the climate change and its mitigation. Calculate the climate, the social and the economic risks.

The role of the teacher in the strategy of experiential learning, which involves implementation of a case study, is the role of the leader and instructor who only guides the process. The previous tasks The student is to be prepared for independent implementation of the project through the instrumentality of previous task performance.

Learning Assessment

In the process of training master students, the following assessment methods will be applied:

1) online test input control, which will be used to identify the level of training of master students;

2) consolidation of theoretical material will be tested using online tests for self-assessment, which can be used by students to better master the theoretical part of the course and analyze errors, and online final tests, the score for which will be taken into account when deriving the final mark for the course;

3) practical tasks, materials for which will be available on the course website (tasks and tracking of the stages of implementation will be available in online and offline modes);

4) seminars on the proposed topics, on which students can acquire the experience of mutual assessment (how fully the speaker described the topic, whether all the facts were stated, whether the conclusions were made and how these conclusions reflect the essence of the report);

5) discussions and round tables, which will be held at the final stage of training and will be devoted to the discussion of the most important problems in the field of climate change;

6) application of the method of situational analysis. When applying this method of assessment, it is also possible for students to develop mutual assessment skills (in this case, students can use the following criteria for mutual evaluation: whether all factors were taken into account when analyzing a situation, whether a fairly complete analysis was made at all stages of work, does this study have a practical significance, etc.);

7) final test assessment (exam).

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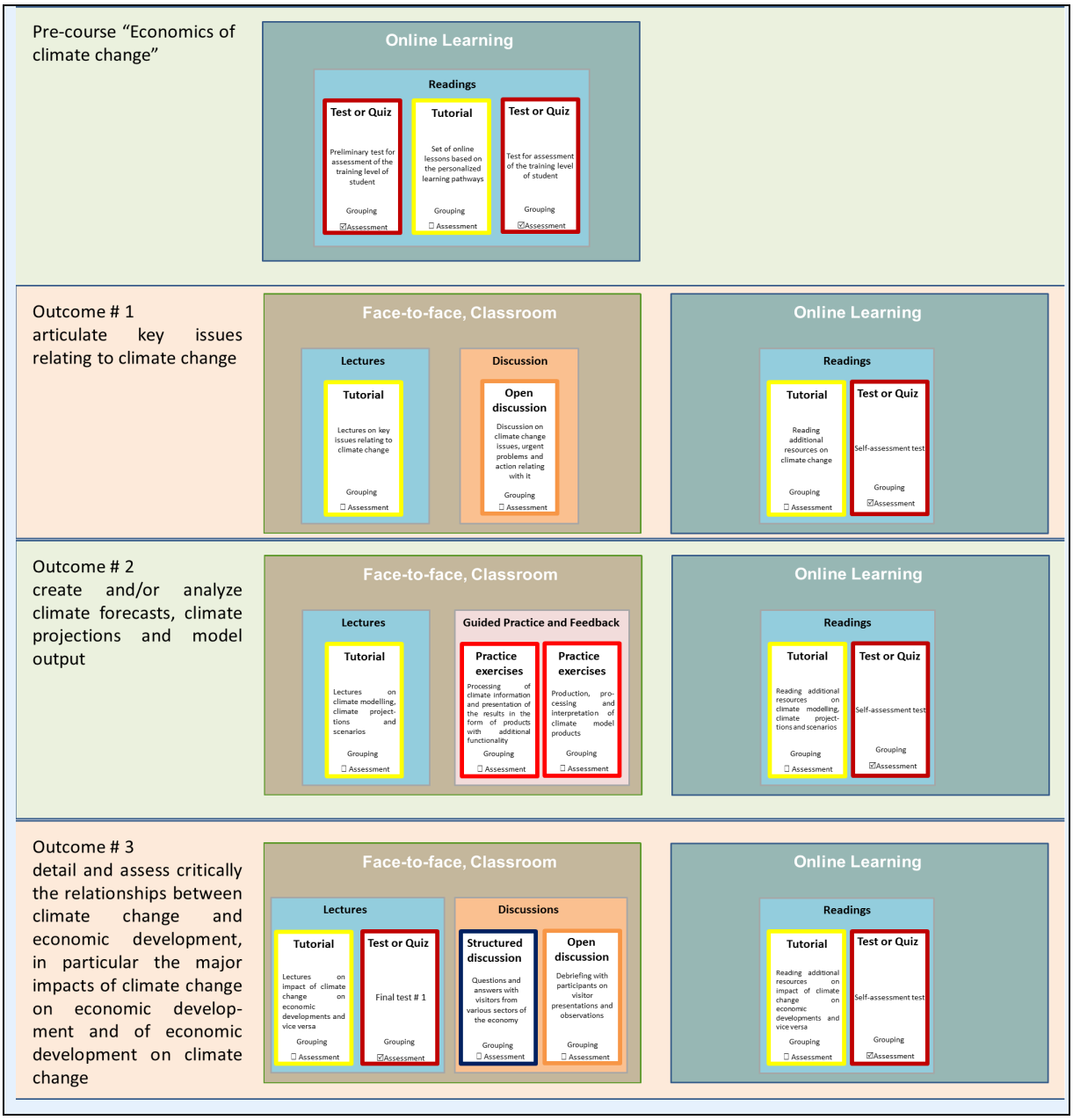
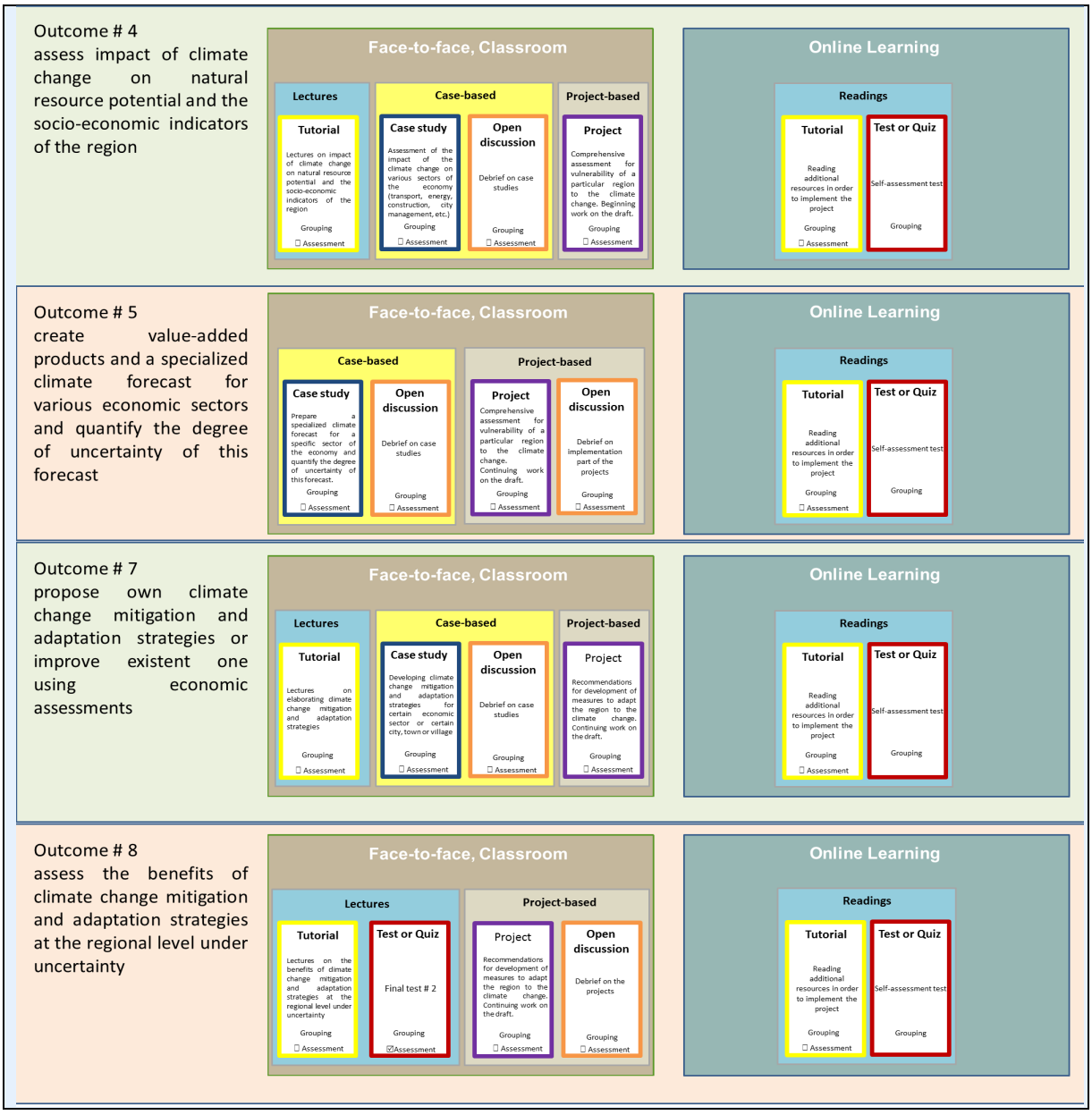
Training Storyboard





Learning Resources and Tools

Books:

1. *IPCC, 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H. -O. Pörtner, D.C. Roberts, M.*
2. *IPCC (2018). Masson-Delmotte, V.; Zhai, P.; Pörtner, H. O.; Roberts, D.; et al. (eds.). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (PDF). Intergovernmental Panel on Climate Change.*
3. *Neelin, J. David, 2011: Climate change and climate modeling, (Cambridge Univ. Press, Cambridge), 282 pp. (e-textbook)*
4. *Stern Review: The Economics of Climate Change. http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf*
5. *Stocker, Thomas, 2014, Introduction to Climate Modelling, Springer, ISBN 978-3-642-00773-6, 174 pp. (e-textbook)*
6. *Pierrehumbert, Raymond T., 2010: Principles of Planetary Climate, (Cambridge University Press, Cambridge, UK), 680 pp. (e-textbook)*

URL:

1. *https://climatedataguide.ucar.edu/ Description of bases of climate data*
2. *http://www.ipcc.ch/index.htm Assessment reports*
3. *http://www.esa.int/Our_Activities/Observing_the_Earth/Space_for_our_climate/ Using and interpretation of satellite information in climatology*
4. *http://www.climate.be/textbook/ebook.html. Introduction to climate dynamics and climate modelling. E-book.*

Resources for preparation to discussions

On-line resources:

https://www.meted.ucar.edu/

https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/

http://www.skepticalscience.com/

MOOC (https://sdgacademy.org/courses/)

1. Macroeconomics for a Sustainable Planet
2. Planetary Boundaries
3. The Age of Sustainable Development
4. Cities and the Challenge of Sustainable Development
5. Globalization: Past and Future

Scientific papers:

1. *Rockström and 27 co-authors (2009)* ***'A Safe Operating Space for Humanity'*** *https://www.ecologyandsociety.org/vol14/iss2/art32/*
2. *Steffen and 17 co-authors (2015)* ***'Planetary Boundaries: guiding human development on a changing planet'.*** *http://precaution.org/lib/steffen_planetary_boundaries(incl_supplemental).150213.pdf*
3. *Climate change: observed impacts on planet Earth/ edited by Trevor M. Letcher. – 1st ed.p. cm Includes bibliographical references and index. 2009. 444 pp. ISBN 978-0-444-53301-2.*
4. *The Kyoto Protocol.*
5. *COP21-The Paris Agreement.*

For case studies:

climate indices of interaction between ocean and atmosphere (calculation procedures, historical archive of all indices)

http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml

current climate data and climatic indices

http://www.ecad.eu/dailydata/index.php

climate data library (weekly, monthly, seasonal averaged data; climate indices)

http://iridl.ldeo.columbia.edu/

climate data (gridded climate data, climate model simulation, reanalysis dataset etc.)

https://www.esrl.noaa.gov/psd/data/

For implementation of the Project:

1. above-listed databases
2. statistical compendiums for various regions of Ukraine, Russian Federation and other countries of the CIS for determination of socio-economic indicators of the region.
3. assessment reports on climate changes for Ukraine, Russian Federation and other countries of the CIS.
4. Оценка уязвимости к изменениям климата и разработка мер по адаптации к изменениям климата и смягчения последствий. (Assessment of vulnerability to climate change and development of climate change adaptation and mitigation strategies)
   Оцінка вразливості до змін клімату: Україна/ О.Г.Шевченко та ін. – Myflaer, Київ, 2014. - 62 с. http://necu.org.ua/wp-content/uploads/ukraine_cc_vulnerability.pdf
5. Climate norms for the 1961–1990 period

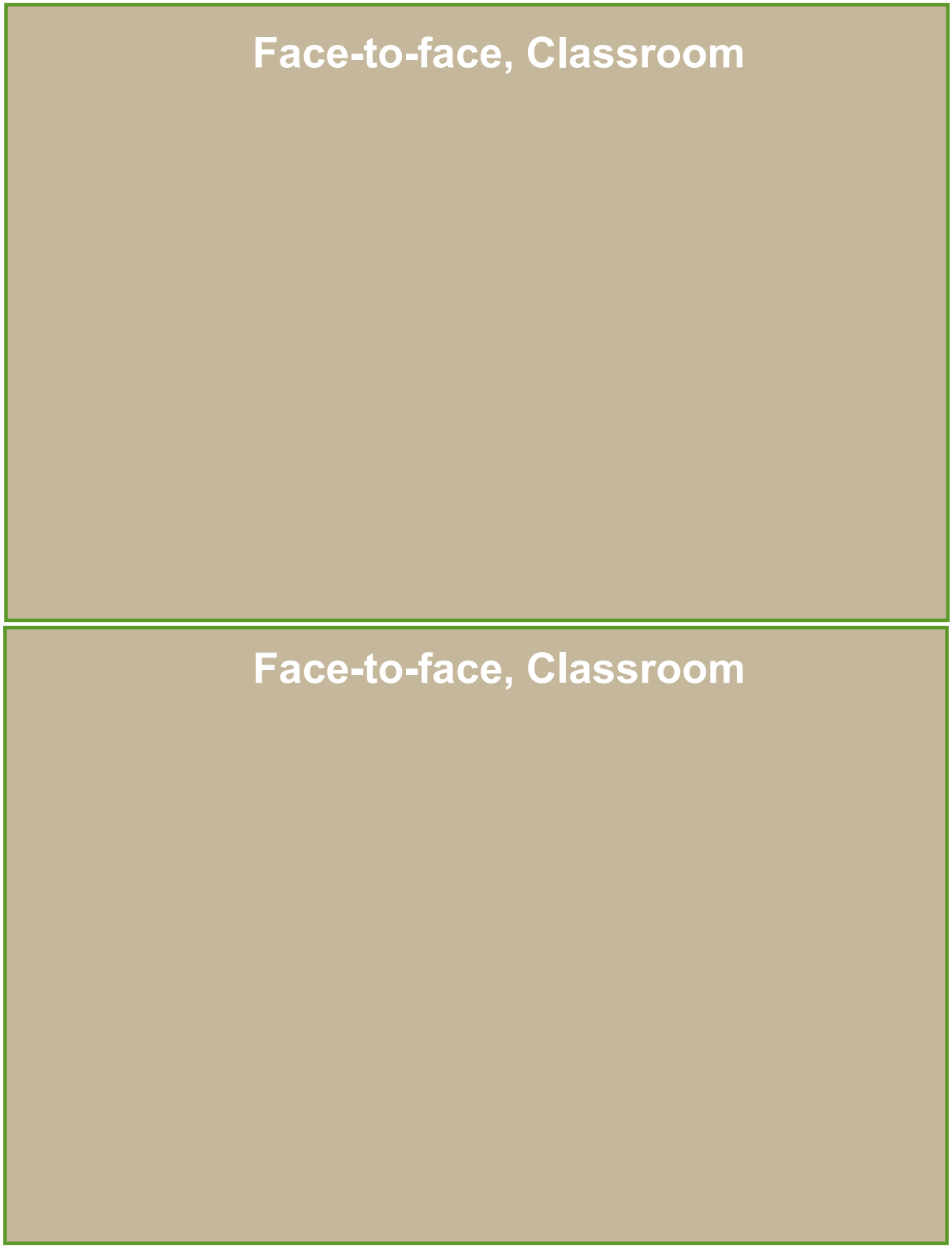
There is a computer class with Internet access and required programs for conducting of calculations for implementation of practice tasks and the Projects.

Content resources you will need to search for

1. more detailed information on socio-economic indicators
2. techniques of assessment of climate and socio-economic risks
3. techniques of assessment of uncertanties

Own online resource on Economics of climate change in Odessa State Environmental University is developed.

Annex 3. Story board materials



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Online Learning

Online Learning

Informal, On-the-job, In-the-field

Informal, On-the-job, In-the-field

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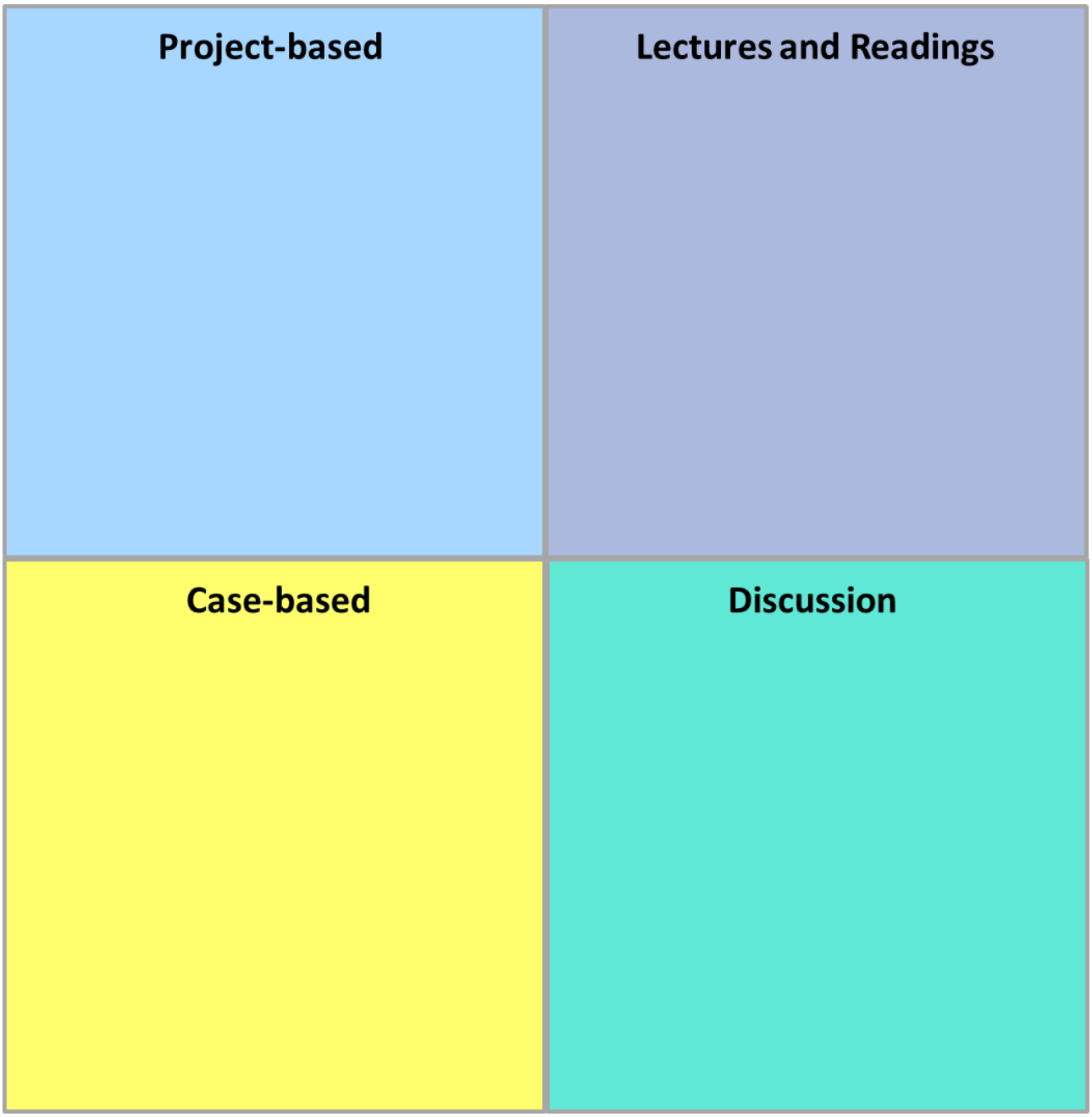
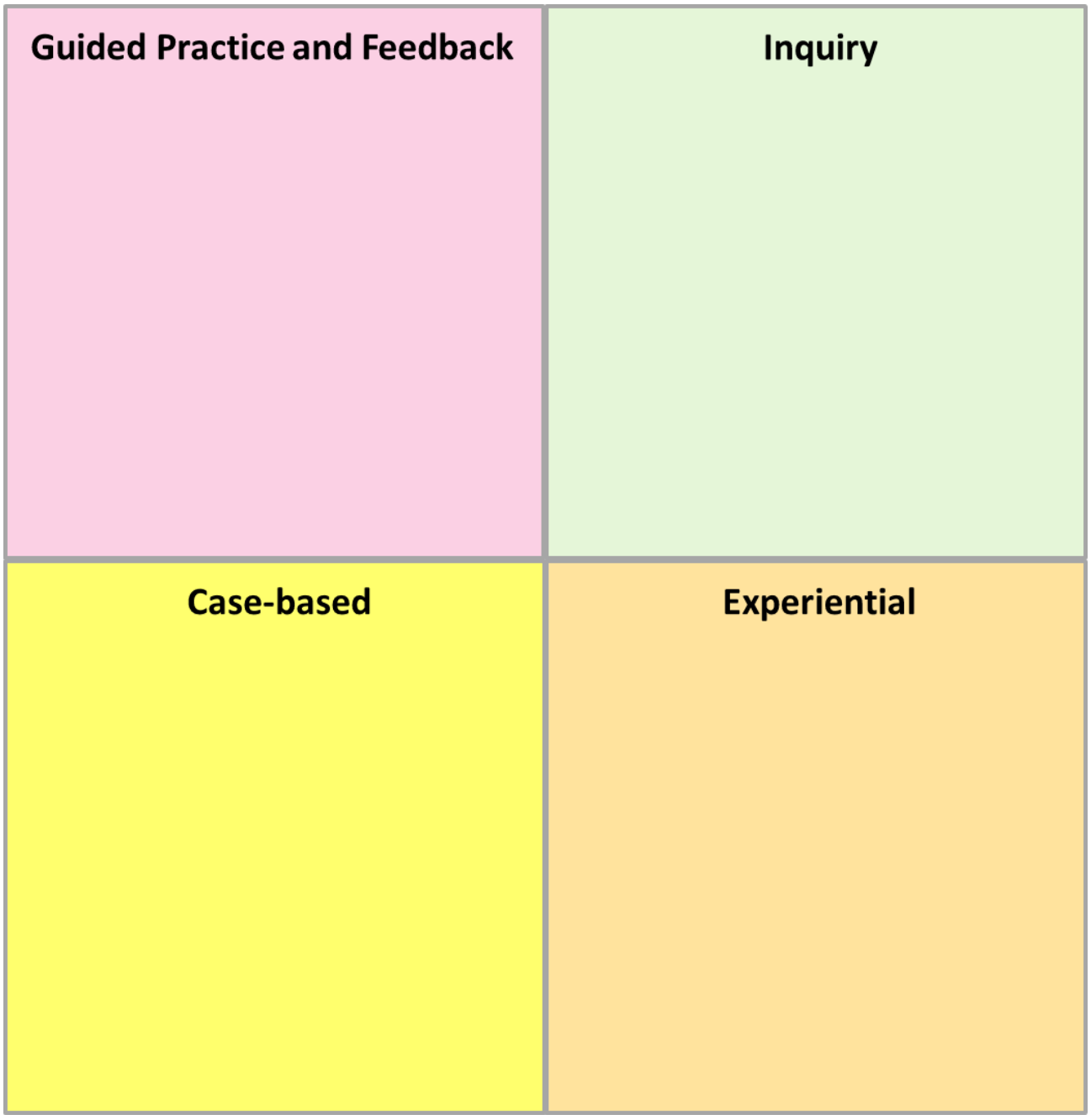

Project-based
Lectures and Readings
Case-based
Discussion



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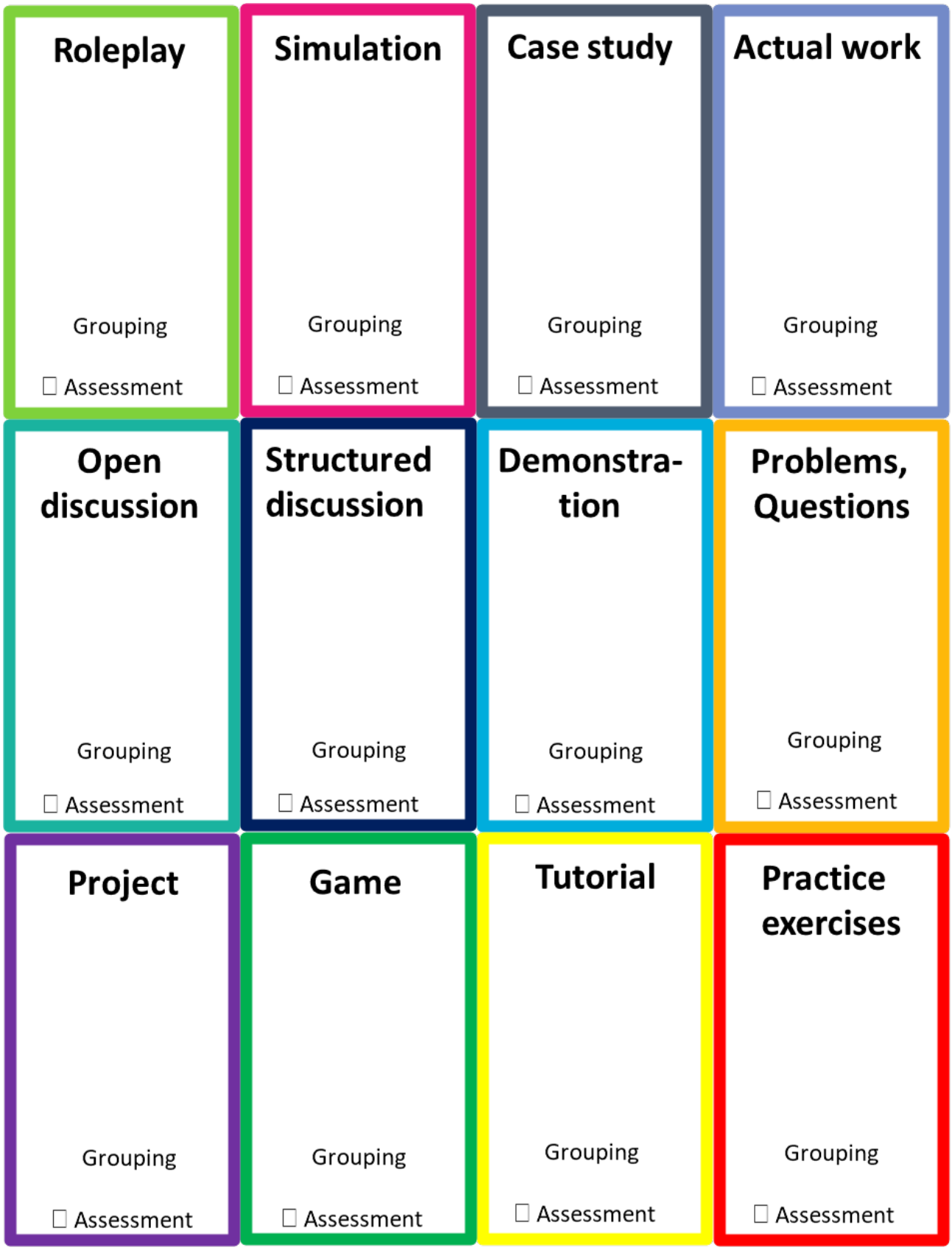
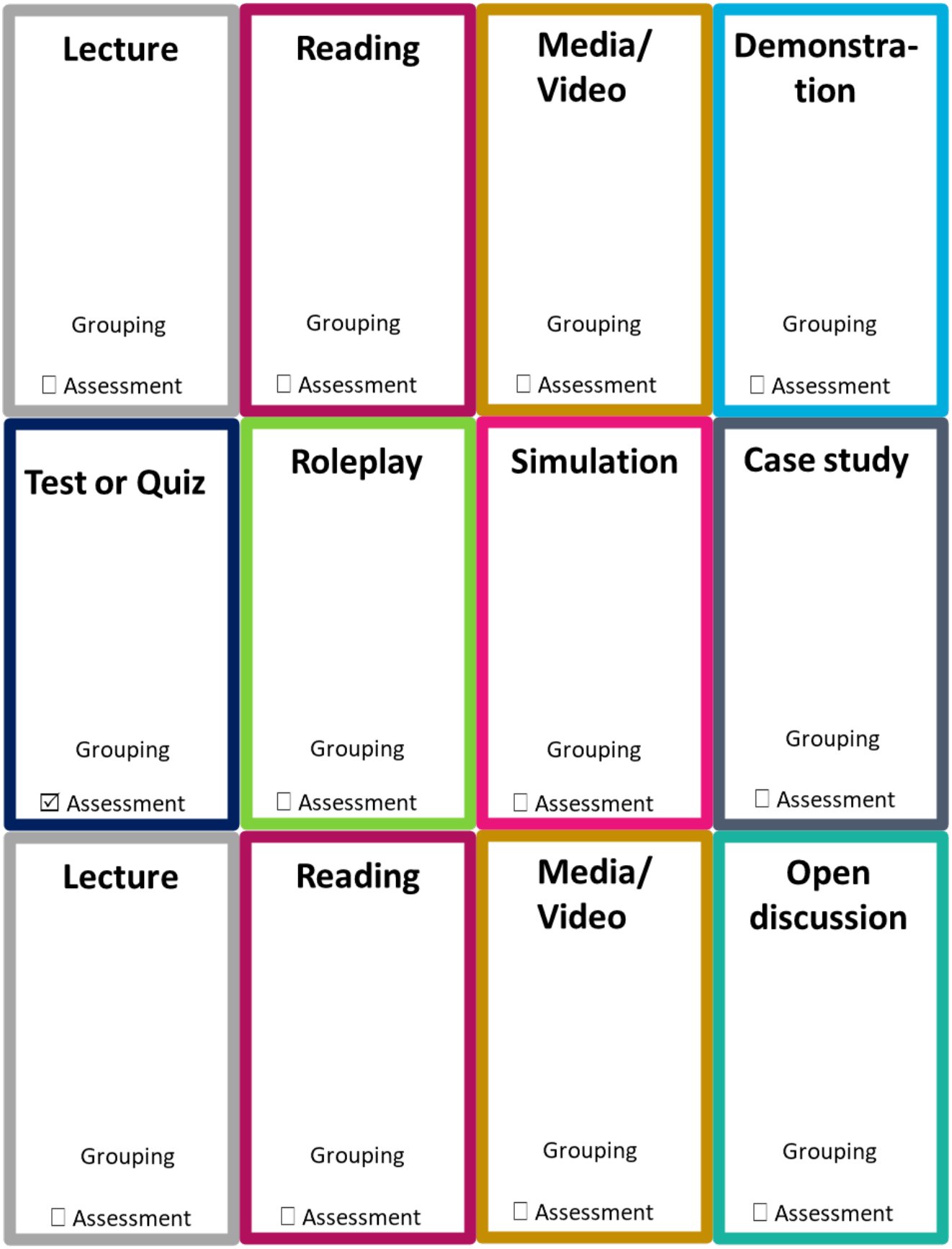

Roleplay
Grouping
Assessment
Simulation
Grouping
Assessment
Case study
Grouping
Assessment
Actual work
Grouping
Assessment
Open discussion
Grouping
Assessment
Structured discussion
Grouping
Assessment
Demonstra-tion
Grouping
Assessment
Problems, Questions
Grouping
Assessment
Project
Grouping
Assessment
Game
Grouping
Assessment
Tutorial
Grouping
Assessment
Practice exercises
Grouping
Assessment



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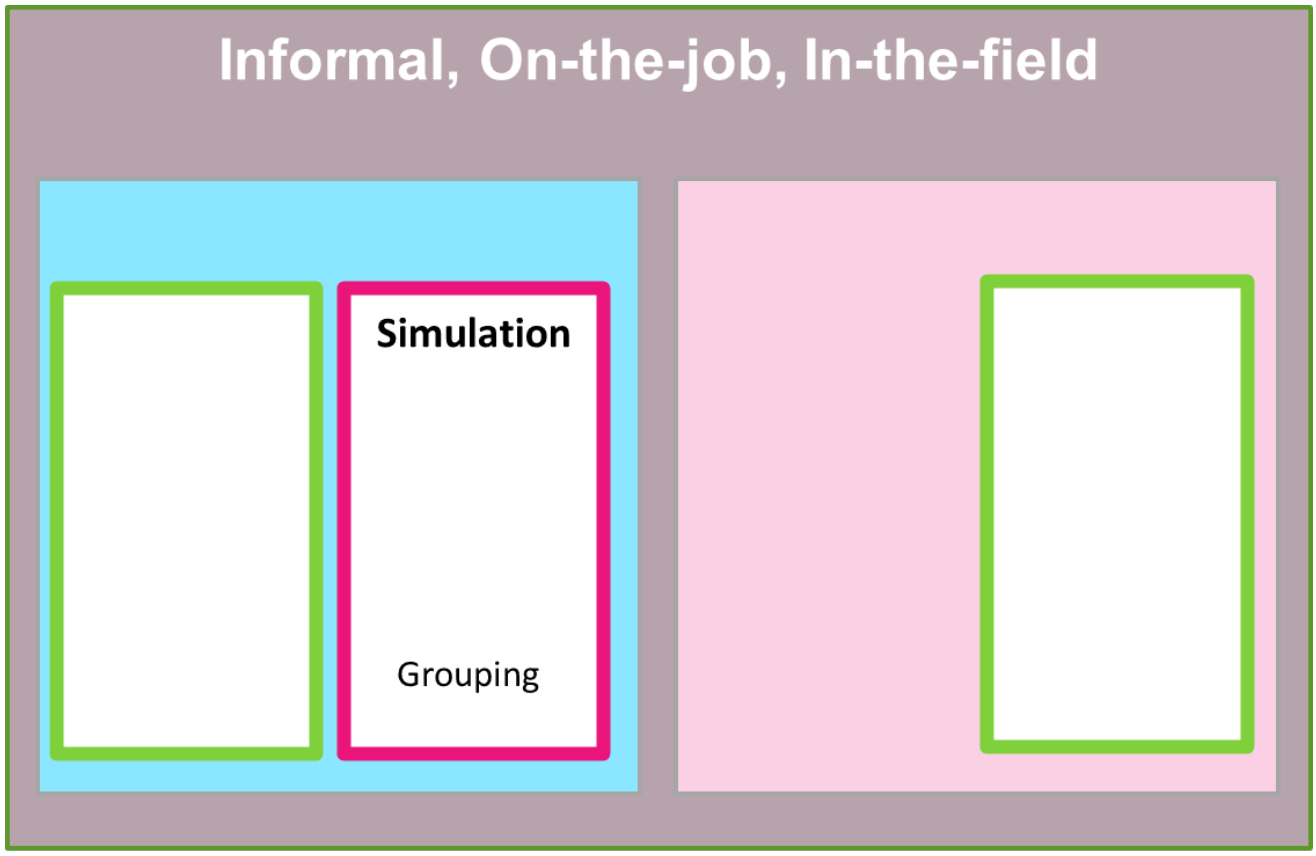
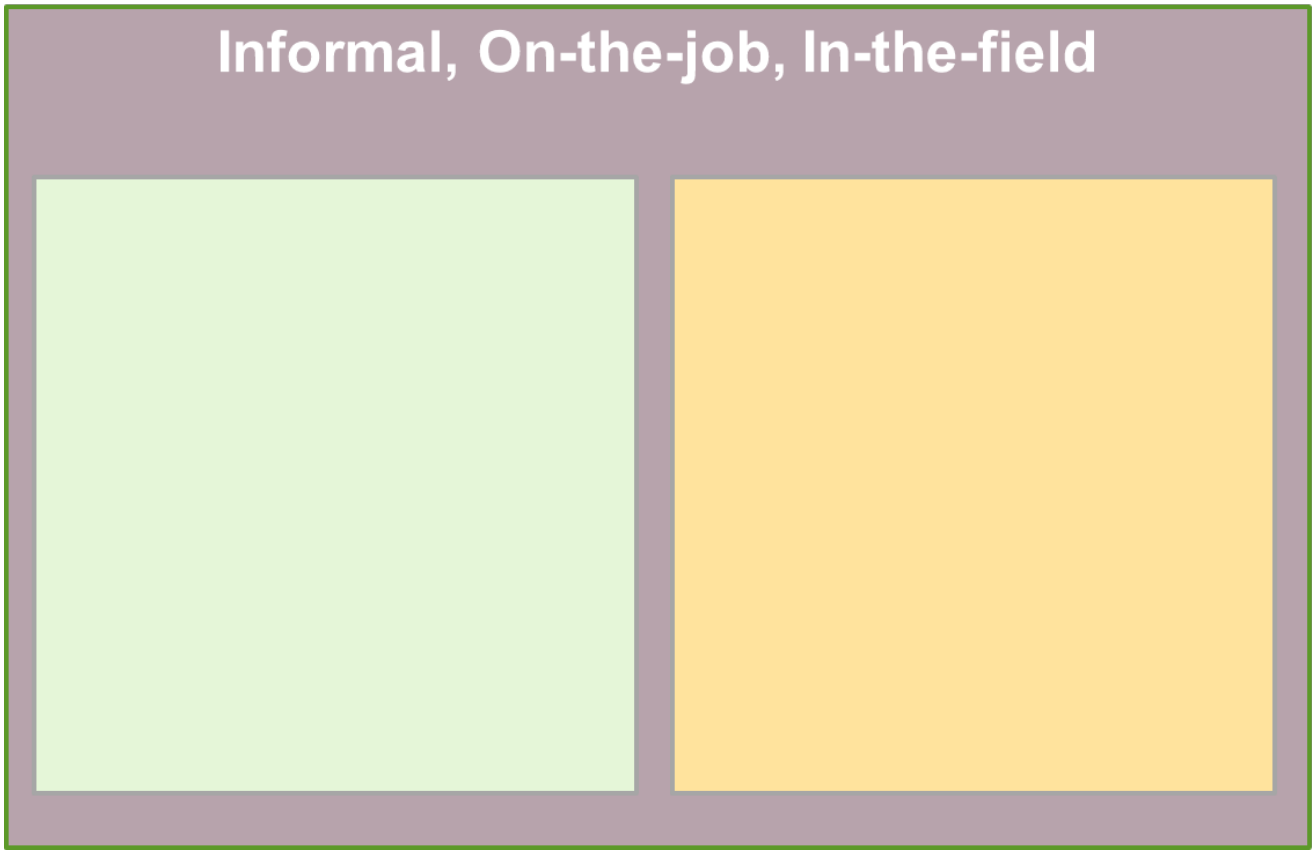
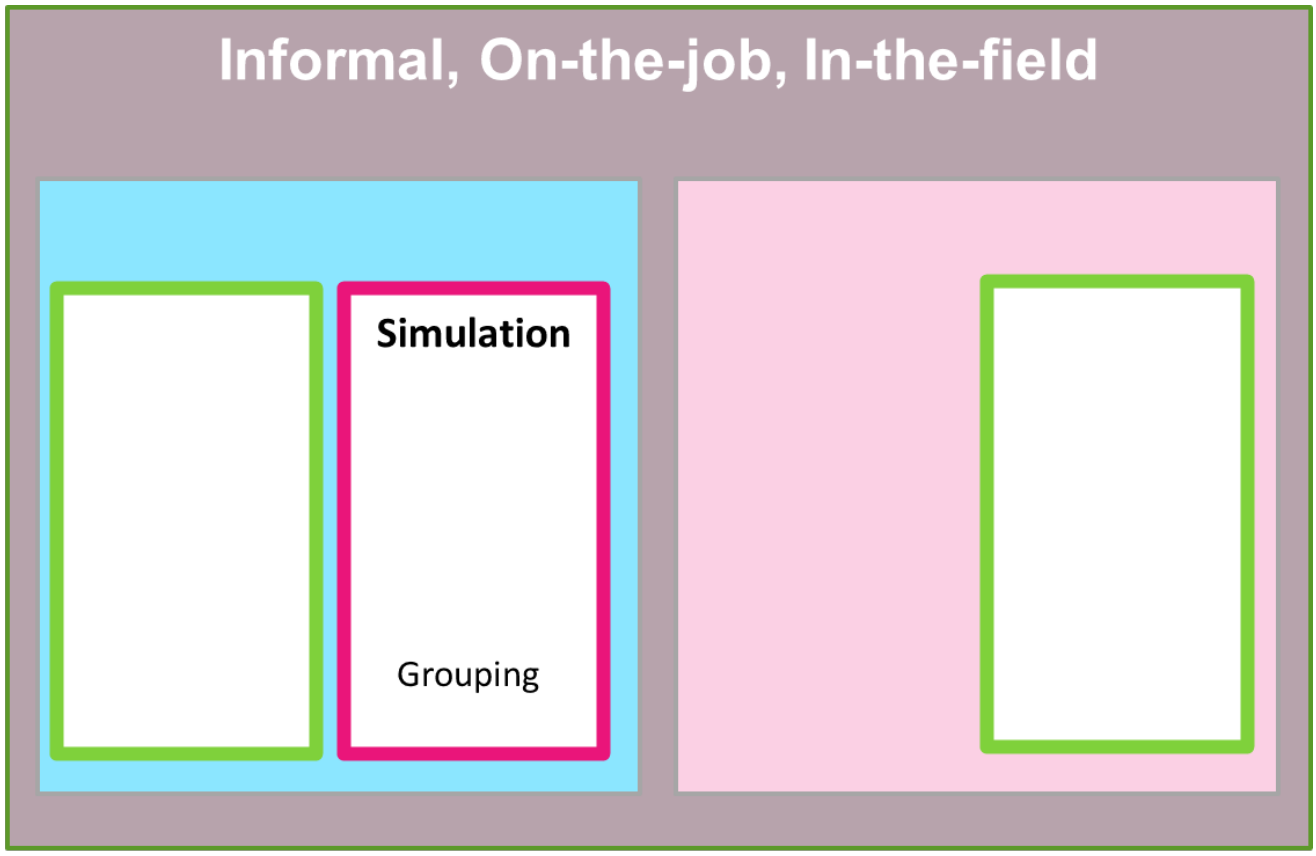
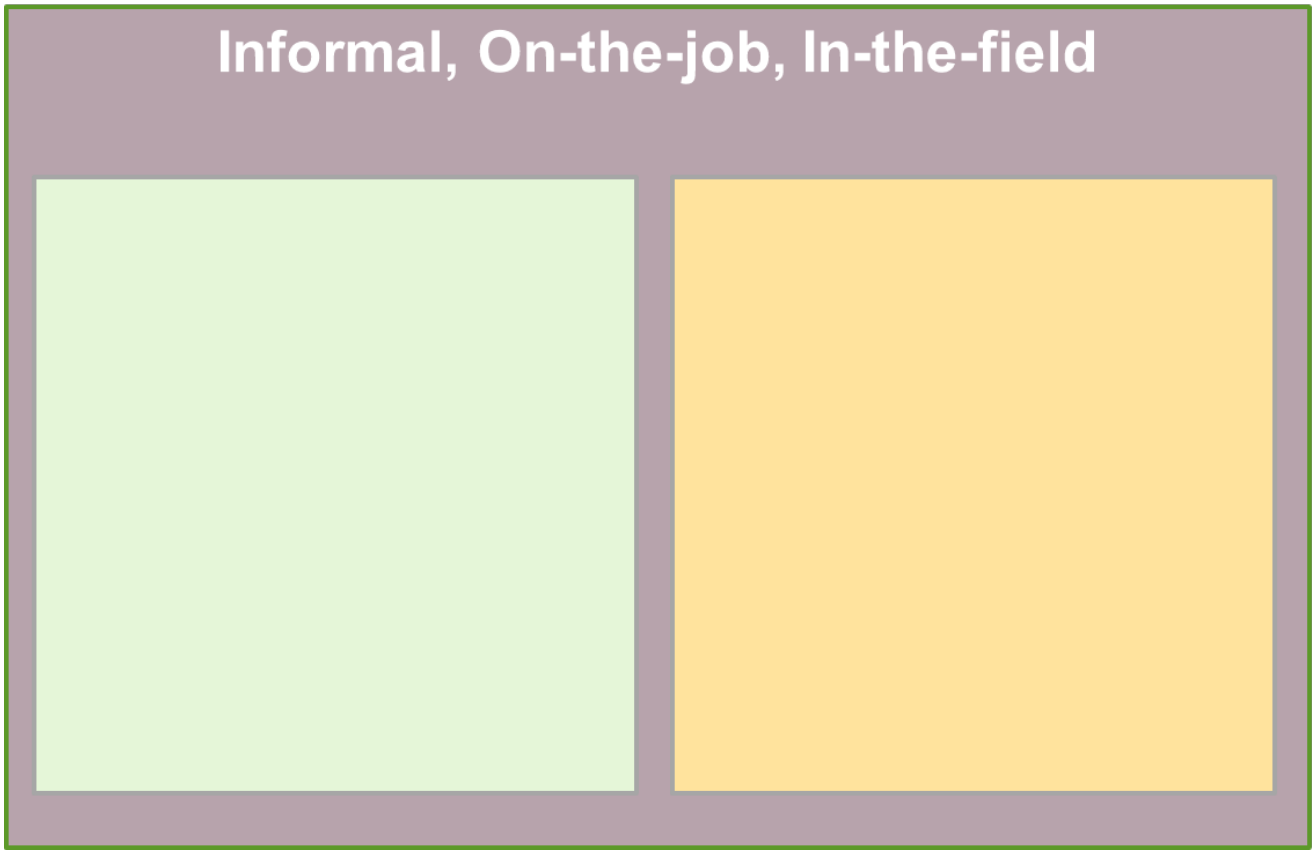

Informal, On-the-job, In-the-field
Simulation
Grouping


Informal, On-the-job, In-the-field





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Annex 4. Competencies and Learning Outcomes in Climate Service PhD Courses

Assessing Climate Change Impacts Across Sectors and Scales

C1. Assessment of the impact of climate change, variability and extremes on different areas/spheres (society, environment, economy, etc.) at different scales, taking into account the full range of links between the climate system components and transdisciplinary interactions with society

- LO1. Explain the workflow of climate dataset creation and management, including the successive application of data rescue, quality control, homogenization and integration into a climate database management system. DM
- LO2. Describe the geographical characteristics and historical events influencing the climate observing network, including political events and changes in observing policies and instrumentation. DM
- LO3. Demonstrate proficiency in using various software tools essential for climate data management, including office suites, statistical packages, GIS, and specific quality control and homogenization packages. DM
- LO4. Design a database of climate data and metadata using a climate data management system, including raw, quality controlled and homogenized records. DM
- LO5. Create, document, and analyse specific purpose climate datasets, including metadata and explanations of their suitable uses and associated uncertainties. DM
- LO6. Retrieve climate and sectorial data from original sources inside and outside of the organization, organize, store, and document it. DCP
- LO7. Characterize the normal climate of the study area and describe its variability and recent changes, applying descriptive statistical methods and significance analysis. DCP
- LO8. Analyse and explain the climate of the study area and its spatial and temporal changes by applying knowledge of climate classifications, inferential and multivariate statistics, and geostatistical techniques, including data interpolation methods. DCP
- LO9. Effectively create synthesis reports that convert climate products into accessible climate services for users by utilizing and adapting various software tools for climate data analysis and climate product generation. DCP
- LO10. Create sub-seasonal, seasonal and longer-scale forecasts for different geographical regions including measure of uncertainty tailored to specific user needs. FM
- LO11. Perform forecast verification on model outputs using WMO standard verification techniques. FM
- LO12. Formulate and apply different types of climate scenarios, including incremental, analogue, and global climate models, using appropriate boundary conditions, radiative forcing, and model parameterization. FM

Strategizing Climate Mitigation and Adaptation for Sustainable Development

C2. Creation, development and improvement of concepts/ideas and strategies for climate change mitigation and adaptation independently or in cooperation with representatives of climate-sensitive economic sectors, public authorities, private enterprises, etc. to achieve the sustainable development goals

- LO1. Critically analyse the complex interactions among the atmosphere, land, biology, and oceans, including the feedback mechanisms within the Earth system, while considering the impacts of human activities on the Earth's environment. UN SDG
- LO2. Critically analyse the historical evolution and contemporary frameworks of sustainability, evaluating the political and socio-economic factors influencing on sustainability policies. UN SDG

LO3. Identify the major global megatrends and their implications for current and future environmental, social, and economic changes, with a particular emphasis on how these trends affect the sustainability of climate-dependent sectors. UN SDG
LO4. Evaluate the role and impact of the Sustainable Development Goals, with a particular focus on SDG 13 - Climate Action, in facilitating sustainability transitions into various economic sectors and at various governmental levels. UN SDG
LO5. Evaluate future scenarios for the Earth system under different development pathways by utilizing climate models and future climate projections, to understand potential outcomes and advance sustainability agendas aligned with the UN Sustainable Development Goals. UN SDG
LO6. Evaluate the current climate policy framework in Ukraine, including national legislation, international commitments, and institutional arrangements. CPU
LO7. Detect and propose the best climate policy options for a selected area or economic sector based on an economic cost-benefit analysis, considering long-term socioeconomic and climate change uncertainties. CPU
LO8. Apply program evaluation approaches to assess the effectiveness of service delivery and stakeholder engagement. MCSU
LO9. Update climate services in alignment with WMO standards by conducting a comprehensive analysis of stakeholder needs, considering their field of activity, constraints, timelines, expectations, terminology, and the extent of climate impact. MCSU
LO10. Make use of appropriate channels of communication, including management of social media and liaison with media agents. BCSCS
LO11. Formulate climate information in language that is both scientifically accurate and tailored to the intended users, integrating information about uncertainties and risks in the delivery.. BCSCS
LO12. Propose innovative strategies to advance sustainability agendas by integrating practices aligned with the UN Sustainable Development Goals into various economic sectors and at various governmental levels. UN SDG

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Annex 5. PhD Programme in Climate Service

PhD Programme in Climate Service

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Dataset Management	DM	**5**
2	Deriving Climate Products	DCP	**4**
3	Forecasting Models	FM	**3**
4	UN Sustainable Development Goals and Goal 13	UN SDG	**6**
5	Climate Policy in Ukraine	CPU	**2**
6	Management of Climate Service in Ukraine	MCSU	**2**
7	Building Communication Skills in Climate Service	BCSCS	**2**
TOTAL			**24**

Subject: Dataset Management (5 ECTS, C1) Abbrev. DM		
Key Words	Build Dataset, Quality Control of Data, Homogeneization, Create and Store Dataset, Output Data	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply quality control processes to climate data and resulting time series	**The module 1: Workflow and Quality Control in Climate Dataset Management:** Explain the workflow of climate dataset creation and management, including the successive application of data rescue, quality control, homogenization and integration into a climate database management system	1,0
Assess the location and characteristics of the observation sites against the requirements for a climate observation reference network	**The module 2: Geographical and Historical Contexts in Climate Data** Describe the geographical characteristics and historical events influencing the climate observing network, including political events and changes in observing policies and instrumentation.	1,0
Conduct climate data preservation and rescue procedures	**The module 3: Climate Data Handling and Software Proficiency** Demonstrate proficiency in using and adapting various software tools essential for climate data management, including office suites, statistical packages, GIS, and specific quality control and homogenization packages	1,0
Collect and store in relational databases climate data and metadata	**The module 4: Climate Data Organization and Metadata Management** Design a database of climate data and metadata using a climate data management system, including raw, quality controlled and homogenized records;	1,0
Create, archive, and document climate datasets.	**The module 5: Creation and Analysis of Climate Datasets** Create, document, and analyze specific purpose climate datasets, including metadata and explanations of their suitable uses and associated uncertainties	1,0

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Subject: Deriving Climate Products (4 ECTS, C2) Abbrev. DCP		
Key Words	Basic Climate Indices (eg: extremes); Sectorial Climate Indices; Statistical Analysis (descriptive and exploratory); Report (write + graphics)	
Performance Criteria	**Learning Outcomes**	**ECTS**
Identify and retrieve climate data from different sources to generate climate products	**The module 1: Data Retrieval and Management for Deriving Climate Products** Retrieve climate and sectorial data from original sources inside and outside of the organization, organize, store, and document it	1,0
Accurately compute basic climate products, including normals, averages, anomalies, and sector-specific climate indices tailored to specific analytical needs.	**The module 2: Descriptive Statistical Methods for Climate Analysis** Characterize the normal climate of the study area and describe its variability and recent changes, applying descriptive statistical methods and significance analysis	1,0
Apply statistical and geostatistical analysis to monitor the spatial distribution and temporal evolution of climate	**The module 3: Advanced Climate Analysis Techniques** Analyze the climate of the study area and its spatial and temporal changes by applying knowledge of climate classifications, inferential and multivariate statistics, and geostatistical techniques, including data interpolation methods.	1,0
Create value-added products, such as graphics, maps and reports to explain climate characteristics and evolution, according to the needs of specific sectors such as health, agriculture, water, energy and disaster management	**The module 4: Climate data analysis and product generation** Effectively create synthesis reports that convert climate products into accessible climate services for users by utilizing and adapting various software tools for climate data analysis and climate product generation	1,0

Subject: Forecasting Models (3 ECTS, C3) Abbrev. FM		
KeyWords	Forecasts, Projections (seasonal and long term), Scenarios, Statistical Analysis (descriptive + exploratory), Report (Report (write + graphics), Uncertainty in Climate Models and Climate Projections	
Performance Criteria	**Learning Outcomes**	**ECTS**
Create sub-seasonal, seasonal and longer scale forecast products	**The module 1: Creating Climate Forecasts** Create sub-seasonal, seasonal and longer-scale forecasts for different geographical regions including measure of uncertainty tailored to specific user needs	1,0
Evaluate the performance of climate models output and quantify the associated uncertainties	**The module 2: Performing Forecast Verification** Perform forecast verification on model outputs using WMO standard verification techniques	1,0
Create future climate projections using climate models over selected domain for different scenarios and parametrization	**The module 3: Applying Climate Scenarios** Formulate and apply different types of climate scenarios, including incremental, analogue, and global climate models, using appropriate boundary conditions, radiative forcing, and model parameterization	1,0

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Subject: UN Sustainable Development Goals and Goal 13 (6 ECTS, C3, C2 & C5) Abbrev. UN SDG		
Key Words	Climate Evolution, Atmospheric Patterns, SDGs, Economic and Social Structure, Ways of Transition to Sustainability under Climate Change, Future Projections, Impact, Communication	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to climate of the region of interest to be taken into account under specific problem solution implementation	**The module 1: Earth System and its trajectories in the Anthropocene** Critically analyse the complex interactions among the atmosphere, land, biology, and oceans, including the feedback mechanisms within the Earth system, while considering the impacts of human activities on the Earth's environment.	1,0
Assess the potential implications of identified global megatrends on future scenarios and trends in specific contexts	**The module 2: Global Megatrends: Drivers of Current and Future Change** Identify the major global megatrends and their implications for current and future environmental, social, and economic changes, with a particular emphasis on how these trends affect the sustainability of climate-dependent sectors	1,0[8]
Evaluate current sustainability policies, and develop a strategic plan for implementing sustainable practices in a chosen sector	**The module 3: The Development of the Concept and Politics of Sustainability** Critically analyse the historical evolution and contemporary frameworks of sustainability, evaluating the political and socio-economic factors influencing on sustainability policies	1,0
Critically evaluate how specific Sustainable Development Goals contribute to sustainability transitions at global, regional and local levels	**The module 4: The UN Sustainable Development Goals in Sustainability Transitions** Evaluate the role and impact of the Sustainable Development Goals in facilitating global sustainability transitions, with a particular focus on SDG 13 - Climate Action, in facilitating sustainability transitions into various economic sectors and at various governmental levels	1,0[9]
Select the best ways to implement the sustainable development goals in Ukraine	**The module 5: Future Scenarios and Ways of Transitions to Sustainability** Evaluate future scenarios for the Earth system under different development pathways by utilizing climate models and future climate projections, to understand potential outcomes and advance sustainability agendas aligned with the UN Sustainable Development Goals	1,0
Evaluate current sustainability policies, and plans for implementing sustainable practices in a chosen sector	**The module 6: Innovative strategies** Propose innovative strategies to advance sustainability agendas by integrating practices aligned with the UN Sustainable Development Goals into various economic sectors and at various governmental levels	1,0[10]

[8] The module will be developed by Ukrainian partner universities in relevant sectors.
[9] The module will be developed by Ukrainian partner universities in relevant sectors.
[10] The module will be developed by Ukrainian partner universities in relevant sectors.

Subject: Climate Policy in Ukraine (2 ECTS, C3 & C5) Abbrev. CPU		
Key Words	Key political, social and economic sectors in Ukraine; Compute Climate Products for key sectors; Statistical analysis; Effective Communication (policies)	
Performance Criteria	**Learning Outcome**	**ECTS**
Work closely with decision and policy-makers to develop the best strategy for the implementation of international climate agreements in Ukraine	**The module 1: Analysis and Evaluation of Climate Policy Framework** Evaluate the current climate policy framework in Ukraine, including national legislation, international commitments, and institutional arrangements	1,0
Conduct competent economic cost-benefit analysis and quantify strengths and weaknesses of the climate policy solutions proposed	**The module 2: Cost-Benefit Analysis of Climate Policy Proposals** Detect and propose the best climate policy options for a selected area or economic sector based on an economic cost-benefit analysis, considering long-term socioeconomic and climate change uncertainties	1,0

Subject: Management of Climate Service in Ukraine (2 ECTS, C4) Abbrev. MCSU		
Key Words	WMO Standards, Quality Management, Monitoring, Policy Formulation, Stakeholder engagement	
Performance Criteria	**Learning Outcome**	**ECTS**
Monitor the functions of climate services, including validation of data, products and services	**The module 1: Program Evaluation for Climate Services** Apply program evaluation approaches to assess the effectiveness of service delivery and stakeholder engagement.	1,0
Make decisions about service improvement based on evaluation results	**The module 2: Enhancing Climate Services through Stakeholder Analysis:** Update climate services by conducting a comprehensive analysis of stakeholder needs and characteristics, including operations, limitations, time frames, expectations, terminology, climate impact considerations, and adherence to World Meteorological Organization (WMO) standards.	1,0

Subject Building Communication Skills for Climate Service (2 ECTS, C5) Abbrev. BCSCS		
Key words:	Media liaison, Tailored messaging, Audience-specific language, Effective communication	
Performance Criteria	**Learning Outcomes**	**ECTS**
Establish effective communication channels with users of climate services and build outreach capacities, such as Regional Climate Outlook Forums etc;	**The module 1: Effective Communication Strategies for Climate Services** Make use of appropriate channels of communication, including management of social media and liaison with media agents	1,0
	The module 2: Tailoring Climate Information for Diverse Stakeholders Formulate climatological information in a language which is both scientifically sound and adapted to the chain of foreseen users, integrating the communication of uncertainties and risks in the delivery of climate information;	1,0

Annex 7. Competencies and Learning Outcomes of Climate Service Master's Courses

Climate Dynamics Understanding

C1. Identify and analyze the climate change causes and critical points of the Earth as a single system to quantify the contribution of climate change and human activity to the socio-economic system

- LO1. Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the nature and causes of climate variability and climate change. GCDM
- LO2. Comprehend the key processes driving climate dynamics, such as radiative forcing, greenhouse gas concentrations, ocean currents, atmospheric circulation, and feedback mechanisms. GCDM
- LO3. Describe the teleconnection between sea-surface temperature patterns and seasonal variation in rainfall and other hydro-climatic variables for the region of interest. GCDM
- LO4. Differentiate between natural climate variability and anthropogenic influences, and analyze the causes and impacts of variations and long-term changes in the climate system. GCDM
- LO5. Understand how changes in one component of the climate system can lead to cascading effects and feedback loops, appreciating the complexity of Earth's climate dynamics. GCDM

Data Management and Analysis

C2. Obtain climate information to meet the needs of the end user, using all available services and climate databases (IRI/LDEO Climate data Library, Copernicus Climate Data Store, IS-ENES Climate4Impact, etc.)

- LO1. Collect information on additional sources of climate data and metadata and use it to prepare and run data-rescue campaigns. DICS
- LO2. Discuss the strengths and weaknesses of the observational network and data availability for climate studies. DICS
- LO3. Apply quality control and homogenization techniques and evaluate the quality and homogeneity of a climate data network after gathering documentary, statistical, and graphical evidence. DICS
- LO4. Design a database of climate data and metadata using a climate data management system, including raw, quality-controlled, and homogenized records. DICS
- LO5. Create and document climate datasets for specific purposes, including metadata and an explanation of their possible uses and associated uncertainties. DICS

Climate Products

C3. Create and interpret various climate products for different geographic regions and time periods, using all available state-of-the-art tools and techniques to provide quality information tailored to the user's needs, including an explanation of their possible uses and associated

- LO1. Tailor climate data and information to meet the specific needs of diverse end users, such as policymakers, researchers, and industry professionals, ensuring the relevance and usability of the information provided. CP
- LO2. Make use of climate data, climate indices, other climate-related information and sectorial data to derive climate product. CP
- LO3. Define the impact of climate on strategic sectors, especially GFCS key sectors: agriculture and food security, disaster risk reduction, energy, health and water. CP
- LO4. Operate climate models output to create sub-seasonal, seasonal and long-term climate forecasts for different climate scenarios, assessing their quality and uncertainty. GCDM

Climate Impact Assessment

C4. Assess the vulnerability, resistance and adaptability of the economy sector or economy as a whole to climate risks, in the context of current and future climate and environmental changes in Ukraine

- LO1. Explain the key concepts of impact, risk, vulnerability, adaptation capacity, and uncertainty related to climate variability and climate change. CRA

LO2. Recognize regional variations in climate change and the potential impacts of climate change on different sectors (e.g., agriculture, water resources, health, and infrastructure). CRA
LO3. Choose and apply suitable analytical tools and methodologies for conducting climate vulnerability and risk assessments, ensuring accuracy and reliability of results. CRA
LO4. Prioritize vulnerabilities and risks based on severity, likelihood, and potential impact on vulnerable communities, ecosystems, and economic sectors. CRA
LO5. Provide a detailed analysis of short-term and long-term social and economic consequences of climate change. CRA
LO6. Use appropriate economic models to evaluate damages and identify adaptation needs based on these economic assessments. CRA

Climate Communication

C5. Ensure constant and effective communication to end users/stakeholders to identify and select the best solutions for the economy and society as a whole

LO1. Select, among the available climate products, those suitable to explain the impact of climate over the sectors of economic activity, social, and geopolitical key issues, while integrating uncertainties and risks in the delivery of climate information. SCSC
LO2. Present climate data and findings in a clear and effective manner, using visualizations, reports, and presentations that are accessible to both technical and non-technical audiences. CSCS
LO3. Assess how gender-related factors contribute to vulnerabilities among different individuals and groups, including the impact of socio-cultural norms, economic disparities, and access to resources on their ability to respond to climate risks. GVPG
LO4. Create synthesis reports, including textual, graphical, and cartographic information, to convert climate products into climate services and communicate them to users. CP

Policy and Resilience Strategy Development

C6. Evaluate and design climate action plans and resilience strategies, including the analysis of successful case studies, the creation of adaptation strategies, and the integration of climate justice principles to ensure equitable and effective outcomes.

LO1. Critically evaluate the effectiveness of various climate action plans and strategies, including those outlined in the Paris Agreement, assessing their potential impact on global and national scales. BCP
LO2. Analyse and synthesize case studies of successful climate resilience initiatives from various global contexts, identifying key factors that contributed to their success and applying these insights to develop effective resilience strategies for different regions. BCP
LO3. Design and propose effective adaptation strategies tailored to specific climate risks, integrating principles of resilience and sustainability to enhance the adaptive capacity of affected communities. MAS
LO4. Design and propose adaptation strategies that address the unique needs of vulnerable gender-specific groups, ensuring inclusive and equitable approaches to resilience-building and resource allocation. GVPG
LO5. Design and propose low-emission solutions across different sectors, including energy, agriculture, and business, incorporating innovative technologies and policies to achieve substantial reductions in greenhouse gas emissions. MAS
LO6. Analyse the implications of climate justice in the design and implementation of adaptation strategies, ensuring equitable and inclusive outcomes. MAS

Annex 8. Master Programme in Climate Service

Master Programme in Climate Service

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Fundamentals of Global Climate Dynamics and Modelling	GCDM	**6**
2	Data and Information for Climate Services	DICS	**5**
3	Climate Products (Climate and Socioeconomic Indicators for Climate Services)	CP	**4**
4	Gender, Specifically Vulnerability Persons and Groups	GVPG	**2**
5	Climate Risk Assessment	CRA	**6**
6	Communication Skills for Climate Service	CSCS	**2**
7	Basic of Climate Policy (International and National aspects)	BCP	**2**
8	Mitigation and Adaptation Strategies in Ukraine for different sectors including…	MAS	**3**
	TOTAL		**30**

Subject: Fundamentals of global climate dynamics and modelling (6 ECTS) Abbrev. GCDM		
Key Words:	*Global Climate Systems, Climate Evolution, Atmospheric Patterns, Climate Modelling, Future Projections*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to climate of the region of interest to be taken into account under specific problem solution implementation	**Module 1: Introduction to Atmospheric Processes and Climate Systems** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
	Module 2: Climate Dynamics and Key Driving Processes Comprehend the key processes driving climate dynamics, such as radiative forcing, greenhouse gas concentrations, ocean currents, atmospheric circulation, and feedback mechanisms.	1,0
	Module 3: Teleconnections and Regional Hydro-Climate Variability Describe the teleconnection between sea-surface temperature patterns and seasonal variation in rainfall and other hydro-climatic variables for the region of interest;	1,0
	Module 4: Natural vs. Anthropogenic Climate Influences Differentiate between natural climate variability and anthropogenic influences, and analyze the causes and impacts of variations and long-term changes in the climate system	1,0
	Module 5: Complexity and Feedback Loops in Earth's Climate System Understand how changes in one component of the climate system can lead to cascading effects and feedback loops, appreciating the complexity of Earth's climate dynamics	1,0
	Module 6: Climate Modelling and Prediction Operate climate models output to create sub-seasonal, seasonal and long-term climate forecasts for different climate scenarios, assessing their quality and uncertainty	1,0

Subject: Data and Information for Climate Services (5 ECTS) C1 Abbrev. DICS		
Key Words:	Build Dataset, Quality Control of Data, Homogeneization, Create and Store Dataset, Output Data	
Performance Criteria	Learning Outcomes	ECTS
Conduct climate data preservation and rescue procedures	**Module 1. Climate Data Collection and Data-Rescue** Collect information on additional sources of climate data and metadata and use it to prepare and run data-rescue campaigns	1,0
Apply quality control processes to climate data and resulting time series; Assess climate data homogeneity and adjust inhomogeneous time series;	**Module 2 Evaluating Observational Networks for Climate Studies** Discuss the strengths and weaknesses of the observational network and data availability for climate studies	1,0
	Module 3 Quality Control and Homogenization of Climate Data Apply quality control and homogenization techniques and evaluate the quality and homogeneity of a climate data network after gathering documentary, statistical and graphical evidences	1,0
Create, archive and document climate datasets for	**Module 4 Climate Data Management Systems and Database Design** Design a database of climate data and metadata using a climate data management system, including raw, quality controlled and homogenized records	1,0
	Module 5 Creating and Documenting Climate Datasets Create and document climate datasets for specific purposes including metadata and an explanation of their possible uses and associated uncertainties	1,0

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Subject: Climate Products (Climate and Socioeconomic Indicators for Climate Services) (C2, 4 ECTS) Abbrev. CP		
Key Words:	*Basic Climate Indices (eg: extremes); Sectorial Climate Indices; Statistical Analysis (descriptive and exploratory); Report (write + graphics)*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Compute sector-specific climate indices and other sector-oriented climate products	**Module 1. Deriving Climate Products from Data and Indices** Make use of climate data, climate indices, other climate-related information and sectorial data to derive climate product	1,0
Apply statistical and geostatistical analysis to monitor the spatial distribution and temporal evolution of climate;	**Module 2. Assessing Climate Impacts on Strategic Sectors** Define the impact of climate on strategic sectors, especially GFCS key sectors: agriculture and food security, disaster risk reduction, energy, health and water	1,0
Design climate products for specific sectors such as agriculture and food security, disaster risk reduction, energy, health and water	**Module 3. Tailoring Climate Information for Diverse End Users** Tailor climate data and information to meet the specific needs of diverse end users, such as policymakers, researchers, and industry professionals, ensuring the relevance and usability of the information provided	1,0
	Module 4. Communicating Climate Services through Synthesis Reports Create synthesis reports, including textual, graphical and cartographic information to convert climate products into climate services and communicate them to users	1,0

Subject: Gender, Specifically Vulnerability Persons and Groups (C5, 2 ECTS) Abbrev. GVPG		
Performance Criteria	**Learning Outcomes**	**ECTS**
Key Words	Climate Impact, Gender Vulnerability, Social Inequality, Marginalized Groups, Gender-Specific Risks, Equity, Cultural Sensitivity, Human Rights	
Conduct a comprehensive analysis using case studies and real-world data to identify and explain the impact of socio-cultural norms, economic disparities, and access to resources on the vulnerability of specific gender groups	**Module 1: Analyze Gender-Specific Vulnerabilities** Assess how gender-related factors contribute to vulnerabilities among different individuals and groups, including the impact of socio-cultural norms, economic disparities, and access to resources on their ability to respond to climate risks	1,0
Develop and propose targeted adaptation strategies tailored to the unique needs of vulnerable gender-specific groups, evaluating their effectiveness and feasibility through scenario analysis and stakeholder feedback	**Module 2: Develop Targeted Adaptation Strategies** Design and propose adaptation strategies that address the unique needs of vulnerable gender-specific groups, ensuring inclusive and equitable approaches to resilience-building and resource allocation	1,0

Subject: Climate Risk Assessment (C5, 6 ECTS) Abbrev. CRA		
Performance Criteria	**Learning Outcomes**	**ECTS**
Key Words	Vulnerability Assessment, Climate Impact Analysis, Resilience Planning, Exposure and Sensitivity	
Define and differentiate between impact, vulnerability, risk, adaptation capacity, and uncertainty in both written and oral presentations.	**Module 1: Conceptual Framework for Climate Impact and Risk** Explain the key concepts of impact, risk, vulnerability, adaptation capacity, and uncertainty related to climate variability and climate change	1,0
Conduct climate vulnerability and risk assessments for specific economic sectors/geographic area/vulnerable community/ecosystems using appropriate data and analytical tools	**Module 2: Climate Change Impacts** Recognize regional variations in climate change impacts and vulnerabilities and the potential impacts of climate change on different sectors (e.g., agriculture, water resources, health, and infrastructure) and assess the adaptation needs of different communities, particularly vulnerable and marginalized groups	1,0
	Module 3: Analytical Tools and Methodologies Choose and apply suitable analytical tools and methodologies for conducting climate vulnerability and risk assessments, ensuring accuracy and reliability of results	1,0
	Module 4: Identification of Climate Vulnerabilities and Risks Prioritize vulnerabilities and risks based on severity, likelihood, and potential impact on vulnerable communities, ecosystems and economic sectors	1,0
Assess the economic damage that will be caused to the industry/enterprise/geographic area as a result of climate change	**Module 5: Understanding of Economic Impacts** Provide a detailed analysis of short-term and long-term social and economic consequences of climate change	1,0
	Module 6: Economic damages and Adaptation Needs Use appropriate economic models to evaluate damages and identify adaptation needs based on these economic assessments	1,0

Subject: Communication Skills for Climate Service (C5, 2 ECTS) Abbrev. CSCS		
Performance Criteria	**Learning Outcomes**	**ECTS**
Key Words	Tailored messaging, Audience-specific language, Effective communication	
Prioritize the communication of climatological information according to social, political and economic relevance	**Module 1: Evaluating Climate Products for Sectoral Impact Analysis** Select, among the available climate products, those suitable to explain the impact of climate over the sectors of economic activity, social and geopolitical key issues, while integrating uncertainties and risks in the delivery of climate information	1,0
Customize climate communications for broad and varied audiences	**Module 2: Effective Communication of Climate Data** Enhance the ability to present climate data and findings in a clear and effective manner, using visualizations, reports, and presentations that are accessible to both technical and non-technical audiences.	1,0

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Subject: Basic of Climate Policy (International and National aspects) (C2, C3, C5, 2 ECTS) Abbrev. BCP		
Performance Criteria	**Learning Outcomes**	**ECTS**
Key Words	Climate Mitigation, Paris Agreement, Carbon Pricing, Climate Justice	
Take part in development, improvement and implementation of the low-emission solutions that can be put in place by the business community and the public at large to mitigate climate change	**Module 1: Evaluate Climate Action Plans** Critically evaluate the effectiveness of various climate action plans and strategies, including those outlined in the Paris Agreement, assessing their potential impact on global and national scales	1,0
	Module 2: Case Studies of Successful Climate Resilience Initiatives from Around the World Analyze and synthesize case studies of successful climate resilience initiatives from various global contexts, identifying key factors that contributed to their success and applying these insights to develop effective resilience strategies for different regions	1,0

Subject: Mitigation and adaptation strategies in different sectors (C1, C2, C3, C5, 3 ECTS) Abbrev. MAS		
Performance Criteria	**Learning Outcomes**	**ECTS**
Key Words	Sector-Specific Strategies, Climate Mitigation, Climate Adaptation, Resilience, Risk Reduction, Environmental Impact Assessment, Cross-Sectoral Integration	
Design adaptation and mitigation strategies to enhance resilience community/economic sector/ecosystem	**Module 1: Adaptation Strategies** Design and propose effective adaptation strategies tailored to specific climate risks, integrating principles of resilience and sustainability to enhance the adaptive capacity of affected communities	1,0 [11]
	Module 2: Low-emission Solutions Design and propose low-emission solutions across different sectors, including energy, agriculture, and business, incorporating innovative technologies and policies to achieve substantial reductions in greenhouse gas emissions	1,0 [12]
	Module 3: Assessment of Adaptation Needs and Climate Justice Analyze the implications of climate justice in the design and implementation of adaptation strategies, ensuring equitable and inclusive outcomes	1,0

[11] The module will be developed by Ukrainian partner universities in relevant sectors.
[12] The module will be developed by Ukrainian partner universities in relevant sectors.

Annex 9. Competencies and Learning Outcomes in Master 2 Courses

Understanding the Complex Dynamics of the Earth System

C1. Articulate and exemplify the complex interactions between various components of the non-linear, coupled Earth system

- LO1. Demonstrate knowledge and understanding of the main components of the climate system, including the atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere, and explain their individual roles in climate dynamics. ICS
- LO2. Explain the interactions between the components of the climate system, focusing on key feedback mechanisms, such as albedo changes, permafrost melt, soil degradation, and wildfire frequency, and their influence on global climate patterns. ICS
- LO3. Identify and describe the primary causes of climate change, including natural and anthropogenic factors, and illustrate how these causes contribute to global warming and climate variability BCCS
- LO4. Explain the primary consequences of climate change for water and food supplies, energy consumption, and economic growth. BCCS

Economic Activities and Climate Change: Interconnected Dynamics

C2. Comprehend the dynamic link between economic activities and climate change and explain how they influence and interact with each other

- LO1. Understand fundamental concepts in climate change economics, including the role of climate change as an economic externality and its implications for market dynamics, illustrated through relevant case studies. ECC
- LO2. Recognize and analyze key economic policies designed to reduce greenhouse gas emissions, such as carbon taxes and cap-and-trade systems, using case studies to illustrate their effectiveness and challenges. ECC
- LO3. Explore how climate change influences monetary policy, examining the role of central banks in managing climate-related financial risks and assessing real-world examples of policy responses. ECC
- LO4. Gain familiarity with basic climate-economy modelling techniques, including integrated assessment models, to explore the relationship between economic activities and climate change. ECC
- LO5. Analyse and discuss the economic factors that influence adaptation decisions, including cost-benefit considerations, resource availability, market dynamics, and the economic impact of climate risks on different sectors and communities, while drawing insights from best practice case studies. ECC
- LO6. Synthesize knowledge of climate change economics to formulate policy recommendations that enhance climate resilience in vulnerable economic sectors, focusing on strategies that promote both economic growth and environmental sustainability. ECC

Using Projections and Scenarios for Sustainable Economic Planning

C3. Skillfully apply projections and scenarios for informed decision-making in economic sector sustainability and resilient planning, as well as adeptly recognize and classify uncertainties across contexts

- LO1. Effectively use the available visualized climate empirical and modelled data to describe the state of the climate system and assess changes within it. ICS
- LO2. Explain the economic and environmental bases for the main climate change SSP-RCP scenarios, identifying the primary drivers for each scenario. CCP&S
- LO3. Discuss the regional climate model predictions for climate projections based on the worst- and best-case scenarios, and their impacts on various economic sectors, geographic regions, ecosystems, human health, and the economy as a whole. CCP&S

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Navigating Legal, Ethical, and Communicative Challenges in Global Climate Governance

C4. Apply the knowledge obtained to navigate legal, communicative, and ethical challenges, contributing to effective global climate governance

- LO1. Comprehend the fundamental theories and principles of effective communication, specifically focusing on how these can be applied to convey complex climate change concepts to diverse audiences, including policymakers, industry stakeholders, and the general public. CCC&PE
- LO2. Apply targeted communication strategies to engage effectively with experts in climate services and key climate-dependent economic sectors, aiming to foster collaboration and achieve mutually beneficial outcomes, while actively involving the general public in climate action initiatives and promoting community awareness. CCC&PE
- LO3. Develop and implement strategies that foster collaboration and achieve mutually beneficial outcomes in climate-related initiatives CCC&PE
- LO4. Analyse the key legal frameworks and principles governing climate change at the international, national, and local levels, including treaties, regulations, and case law, to understand their implications for climate action and policy. CCL&IA
- LO5. Evaluate the effectiveness of major international agreements, such as the Paris Agreement and the Kyoto Protocol, in addressing climate change, assessing their mechanisms for compliance, enforcement, and the role of various stakeholders in achieving climate goals. CCL&IA

Actionable Recommendations for Economic Resilience and Climate Strategies

C5. Based on economic assessments provide action-oriented recommendations on development and improvement of adaptation and mitigation strategies that enhance resilience and minimize negative impacts

- LO1. Critically assess mitigation strategies tailored to specific sectors, such as energy, transportation, or agriculture, analyzing their potential for reducing greenhouse gas emissions and the challenges of implementation. CCM&A
- LO2. Develop the ability to evaluate adaptation approaches designed to support communities disproportionately impacted by climate change, considering factors such as vulnerability, adaptability, and climate justice. CCM&A
- LO3. Explore the synergies between mitigation and adaptation strategies, identifying and quantifying the co-benefits (e.g., improved public health, job creation, biodiversity conservation) that can arise from effective climate policies. CCM&A
- LO4. Integrate knowledge from various disciplines, including economics, policy, science, and technology, to develop comprehensive and effective climate change solutions. CCM&A
- LO5. Examine real-world case studies of successful climate change mitigation and adaptation initiatives, extracting key lessons and best practices that can be applied to their own contexts. CCM&A
- LO6. Integrate their knowledge of sectoral mitigation strategies, adaptation measures, and best practices to create comprehensive climate action plans tailored to specific geographic regions, economic sectors, or communities. CCM&A

Comprehensive Climate Impact and Risk Assessment

C6. Conduct comprehensive climate impact and risk assessments to identify, prioritize, and manage the risks associated with climate variability and change.

- LO1. Understand the key concepts of impact, risk, vulnerability and adaptative capacity related to climate variability and climate change CRIVA
- LO2. Identify climate hazards and the vulnerability of exposed groups or affected areas. CRIVA
- LO3. Identify and prioritize expected future impacts of climate hazards on specific economic sectors, geographical regions, and people, considering demographic and socio-economic factors. CRIVA
- LO4. Conduct vulnerability assessments by analyzing socio-economic, environmental, and non-climatic data trends, such as population growth and land use change. CRIVA
- LO5. Determine the key risks based on the interplay of hazards and impacts. CRIVA
- LO6. Assess adaptive capacity to identify potential adaptation strategies for mitigating the impacts of climate change. CRIVA

Annex 10. Master Programme in Climate Change Adaptation and Mitigation

Master Programme in Climate Change Adaptation and Mitigation

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Introduction to the Climate System	ICS	**3**
2	Basic Climate Change Science: Global Warming, Greenhouse Gases and Consequences.	BCCS	**2**
3	Climate Change Projections and Scenarios	CCP&S	**2**
4	Climate Risk, Impacts and Vulnerability Assessments	CRIVA	**6**
5	Climate Change Communication and Public Engagement	CCC&PE	**3**
6	Climate Change Law and International Agreements	CCL&IA	**2**
7	Climate Change Mitigation and Adaptation: Case Studies and Best Practices in specific scope of activity	CCM&A	6
8	Economics of Climate Change: Case Studies and Best Practices in specific scope of activity	ECC	**6**
TOTAL			**30**

Descriptions of Courses within the Master Programme in Climate Change Adaptation and Mitigation

Subject: Introduction to the Climate System (3 ECTS) Abbrev. ICS		
Key Words:	*Climate system, climate system components, feedback mechanisms, climate information*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Interpret the climate system state using available climate model outputs and dataset	**Module 1: Climate System Components** Demonstrate knowledge and understating of the main components of the climate system, including the atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere, and explain their individual roles in climate dynamics	1,0
	Module 2: Interactions and Feedback Mechanisms Explain the interactions between the components of the climate system, focusing on key feedback mechanisms e.g. albedo changes, permafrost melt, soil degradation and wildfire frequency, and their influence on global climate patterns	1,0
	Module 3: Climate Information Effectively use the available visualized climate empirical and modelled data to describe the state of the climate system and assess changes within it	1,0

Subject: Basic Climate Change Science: Global Warming, Greenhouse Gases and Consequences. (2 ECTS) Abbrev. BCCS		
Key Words:	*Climate change, impact of climate change, consequences of climate change*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Clearly articulate the causes and impacts of climate change through written reports and oral presentations, using accurate data and case studies	**Module 1: Causes of Climate Change** Identify and describe the primary causes of climate change, including natural and anthropogenic factors, and illustrate how these causes contribute to global warming and climate variability	1,0
	Module 2: Consequences of Climate Change Explain the primary consequences of climate change for water and food supplies, coastal damages, relocation costs, energy consumption, and economic growth	1,0

Subject: Climate Change Projections and Scenarios (2 ECTS) Abbrev. CCP&S		
Key Words:	*Emission scenarios, future climate change impact, climate projections*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Identify possible future climate change impact under various climate change SSP-RCP scenarios	**Module 1: Emission Scenarios and Their Impacts** Explain the economic and environmental bases for the main climate change SSP-RCP scenarios, identifying the primary drivers for each scenario	1,0
	Module 2: Regional Climate Model Predictions and Their Impacts Discuss the regional climate model predictions for climate projections based on the worst and best-case scenarios, and their impacts on various economic sectors, geographic regions, ecosystems, human health, and the economy as a whole.	1,0

Subject: Climate risk, impacts and vulnerability assessments (6 ECTS) Abbrev. CRIVA		
Key Words:	*Impact, vulnerability, adaptive capacity, exposure, risk, uncertainty*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply the key concepts learned to real-world scenarios, demonstrating their relevance in understanding climate variability and change	**Module 1: Foundations of Climate Impact and Risk Assessment** Understand the key concepts of impact, risk, vulnerability and adaptative capacity related to climate variability and climate change	1,0
Create vulnerability maps that illustrate the relationship between climate hazards and affected populations	**Module 2: Identifying Climate Hazards** Identify climate hazards and the vulnerability of exposed groups or affected areas	1,0
Incorporate demographic and socio-economic factors into their assessments of future climate impacts	**Module 3: Assessing Future Climate Impacts** Identify and prioritize expected future impacts of climate hazards on specific economic sector, geographical regions and people, considering demographic and socio-economic factors	1,0
Produce comprehensive reports detailing their vulnerability assessments and recommendations for action	**Module 4: Comprehensive Vulnerability Assessments** Conduct vulnerability assessment by analysing socio-economic, environmental, and non-climatic data trends, such as population growth and land use change	1,0
Evaluate the severity and likelihood of identified risks using qualitative and quantitative methods	**Module 5: Risks** Determine the keys risks based on the interplay of hazards and impacts	1,0
Identify potential adaptation strategies tailored to specific vulnerabilities and risks	**Module 6: Evaluating Adaptive Capacity** Assess adaptive capacity to identify potential adaptation strategies for mitigating the impacts of climate change	1,0

Subject: Climate Change Communication and Public Engagement (3 ECTS) Abbrev. CCC&PE		
Key Words:	*Effective communication strategies, climate action initiatives, engagement*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Utilize effective communication strategies (e.g., visual aids, storytelling, interactive engagement) to enhance audience understanding and engagement	**Module 1: Understand the Fundamental Theories and Principles of Effective Climate Communication** Comprehend the fundamental theories and principles of effective communication, specifically focusing on how these can be applied to convey complex climate change concepts to diverse audiences, including policymakers, industry stakeholders, and the general public	1,0
	Module 2: Communicating Climate Change to Diverse Audiences Apply targeted communication strategies to engage effectively with experts in climate services and key climate-dependent economic sectors, aiming to foster collaboration and achieve mutually beneficial outcomes, while actively involving the general public in climate action initiatives and promoting community awareness	1,0
	Module 3: Strategies for Climate Engagement and Collaboration Develop and implement strategies that foster collaboration and achieve mutually beneficial outcomes in climate-related initiatives	1,0

Subject: Climate Change Law and International Agreements (2 ECTS) Abbrev. CCL&IA		
Key Words:	*Legal framework, international agreements,*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Evaluate the implications of specific legal instruments (e.g., treaties, regulations) on climate action and policy development.	**Module 1: Analyze Legal Frameworks and Principles** Analyse the key legal frameworks and principles governing climate change at the international, national, and local levels, including treaties, regulations, and case law, to understand their implications for climate action and policy	0,4
Evaluate the roles and responsibilities of various stakeholders (e.g., governments, NGOs, private sector) in achieving climate goals outlined in international agreements	**Module 2: Evaluate the Effectiveness of International Agreements** Evaluate the effectiveness of major international agreements, such as the Paris Agreement and the Kyoto Protocol, in addressing climate change, assessing their mechanisms for compliance, enforcement, and the role of various stakeholders in achieving climate goals	0,4

Subject: Climate Change Mitigation and Adaptation: Case Studies and Best Practices in specific scope of activity (6 ECTS) Abbrev. CCM&A		
Key Words:	*Climate Change, Sectoral Mitigation Strategies, Climate Action Plans*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Assess the economic, social, and political challenges associated with implementing sectoral mitigation strategies	**Module 1: Evaluate Sectoral Mitigation Strategies** Critically assess mitigation strategies tailored to specific sectors, such as energy, transportation, or agriculture, analyzing their potential for reducing greenhouse gas emissions and the challenges of implementation	1,0[13]
Analyze the effectiveness of adaptation measures in reducing vulnerability and enhancing adaptability	**Module 2: Assess Adaptation Measures for Vulnerable Communities** Develop the ability to evaluate adaptation approaches designed to support communities disproportionately impacted by climate change, considering factors such as vulnerability, adaptability, and climate justice	1,0
Analyze case studies demonstrating the realization of co-benefits from climate action	**Module 3: Analyze Co-Benefits of Climate Action** Explore the synergies between mitigation and adaptation strategies, identifying and quantifying the co-benefits (e.g., improved public health, job creation, biodiversity conservation) that can arise from effective climate policies	1,0
Identify and describe the key concepts and contributions of various disciplines (e.g., economics, environmental science, public policy, and technology) relevant to climate change solutions.	**Module 4: Integrate Interdisciplinary Knowledge** Integrate knowledge from various disciplines, including economics, policy, science, and technology, to develop comprehensive and effective climate change solutions	1,0[14]
Extract lessons and best practices that can be applied to other contexts	**Module 5: Synthesize Best Practices from Case Studies** Examine real-world case studies of successful climate change mitigation and adaptation initiatives, extracting key lessons and best practices that can be applied to their own contexts	1,0
Create comprehensive climate action plans that address both mitigation and adaptation needs	**Module 6: Develop Context-Specific Climate Action Plans** Integrate their knowledge of sectoral mitigation strategies, adaptation measures, and best practices to create comprehensive climate action plans tailored to specific geographic regions, economic sectors, or communities	1,0[15]

[13] The module will be developed by Ukrainian partner universities in relevant sectors.
[14] The module will be developed by Ukrainian partner universities in relevant sectors.
[15] The module will be developed by Ukrainian partner universities in relevant sectors.

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Subject: Economics of Climate Change: Case Studies and Best Practices in specific scope of activity (6 ECTS) Abbrev. ECC		
Key Words	*Economics, Cost, Benefit*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Define key concepts like externalities, market failures, and economic impacts of climate change	**Module 1: Comprehend Climate Change Economics** Understand fundamental concepts in climate change economics, including the role of climate change as an economic externality and its implications for market dynamics, illustrated through relevant case studies.	1,0
Compare and contrast the effects of carbon taxes and cap-and-trade systems	**Module 2: Identify Mitigation Strategies** Recognize and analyze key economic policies designed to reduce greenhouse gas emissions, such as carbon taxes and cap-and-trade systems, using case studies to illustrate their effectiveness and challenges.	1,0
Recognize interactions between monetary policy and climate change mitigation policies	**Module 3: Understand Monetary Policy Interactions** Explore how climate change influences monetary policy, examining the role of central banks in managing climate-related financial risks and assessing real-world examples of policy responses.	1,0
Interpret model outputs in terms of policy implications	**Module 4: Apply Basic Modelling Techniques** Gain familiarity with basic climate-economy modelling techniques, including integrated assessment models, to explore the relationship between economic activities and climate change.	1,0[16]
Identify and critically evaluate key economic factors (e.g., cost-benefit analysis, funding availability, economic incentives, and resource allocation) that influence adaptation decisions	**Module 5: Explore Adaptation Approaches** Analyse and discuss the economic factors that influence adaptation decisions, including cost-benefit considerations, resource availability, market dynamics, and the economic impact of climate risks on different sectors and communities, while drawing insights from best practice case studies.	1,0[17]
Enhance climate resilience of vulnerable economic sector utilizing knowledge of climate change economics	**Module 6: Develop Policy Recommendations for Climate Resilience** Synthesize knowledge of climate change economics to formulate policy recommendations that enhance climate resilience in vulnerable economic sectors, focusing on strategies that promote both economic growth and environmental sustainability	1,0[18]

[16] The module will be developed by Ukrainian partner universities in relevant sectors.
[17] The module will be developed by Ukrainian partner universities in relevant sectors.
[18] The module will be developed by Ukrainian partner universities in relevant sectors.

Annex 11. Professional Development Programme "Climate Services"

COMPETENCIES AND LEARNING OUTCOMES

C1. Effectively manage, analyze, and communicate climate and socio-economic data to support and inform adaptation and mitigation strategies and assess the effectiveness of climate service delivery

- LO1. Design and operate climate database of climate data and metadata using a climate data management system, including raw, quality-controlled and homogenised records to organize, control, analyze and visualize climate data effectively
- LO2. Characterise the climate of the area of study and describe its variability and recent changes
- LO3. Prepare socio-economic, sectorial and climate datasets for own usage, considering the necessary spatial and temporal coverage
- LO4. Utilise the combined socio-economic, sectorial and climate datasets to extract climate-influenced socio-economic indicators
- LO5. Develop and implement climate communication plans and campaigns, tailored to the cultural and educational characteristics of users, using effective materials to support adaptation and mitigation strategies.
- LO6. Apply program evaluation approaches to assess the effectiveness of climate service delivery, taking into account unique climate challenges the country faces

Professional Development Programme "Climate Services"

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Data and Climate Products for Climate Services	DCPS	**2**[19]
2	Climate Risk Assessment for Different Specific Sectors	CRA-Pro	**2**[20]
3	Communication Skills for Climate Service	CSCS-Pro	**1**[21]
4	Management of Climate Service in Ukraine	MSCU-Pro	**1**[22]
TOTAL			**6**

[19] The developers are faculty members of Odesa I.I. Mechnikov National University.
[20] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from other Ukrainian partner universities (1 ECTS credit).
[21] The developers are faculty members of Odesa I.I. Mechnikov National University.
[22] The developers are faculty members of Odesa I.I. Mechnikov National University.

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Descriptions of Courses within the Professional Development Programme "Climate Services"

Data and Climate Products for Climate Services (2 ECTS) Abbrev. DCPS		
Key Words	*Understand climate data and derive fundamental climate indicators.*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Create, archive and document climate datasets Collect and store climate data and metadata in relational databases	**Module 1: Climate Data Management and Analysis** Design and operate climate database of climate data and metadata using a climate data management system, including raw, quality-controlled and homogenised records to organize, control, analyze and visualize climate data effectively	1
Compute basic climate products, normals and averages, or anomalies defined about a reference period Compute sector-specific climate indices and other sector-oriented climate products	**Module 2: Regional Climate Characterization and Trends** Characterise the climate of the area of study and describe its variability and recent changes	1

Climate Risk Assessment for different specific sectors (2 ECTS) Abbrev. CRA-Pro		
Key Words	Climate Risk Assessment	
Performance Criteria	**Learning Outcomes**	**ECTS**
Obtain and use socio-economic and sectoral products	**Module 1: Data Preparation for Climate and Socio-Economic Analysis** Prepare socio-economic, sectorial and climate datasets for own usage, considering the necessary spatial and temporal coverage	1,0
	Module 2. Integrated Analysis of Climate and Socio-Economic Indicators Utilise the combined socio-economic, sectorial and climate datasets to extract climate-influenced socio-economic indicators	1,0[23]

Communication Skills for Climate Service (1 ECTS) Abbrev. CSCS-Pro		
Key Words	*Communication of information*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Develop and deliver, in partnership with users, specific applications for understanding and use of climate products and services	**Module 1. Climate Communication Planning and Implementation** Develop and implement climate communication plans and campaigns, tailored to the cultural and educational characteristics of users, using effective materials to support adaptation and mitigation strategies.	1,0

Management of Climate Services in Ukraine (1 ECTS) MCSU-Pro		
Key Words	*Management, Climate Service, Ukraine*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Improve climate service delivery by understanding and addressing the needs of different stakeholders, including their limitations and climate-related concerns	**Module 1. Evaluation of Climate Services and Program Effectiveness** Apply program evaluation approaches to assess the effectiveness of climate service delivery, taking into account unique climate challenges the country faces	1.0

[23] The developers are faculty members from other Ukrainian partner universities

Annex 12. Professional Development Programme "Climate Change"

COMPETENCIES AND LEARNING OUTCOMES

C1. Integrate understanding of climate system processes to implement and assess adaptation and mitigation measures

- LO1. Understand how changes in one climate system component can lead to cascading effects and feedback loops, appreciating the complexity of Earth's climate dynamics.
- LO2. Recognise and explain the dynamic interplay between the atmosphere and the sea, including the role of ocean currents, heat transfer mechanisms, and the influence of sea surface temperature on atmospheric circulation patterns
- LO3. Understand the principles of adaptation and its role in reducing vulnerability
- LO4. Apply various adaptation strategies, including technological, policy-based, and community-driven approaches
- LO5. Understand the fundamentals of climate change economics and analyze policies for reducing greenhouse gas emissions using real-world case studies.
- LO6. Assess the economic aspects of adaptation decisions and climate-economy models, and formulate recommendations to enhance climate resilience

Professional Development Programme "Climate Change"

	Subject (Course)	**Abbrev.**	**ECTS credits and number of educational modules**
1	Fundamentals of Global Climate Dynamics and Modelling	GCDM-Pro	**2,0** [24]
2	Climate Change Mitigation and Adaptation Plans	CCM&A-Pro	**2,0** [25]
3	Economics of Climate Change	ECC-Pro	**2,0** [26]
TOTAL			**6,0**

[24] The developers are faculty members of Odesa I.I. Mechnikov National University.
[25] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from other Ukrainian partner universities (1 ECTS credit).
[26] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from other Ukrainian partner universities (1 ECTS credit).

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Descriptions of Courses within the Professional Development Programme "Climate Change"

Fundamentals of global climate dynamics and modelling (2 ECTS). Abbrev. GCDM-Pro		
Key Words:	*Climate Change, Atmospheric Dynamics*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Climate System Dynamics and Feedbacks** Understand how changes in one climate system component can lead to cascading effects and feedback loops, appreciating the complexity of Earth's climate dynamics.	1,0
Identify the interactions and influences between the atmosphere and the ocean	**Module 2. Ocean-Atmosphere Interactions and Climate Processes** Recognise and explain the dynamic interplay between the atmosphere and the sea, including the role of ocean currents, heat transfer mechanisms, and the influence of sea surface temperature on atmospheric circulation patterns	1,0

Climate Change Mitigation and Adaptation Plans (2 ECTS). Abbrev. CCM&A-Pro		
Key Words:	*Communication of information*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Propose and/or develop a basic adaptation plan for a chosen scenario	**Module 1. Climate Adaptation: Principles and Applications** Understand the principles of adaptation and its role in reducing vulnerability	1,0
	Module 2. Implementing Adaptation Strategies: Technology, Policy, and Community Approaches Apply various adaptation strategies, including technological, policy-based, and community-driven approaches	1,0[27]

Economics of Climate Change (2 ECTS). Abbrev. ECC-Pro		
Key Words:	*Economics, Cost, Benefit*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Analyzes the effectiveness of economic policies for reducing greenhouse gas emissions using case studies.	**Module 1. Fundamentals of Climate Change Economics and Policy** Understand the fundamentals of climate change economics and analyze policies for reducing greenhouse gas emissions using real-world case studies.	1,0
Evaluate the economic feasibility of specific adaptation projects	**Module 2. Economic Evaluation of Adaptation Projects** Justify the economic feasibility of climate change adaptation projects based on the assessment of their costs, benefits, and impact on stakeholders	1,0[28]

[27] The developers are faculty members from other Ukrainian partner universities
[28] The developers are faculty members from other Ukrainian partner universities

Annex 13. Professional Development Programme in Climate-Smart Agriculture

COMPETENCIES AND LEARNING OUTCOMES

C1. Analyze climate change impacts and risks in agriculture to develop and communicate evidence-based adaptation strategies for sustainable sectoral planning

- LO1. Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change
- LO2. Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming
- LO3. Assess climate risks and vulnerabilities in agricultural systems by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors.
- LO4. Evaluate adaptive capacity and determine key risks to develop effective adaptation strategies for specific agricultural sectors or regions.
- LO5. Use climate service products to identify and analyze climate risks and vulnerabilities in agricultural systems.
- LO6. Develop synthesis reports—including textual, graphical, and cartographic information—to present climate change impacts and support evidence-based agricultural planning.

Professional Development Programme in Climate-Smart Agriculture

	Subject (Course)	**Abbrev.**	**ECTS credits and number of educational modules**
1	Introduction to Climate Change	ICC	**2,0** [29]
2	Climate Risk Assessment in the Agriculture sector (with a case study in a specific agriculture sector or geographical region)	CRA-AgPro	**2,0** [30]
3	Climate Service Products for Climate Risk Assessment in Agriculture Sector	CSP-AgPro	**2,0** [31]
TOTAL			**6**

[29] The developers are faculty members of Odesa I.I. Mechnikov National University.
[30] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Bila Tserkva National Agrarian University (1 ECTS credit).
[31] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Bila Tserkva National Agrarian University (1 ECTS credit).

Descriptions of Courses within the Professional Development Programme in Climate-Smart Agriculture

Subject: Introduction to Climate Change (2 ECTS). Abbrev. ICC		
Key Words	*Climate Change, Foundations, Basic Climate Science*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Fundamentals of Atmospheric Processes and Climate** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
Interpret of temperature anomalies and their connection to global warming	**Module 2. Analyzing Temperature Anomalies and Global Warming Trends** Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming	1,0

Subject: Climate Risk Assessment in the Agriculture sector (with a case study in a specific agriculture sector or geographical region) (2 ECTS). Abbrev. CRA-AgPro		
Key Words	*Climate Risk Assessment, Adaptive capacity, Key risks*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Collect and analyze climate, agricultural, and socio-economic data to assess risks and vulnerabilities in agricultural systems, and develop actionable adaptation strategies with clear recommendations and visualizations for decision-making.	**Module 1. Climate Risk and Vulnerability Assessment in Agriculture** Assess climate risks and vulnerabilities in agricultural systems by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors.	1,0
	Module 2. Developing Adaptation Strategies for Agricultural Systems Evaluate adaptive capacity and determine key risks to develop effective adaptation strategies for specific agricultural sectors or regions.	1,0[32]

Subject: Climate Service Products for Climate Risk Assessment in Agriculture Sector (2 ECTS). Abbrev. CSP-AgPro		
Key Words:	*Basic Climate Indices (eg: extremes), Sectorial Climate Indices, Statistical Analysis, Climate Risk Assessment, Agriculture*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply climate service products to assess climate-related risks to crop and livestock production, and produce synthesis reports with textual, graphical, and cartographic outputs to support evidence-based agricultural planning and policy decisions.	**Module 1. Application of Climate Service Products for Agricultural Risk Assessment** Use climate service products to identify and analyze climate risks and vulnerabilities in agricultural systems.	1,0
	Module 2. Synthesis and Communication of Climate Impacts for Agriculture Develop synthesis reports - including textual, graphical, and cartographic information - to present climate change impacts and support evidence-based agricultural planning.	1,0[33]

[32] The module is developed by Bila Tserkva National Agrarian University
[33] The module is developed by Bila Tserkva National Agrarian University

Annex 14. Professional Development Programme in Climate-Smart Health Care

COMPETENCIES AND LEARNING OUTCOMES

C1. Analyze climate change impacts and risks in the health care sector to develop and communicate evidence-based adaptation strategies that enhance resilience and sustainability

- LO1. Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the nature and causes of climate variability and climate change.
- LO2. Interpret temperature anomalies and other climate indicators in historical data and explain their direct connections to health-related impacts of global warming.
- LO3. Assess climate risks and vulnerabilities in health systems by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors affecting public health.
- LO4. Evaluate adaptive capacity and determine key risks to develop effective adaptation strategies for health services and vulnerable populations.
- LO5. Use climate service products to identify and analyze climate-sensitive health risks and vulnerabilities.
- LO6. Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on health and support evidence-based health sector planning.

Professional Development Programme in Climate-Smart Health Care

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Introduction to Climate Change	ICC	**2,0**[34]
2	Climate Risk Assessment in the Health Care sector (with a case study in a specific health care sector or geographical region)	CRA-HCPro	**2,0**[35]
3	Climate Service Products for Climate Risk Assessment in Health Care Sector	CSP-HCPro	**2,0**[36]
TOTAL			**6**

[34] The developers are faculty members of Odesa I.I. Mechnikov National University.
[35] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Odesa National Medical University (1 ECTS credit).
[36] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Odesa National Medical University (1 ECTS credit).

Descriptions of Courses within the Professional Development Programme in Climate-Smart Health Care

Subject: Introduction to Climate Change (2 ECTS). Abbrev. ICC		
Key Words	*Climate Change, Foundations, Basic Climate Science*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Fundamentals of Atmospheric Processes and Climate** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
Interpret of temperature anomalies and their connection to global warming	**Module 2. Analyzing Temperature Anomalies and Global Warming Trends** Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming	1,0

Subject: Climate Risk Assessment in the Health Care sector (with a case study in a specific health care sector or geographical region) (2 ECTS). Abbrev. CRA-HCPro		
Key Words	*Climate Risk Assessment, Adaptive capacity, Key risks*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Collect and analyze climate, health, and socio-economic data to assess risks and vulnerabilities in health care systems, and develop actionable adaptation strategies with clear recommendations and visualizations for decision-making.	**Module 1. Climate Risk and Vulnerability Assessment in Health Care Sector** Assess climate risks and vulnerabilities in health systems by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors affecting public health.	1,0
	Module 2. Developing Adaptation Strategies for Health Care Sector Evaluate adaptive capacity and determine key risks to develop effective adaptation strategies for health services and vulnerable populations.	1,0[37]

Subject: Climate Service Products for Climate Risk Assessment in Health Care Sector (2 ECTS). Abbrev. CSP-HCPro		
Key Words	*Basic Climate Indices (eg: extremes), Sectorial Climate Indices, Statistical Analysis, Climate Risk Assessment,* Health Care Sector	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply climate service products to assess climate-related risks to health services and infrastructure, and produce synthesis reports with textual, graphical, and cartographic outputs to support evidence-based health planning and policy decisions.	**Module 1. Application of Climate Service Products in Health Care Risk Assessment** Use climate service products to identify and analyze climate-sensitive health risks and vulnerabilities.	1,0
	Module 2. Synthesis and Communication of Climate Impacts in the Health Care Sector Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on health and support evidence-based health sector planning.	1,0[38]

[37] The module is developed by Odesa National Medical University
[38] The module is developed by Odesa National Medical University

Annex 15. Professional Development Programme in Climate-Smart Construction and Architecture

COMPETENCIES AND LEARNING OUTCOMES

C1. Analyze climate change impacts and risks in the construction and architecture sector to develop and communicate evidence-based adaptation strategies that enhance the resilience and sustainability of the built environment.

- LO1. Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the nature and causes of climate variability and climate change relevant to construction and architectural design.
- LO2. Interpret temperature anomalies, precipitation patterns, and other climate indicators in historical data and explain their direct and indirect impacts on building performance, materials, and urban infrastructure.
- LO3. Assess climate risks and vulnerabilities in the construction and architecture sector by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors influencing the resilience of buildings and settlements.
- LO4. Evaluate adaptive capacity and determine key risks to develop effective adaptation and mitigation strategies for climate-resilient design, construction practices, and urban planning.
- LO5. Use climate service products to identify and analyze climate-sensitive aspects of building design, energy efficiency, and environmental performance.
- LO6. Develop synthesis reports—including textual, graphical, and cartographic information—to present the impacts of climate change on the built environment and support evidence-based planning and decision-making in the construction and architecture sector.

Professional Development Programme in Climate-Smart Construction and Architecture

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Introduction to Climate Change	ICC	**2,0**[39]
2	Climate Risk Assessment in the Construction and Architecture (with a case study in a specific construction and architecture sector or geographical region)	CRA-ConstPro	**2,0**[40]
3	Climate Service Products for Climate Risk Assessment in Construction and Architecture	CSP-ConstPro	**2,0**[41]
TOTAL			**6**

[39] The developers are faculty members of Odesa I.I. Mechnikov National University.
[40] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Kyiv National University of Construction and Architecture (1 ECTS credit).
[41] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Kyiv National University of Construction and Architecture (1 ECTS credit).

Co-funded by the Erasmus+ Programme of the European Union

Descriptions of Courses within the Professional Development Programme in Climate-Smart Construction and Architecture

Subject: Introduction to Climate Change (2 ECTS). Abbrev. ICC		
Key Words	*Climate Change, Foundations, Basic Climate Science*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Fundamentals of Atmospheric Processes and Climate** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
Interpret of temperature anomalies and their connection to global warming	**Module 2. Analyzing Temperature Anomalies and Global Warming Trends** Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming	1,0

Subject: Climate Risk Assessment in the Construction and Architecture (with a case study in a specific construction and architecture sector or geographical region) (2 ECTS). Abbrev. CRA-ConstPro		
Key Words	*Climate Risk Assessment, Adaptive capacity, Key risks*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Collect and analyze climate, building, and socio-economic data to assess risks and vulnerabilities in the built environment, and develop actionable adaptation strategies with clear recommendations and visualizations for decision-making.	**Module 1. Climate Risk and Vulnerability Assessment for Construction and Architecture** Assess climate risks and vulnerabilities in the construction and architecture sector by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors influencing the resilience of buildings and settlements.	1,0
	Module 2. Developing Adaptation Strategies for Construction and Architecture Evaluate adaptive capacity and determine key risks to develop effective adaptation and mitigation strategies for climate-resilient design, construction practices, and urban planning.	1,0[42]

Subject: Climate Service Products for Climate Risk Assessment in Construction and Architecture (2 ECTS). Abbrev. CSP-ConstPro		
Key Words	*Basic Climate Indices (eg: extremes), Sectorial Climate Indices, Statistical Analysis, Climate Risk Assessment, Construction and Architecture*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply climate service products to assess climate-related risks to buildings, infrastructure, and urban planning, and produce synthesis reports with textual, graphical, and cartographic outputs to support evidence-based construction and architecture planning.	**Module 1. Application of Climate Service Products for Construction and Architecture Risk Assessment** Use climate service products to identify and analyze climate-sensitive aspects of building design, energy efficiency, and environmental performance.	1,0
	Module 2. Synthesis and Communication of Climate Impacts in the Construction and Architecture Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on the built environment and support evidence-based planning and decision-making in the construction and architecture sector.	1,0[43]

[42] The module is developed by Kyiv National University of Construction and Architecture
[43] The module is developed by Kyiv National University of Construction and Architecture

Annex 16. Professional Development Programme in Climate-Smart City Management

COMPETENCIES AND LEARNING OUTCOMES

C1. Analyze climate change impacts and risks in the city management sector to develop and communicate evidence-based adaptation strategies that enhance the resilience and sustainability of urban systems.

- LO1. Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the nature and causes of climate variability and climate change relevant to urban environments and city management.
- LO2. Interpret temperature anomalies, precipitation patterns, and other climate indicators in historical data and explain their direct and indirect impacts on urban infrastructure, public services, and population well-being.
- LO3. Assess climate risks and vulnerabilities in urban areas by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors that affect city systems and communities.
- LO4. Evaluate adaptive capacity and determine key risks to develop effective adaptation and mitigation strategies for sustainable urban planning, governance, and service delivery.
- LO5. Apply climate service products to identify and analyze climate-sensitive aspects of city management, including infrastructure resilience, critical services, and urban planning, to support evidence-based decision-making and climate adaptation strategies.
- LO6. Develop synthesis reports—including textual, graphical, and cartographic information—to present the impacts of climate change on cities and support evidence-based urban management and policy decisions.

Professional Development Programme in Climate-Smart City Management

	Subject (Course)	**Abbrev.**	**ECTS credits and number of educational modules**
1	Introduction to Climate Change	ICC	**2,0**[44]
2	Climate Risk Assessment in the City Management (with a case study in specific city management sector or geographical region)	CRA-CMPro	**2,0**[45]
3	Climate Service Products for Climate Risk Assessment in City Management	CSP-CMPro	**2,0**[46]
TOTAL			**6**

[44] The developers are faculty members of Odesa I.I. Mechnikov National University.
[45] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from O.M. Beketov National University of Urban Economy in Kharkiv (1 ECTS credit).
[46] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from O.M. Beketov National University of Urban Economy in Kharkiv (1 ECTS credit).

Descriptions of Courses within the Professional Development Programme in Climate-Smart City Management

Subject: Introduction to Climate Change (2 ECTS). Abbrev. ICC		
Key Words	*Climate Change, Foundations, Basic Climate Science*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Fundamentals of Atmospheric Processes and Climate** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
Interpret of temperature anomalies and their connection to global warming	**Module 2. Analyzing Temperature Anomalies and Global Warming Trends** Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming	1,0

Subject: Climate Risk Assessment in the City Management (with a case study in specific city management sector or geographical region) (2 ECTS). Abbrev. CRA-CMPro		
Key Words	*Climate Risk Assessment, Adaptive capacity, Key risks*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Collect and analyze climate, urban, and socio-economic data to assess risks and vulnerabilities in city management systems, and develop actionable adaptation strategies with clear recommendations and visualizations for decision-making.	**Module 1. Climate Risk and Vulnerability Assessment in City Management** Assess climate risks and vulnerabilities in urban areas by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors that affect city systems and communities.	1,0
	Module 2. Developing Adaptation Strategies for City Management Evaluate adaptive capacity and determine key risks to develop effective adaptation and mitigation strategies for sustainable urban planning, governance, and service delivery.	1,0[47]

Subject: Climate Service Products for Climate Risk Assessment in City Management (2 ECTS). Abbrev. CSP-CMPro		
Key Words	*Basic Climate Indices (eg: extremes), Sectorial Climate Indices, Statistical Analysis, Climate Risk Assessment, City Management*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply climate service products to assess climate-related risks to urban infrastructure, services, and planning, and produce synthesis reports with textual, graphical, and cartographic outputs to support evidence-based urban management and policy decisions.	**Module 1. Application of Climate Service Products for City Management Risk Assessment** Apply climate service products to identify and analyze climate-sensitive aspects of city management, including infrastructure resilience, critical services, and urban planning, to support evidence-based decision-making and climate adaptation strategies.	1,0
	Module 2. Synthesis and Communication of Climate Impacts in the City Management Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on cities and support evidence-based urban management and policy decisions.	1,0[48]

[47] The module is developed by O.M. Beketov National University of Urban Economy in Kharkiv
[48] The module is developed by O.M. Beketov National University of Urban Economy in Kharkiv

Annex 17. Professional Development Programme in Climate-Smart Energy Sector

COMPETENCIES AND LEARNING OUTCOMES

C1. Analyze climate change impacts and risks in the energy sector to develop and communicate evidence-based adaptation strategies that enhance the resilience, efficiency, and sustainability of energy systems.

- LO1. Describe the fundamental concepts of atmospheric processes, weather systems, and climate, including the nature and causes of climate variability and climate change relevant to construction and architectural design.
- LO2. Interpret temperature anomalies, precipitation patterns, and other climate indicators in historical data and explain their direct and indirect impacts on building performance, materials, and urban infrastructure.
- LO3. Assess climate risks and vulnerabilities in the energy sector by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors that influence the resilience of energy infrastructure and systems.
- LO4. Evaluate adaptive capacity and determine key risks to develop effective adaptation and mitigation strategies for climate-resilient energy production.
- LO5. Apply climate service products to identify and analyze climate-sensitive aspects of energy generation, efficiency, and overall system performance.
- LO6. Develop synthesis reports—including textual, graphical, and cartographic information—to present the impacts of climate change on the energy sector and support evidence-based planning and decision-making.

Professional Development Programme in in Climate-Smart Energy Sector

	Subject (Course)	**Abbrev.**	**ECTS credits and number of educational modules**
1	Introduction to Climate Change	ICC	**2,0**[49]
2	Climate Risk Assessment in the Energy Sector (with a case study in a specific energy sector or geographical region)	CRA-EnPro	**2,0**[50]
3	Climate Service Products for Climate Risk Assessment in Energy Sector	CSP-EnPro	**2,0**[51]
TOTAL			**6**

[49] The developers are faculty members of Odesa I.I. Mechnikov National University.
[50] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Lviv Polytechnic National University (1 ECTS credit).
[51] The course is developed by faculty members of Odesa I.I. Mechnikov National University (1 ECTS credit) in collaboration with faculty members from Lviv Polytechnic National University (1 ECTS credit).

Descriptions of Courses within the Professional Development Programme in Climate-Smart Energy Sector

Subject: Introduction to Climate Change (2 ECTS). Abbrev. ICC		
Key Words	*Climate Change, Foundations, Basic Climate Science*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Fundamentals of Atmospheric Processes and Climate** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
Interpret of temperature anomalies and their connection to global warming	**Module 2. Analyzing Temperature Anomalies and Global Warming Trends** Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming	1,0

Subject: Climate Risk Assessment in the Energy Sector (with a case study in a specific energy sector or geographical region) (2 ECTS). Abbrev. CRA-EnPro		
Key Words	*Climate Risk Assessment, Adaptive capacity, Key risks*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Collect and analyze climate, energy, and socio-economic data to assess risks and vulnerabilities in energy systems, and develop actionable adaptation strategies with clear recommendations and visualizations for decision-making.	**Module 1. Climate Risk and Vulnerability Assessment in Energy Sector** Assess climate risks and vulnerabilities in the energy sector by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors that influence the resilience of energy infrastructure and systems.	1,0
	Module 2. Developing Adaptation Strategies for Energy Sector Evaluate adaptive capacity and determine key risks to develop effective adaptation and mitigation strategies for climate-resilient energy production	1,0[52]

Subject: Climate Service Products for Climate Risk Assessment in Energy Sector (2 ECTS). Abbrev. CSP-EnPro		
Key Words	*Basic Climate Indices (eg: extremes), Sectorial Climate Indices, Statistical Analysis, Climate Risk Assessment, Energy*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply climate service products to assess climate-related risks to energy production, distribution, and demand, and produce synthesis reports with textual, graphical, and cartographic outputs to support evidence-based energy planning and policy decisions.	**Module 1. Application of Climate Service Products for Energy Risk Assessment** Apply climate service products to identify and analyze climate-sensitive aspects of energy generation, efficiency, and overall system performance.	1,0
	Module 2. Synthesis and Communication of Climate Impacts in the Energy Sector Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on the energy sector and support evidence-based planning and decision-making	1,0[53]

[52] The module is developed by Lviv Polytechnic National University
[53] The module is developed by Lviv Polytechnic National University

Annex 18. Professional Development Programme in Climate-Smart Water Management

COMPETENCIES AND LEARNING OUTCOMES

C1. Analyze climate change impacts and risks in the water management sector to develop and communicate evidence-based adaptation strategies that enhance the resilience and sustainability of water resources and related systems.

- LO1. Describe the fundamental concepts of atmospheric processes, hydrological cycles, and climate systems, including the nature and causes of climate variability and climate change relevant to water management.
- LO2. Interpret temperature, precipitation, and streamflow anomalies in historical data and explain their connections to climate change impacts on water availability, quality, and distribution.
- LO3. Assess climate risks and vulnerabilities in water management systems by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors affecting water resources.
- LO4. Evaluate adaptive capacity and determine key risks to develop effective adaptation strategies for integrated water resource management under changing climatic conditions.
- LO5. Use climate service products to identify and analyze climate-related risks to water supply and demand.
- LO6. Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on water resources and support evidence-based water management and policy decisions.

Professional Development Programme in Climate-Smart Water Management

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Introduction to Climate Change	ICC	**2,0**[54]
2	Climate Risk Assessment in the Water Management (with a case study in a specific water management sector or geographical region)	CRA-WMPro	**2,0**[55]
3	Climate Service Products for Climate Risk Assessment in Water Management	CSP-WMPro	**2,0**[56]
TOTAL			**6**

[54] The developers are faculty members of Odesa I.I. Mechnikov National University.
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Descriptions of Courses within the Professional Development Programme in Climate-Smart Water Management

Subject: Introduction to Climate Change (2 ECTS). Abbrev. ICC		
Key Words	*Climate Change, Foundations, Basic Climate Science*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Detect and identify all contributors to the climate of the region of interest to be taken into account under specific problem-solution implementation	**Module 1. Fundamentals of Atmospheric Processes and Climate** Describe the fundamental concepts of atmospheric processes, weather systems and climate, including the nature and causes of climate variability and climate change	1,0
Interpret of temperature anomalies and their connection to global warming	**Module 2. Analyzing Temperature Anomalies and Global Warming Trends** Proficiently interpret temperature anomalies in historical climate data and articulate their direct correlation to the phenomenon of global warming	1,0

Subject: Climate Risk Assessment in the Water Management (with a case study in a specific water management sector or geographical region) (2 ECTS). Abbrev. CRA-WMPro		
Key Words	*Climate Risk Assessment, Adaptive capacity, Key risks*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Collect and analyze climate, hydrological, and socio-economic data to assess risks and vulnerabilities in water management systems, and develop actionable adaptation strategies with clear recommendations and visualizations for decision-making.	**Module 1. Climate Risk and Vulnerability Assessment in Water Management** Assess climate risks and vulnerabilities in water management systems by identifying climate hazards and analyzing socio-economic, environmental, and non-climatic factors affecting water resources.	1,0
	Module 2. Developing Adaptation Strategies for Water Management Evaluate adaptive capacity and determine key risks to develop effective adaptation strategies for integrated water resource management under changing climatic conditions.	1,0

Subject: Climate Service Products for Climate Risk Assessment in Water Management (2 ECTS). Abbrev. CSP-WMPro		
Key Words	*Basic Climate Indices (eg: extremes), Sectorial Climate Indices, Statistical Analysis, Climate Risk Assessment, Water Management*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Apply climate service products to assess climate-related risks to water supply and demand, and produce synthesis reports with textual, graphical, and cartographic outputs to support evidence-based water management and decision-making.	**Module 1. Application of Climate Service Products in Water Management Risk Assessment** Use climate service products to identify and analyze climate-related risks to water supply and demand.	1,0
	Module 2. Synthesis and Communication of Climate Impacts in the Water Management Develop synthesis reports - including textual, graphical, and cartographic information - to present the impacts of climate change on water resources and support evidence-based water management and policy decisions.	1,0

Annex 19. Climate-Oriented Policy and Natural Resources Management

COMPETENCIES AND LEARNING OUTCOMES

C1. Ability to analyse and integrate climate-oriented policy, legal, socio-economic, and environmental approaches in order to support evidence-based managerial decision-making in the fields of climate policy, energy transition, and sustainable water resource management under conditions of climate change.

LO1. Analyse the nature of contemporary climate change and its environmental, social, and economic impacts across key development sectors, including energy, agriculture, urban systems, and water resources.
LO2. Interpret international and national climate policy instruments, energy transition mechanisms, and the "green" transformation in order to assess their role in achieving climate goals and sustainable development in Ukraine.
LO3. Explain the principles, institutional mechanisms, and legal foundations of Ukraine's state water policy, taking into account European directives and climate-related challenges.
LO4. Assess the status of surface and groundwater resources, water balances, and water-related risks (floods, droughts, water scarcity) based on monitoring data, hydrological calculations, and climate information.
LO5. Apply engineering–hydrological, spatial, and digital tools (models, GIS, remote sensing) to forecast water regimes and support managerial decision-making.
LO6. Substantiate measures for the rational use, restoration, and protection of water resources, including nature-based solutions, to enhance water security and the resilience of aquatic ecosystems under climate change.

Professional Development Programme in Climate-Oriented Policy and Natural Resources Management

	Subject (Course)	Abbrev.	ECTS credits and number of educational modules
1	Climate Policy, Energy Transition, and Socio-economic Aspects of the "Green" Transformation	CPET-SETPro	**2,0**[57]
2	Ensuring the Implementation of State Policy in the Development of Water Management, Management and Control of Water Use and Protection, Rational Use and Restoration of Water Resources (surface and groundwater)	WR-GovPro	**2,0**[58]
TOTAL			**6**

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Descriptions of Courses within the Professional Development Programme in Climate-Oriented Policy and Natural Resources Management

Subject: Climate Policy, Energy Transition, and Socio-economic Aspects of the "Green" Transformation (2 ECTS). Abbrev. CPET-SETPro		
Key Words	*Climate Change, Climate Policy, Energy Transition, Green Transformation, International Climate Agreements*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Assess climate risks for economic sectors and territories based on the analysis of climatic, natural, and socio-economic factors in order to define adaptation priorities. Substantiate managerial, strategic, and project-based adaptation decisions based on the analysis of climate trends, risks, and scenarios.	**Module 1. Climate Change and Its Impacts on Natural Systems and Society** Analyse the nature of contemporary climate change and its environmental, social, and economic impacts across key development sectors, including energy, agriculture, urban systems, and water resources.	1,0
Assess the effectiveness and practical relevance of international and national climate policy and energy transition instruments. Substantiate managerial and policy decisions in the field of climate policy, taking into account the roles of key stakeholders.	**Module 2. Climate Policy, Energy Transition, and "Green" Transformation** Interpret international and national legal instruments of climate policy, assess their effectiveness, implementation mechanisms, and the role of stakeholders in achieving climate and socio-economic goals.	1,0

Subject: Ensuring the Implementation of State Policy in the Development of Water Management, Management and Control of Water Use and Protection, Rational Use and Restoration of Water Resources (surface and groundwater) (4 ECTS). Abbrev. WR-GovPro		
Key Words	*State Water Policy, Water Resource Management, EU Water Framework Directive, Water Risks, Nature-Based Solutions, Water Security*	
Performance Criteria	**Learning Outcomes**	**ECTS**
Assess the foundations of Ukraine's state water policy and European regulatory approaches to water resource management in order to support informed managerial decisions on water security under climate change and wartime conditions.	**Module 1. State Policy and Institutional–Legal Foundations of Water Resource Management** Explain the objectives, principles, and implementation mechanisms of Ukraine's state water policy, as well as the requirements of key EU directives (WFD, Floods Directive, Nitrates Directive) in the context of climate and security challenges.	1,0
Assess the status of surface and groundwater resources and interpret state monitoring data using GIS and remote sensing to support water resource management.	**Module 2. State Monitoring and Control of Water Resources** Analyse the quantitative and qualitative status of water resources based on hydrological and hydrochemical indicators, spatial data, and digital monitoring tools.	1,0
Apply engineering–hydrological methods and the "Climate–Runoff" model to calculate and forecast river basin water regimes under climate variability.	**Module 3. Engineering Methods for Water Regime Assessment and Forecasting** Use modern hydrological models, statistical and balance approaches to assess runoff, floods, and droughts in accordance with international (WMO) standards.	1,0
Assess water-related risks and substantiate measures for the rational use, restoration, and protection of water resources using nature-based solutions and spatial risk models.	**Module 4. Water Risk Management and Environmental Safety of Water Resources** Analyse risks related to floods, droughts, and degradation of aquatic ecosystems and develop managerial solutions to enhance the resilience of water systems.	1,0

Summary table of developers for the ClimEd professional development courses

№	Professional Development Programme	Course	Module	Developer
1	**Climate Services**	Data and Climate Products for Climate Services	**Module 1:** Climate Data Management and Analysis	Odesa I.I. Mechnikov National University
			Module 2: Regional Climate Characterization and Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment for Different Specific Sectors	**Module 1:** Data Preparation for Climate and Socio-Economic Analysis	Odesa I.I. Mechnikov National University
			Module 2: Integrated Analysis of Climate and Socio-Economic Indicators	All Ukrainian partner universities
		Communication Skills for Climate Service	**Module 1:** Climate Communication Planning and Implementation	Odesa I.I. Mechnikov National University
		Management of Climate Service in Ukraine	**Module 1:** Evaluation of Climate Services and Program Effectiveness	Odesa I.I. Mechnikov National University
2	**Climate Change**	Fundamentals of Global Climate Dynamics and Modelling	**Module 1:** Climate System Dynamics and Feedbacks	Odesa I.I. Mechnikov National University
			Module 2: Ocean-Atmosphere Interactions and Climate Processes	Odesa I.I. Mechnikov National University
		Climate Change Mitigation and Adaptation Plans	**Module 1:** Climate Adaptation: Principles and Applications	Odesa I.I. Mechnikov National University
			Module 2: Implementing Adaptation Strategies: Technology, Policy, and Community Approaches	All Ukrainian partner universities
		Economics of Climate Change	**Module 1:** Evaluating Climate Mitigation: Costs and Benefits	Odesa I.I. Mechnikov National University
			Module 2. Economic Evaluation of Adaptation Projects	All Ukrainian partner universities

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№	Professional Development Programme	Course	Module	Developer
3	**Climate-Smart Agriculture**	Introduction to Climate Change	**Module 1:** Fundamentals of Atmospheric Processes and Climate	Odesa I.I. Mechnikov National University
			Module 2: Analyzing Temperature Anomalies and Global Warming Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment in the Agriculture sector (with a case study in a specific agriculture sector or geographical region)	**Module 1:** Climate Risk and Vulnerability Assessment in Agriculture	Odesa I.I. Mechnikov National University
			Module 2: Developing Adaptation Strategies for Agricultural Systems	Bila Tserkva National Agrarian University
		Climate Service Products for Climate Risk Assessment in Agriculture Sector	**Module 1:** Application of Climate Service Products for Agricultural Risk Assessment	Odesa I.I. Mechnikov National University
			Module 2: Synthesis and Communication of Climate Impacts for Agriculture	Bila Tserkva National Agrarian University
4	**Climate-Smart Health Care**	Introduction to Climate Change	**Module 1:** Fundamentals of Atmospheric Processes and Climate	Odesa I.I. Mechnikov National University
			Module 2: Analyzing Temperature Anomalies and Global Warming Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment in the Health Care sector (with a case study in a specific health care sector or geographical region)	**Module 1:** Climate Risk and Vulnerability Assessment in Health Care Sector	Odesa I.I. Mechnikov National University
			Module 2: Developing Adaptation Strategies for Health Care Sector	Odesa National Medical University
		Climate Service Products for Climate Risk Assessment in Health Care Sector	**Module 1:** Application of Climate Service Products in Health Care Risk Assessment	Odesa I.I. Mechnikov National University
			Module 2: Synthesis and Communication of Climate Impacts in the Health Care Sector	Odesa National Medical University

№	Professional Development Programme	Course	Module	Developer
5	**Climate-Smart Construction and Architecture**	Introduction to Climate Change	**Module 1:** Fundamentals of Atmospheric Processes and Climate	Odesa I.I. Mechnikov National University
			Module 2: Analyzing Temperature Anomalies and Global Warming Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment in the Construction and Architecture (with a case study in a specific construction and architecture sector or geographical region)	**Module 1:** Climate Risk and Vulnerability Assessment in Energy Sector	Odesa I.I. Mechnikov National University
			Module 2: Developing Adaptation Strategies for Energy Sector	Kyiv National University of Construction and Architecture
		Climate Service Products for Climate Risk Assessment in Construction and Architecture	**Module 1:** Application of Climate Service Products for Energy Risk Assessment	Odesa I.I. Mechnikov National University
			Module 2: Synthesis and Communication of Climate Impacts in the Energy Sector	Kyiv National University of Construction and Architecture
6	**Climate-Smart City Management**	Introduction to Climate Change	**Module 1:** Fundamentals of Atmospheric Processes and Climate	Odesa I.I. Mechnikov National University
			Module 2: Analyzing Temperature Anomalies and Global Warming Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment in the City Management (with a case study in specific city management sector or geographical region)	**Module 1:** Climate Risk and Vulnerability Assessment in City Management	Odesa I.I. Mechnikov National University
			Module 2: Developing Adaptation Strategies for City Management	O.M. Beketov National University of Urban Economy in Kharkiv
		Climate Service Products for Climate Risk Assessment in City Management	**Module 1:** Application of Climate Service Products for City Management Risk Assessment	Odesa I.I. Mechnikov National University
			Module 2: Synthesis and Communication of Climate Impacts in the City Management	O.M. Beketov National University of Urban Economy in Kharkiv

№	Professional Development Programme	Course	Module	Developer
7	**Climate-Smart Energy Sector**	Introduction to Climate Change	**Module 1:** Fundamentals of Atmospheric Processes and Climate	Odesa I.I. Mechnikov National University
			Module 2: Analyzing Temperature Anomalies and Global Warming Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment in the Energy Sector (with a case study in a specific energy sector or geographical region)	**Module 1:** Climate Risk and Vulnerability Assessment in Energy Sector	Odesa I.I. Mechnikov National University
			Module 2: Developing Adaptation Strategies for Energy Sector	Lviv Polytechnic National University
		Climate Service Products for Climate Risk Assessment in Energy Sector	**Module 1:** Application of Climate Service Products for Energy Risk Assessment	Odesa I.I. Mechnikov National University
			Module 2: Synthesis and Communication of Climate Impacts in the Energy Sector	Lviv Polytechnic National University
8	**Climate-Smart Water Management**	Introduction to Climate Change	**Module 1:** Fundamentals of Atmospheric Processes and Climate	Odesa I.I. Mechnikov National University
			Module 2: Analyzing Temperature Anomalies and Global Warming Trends	Odesa I.I. Mechnikov National University
		Climate Risk Assessment in the Water Management (with a case study in a specific water management sector or geographical region)	**Module 1:** Climate Risk and Vulnerability Assessment in Water Management	Odesa I.I. Mechnikov National University
			Module 2: Developing Adaptation Strategies for Water Management	Odesa I.I. Mechnikov National University
		Climate Service Products for Climate Risk Assessment in Water Management	**Module 1:** Application of Climate Service Products in Water Management Risk Assessment	Odesa I.I. Mechnikov National University
			Module 2: Synthesis and Communication of Climate Impacts in the Water Management	Odesa I.I. Mechnikov National University

№	Professional Development Programme	Course	Module	Developer
9	**Climate-Oriented Policy and Natural Resource Management**	Climate Policy, Energy Transition, and Socio-economic Aspects of the "Green" Transformation	**Module 1:** Climate Change and Its Impacts on Natural Systems and Society	Odesa I.I. Mechnikov National University
			Module 2: Climate Policy, Energy Transition, and "Green" Transformation	Odesa I.I. Mechnikov National University
		Ensuring the Implementation of State Policy in the Development of Water Management, Management and Control of Water Use and Protection, Rational Use and Restoration of Water Resources (surface and groundwater)	**Module 1:** State Policy and Institutional–Legal Foundations of Water Resource Management	Odesa I.I. Mechnikov National University
			Module 2: State Monitoring and Control of Water Resources	Odesa I.I. Mechnikov National University
			Module 3: Engineering Methods for Water Regime Assessment and Forecasting	Odesa I.I. Mechnikov National University
			Module 4: Water Risk Management and Environmental Safety of Water Resources	Odesa I.I. Mechnikov National University